

# **SEATTLE FUEL GAS CODE**

# **2003**

ORDINANCE 121520  
**Effective AUGUST 15, 2004**  
with transition period ending October 14, 2004

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# PREFACE

## Introduction

Internationally, code officials recognize the need for a modern, up-to-date fuel gas code addressing the design and installation of fuel gas systems and gas-fired appliances through requirements emphasizing performance. The *International Fuel Gas Code*®, in this 2003 edition, is designed to meet these needs through model code regulations that safeguard the public health and safety in all communities, large and small.

This comprehensive fuel gas code establishes minimum regulations for fuel gas systems and gas-fired appliances using prescriptive and performance-related provisions. It is founded on broad-based principles that make possible the use of new materials and new fuel gas system and appliance designs. This 2003 edition is fully compatible with all the *International Codes* (“I-Codes”) published by the International Code Council (ICC), including the *International Building Code*, *ICC Electrical Code*, *International Energy Conservation Code*, *International Existing Building Code*, *International Fire Code*, *International Mechanical Code*, *ICC Performance Code*, *International Plumbing Code*, *International Private Sewage Disposal Code*, *International Property Maintenance Code*, *International Residential Code*, *International Urban-Wildland Interface Code* and *International Zoning Code*.

The *International Fuel Gas Code* provisions provide many benefits, among which is the model code development process that offers an international forum for fuel gas technology professionals to discuss performance and prescriptive code requirements. This forum provides an excellent arena to debate proposed revisions. This model code also encourages international consistency in the application of provisions.

## Development

The first edition of the *International Fuel Gas Code* (1997) was the culmination of an effort initiated in 1996 by a development committee appointed by ICC and consisting of representatives of the three statutory members of the International Code Council: Building Officials and Code Administrators International, Inc. (BOCA), International Conference of Building Officials (ICBO) and Southern Building Code Congress International (SBCCI) and the gas industry. The intent was to draft a comprehensive set of regulations for fuel gas systems and gas-fired appliances consistent with and inclusive of the scope of the existing mechanical, plumbing and gas codes. Technical content of the latest model codes promulgated by BOCA, ICBO, SBCCI and ICC and the *National Fuel Gas Code* (ANSI Z223.1) was utilized as the basis for the development. This 2003 edition presents the code as originally issued, with code changes approved through the ICC Code Development Process through 2002 and standard revisions correlated with ANSI Z223.1-2002. A new edition such as this is promulgated every three years.

With the development and publication of the family of *International Codes* in 2000, the continued development and maintenance of the model codes individually promulgated by BOCA (“BOCA National Codes”), ICBO (“Uniform Codes”) and SBCCI (“Standard Codes”) was discontinued. This 2003 *International Fuel Gas Code*, as well as its predecessor — the 2000 edition, is intended to be the successor fuel gas code to those codes previously developed by BOCA, ICBO and SBCCI.

The development of a single set of comprehensive and coordinated family of *International Codes* was a significant milestone in the development of regulations for the built environment. The timing of this publication mirrors a milestone in the change in structure of the model codes, namely, the pending Consolidation of BOCA, ICBO and SBCCI into the ICC. The activities and services previously provided by the individual model code organizations will be the responsibility of the Consolidated ICC.

This code is founded on principles intended to establish provisions consistent with the scope of a fuel gas code that adequately protects public health, safety and welfare; provisions that do not unnecessarily increase construction costs; provisions that do not restrict the use of new materials, products or methods of construction; and provisions that do not give preferential treatment to particular types or classes of materials, products or methods of construction.

## Format

The *International Fuel Gas Code* is segregated by section numbers into two categories — “code” and “standard” — all coordinated and incorporated into a single document. The sections that are “code” are designated by the acronym “IFGC” next to the main section number (e.g., Section 101). The sections that are “standard” are designated by the acronym “IFGS” next to the main section number (e.g., Section 304).

## Adoption

The *International Fuel Gas Code* is available for adoption and use by jurisdictions internationally. Its use within a governmental jurisdiction is intended to be accomplished through adoption by reference in accordance with proceedings establishing the jurisdiction’s laws. At the time of adoption, jurisdictions should insert the appropriate information in provisions requiring specific local information, such as the name of the adopting jurisdiction. These locations are shown in bracketed words in small capital letters in the

## PREFACE

code and in the sample ordinance. The sample adoption ordinance on page v addresses several key elements of a code adoption ordinance, including the information required for insertion into the code text.

## Maintenance

The *International Fuel Gas Code* is kept up to date through the review of proposed changes submitted by code enforcing officials, industry representatives, design professionals and other interested parties. Proposed changes are carefully considered through an open code development process in which all interested and affected parties may participate. The code development process of the *International Fuel Gas Code* is slightly different than the process for the other *International Codes*.

Proposed changes to text designated “IFGC” are subject to the ICC Code Development Process. For more information regarding the code development process, contact the Code and Standard Development Department of the International Code Council.

Proposed changes to text designated as “IFGS” are subject to the standards development process which maintains the *National Fuel Gas Code* (ANSI Z223.1). For more information regarding the standard development process, contact the American Gas Association (AGA) at 400 N. Capitol Street, N.W., Washington, DC 20001.

While the development procedure of the *International Fuel Gas Code* assures the highest degree of care, ICC and the founding members of ICC — BOCA, ICBO, SBCCI — and AGA, their members and those participating in the development of this code do not accept any liability resulting from compliance or noncompliance with the provisions because ICC, its founding members and AGA do not have the power or authority to police or enforce compliance with the contents of this code. Only the governmental body that enacts the code into law has such authority.

## Letter Designations in Front of Section Numbers

In each ICC Code Development Cycle, proposed changes to sections marked “IFGC” are considered at the Code Development Hearing by the International Fuel Gas Code Development Committee, whose action constitutes a recommendation to the voting membership for final action on the proposed changes. Proposed changes to a code section whose number begins with a letter in brackets are considered by a different code development committee. For instance, proposed changes to code sections which have the letter [B] in front (e.g., [B] 302), are considered by the International Building Code Development Committee at the Code Development Hearing. Where this designation is applicable to the entire content of a main section of the code, the designation appears at the main section number and title and is not repeated at every subsection in that section.

The content of sections in this code which begin with a letter designation is maintained by another code development committee in accordance with the following: [B] = International Building Code Development Committee and [M] = International Mechanical Code Development Committee.

## Marginal Markings

Solid vertical lines in the margins within the body of the code indicate a technical change from the requirements of the 2000 edition. Deletion indicators (➡) are provided in the margin where a paragraph or item has been deleted.

# ORDINANCE

The *International Codes* are designed and promulgated to be adopted by reference by ordinance. Jurisdictions wishing to adopt the 2003 *International Fuel Gas Code* as an enforceable regulation governing fuel gas systems and gas-fired appliances should ensure that certain factual information is included in the adopting ordinance at the time adoption is being considered by the appropriate governmental body. The following sample adoption ordinance addresses several key elements of a code adoption ordinance, including the information required for insertion into the code text.

## SAMPLE ORDINANCE FOR ADOPTION OF THE *INTERNATIONAL FUEL GAS CODE* ORDINANCE NO. \_\_\_\_\_

An ordinance of the [JURISDICTION] adopting the 2003 edition of the *International Fuel Gas Code*, regulating and governing fuel gas systems and gas-fired appliances in the [JURISDICTION]; providing for the issuance of permits and collection of fees therefor; repealing Ordinance No. \_\_\_\_\_ of the [JURISDICTION] and all other ordinances and parts of the ordinances in conflict therewith.

The [GOVERNING BODY] of the [JURISDICTION] does ordain as follows:

**Section 1.** That a certain document, three (3) copies of which are on file in the office of the [TITLE OF JURISDICTION'S KEEPER OF RECORDS] of [NAME OF JURISDICTION], being marked and designated as the *International Fuel Gas Code*, 2003 edition, including Appendix Chapters [FILL IN THE APPENDIX CHAPTERS BEING ADOPTED] (see *International Fuel Gas Code* Section 101.3, 2003 edition), as published by the International Code Council, be and is hereby adopted as the Fuel Gas Code of the [JURISDICTION], in the State of [STATE NAME] for regulating and governing fuel gas systems and gas-fired appliances as herein provided; providing for the issuance of permits and collection of fees therefor; and each and all of the regulations, provisions, penalties, conditions and terms of said Fuel Gas Code on file in the office of the [JURISDICTION] are hereby referred to, adopted, and made a part hereof, as if fully set out in this ordinance, with the additions, insertions, deletions and changes, if any, prescribed in Section 2 of this ordinance.

**Section 2.** The following sections are hereby revised:

Section 101.1. Insert: [NAME OF JURISDICTION]

Section 106.5.2. Insert: [APPROPRIATE SCHEDULE]

Section 106.5.3. Insert: [PERCENTAGES IN TWO LOCATIONS]

Section 108.4. Insert: [SPECIFY OFFENSE] [AMOUNT] [NUMBER OF DAYS]

Section 108.5. Insert: [AMOUNTS IN TWO LOCATIONS]

**Section 3.** That Ordinance No. \_\_\_\_\_ of [JURISDICTION] entitled [FILL IN HERE THE COMPLETE TITLE OF THE ORDINANCE OR ORDINANCES IN EFFECT AT THE PRESENT TIME SO THAT THEY WILL BE REPEALED BY DEFINITE MENTION] and all other ordinances or parts of ordinances in conflict herewith are hereby repealed.

**Section 4.** That if any section, subsection, sentence, clause or phrase of this ordinance is, for any reason, held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this ordinance. The [GOVERNING BODY] hereby declares that it would have passed this ordinance, and each section, subsection, clause or phrase thereof, irrespective of the fact that any one or more sections, subsections, sentences, clauses and phrases be declared unconstitutional.

**Section 5.** That nothing in this ordinance or in the Fuel Gas Code hereby adopted shall be construed to affect any suit or proceeding impending in any court, or any rights acquired, or liability incurred, or any cause or causes of action acquired or existing, under any act or ordinance hereby repealed as cited in Section 2 of this ordinance; nor shall any just or legal right or remedy of any character be lost, impaired or affected by this ordinance.

**Section 6.** That the [JURISDICTION'S KEEPER OF RECORDS] is hereby ordered and directed to cause this ordinance to be published. (An additional provision may be required to direct the number of times the ordinance is to be published and to specify that it is to be in a newspaper in general circulation. Posting may also be required.)

**Section 7.** That this ordinance and the rules, regulations, provisions, requirements, orders and matters established and adopted hereby shall take effect and be in full force and effect [TIME PERIOD] from and after the date of its final passage and adoption.



## DEPARTMENT OF PLANNING AND DEVELOPMENT

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If you would like to receive occasional email messages notifying you of future amendments and errata to the Seattle Fuel Gas Code or other codes, go to the Technical Codes page on DPD's website <http://www.seattle.gov/dpd/TechCodes/>. Click the link "Subscribe to Mailing List" in the right column under "Resources".

If you have questions about this service, contact Maureen Traxler at 206.233.3892 or [maureen.traxler@seattle.gov](mailto:maureen.traxler@seattle.gov).

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# CHAPTER 1

## ADMINISTRATION

Note: Chapter 1 is entirely Seattle amendments to the *International Fuel Gas Code* and is not underlined.

### SECTION 101 TITLE

These regulations shall be known as the “Seattle Fuel Gas Code,” may be cited as such, and will be referred to herein as “this code.” All references to the *International Fuel Gas Code* contained in this code shall mean the *Seattle Fuel Gas Code*.

### SECTION 102 PURPOSE

The purpose of this code is to provide minimum standards to safeguard life or limb, health, property and public welfare by regulating and controlling the design, construction, installation, quality of materials, location, operation, and maintenance or use of heating, ventilating, cooling, refrigeration systems, incinerators and other miscellaneous heat-producing appliances within the City.

The purpose of this code is to provide for and promote the health, safety and welfare of the general public, and not to create or otherwise establish or designate any particular class or group of persons who will or should be especially protected or benefited by the terms of this code.

### SECTION 103 SCOPE

**103.1 Applicability.** The provisions of this code shall apply to the erection, installation, alteration, repair, relocation, replacement, addition to, use or maintenance of any fuel-gas piping systems, fuel-gas utilization equipment and related accessories within the City. The design and testing of equipment regulated by this code shall be subject to the approval of the code official.

#### Exceptions:

1. Detached one- and two-family dwellings and multiple single-family dwellings (townhouses) not more than three stories above grade plane in height with separate means of egress and their accessory structures shall comply with the *International Residential Code*.
2. The standards for liquefied petroleum gas installations shall be the 2001 edition of NFPA 58 (Liquefied Petroleum Gas Code) as amended and the 2002 edition of ANSI Z223.1/NFPA 54 (National Fuel Gas Code).

**103.2 Alterations.** Additions, alterations, repairs and replacement of equipment or systems shall comply with the provisions for new equipment and systems except as otherwise provided in Section 104 of this code.

**103.3 Most Restrictive.** Where, in any specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall be applicable.

**[W] 103.4 Conflict with Ventilation Code.** In the case of conflict between the ventilation requirements of this code and the ventilation requirements of Washington Administrative Code

Chapter 51-13 the Washington State Ventilation and Indoor Air Quality Code (VIAQ), the provisions of the VIAQ shall govern.

**103.5 Referenced codes and standards.** The codes and standards referenced in this code shall be considered part of the requirements of this code to the prescribed extent of each such reference. Where differences occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

**Exception:** Where enforcement of a code provision would violate the conditions of the listing of the equipment or appliance, the conditions of the listing and manufacturer’s instructions shall apply.

**103.6 Appendices.** Provisions in the appendices shall not apply unless specifically referenced in the adopting ordinance.

**103.7 Metric units.** Wherever in this ordinance there is a conflict between metric units of measurement and English units, the English units shall govern.

### SECTION 104

#### APPLICATION TO EXISTING MECHANICAL SYSTEMS

**104.1 Additions, Alterations or Repairs.** Additions, alterations, renovations or repairs may be made to any mechanical system without requiring the existing mechanical system to comply with all the requirements of this code, provided the addition, alteration, renovation or repair conforms to that required for a new mechanical system. Additions, alterations, renovations or repairs shall not cause an existing system to become unsafe, unhealthy or overloaded.

Minor additions, alterations, renovations, and repairs to existing mechanical systems may be installed in accordance with the law in effect at the time the original installation was made, when approved by the code official.

**104.2 Existing Installations.** Mechanical systems lawfully in existence at the time of the adoption of this code may have their use, maintenance or repair, conversion of fuel, or component replacement continued if the use, maintenance, repair, conversion of fuel, or component replacement is in accordance with the basic original design and location, and no hazard to life, health or property has been created by such mechanical system.

**104.3 Changes in Building Occupancy.** Mechanical systems which are a part of any building or structure undergoing a change in use or occupancy, as defined in the Building Code, shall comply with all requirements of this code which may be applicable to the new use or occupancy.

**104.4 Maintenance.** All mechanical systems, materials and appurtenances, both existing and new, and all parts thereof shall be maintained in proper operating condition in accordance with the original design and in a safe and hazard-free condition. All devices or safeguards which are required by this code shall be maintained in conformance with the code edition under which installed. The owner or the owner's designated agent shall be responsible for maintenance of mechanical systems and equipment. To determine compliance with this subsection, the

## ADMINISTRATION

code official may cause a mechanical system or equipment to be reinspected.

The Fire Chief and the code official shall each have authority to obtain compliance with the requirements of this subsection.

**EXCEPTION:** The code official may modify the requirements of this section where all or a portion of the building is unoccupied.

**104.5 Moved Buildings.** Building or structures moved into or within the City shall comply with standards adopted by the code official. No building shall be moved into or within the City unless, prior to moving, the code official has inspected the building for compliance with this code and the permit holder has agreed to correct all deficiencies found and has been issued a building permit for the work. A bond or cash deposit in an amount sufficient to abate or demolish the building shall be posted prior to issuance of a permit. See Section 116 for information required on plans. Any moved building that is not in complete compliance with standards for moved buildings within eighteen months from the date of permit issuance and is found to be a public nuisance may be abated.

**104.6 Historic Buildings and Structures.** The code official may modify the specific requirements of this code as it applies to buildings and structures designated as landmarks of historical or cultural importance and require in lieu thereof alternate requirements which, in the opinion of the code official, will result in a reasonable degree of safety to the public and the occupants of those buildings.

A historic building or structure is one which has been designated for preservation by the City Landmarks Preservation Board or the State of Washington, has been listed, or has been determined eligible to be listed, in the National Register of Historic Places, has been officially nominated for such status, or is a structure contributing to the character of a designated landmark or special review district.

## SECTION 105 ALTERNATE MATERIALS AND METHODS OF CONSTRUCTION

This code does not prevent the use of any material, design or method of construction not specifically allowed or prohibited by this code, provided the alternate has been approved and its use authorized by the code official.

The code official may approve an alternate, provided he/she finds that the proposed alternate complies with the provisions of this code and that the alternate, when considered together with other safety features of the building or other relevant circumstances, will provide at least an equivalent level of strength, effectiveness, fire resistance, durability, safety and sanitation.

The code official may require that sufficient evidence or proof be submitted to reasonably substantiate any claims regarding the use or suitability of the alternate. The code official may, but is not required to, record the approval of modifications and any relevant information in the files of the code official or on the approved permit plans.

## SECTION 106 MODIFICATIONS

The code official may approve modifications for individual cases, provided the code official finds: (1) there are practical difficulties involved in carrying out the provisions of this code; (2) the modification is in conformity with the intent and purpose of this code; and (3) the modification will provide a reasonable level of fire protection and structural integrity when considered together with other safety features of the building or other relevant circumstances. The code official may, but is not required to, record the approval of modifications and any relevant information in the files of the code official or on the approved permit plans.

## SECTION 107 TESTS

Whenever there is insufficient evidence of compliance with the provisions of this code, or evidence that any material or method of construction does not conform to the requirements of this code, the code official may require tests as proof of compliance to be made at no expense to the City.

Test methods shall be as specified in this code or by other recognized test standards. If there are no recognized and accepted test methods for the proposed alternate, the code official shall determine the test procedures.

All tests shall be made by an approved agency. Reports of such tests shall be retained by the code official.

## SECTION 108 JURISDICTION AND POWERS AND DUTIES OF THE CODE OFFICIAL

**108.1 Jurisdiction.** The Department of Planning and Development is the code enforcement agency in the City of Seattle for this code. The Director of the Department of Planning and Development is the code official.

**108.2 General.** The code official is authorized and directed to enforce this code, except that enforcement of Chapters 4 are the primary responsibility of the Director of Public Health, and enforcement authority as provided in this code to the code official is also vested in the Director of Public Health and the Fire Chief. Compliance with the requirements of this code is the obligation of the owner of the building, structure or premises, the duly authorized agent of the owner, or other person responsible for the condition or work, and not of the City or any of its officers or employees.

**108.3 Deputies.** The code official may appoint such officers and inspectors and other employees as shall be authorized from time to time. The code official may deputize such inspectors or employees as may be necessary to carry out the functions of the code official.

**108.4 Right of Entry.** With the consent of the owner or occupier of a building or premises, or pursuant to a lawfully issued warrant, the code official may enter a building or premises at any reasonable time to perform the duties imposed by this code.

**108.5 Stop Orders.** Whenever any work is being done contrary to the provisions of this code, or in the event of dangerous or unsafe conditions related to construction or demolition, the code official may order the affected work stopped by a notice describing the violation in writing, posted on the premises or served on any person responsible for the condition or work. It is unlawful for

any person to engage in or to cause such work to be done until authorization from the code official is received.

**108.6 Authority to Disconnect Utilities in Emergencies.** The code official has the authority to disconnect fuel–gas utility service or energy supplies to a building, structure, premises or equipment regulated by this code in case of emergency where necessary to eliminate an immediate hazard to life or property. The code official may enter any building or premises to disconnect utility service. The code official shall, whenever possible, notify the serving utility, the owner and occupant of the building, structure or premises of the decision to disconnect prior to taking such action, and shall notify such serving utility, owner and occupant of the building, structure or premises in writing of such disconnection immediately thereafter.

**108.7 Authority to Condemn Equipment.** Whenever the code official ascertains that any equipment, or portion thereof, regulated by this code has become hazardous to life, health or property, the code official shall order in writing that such equipment may either be disconnected, removed or restored to a safe or sanitary condition, as appropriate. The written notice itself shall fix a time limit for compliance with such order. It is unlawful for any person to use or maintain defective equipment after receiving such notice.

When such equipment or installation is to be disconnected, the code official shall give written notice of such disconnection and causes therefor shall be given within 24 hours to the serving utility, the owner and occupant of the building, structure or premises. When any equipment is maintained in violation of this code, and in violation of a notice issued pursuant to the provisions of this section, the code official shall institute any appropriate action to prevent, restrain, correct or abate the violation.

**108.8 Connection after Order to Disconnect.** No person shall make connections from any energy, fuel or power supply nor supply energy or fuel to any equipment regulated by this code which has been disconnected or ordered to be disconnected by the code official, or the use of which has been ordered to be discontinued by the code official until the code official authorizes the reconnection and use of such equipment.

**108.9 Liability.** Nothing contained in this code is intended to be nor shall be construed to create or form the basis for any liability on the part of the City, or its officers, employees or agents, for any injury or damage resulting from the failure of equipment to conform to the provisions of this code, or by reason or in consequence of any inspection, notice, order, certificate, permission or approval authorized or issued or done in connection with the implementation or enforcement of this code, or by reason of any action or inaction on the part of the City related in any manner to the enforcement of this code by its officers, employees or agents.

This code shall not be construed to relieve from or lessen the responsibility of any person owning, operating or controlling any building or structure for any damages to persons or property caused by defects, nor shall the Department of Planning and Development or the City of Seattle be held as assuming any such liability by reason of the inspections authorized by this code or any permits or certificates issued under this code.

**108.10 Cooperation of Other Officials and Officers.** The code official may request, and shall receive so far as is required in the

discharge of the code official's duties, the assistance and cooperation of other officials of the City of Seattle.

## **SECTION 109 UNSAFE EQUIPMENT AND HAZARD CORRECTION ORDER**

**109.1 Unsafe Equipment.** Any equipment regulated by this code which constitutes a fire or health hazard or is otherwise dangerous to human life is, for the purpose of this section, unsafe. Any use of equipment regulated by this code constituting a hazard to safety, health or public welfare by reason of inadequate maintenance, dilapidation, obsolescence, fire hazard, disaster, damage or abandonment is, for the purpose of this section, an unsafe use. Any such unsafe equipment is hereby declared to be a public nuisance and may be abated.

**109.2 Hazard Correction Order.** Whenever the code official finds that unsafe equipment exists, the code official may issue a hazard correction order specifying the conditions causing the equipment to be unsafe and directing the owner or other person responsible for the unsafe equipment to correct the condition. In lieu of correction, the owner may submit a report or analysis to the code official analyzing said conditions and establishing that the equipment is, in fact, safe. The code official may require that the report or analysis be prepared by a licensed engineer. It is unlawful for any person to fail to comply with a hazard correction order as specified in this subsection.

## **SECTION 110 APPEALS**

Appeals from decisions or actions pertaining to the administration and enforcement of this code shall be addressed to the code official. The appellant may request a review by three or more members of the Construction Codes Advisory Board, convened by the Chair. The issue of the appeal shall be taken into account by the Chair when selecting members to hear an appeal. The results of this appeal shall be advisory only.

## **SECTION 111 VIOLATIONS AND PENALTIES**

**111.1 Violations.** It is a violation of this code for any person, firm or corporation to install, erect, construct, enlarge, alter, repair, replace, remodel, move, improve, remove, convert or demolish, equip, occupy, use or maintain any mechanical systems or equipment or cause or permit the same to be done in the City, contrary to or in violation of any of the provisions of this code.

It is a violation of this code for any person, firm or corporation to use any material or to install any device, appliance or equipment which does not comply with the applicable standards of this code or which has not been approved by the code official.

**111.2 Notice of Violation.** If, after investigation, the code official determines that standards or requirements of this code have been violated, the code official may serve a notice of violation upon the owner or other person responsible for the action or condition. The notice of violation shall state the standards or requirements violated, shall state what corrective action, if any, is necessary to comply with the standards or requirements, and shall set a reasonable time for compliance. The notice shall be served upon the owner or other responsible person by personal service, registered mail or certified mail with return receipt requested, addressed to the last known address of such person. In addition, a

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copy of the notice may be posted at a conspicuous place on the property. The notice of violation shall be considered an order of the code official. Nothing in this subsection shall be deemed to limit or preclude any action or proceeding pursuant to Sections 108 or 109 of this code, and nothing in this section shall be deemed to obligate or require the code official to issue a notice of violation prior to the imposition of civil or criminal penalties in this section.

**111.3 Civil Penalties.** Any person, firm or corporation failing to comply with the provisions of this code shall be subject to a cumulative civil penalty in an amount not to exceed \$500 per day for each violation from the date the violation occurs or begins until compliance is achieved. In cases where the code official has issued a notice of violation, the violation will be deemed to begin, for purposes of determining the number of days of violation, on the date compliance is required by the notice of violation.

**111.4 Criminal Penalty.** Anyone who violates or fails to comply with any order issued by the code official pursuant to this code or who removes, mutilates, destroys or conceals a notice issued or posted by the code official shall, upon conviction thereof, be punished by a fine of not more than \$1,000 or by imprisonment for not more than 360 days, or by both such fines and imprisonment. Each day's violation or failure to comply shall constitute a separate offense.

Anyone violating or failing to comply with any of the provisions of this code and who within the past five years has a judgment against them pursuant to Section 111.3, shall upon conviction thereof, be punished by a fine in a sum not to exceed \$500 or imprisonment for not more than 180 days, or by both such fine and imprisonment. Each day's violation or failure to comply shall constitute a separate offense.

**111.5 Additional Relief.** The code official may seek legal or equitable relief to enjoin any acts or practices and abate any condition which constitutes a violation of this code when civil or criminal penalties are inadequate to effect compliance.

### SECTION 112 NOTICES

It is unlawful for any person to remove, mutilate, destroy or conceal any notice issued or posted by the code official pursuant to the provisions of this code or any notice issued or posted by the code official in response to a natural disaster or other emergency.

The code official may record a copy of any order or notice with the Department of Records and Elections of King County.

The code official may record with the Department of Records and Elections of King County a notification that a permit has expired without a final inspection after reasonable efforts have been made to provide a final inspection.

### SECTION 113 RULES OF THE CODE OFFICIAL

**113.1 Authority.** The code official has the power to render interpretations of this code and to adopt and enforce rules and regulations supplemental to this code as may be deemed necessary in order to clarify the application of the provisions of this code. Such interpretations, rules and regulations shall be in conformity with the intent and purpose of this code. The code official is authorized to promulgate, adopt and issue the following rules:

“Building Construction Standards” to promulgate standards which are acceptable as a method or as an alternative design for meeting code required performance criteria, to recognize new technical data affecting code requirements, and to eliminate conflicts among code requirements.

“Code Interpretations” to interpret and clarify conditions or language expressed in this code.

Any other rule necessary for the administration of the purpose and intent of this code.

**113.2 Procedure for Adoption of Rules.** The code official shall promulgate, adopt and issue rules according to the procedures as specified in Chapter 3.02 of the Administrative Code, Seattle Municipal Code.

### SECTION 114 CONSTRUCTION CODES ADVISORY BOARD

A committee of the Construction Codes Advisory Board may examine proposed administrative rules, appeals and amendments relating to this code and related provisions of other codes and make recommendations to the code official and to the City Council for changes in this code. The committee will be called on as needed by the Construction Codes Advisory Board.

### SECTION 115 PERMITS

**115.1 Permits Required.** It is unlawful to make any installation, alteration, repair, replacement or remodel of any mechanical system regulated by this code except as permitted in Section 115.2 of this code, or to allow the same to be done without first obtaining a separate mechanical permit for each separate building or structure. All work shall comply with this code, even where no permit is required.

**115.2 Work Exempt from Permit.** A mechanical permit is not required for the following:

1. Any portable heating appliance, portable ventilating equipment, or portable cooling unit, provided that the total capacity of these portable appliances shall not exceed 40 percent of the cumulative heating, cooling or ventilating requirements of a building or dwelling unit and shall not exceed 3 kW or 10,000 Btu input.
2. Any closed system of steam, hot or chilled water piping within heating or cooling equipment regulated by this code.
3. Minor work or the replacement of any component part of a mechanical system which does not alter its original approval and complies with other applicable requirements of this code.

Exemption from the permit requirements of this code shall not be deemed to grant authorization for any work to be done in any manner in violation of the provisions of this code or any other laws or ordinances of the City.

**115.3 Flood Hazard Areas.** In addition to the permit required by this section, all work to be performed in areas of special flood hazard, as identified in the report entitled “Flood Insurance Study for King County, Washington and Incorporated Areas” and the accompanying Flood Insurance Rate Maps and filed in C.F. 295948, is subject to additional standards and requirements, including floodplain development approval or a Floodplain

Development License, as set forth in Chapter 25.06, the Seattle Floodplain Development Ordinance.

**115.4 Emergency Repairs.** In the case of an emergency, the installation, alteration or repair of any refrigeration system or equipment may be made without a permit, provided that application for a permit shall be made within twenty-four hours or within one working day from the time when the emergency work was started.

### **SECTION 116 APPLICATION FOR PERMIT AND INFORMATION ON PLANS AND SPECIFICATIONS**

**116.1 Application.** To obtain a permit, the applicant shall first file an application in writing on a form furnished by the Department of Planning and Development for that purpose. Every such application shall:

1. Identify and describe the work to be covered by the permit for which application is made.
2. Describe the land on which the proposed work is to be done by legal description, property address or similar description that will readily identify and definitely locate the proposed building or work.
3. Provide contractor's state license number (required if permit is to be issued to the contractor). To obtain a permit for work on a refrigeration system, the applicant shall also provide the number of the refrigeration contractor license issued by the City.
4. Be accompanied by plans, diagrams, computations and specifications, equipment schedule and other data as required in Sections 116.2 and 116.3.
5. State the valuation of the mechanical work to be done. The value or valuation of the mechanical work shall be the estimated current value of all labor and material, whether actually paid for or not, for which the permit is issued.
6. Be signed by the owner of the property or building, or his/her authorized agent, who may be required to submit evidence to indicate such authority.
7. Give such other data and information as may be required by the code official.
8. Indicate the name of the owner and contractor and the name, address and phone number of a contact person.

**116.2 Plans and Specifications.** Plans, engineering calculations, diagrams and other data shall be submitted in one or more sets with each application for a permit. The code official may require plans, computations and specifications to be prepared and designed by an engineer or architect licensed by the state to practice as such. Projects having a total mechanical valuation of \$30,000 or larger shall require a mechanical engineering stamp and signature on each sheet.

**EXCEPTION:** The code official may waive the requirements for a mechanical engineer's stamp or submission of plans, calculations or other data if the code official finds that the nature of the work applied for is such that the reviewing of plans is not necessary to obtain compliance with this code.

### **116.3 Information on Plans and Specifications.**

**116.3.1 Clarity of plans.** Plans shall be drawn to a clearly indicated and commonly accepted scale upon substantial paper such as blueprint quality or standard drafting paper. Tissue paper, posterboard or cardboard will not be accepted. The plans shall be of microfilm quality and limited to a minimum size of 18 inches by 18 inches and a maximum size of 41 inches by 54 inches.

**116.3.2 Fire-resistive notes.** The code official may require that plans for buildings more than two stories in height of other than Group R, Division 3 and Group U Occupancies indicate how required structural and fire-resistive integrity will be maintained where a penetration will be made for electrical, mechanical, plumbing and communication conduits, pipes and similar systems.

**116.3.3 Information required on plans.** The plans or specifications shall show the following:

1. Layout for each floor with dimensions of all working spaces and a legend of all symbols used.
2. Location, size and material of all piping.
3. Location, size and materials of all air ducts, air inlets and air outlets.
4. Location of all fans, warm-air furnaces, boilers, absorption units, refrigerant compressors and condensers and the weight of all pieces of such equipment weighing 200 pounds or more.
5. Rated capacity or horsepower and efficiency rating of all boilers, warm-air furnaces, heat exchangers, blower fans, refrigerant compressors and absorption units. See also the Seattle Energy Code.
6. Location, size and material of all combustion products vents and chimneys.
7. Location and area of all ventilation and combustion air openings and ducts.
8. Location of all air dampers and fire shutters.
9. The first sheet of each set of plans and specifications shall show the address of the proposed work and the name and address of the owner or lessee of the premises.

Plans and specifications shall be of sufficient clarity to show that the proposed installation will conform to the provisions of this code and to the provisions of all applicable laws, ordinances, rules, regulations and orders.

Architectural drawings, typical envelope cross sections and other drawings or data may be required to support system sizing calculations or other thermal requirements of this code or the Seattle Energy Code.

### **SECTION 117 PERMIT ISSUANCE**

#### **117.1 Issuance.**

**117.1.1 General.** The application, plans, specifications, and other data filed by an applicant for permit shall be reviewed by the code official. Such plans may be reviewed by other

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departments of the City to check compliance with the laws and ordinances under their jurisdiction. If the code official finds that the work as described in an application for a permit and the plans, specifications and other data filed therewith substantially conforms to the requirements of this code and other pertinent laws and ordinances and that the fees specified in the Fee Subtitle have been paid, the code official shall issue a permit to the applicant who becomes the permit holder or authorized agent.

**EXCEPTION:** The code official may issue a permit for the construction of part of a building or structure before complete plans for the whole building or structure have been submitted or approved, provided that the proposed project complies with the State Environmental Policy Act as adopted by the City (Chapter 25.05 Seattle Municipal Code) and as amended and the Land Use Code as amended; and provided further that adequate information and plans have been filed and checked to assure compliance with all pertinent requirements of this and other pertinent codes. The holder of such a permit shall proceed at his/her own risk without assurance that the permit for the entire building or structure will be granted.

**117.1.2 Compliance with approved plans and permit.** When the code official issues a permit, the code official shall endorse the permit in writing and endorse in writing or stamp the plans "APPROVED." Such approved plans and permit shall not be changed, modified or altered without authorization from the code official, and all work shall be done in accordance with the approved plans and permit except as the code official may require during field inspection to correct errors or omissions.

**117.1.3 Amendments to the permit.** When substitutions or changes are made during construction, approval shall be secured prior to execution, however, the building inspector may approve minor modifications for work not reducing the structural strength and fire and life safety of the structure. The building inspector shall determine if it is necessary to revise the approved plans. These substitutions and changes shall conform to the requirements of this code and other pertinent laws and ordinances. Minor substitutions or changes shall be documented, but shall not incur additional fees if these substitutions and/or changes do not (1) add to the general scope of work; (2) change the basic design concept; (3) involve major relocation of equipment, ducts, or pipes; (4) substantially alter approved equipment size; (5) require extensive re-review of the plans and specifications.

All other changes, substitutions, or clarifications shall be shown on two sets of plans which shall be submitted to and approved by the code official prior to execution or occupancy. These submittals shall be accompanied by appropriate fees as specified in the Fee Subtitle prior to issuance of the Certificate of Occupancy.

**117.1.4 Cancellation of permit application.** Applications may be cancelled if no permit is issued by the earlier of the following: (1) within twelve months following the date of application; or (2) within sixty days from the date of written notice of approval for issuance. Plans and other data submitted for review may thereafter be returned to the applicant or destroyed by the building official.

The building official shall notify the applicant in writing at least thirty days before the application is cancelled. The notice shall specify a date by which a request for extension must be submitted. The date shall be at least two weeks prior to the date on which the application will be cancelled.

At the discretion of the building official, applications for projects that require more than twelve months to complete may be extended for a period that provides reasonable time to complete the work, but in no case longer than twenty-four months from the date of application. No application shall be extended more than once. In order to renew action on an application after cancellation, the applicant shall submit a new application and pay a new fee.

Notwithstanding other provisions of this code, applications may be extended where issuance of the permit is delayed by litigation, preparation of environmental impact statements, appeals, strikes or other causes related to the application that are beyond the applicant's control, or while the applicant is making progress toward issuance of a master use permit.

See the Fee Subtitle for fee refunds.

**117.2 Retention of Plans.** One set of approved plans, which may be on microfilm, shall be retained by the code official. One set of approved plans shall be returned to the applicant, and shall be kept at the site of the building or work at all times during which the work authorized is in progress for use by the inspection personnel.

**117.3 Validity of permit.** The issuance or granting of a permit or approval of plans shall not be construed to be a permit for, or an approval of, any violation of any of the provisions of this code or other pertinent laws and ordinances. No permit presuming to give authority to violate or cancel the provisions of this code shall be valid, except insofar as the work or use which it authorizes is lawful.

The issuance of a permit based upon plans shall not prevent the code official from thereafter requiring the correction of errors in said plans, or from preventing building operations being carried on thereunder when in violation of this code or of other pertinent laws and ordinances of the City.

The issuance of a mechanical permit shall not prevent the code official from requiring correction of conditions found to be in violation of this code or other pertinent laws of the City, nor shall the period of time for which any such permit is issued be construed to extend or otherwise affect any period of time for compliance specified in any notice or order issued by the code official or other administrative authority requiring the correction of any such conditions.

### 117.4 Permit Expiration and Renewal.

**117.4.1 Expiration.** Permits and renewed permits shall expire eighteen months from the date of issuance.

#### EXCEPTIONS:

1. Initial permits for major construction projects that require more than eighteen months to complete, according to a construction schedule submitted by the applicant, may be issued for a period that provides reasonable time to complete the work but in no case longer than three years.

2. Permits which expire in less than eighteen months may be issued where the code official determines a shorter period is appropriate.

**117.4.2 Renewal.** Permits may be renewed and renewed permits may be further renewed by the code official, provided the following conditions are met:

1. Application for renewal shall be made within the thirty-day period immediately preceding the date of expiration of the permit;
2. The work authorized by the permit has been started and is progressing at a rate approved by the code official. Progress justifying renewal of a permit, except as specified by Item 3, shall include, but is not limited to, requesting of a required inspection, the arranging of financing, selection of contractors and subcontractors, securing other necessary permits and licenses, site preparation such as demolition, clearing and excavation, soils investigation and work done to overcome unusual construction difficulties;
3. If an application for renewal is made either more than eighteen months after the date of mandatory compliance with a new or revised edition of this code or after the effective date of an amendment to applicable provisions of the Land Use Code, the permit shall not be renewed unless:
  - (i) The code official determines that the permit complies, or is modified to comply with the code or codes in effect on the date of application renewal; or
  - (ii) The work authorized by the permit is substantially underway and progressing at a rate approved by the code official. Progress justifying renewal of the permit shall be evidenced by notification by the permit holder that a construction step is ready for an inspection required by Section 119.4 of this code.

Permits may also be renewed where commencement or completion of the work authorized by the permit is delayed by litigation, appeals, strikes or other causes related to the work authorized by the permit, beyond the permit holder's control.

**117.4.3 Re-establishment.** A new permit shall be required to complete work where a permit has expired and was not renewed.

**EXCEPTION:** A permit which has been expired for less than one year may be reestablished upon approval of the code official provided it complies with Items 2 and 3 of Section 117.4.2.

**117.5 Suspension or Revocation.** The code official may, by written order, suspend or revoke a permit issued under the provisions of this code whenever the permit is issued in error or on the basis of incorrect information supplied, or in violation of any ordinance or regulation or any provisions of this code.

## SECTION 118 FEES

A fee for each mechanical permit and for other activities related to the enforcement of this code shall be paid as set forth in the Fee Subtitle.

## SECTION 119 INSPECTIONS

**119.1 General.** All construction or work for which a permit is required is subject to inspection by the code official, and certain types of construction shall have special inspections by registered special inspectors as specified in Section 1704 of the Seattle Building Code.

**119.2 Inspection Requests.** It is the duty of the owner of the property or the owner's authorized agent, or the person designated by the owner/agent to do the work authorized by a permit, to notify the code official that work requiring inspection as specified in this section and Section 120 is ready for inspection.

It is the duty of the person requesting any inspections required by this code to provide access to and means for proper inspection of such work. It is the duty of the permit holder to cause the work to be accessible and exposed for inspection purposes until approved by the code official. Neither the code official nor the City shall be liable for expense entailed in the required removal or replacement of any material to allow inspection.

**119.3 Inspection Record.** Work requiring a mechanical permit shall not be commenced until the permit holder or agent has posted an inspection record in a conspicuous place on the premises and in a position which allows the code official to conveniently make the required entries thereon regarding inspection of the work. This record shall be maintained in such a position by the permit holder until final approval has been granted by the code official.

**119.4 Approvals Required.** No work shall be done on any part of the building or structure beyond the point indicated in each successive inspection without first obtaining the written approval of the code official. Such written approval shall be given only after an inspection has been made of each successive step in the construction as indicated by each of the inspections required in this section.

All mechanical systems for which a permit is required by this code shall be inspected by the code official. No portion of any mechanical system intended to be concealed shall be concealed until inspected and approved. Neither the code official nor the City shall be liable for expense entailed in the removal or replacement of material required to permit inspection. When the installation of a mechanical system is complete, an additional and final inspection shall be made.

Approval as a result of an inspection shall not be construed to be an approval of a violation of the provisions of this code or of other pertinent laws and ordinances of the City. Inspections presuming to give authority to violate or cancel the provisions of this code or of other pertinent laws and ordinances of the City shall not be valid.

**119.5 Operation of Mechanical Equipment.** The requirements of this section shall not be considered to prohibit the operation of any mechanical systems installed to replace existing equipment or fixtures serving an occupied portion of the building in the event a request for inspection of such equipment or fixture has been filed with the code official more than 48 hours after such replacement work is completed, and before any portion of such mechanical system is concealed by any permanent portion of the building.



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**119.6 Testing of Equipment and Systems.** When applicable, fuel-gas piping shall be tested and approved as required by this code.

**119.7 Other Inspections.** In addition to the called inspections required by this code, the code official may make or require any other inspections of any mechanical work to ascertain compliance with the provisions of this code and other laws and ordinances which are enforced by the code official.

Where work for which any permit or approval is required is commenced or performed prior to making formal application and receiving the code official's permission to proceed, the code official may make a special investigation inspection before a permit may be issued for such work. Where a special investigation is made, a special investigation fee may be assessed in accordance with the Fee Subtitle.

**119.8 Reinspections.** The code official may require a reinspection when work for which inspection is called is not complete, corrections called for are not made, the inspection record is not properly posted on the work site, the approved plans are not readily available to the inspector, for failure to provide access on the date for which inspection is requested, or when deviations from plans which require the approval of the code official have been made without proper approval.

For the purpose of determining compliance with Section 104.4, Maintenance, the code official or the Fire Chief may cause any structure to be reinspected.

The code official may assess a reinspection fee as set forth in the Fee Subtitle for any action listed above for which reinspection may be required. In instances where reinspection fees have been assessed, no additional inspection of the work shall be performed until the required fees have been paid.

## SECTION 120 CONNECTION APPROVAL

**120.1 Energy Connections.** No person shall make connections from a source of energy fuel to a mechanical system or equipment regulated by this code and for which a permit is required until approved by the code official.

**120.2 Temporary Connections.** The code official may authorize temporary connection of the mechanical equipment to the source of energy fuel for the purpose of testing the equipment, or for use under a temporary certificate of occupancy.

# CHAPTER 2 DEFINITIONS

## SECTION 201 (IFGC) GENERAL

**201.1 Scope.** Unless otherwise expressly stated, the following words and terms shall, for the purposes of this code and standard, have the meanings indicated in this chapter.

**201.2 Interchangeability.** Words used in the present tense include the future; words in the masculine gender include the feminine and neuter; the singular number includes the plural and the plural, the singular.

**201.3 Terms defined in other codes.** Where terms are not defined in this code and are defined in the ~~ICC~~ *Seattle Electrical Code*, *International Building Code*, *International Fire Code*, *International Mechanical Code* or *International Uniform Plumbing Code*, such terms shall have meanings ascribed to them as in those codes.

**Interpretation I201.3:** Unless otherwise amended, whenever an International, National, or Uniform code is referenced in this code, it shall mean the Seattle edition of that code, including local amendments.

**201.4 Terms not defined.** Where terms are not defined through the methods authorized by this section, such terms shall have ordinarily accepted meanings such as the context implies.

## SECTION 202 (IFGC) GENERAL DEFINITIONS

**ACCESS (TO).** That which enables a device, appliance or equipment to be reached by ready access or by a means that first requires the removal or movement of a panel, door or similar obstruction (see also "Ready access").

**AIR CONDITIONER, GAS-FIRED.** A gas-burning, automatically operated appliance for supplying cooled and/or dehumidified air or chilled liquid.

**AIR CONDITIONING.** The treatment of air so as to control simultaneously the temperature, humidity, cleanness and distribution of the air to meet the requirements of a conditioned space.

**AIR, EXHAUST.** Air being removed from any space or piece of equipment and conveyed directly to the atmosphere by means of openings or ducts.

**AIR-HANDLING UNIT.** A blower or fan used for the purpose of distributing supply air to a room, space or area.

**AIR, MAKEUP.** Air that is provided to replace air being exhausted.

**ALTERATION.** A change in a system that involves an extension, addition or change to the arrangement, type or purpose of the original installation.

**ANODELESS RISER.** A transition assembly in which plastic piping is installed and terminated above ground outside of a building.

**APPLIANCE (EQUIPMENT).** Any apparatus or equipment that utilizes gas as a fuel or raw material to produce light, heat, power, refrigeration or air conditioning.

**APPLIANCE, FAN-ASSISTED COMBUSTION.** An appliance equipped with an integral mechanical means to either draw or force

products of combustion through the combustion chamber or heat exchanger.

**APPLIANCE, AUTOMATICALLY CONTROLLED.** Appliances equipped with an automatic burner ignition and safety shutoff device and other automatic devices which accomplish complete turn-on and shutoff of the gas to the main burner or burners, and graduate the gas supply to the burner or burners, but do not affect complete shutoff of the gas.

### APPLIANCE TYPE.

**Low-heat appliance (residential appliance).** Any appliance in which the products of combustion at the point of entrance to the flue under normal operating conditions have a temperature of 1,000°F (538°C) or less.

**Medium-heat appliance.** Any appliance in which the products of combustion at the point of entrance to the flue under normal operating conditions have a temperature of more than 1,000°F (538°C), but not greater than 2,000°F (1093°C).

**APPLIANCE, UNVENTED.** An appliance designed or installed in such a manner that the products of combustion are not conveyed by a vent or chimney directly to the outside atmosphere.

**APPLIANCE, VENTED.** An appliance designed and installed in such a manner that all of the products of combustion are conveyed directly from the appliance to the outside atmosphere through an approved chimney or vent system.

**APPROVED.** Approved by the code official or other authority having jurisdiction.

**APPROVED AGENCY.** An established and recognized agency that is approved by the code official and regularly engaged in conducting tests or furnishing inspection services.

**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) (101 kPa absolute) at sea level.

**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.

**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 appliance for supplying steam or hot water.

~~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 that operates at water pressures not exceeding 160 pounds per square inch gauge (psig) (1100 kPa gauge) and at water temperatures not exceeding 250°F (121°C) at or near the boiler outlet.~~

~~Hot water supply boiler. A boiler, completely filled with water, which furnishes hot water to be used externally to itself, and that~~

## DEFINITIONS

~~operates at water pressures not exceeding 160 psig (1100 kPa gauge) and at water temperatures not exceeding 250°F (121°C) at or near the boiler outlet.~~

~~**Steam heating boiler.** A boiler in which steam is generated and that operates at a steam pressure not exceeding 15 psig (100 kPa gauge).~~

**BOILER CODE.** *The Seattle Boiler and Pressure Vessel Code.*

**BRAZING.** A metal-joining process wherein coalescence is produced by the use of a nonferrous filler metal having a melting point above 1,000°F (538°C), but lower than that of the base metal being joined. The filler material is distributed between the closely fitted surfaces of the joint by capillary action.

**BROILER.** A general term including salamanders, barbecues and other appliances 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 1 pound (454 g) of water 1°F (1.8°C) (1 Btu = 1055 J).

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

**Induced-draft.** A burner that depends on draft induced by a fan that is an integral part of the appliance and is located downstream from the burner.

**Power.** A burner in which gas, air or both are supplied at pressures exceeding, for gas, the line pressure, and for air, atmospheric pressure, with this added pressure being applied at the burner.

**CHIMNEY.** A primarily vertical structure containing one or more flues, for the purpose of carrying gaseous products of combustion and air from an appliance to the outside atmosphere.

**Factory-built chimney.** A listed and labeled chimney composed of factory-made components, assembled in the field in accordance with manufacturer's instructions and the conditions of the listing.

**Masonry chimney.** A field-constructed chimney composed of solid masonry units, bricks, stones or concrete.

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

**CLEARANCE.** The minimum distance through air measured between the heat-producing surface of the mechanical appliance, device or equipment and the surface of the combustible material or assembly.

**CLOTHES DRYER.** An appliance used to dry wet laundry by means of heated air. Dryer classifications are as follows:

**Type 1.** Factory-built package, multiple production. Primarily used in family living environment. Usually the smallest unit physically and in function output.

**Type 2.** Factory-built package, multiple production. Used in business with direct intercourse of the function with the public. Not designed for use in individual family living environment.

**CODE.** These regulations, subsequent amendments thereto or any emergency rule or regulation ~~that the administrative authority having jurisdiction~~ has been lawfully adopted.

**CODE OFFICIAL.** ~~The officer or other designated authority charged with the administration and enforcement of this code,~~ Director of the Department of Planning and Development or a duly authorized representative.

**COMBUSTION.** In the context of this code, refers to the rapid oxidation of fuel accompanied by the production of heat or heat and light.

**COMBUSTION AIR.** Air necessary for complete combustion of a fuel, including theoretical air and excess air.

**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 inert gases, but excluding excess air.

**CONCEALED LOCATION.** A location that cannot be accessed without damaging permanent parts of the building structure or finish surface. Spaces above, below or behind readily removable panels or doors shall not be considered as concealed.

**CONCEALED PIPING.** Piping that is located in a concealed location (see "Concealed location").

**CONDENSATE.** The liquid that condenses from a gas (including flue gas) caused by a reduction in temperature or increase in pressure.

**CONNECTOR.** The pipe that connects an approved appliance to a chimney, flue or vent.

**CONSTRUCTION DOCUMENTS.** All of the written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of the project necessary for obtaining a mechanical permit.

**CONTROL.** A manual or automatic device designed to regulate the gas, air, water or electrical supply to, or operation of, a mechanical system.

**CONVERSION BURNER.** A unit consisting of a burner and its controls for installation in an appliance originally utilizing another fuel.

**COUNTER APPLIANCES.** Appliances such as coffee brewers and coffee urns and any appurtenant water-heating equipment, food and dish warmers, hot plates, griddles, waffle bakers and other appliances designed for installation on or in a counter.

**CUBIC FOOT.** The amount of gas that occupies 1 cubic foot (0.02832 m<sup>3</sup>) when at a temperature of 60°F (16°C), saturated with water vapor and under a pressure equivalent to that of 30 inches of mercury (101 kPa).

**DAMPER.** A manually or automatically controlled device to regulate draft or the rate of flow of air or combustion gases.

**DECORATIVE APPLIANCE, VENTED.** A vented appliance wherein the primary function lies in the aesthetic effect of the flames.

**DECORATIVE APPLIANCES FOR INSTALLATION IN VENTED FIREPLACES.** A vented appliance designed for installation within the fire chamber of a vented fireplace, wherein the primary function lies in the aesthetic effect of the flames.

**DEMAND.** The maximum amount of gas input required per unit of time, usually expressed in cubic feet per hour, or Btu/h (1 Btu/h = 0.2931 W).

**DESIGN FLOOD ELEVATION.** The elevation of the "design flood," including wave height, relative to the datum specified on the community's legally designated flood hazard map.

**DILUTION AIR.** Air that is introduced into a draft hood and is mixed with the flue gases.

**DIRECT-VENT APPLIANCES.** Appliances that are constructed and installed so that all air for combustion is derived directly from the outside atmosphere and all flue gases are discharged directly to the outside atmosphere.

**DRAFT.** The pressure difference existing between the equipment or any component part and the atmosphere, that causes a continuous flow of air and products of combustion through the gas passages of the appliance to the atmosphere.

**Mechanical or induced draft.** The pressure difference created by the action of a fan, blower or ejector, that is located between the appliance and the chimney or vent termination.

**Natural draft.** The pressure difference created by a vent or chimney because of its height, and the temperature difference between the flue gases and the atmosphere.

**DRAFT HOOD.** A nonadjustable device built into an appliance, or made as part of the vent connector from an appliance, that is designed to (1) provide for 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 operation of the appliance.

**DRAFT REGULATOR.** A device that 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 the condensate is removable.

**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 warm-air furnace normally installed in an air distribution duct to supply warm air for heating. This definition shall apply only to a warm-air heating appliance that depends for air circulation on a blower not furnished as part of the furnace.

**DUCT SYSTEM.** A continuous passageway for the transmission of air that, in addition to ducts, includes duct fittings, dampers, plenums, fans and accessory air-handling equipment.

**ENERGY CODE.** *The Washington State Energy Code with Seattle Amendments.*

**EQUIPMENT.** See "Appliance."

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

**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.

**Factory-built fireplace.** A fireplace composed of listed factory-built components assembled in accordance with the terms of listing to form the completed fireplace.

**FIRING VALVE.** A valve of the plug and barrel type designed for use with gas, and equipped with a lever handle for manual operation and a dial to indicate the percentage of opening.

**FLAME SAFEGUARD.** A device that will automatically shut off the fuel supply to a main burner or group of burners when the means of ignition of such burners becomes inoperative, and when flame failure occurs on the burner or group of burners.

**FLOOD HAZARD AREA.** The greater of the following two areas:

1. The area within a floodplain subject to a 1 percent or greater chance of flooding in any given year.
2. This area designated as a flood hazard area on a community's flood hazard map, or otherwise legally designated.

**FLOOR FURNACE.** A completely self-contained furnace suspended from the floor of the space being heated, taking air for combustion from outside such space and with means for observing flames and lighting the appliance from such space.

**Gravity type.** A floor furnace depending primarily upon circulation of air by gravity. This classification shall also include 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.

**Fan type.** A floor furnace equipped with a fan which provides the primary means for circulating air.

**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 COLLAR.** That portion of an appliance designed for the attachment of a draft hood, vent connector or venting system.

**FLUE GASES.** Products of combustion plus excess air in appliance flues or heat exchangers.

**FLUE LINER (LINING).** A system or material used to form the inside surface of a flue in a chimney or vent, for the purpose of protecting the surrounding structure from the effects of combustion products and for conveying combustion products without leakage to the atmosphere.

**FUEL GAS.** Fuel gases include: a natural gas, manufactured gas, liquefied petroleum gas, hydrogen gas and mixtures of these gases.

**FUEL GAS UTILIZATION EQUIPMENT.** See "Appliance."

**FURNACE.** A completely self-contained heating unit that is designed to supply heated air to spaces remote from or adjacent to the appliance location.

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

**Downflow furnace.** A furnace designed with airflow discharge vertically downward at or near the bottom of the furnace.

**Forced air furnace with cooling unit.** A single-package unit, consisting of a gas-fired forced-air furnace of one of the types listed below combined with an electrically or fuel gas-powered summer air-conditioning system, contained in a common casing.

**Forced-air type.** A central furnace equipped with a fan or blower which provides the primary means for circulation of air.

**Gravity furnace with booster fan.** A furnace equipped with a booster fan that does not materially restrict free circulation of air by gravity flow when the fan is not in operation.

**Gravity type.** A central furnace depending primarily on circulation of air by gravity.

**Horizontal forced-air type.** A furnace with airflow through the appliance essentially in a horizontal path.

**Multiple-position furnace.** A furnace designed so that it can be installed with the airflow discharge in the upflow, horizontal or downflow direction.

## DEFINITIONS

**Upflow furnace.** A furnace designed with airflow 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.

**FURNACE, ENCLOSED.** A specific heating, or heating and ventilating, furnace incorporating an integral total enclosure and using only outside air for combustion.

**FURNACE PLENUM.** An air compartment or chamber to which one or more ducts are connected and which forms part of an air distribution system.

**GAS CONVENIENCE OUTLET.** A permanently mounted, manually operated device that provides the means for connecting an appliance to, and disconnecting an appliance from, the supply piping. The device includes an integral, manually operated valve with a nondisplaceable valve member and is designed so that disconnection of an appliance only occurs when the manually operated valve is in the closed position.

**GASEOUS HYDROGEN SYSTEM.** See Section 702.1.

**GAS PIPING.** An installation of pipe, valves or fittings installed on a premises or in a building and utilized to convey fuel gas.

**GAS UTILIZATION EQUIPMENT.** An appliance that utilizes gas as a fuel or raw material or both.

**HAZARDOUS LOCATION.** Any location considered to be a fire hazard for flammable vapors, dust, combustible fibers or other highly combustible substances. The location is not necessarily categorized in the building code as a high-hazard group classification.

**HOUSE PIPING.** See “Piping system.”

**HYDROGEN CUT-OFF ROOM.** See Section 702.1.

**HYDROGEN GENERATING APPLIANCE.** See Section 702.1.

**IGNITION PILOT.** A pilot that operates during the lighting cycle and discontinues during main burner operation.

**IGNITION SOURCE.** A flame, spark or hot surface capable of igniting flammable vapors or fumes. Such sources include appliance burners, burner ignitors, and electrical switching devices.

**INCINERATOR.** An appliance used to reduce combustible refuse material to ashes and which is manufactured, sold and installed as a complete unit.

**INDUSTRIAL AIR HEATERS, DIRECT-FIRED NONRECIRCULATING.** A heater in which all the products of combustion generated by the burners are released into the air stream being heated. The purpose of the heater is to offset building heat loss by heating only outdoor air.

**INDUSTRIAL AIR HEATERS, DIRECT-FIRED RECIRCULATING.** A heater in which all the products of combustion generated by the burners are released into the air stream being heated. The purpose of the heater is to offset building heat loss by heating outdoor air, and, if applicable, indoor air.

**INFRARED RADIANT HEATER.** A heater that directs a substantial amount of its energy output in the form of infrared radiant energy into the area to be heated. Such heaters are of either the vented or unvented type.

**JOINT, FLANGED.** A joint made by bolting together a pair of flanged ends.

**JOINT, FLARED.** A metal-to-metal compression joint in which a conical spread is made on the end of a tube that is compressed by a flare nut against a mating flare.

**JOINT, MECHANICAL.** A general form of gas-tight joints obtained by the joining of metal parts through a positive-holding mechanical construction, such as flanged joint, threaded joint, flared joint or compression joint.

**JOINT, PLASTIC ADHESIVE.** A joint made in thermoset plastic piping by the use of an adhesive substance which forms a continuous bond between the mating surfaces without dissolving either one of them.

**JOINT, PLASTIC 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.

**JOINT, WELDED.** A gas-tight joint obtained by the joining of metal parts in molten state.

**LABELED.** Devices, equipment, appliances or materials to which have been affixed a label, seal, symbol or other identifying mark of a nationally recognized testing laboratory, inspection agency or other organization concerned with product evaluation that maintains periodic inspection of the production of the above-labeled items and by whose label the manufacturer attests to compliance with applicable nationally recognized standards.

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

**LIQUEFIED PETROLEUM GAS or LPG (LP-GAS).** Liquefied petroleum gas composed predominately of propane, propylene, butanes or butylenes, or mixtures thereof that is gaseous under normal atmospheric conditions, but is capable of being liquefied under moderate pressure at normal temperatures.

**LISTED.** Equipment, appliances or materials included in a list published by a nationally recognized testing laboratory, inspection agency or other organization concerned with product evaluation that maintains periodic inspection of production of listed equipment, appliances or materials, and whose listing states either that the equipment, appliance or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner. The means for identifying listed equipment, appliances or materials may vary for each testing laboratory, inspection agency or other organization concerned with product evaluation, some of which do not recognize equipment, appliances or materials as listed unless they are also labeled. The authority having jurisdiction shall utilize the system employed by the listing organization to identify a listed product.

**LIVING SPACE.** Space within a dwelling unit utilized for living, sleeping, eating, cooking, bathing, washing and sanitation purposes.

**LOG LIGHTER.** A manually operated solid fuel ignition appliance for installation in a vented solid fuel-burning fireplace.

**LUBRICATED PLUG-TYPE VALVE.** A valve of the plug and barrel type provided with means for maintaining a lubricant between the bearing surfaces.

**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.

**MECHANICAL EXHAUST SYSTEM.** Equipment installed in and made a part of the vent, which will provide a positive induced draft.

**METER.** The instrument installed to measure the volume of gas delivered through it.

**MODULATING.** Modulating or throttling is the action of a control from its maximum to minimum position in either predetermined steps or increments of movement as caused by its actuating medium.

**OCCUPANCY.** The purpose for which a building, or portion thereof, is utilized or occupied.

**OFFSET (VENT).** A combination of approved bends that makes two changes in direction bringing one section of the vent out of line but into a line parallel with the other section.

**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.

**OUTLET.** A threaded connection or bolted flange in a pipe system to which a gas-burning appliance is attached.

**OXYGEN DEPLETION SAFETY SHUTOFF SYSTEM (ODS).** A system designed to act to shut off the gas supply to the main and pilot burners if the oxygen in the surrounding atmosphere is reduced below a predetermined level.

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

**PIPING.** Where used in this code, "piping" refers to either pipe or tubing, or both.

**Pipe.** A rigid conduit of iron, steel, copper, brass or plastic.

**Tubing.** Semirigid conduit of copper, aluminum, plastic or steel.

**PIPING SYSTEM.** All fuel piping, valves and fittings from the outlet of the point of delivery to the outlets of the equipment shutoff valves.

**PLASTIC, THERMOPLASTIC.** A plastic that is capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature.

**POINT OF DELIVERY.** For natural 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 where a meter is not provided. Where a valve is provided at the outlet of the service meter assembly, such valve shall be considered to be downstream of the point of delivery. For undiluted liquefied petroleum gas systems, the point of delivery shall be considered the outlet of the first-stage pressure regulator that provides utilization pressure, exclusive of line gas regulators, in the system.

**PORTABLE FUEL CELL APPLIANCE.** A fuel cell generator of electricity, which is not fixed in place. A portable fuel cell appliance utilizes a cord and plug connection to a grid-isolated load and has an integral fuel supply.

**PRESSURE DROP.** The loss in pressure due to friction or obstruction in pipes, valves, fittings, regulators and burners.

**PRESSURE TEST.** An operation performed to verify the gas-tight integrity of gas piping following its installation or modification.

**PURGE.** To free a gas conduit of air or gas, or a mixture of gas and air.

**QUICK-DISCONNECT DEVICE.** A hand-operated device that provides a means for connecting and disconnecting an appliance or

an appliance connector to a gas supply and that is equipped with an automatic means to shut off the gas supply when the device is disconnected.

**READY ACCESS (TO).** That which enables a device, appliance or equipment to be directly reached, without requiring the removal or movement of any panel, door or similar obstruction (see "Access").

**REGISTERED DESIGN PROFESSIONAL.** An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed.

**REGULATOR.** A device for controlling and maintaining a uniform supply pressure, either pounds-to-inches water column (MP regulator) or inches-to-inches water column (appliance regulator).

**REGULATOR, GAS APPLIANCE.** A pressure regulator for controlling pressure to the manifold of equipment. Types of appliance regulators are as follows:

**Adjustable.**

1. Spring type, limited adjustment. A regulator in which the regulating force acting upon the diaphragm is derived principally 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.

**Multistage.** A regulator for use with a single gas whose adjustment means is capable of being positioned manually or automatically to two or more predetermined outlet pressure settings. Each of these settings shall be adjustable or nonadjustable. The regulator may modulate outlet pressures automatically between its maximum and minimum predetermined outlet pressure settings.

**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 PRESSURE.** A device placed in a gas line between the service pressure regulator and the equipment for controlling, maintaining or reducing the pressure in that portion of the piping system downstream of the device.

**REGULATOR, MEDIUM-PRESSURE.** A medium-pressure (MP) regulator reduces the gas piping pressure to the appliance regulator or to the appliance utilization pressure.

**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, SERVICE PRESSURE.** A device installed by the serving gas supplier to reduce and limit the service line pressure to delivery pressure.

## DEFINITIONS

**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, back draft, or stoppage beyond the draft hood, and to permit air into the draft hood in the event of a strong chimney updraft.

**RELIEF VALVE (DEVICE).** A safety valve designed to forestall the development of a dangerous condition by relieving either pressure, temperature or vacuum in the hot water supply system.

**RELIEF VALVE, PRESSURE.** An automatic valve that opens and closes a relief vent, depending on whether the pressure is above or below a predetermined value.

### **RELIEF VALVE, TEMPERATURE.**

**Reseating or self-closing type.** An automatic valve that opens and closes a relief vent, depending on whether the temperature is above or below a predetermined value.

**Manual reset type.** A valve that automatically opens a relief vent at a predetermined temperature and that must be manually returned to the closed position.

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

**RISER, GAS.** A vertical pipe supplying fuel gas.

**ROOM HEATER, UNVENTED.** See “Unvented room heater.”

**ROOM HEATER, VENTED.** A free-standing heating unit used for direct heating of the space in and adjacent to that in which the unit is located (see also “Vented room heater”).

**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 (2438 mm), the volume of the room is figured on the basis of a ceiling height of 8 feet (2438 mm).

**SAFETY SHUTOFF DEVICE.** See “Flame safeguard.”

**SHAFT.** An enclosed space extending through one or more stories of a building, connecting vertical openings in successive floors, or floors and the roof.

**SPECIFIC GRAVITY.** As applied to gas, specific gravity is the ratio of the weight of a given volume to that of the same volume of air, both measured under the same condition.

**STATIONARY FUEL CELL POWER PLANT.** A self-contained package or factory-matched packages which constitute an automatically operated assembly of integrated systems for generating electrical energy and recoverable thermal energy that is permanently connected and fixed in place.

### **THERMOSTAT.**

**Electric switch type.** A device that senses changes in temperature and controls electrically, by means of separate components, the flow of gas to the burner(s) to maintain selected temperatures.

**Integral gas valve type.** An automatic device, actuated by temperature changes, designed to control the gas supply to the burner(s) in order to maintain temperatures between

predetermined limits, and in which the thermal actuating element is an integral part of the device.

1. 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.
2. Snap-acting thermostat. A thermostat in which the thermostatic valve travels instantly from the closed to the open position, and vice versa.

**TRANSITION FITTINGS, PLASTIC TO STEEL.** An adapter for joining plastic pipe to steel pipe. The purpose of this fitting is to provide a permanent, pressure-tight connection between two materials which cannot be joined directly one to another.

### **UNIT HEATER.**

**High-static pressure type.** A self-contained, automatically controlled, vented appliance having integral means for circulation of air against 0.2 inch (15 mm H<sub>2</sub>O) or greater static pressure. Such appliance is equipped with provisions for attaching an outlet air duct and, where the appliance is for indoor installation remote from the space to be heated, is also equipped with provisions for attaching an inlet air duct.

**Low-static pressure type.** A self-contained, automatically controlled, vented appliance, intended for installation in the space to be heated without the use of ducts, having integral means for circulation of air. Such units are allowed to be equipped with louvers or face extensions made in accordance with the manufacturer’s specifications.

**UNLISTED BOILER.** A boiler not listed by a nationally recognized testing agency.

**UNVENTED ROOM HEATER.** An unvented heating appliance designed for stationary installation and utilized to provide comfort heating. Such appliances provide radiant heat or convection heat by gravity or fan circulation directly from the heater and do not utilize ducts.

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

**Automatic.** An automatic or semiautomatic device consisting essentially of a valve and operator that control the gas supply to the burner(s) during operation of an appliance. The operator shall be actuated by application of gas pressure on a flexible diaphragm, by electrical means, by mechanical means, or by other approved means.

**Automatic gas shutoff.** A valve used in conjunction with an automatic gas shutoff device to shut off the gas supply to a water-heating system. It shall be constructed integrally with the gas shutoff device or shall be a separate assembly.

**Equipment shutoff.** A valve located in the piping system, used to isolate individual equipment for purposes such as service or replacement.

**Individual main burner.** A valve that controls the gas supply to an individual main burner.

**Main burner control.** A valve that controls the gas supply to the main burner manifold.

**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 that are provided with independent shutoff.

**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.

**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.

**VENT.** A pipe or other conduit composed of factory-made components, containing a passageway for conveying combustion products and air to the atmosphere, listed and labeled for use with a specific type or class of appliance.

**Special gas vent.** A vent listed and labeled for use with listed Category II, III and IV appliances.

**Type B vent.** A vent listed and labeled for use with appliances with draft hoods and other Category I appliances that are listed for use with Type B vents.

**Type BW vent.** A vent listed and labeled for use with wall furnaces.

**Type L vent.** A vent listed and labeled for use with appliances that are listed for use with Type L or Type B vents.

**VENT CONNECTOR.** (See “Connector”).

**VENT GASES.** Products of combustion from appliances plus excess air plus dilution air in the vent connector, gas vent or chimney above the draft hood or draft regulator.

**VENTED APPLIANCE CATEGORIES.** Appliances that are categorized for the purpose of vent selection are classified into the following four categories:

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

**Category II.** An appliance that operates with a nonpositive vent static pressure and with a vent gas temperature that is capable of causing excessive condensate production in the vent.

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

**Category IV.** An appliance that operates with a positive vent static pressure and with a vent gas temperature that is capable of causing excessive condensate production in the vent.

**VENTED ROOM HEATER.** A vented self-contained, free-standing, nonrecessed appliance for furnishing warm air to the space in which it is installed, directly from the heater without duct connections.

**VENTED WALL FURNACE.** A self-contained vented appliance complete with grilles or equivalent, designed for incorporation in or permanent attachment to the structure of a building, mobile home or travel trailer, and furnishing heated air circulated by gravity or by a fan directly into the space to be heated through openings in the casing. This definition shall exclude floor furnaces, unit heaters and central furnaces as herein defined.

**VENTING SYSTEM.** A continuous open passageway from the flue collar or draft hood of an appliance to the outside atmosphere for the purpose of removing flue or vent gases. A venting system is usually composed of a vent or a chimney and vent connector, if used, assembled to form the open passageway.

**Mechanical draft venting system.** A venting system designed to remove flue or vent gases by mechanical means, that consists of an induced draft portion under nonpositive static pressure or a forced draft portion under positive static pressure.

**Forced-draft venting system.** A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under positive static vent pressure.

**Induced draft venting system.** A portion of a venting system using a fan or other mechanical means to cause the removal of flue or vent gases under nonpositive static vent pressure.

**Natural draft venting system.** A venting system designed to remove flue or vent gases under nonpositive static vent pressure entirely by natural draft.

**WALL HEATER, UNVENTED-TYPE.** A room heater of the type designed for insertion in or attachment to a wall or partition. Such heater does not incorporate concealed venting arrangements in its construction and discharges all products of combustion through the front into the room being heated.

**WATER HEATER.** Any heating appliance or equipment, not exceeding a pressure of 160 psi, a volume of 120 gallons and a heat input of 200,00 Btu/h, that heats potable water and supplies such water to the potable hot water distribution system.



## DEFINITIONS

## CHAPTER 3

# GENERAL REGULATIONS

### SECTION 301 (IFGC) GENERAL

**301.1 Scope.** This chapter shall govern the approval and installation of all equipment and appliances that comprise parts of the installations regulated by this code in accordance with Section ~~401.2~~ 103.

**301.1.1 Other fuels.** The requirements for combustion and dilution air for gas-fired appliances shall be governed by Section 304. The requirements for combustion and dilution air for appliances operating with fuels other than fuel gas shall be regulated by the International Mechanical Code.

**301.2 Energy utilization.** Heating, ventilating and air-conditioning systems of all structures shall be designed and installed for efficient utilization of energy in accordance with the ~~International Energy Conservation Code~~ Washington State Energy Code with Seattle Amendments.

**301.3 Listed and labeled.** Appliances regulated by this code shall be listed and labeled unless otherwise approved in accordance with Section 105 or 106. The approval of unlisted appliances in accordance with Section 105 or 106 shall be based upon approved engineering evaluation.

**301.4 Labeling.** Labeling shall be in accordance with the procedures set forth in Sections 301.4.1 through 301.4.2.3.

**301.4.1 Testing.** An approved agency shall test a representative sample of the appliances being labeled to the relevant standard or standards. The approved agency shall maintain a record of all of the tests performed. The record shall provide sufficient detail to verify compliance with the test standard.

**301.4.2 Inspection and identification.** The approved agency shall periodically perform an inspection, which shall be in-plant if necessary, of the appliances to be labeled. The inspection shall verify that the labeled appliances are representative of the appliances tested.

**301.4.2.1 Independent.** The agency to be approved shall be objective and competent. To confirm its objectivity, the agency shall disclose all possible conflicts of interest.

**301.4.2.2 Equipment.** An approved agency shall have adequate equipment to perform all required tests. The equipment shall be periodically calibrated.

**301.4.2.3 Personnel.** An approved agency shall employ experienced personnel educated in conducting, supervising and evaluating tests.

**301.5 Label information.** A permanent factory-applied nameplate(s) shall be affixed to appliances on which shall appear in legible lettering, the manufacturer's name or trademark, the model number, serial number and, for listed

appliances, the seal or mark of the testing agency. A label shall also include the hourly rating in British thermal units per hour (Btu/h) (W); the type of fuel approved for use with the appliance; and the minimum clearance requirements.

**301.6 Plumbing connections.** Potable water supply and building drainage system connections to appliances regulated by this code shall be in accordance with the ~~International~~ Uniform Plumbing Code.

**301.7 Fuel types.** Appliances shall be designed for use with the type of fuel gas to which they will be connected and the altitude at which they are installed. Appliances that comprise parts of the installation shall not be converted for the usage of a different fuel, except where approved and converted in accordance with the manufacturer's instructions. The fuel gas input rate shall not be increased or decreased beyond the limit rating for the altitude at which the appliance is installed.

**301.8 Vibration isolation.** Where means for isolation of vibration of an appliance is installed, an approved means for support and restraint of that appliance shall be provided.

**301.9 Repair.** Defective material or parts shall be replaced or repaired in such a manner so as to preserve the original approval or listing.

**301.10 Wind resistance.** Appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressures determined in accordance with the *International Building Code*.

**301.11 Flood hazard.** For structures located in flood hazard areas, the appliance, equipment and system installations regulated by this code shall be located at or above the design flood elevation and shall comply with the flood-resistant construction requirements of the *International Building Code*.

**Exception:** The appliance, equipment and system installations regulated by this code are permitted to be located below the design flood elevation provided that they are designed and installed to prevent water from entering or accumulating within the components and to resist hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the design flood elevation and shall comply with the flood-resistant construction requirements of the *International Building Code*.

**301.12 Seismic resistance.** When earthquake loads are applicable in accordance with the *International Building Code*, the supports shall be designed and installed for the seismic forces in accordance with that code.

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**301.13 Ducts.** All ducts required for the installation of systems regulated by this code shall be designed and installed in accordance with the *International Mechanical Code*.

**301.14 Rodentproofing.** Buildings or structures and the walls enclosing habitable or occupiable rooms and spaces in which persons live, sleep or work, or in which feed, food or foodstuffs are stored, prepared, processed, served or sold, shall be constructed to protect against rodents in accordance with the *International Building Code*.

**301.15 Prohibited location.** The appliances, equipment and systems regulated by this code shall not be located in an elevator shaft.

### SECTION 302 (IFGC)

#### STRUCTURAL SAFETY

**[B] 302.1 Structural safety.** The building shall not be weakened by the installation of any gas piping. In the process of installing or repairing any gas piping, the finished floors, walls, ceilings, tile work or any other part of the building or premises which is required to be changed or replaced shall be left in a safe structural condition in accordance with the requirements of the *International Building Code*.

**[B] 302.2 Penetrations of floor/ceiling assemblies and fire-resistance-rated assemblies.** Penetrations of floor/ceiling assemblies and assemblies required to have a fire-resistance rating shall be protected in accordance with the *International Building Code*.

**[B] 302.3 Cutting, notching and boring in wood members.** The cutting, notching and boring of wood members shall comply with Sections 302.3.1 through 302.3.4.

**[B] 302.3.1 Engineered wood products.** Cuts, notches and holes bored in trusses, laminated veneer lumber, glued laminated members and I-joists are prohibited except where the effects of such alterations are specifically considered in the design of the member.

**[B] 302.3.2 Joist notching.** Notching at the ends of joists shall not exceed one-fourth the joist depth. Holes bored in joists shall not be within 2 inches (51 mm) of the top and bottom of the joist and their diameter shall not exceed one-third the depth of the member. Notches in the top or bottom of the joist shall not exceed one-sixth the depth and shall not be located in the middle one-third of the span.

**[B] 302.3.3 Stud cutting and notching.** In exterior walls and bearing partitions, any wood stud is permitted to be cut or notched to a depth not exceeding 25 percent of its width. Cutting or notching of studs to a depth not greater

than 40 percent of the width of the stud is permitted in nonload-bearing partitions supporting no loads other than the weight of the partition.

**[B] 302.3.4 Bored holes.** A hole not greater in diameter than 40 percent of the stud depth is permitted to be bored in any wood stud. Bored holes not greater than 60 percent of the depth of the stud are permitted in nonload-bearing partitions or in any wall where each bored stud is doubled, provided not more than two such successive doubled studs are so bored. In no case shall the edge of the bored hole be nearer than  $\frac{5}{8}$  inch (15.9 mm) to the edge of the stud. Bored holes shall not be located at the same section of stud as a cut or notch.

**[B] 302.4 Alterations to trusses.** Truss members and components shall not be cut, drilled, notched, spliced or otherwise altered in any way without the written concurrence and approval of a registered design professional. Alterations resulting in the addition of loads to any member (e.g., HVAC equipment, water heaters) shall not be permitted without verification that the truss is capable of supporting such additional loading.

**[B] 302.5 Cutting, notching and boring holes in structural steel framing.** The cutting, notching and boring of holes in structural steel framing members shall be as prescribed by the registered design professional.

**[B] 302.6 Cutting, notching and boring holes in cold-formed steel framing.** Flanges and lips of load-bearing, cold-formed steel framing members shall not be cut or notched. Holes in webs of load-bearing, cold-formed steel framing members shall be permitted along the centerline of the web of the framing member and shall not exceed the dimensional limitations, penetration spacing or minimum hole edge distance as prescribed by the registered design professional. Cutting, notching and boring holes of steel floor/roof decking shall be as prescribed by the registered design professional.

**[B] 302.7 Cutting, notching and boring holes in nonstructural cold-formed steel wall framing.** Flanges and lips of nonstructural cold-formed steel wall studs shall be permitted along the centerline of the web of the framing member, shall not exceed  $1\frac{1}{2}$  inches (38 mm) in width or 4 inches (102 mm) in length, and the holes shall not be spaced less than 24 inches (610 mm) center to center from another hole or less than 10 inches (254 mm) from the bearing end.

### SECTION 303 (IFGC)

#### APPLIANCE LOCATION

**303.1 General.** Appliances shall be located as required by this section, specific requirements elsewhere in this code and the conditions of the equipment and appliance listing.

**303.2 Hazardous locations.** Appliances shall not be located in a hazardous location unless listed and approved for the specific installation.

**303.3 Prohibited locations.** Appliances shall not be located in, or obtain combustion air from, any of the following rooms or spaces:

1. Sleeping rooms.
2. Bathrooms.
3. Toilet rooms.
4. Storage closets.
5. Surgical rooms.

**Exceptions:**

1. Direct-vent appliances that obtain all combustion air directly from the outdoors.
2. Vented room heaters, wall furnaces, vented decorative appliances and decorative appliances for installation in vented solid fuel-burning fireplaces, provided that the room meets the required volume criteria of Section 304.5.
3. A single wall-mounted unvented room heater equipped with an oxygen depletion safety shutoff system and installed in a bathroom, provided that the input rating does not exceed 6,000 Btu/h (1.76kW) and the bathroom meets the required volume criteria of Section 304.5.
4. A single wall-mounted unvented room heater equipped with an oxygen depletion safety shutoff system and installed in a bedroom, provided that the input rating does not exceed 10,000 Btu/h (2.93 kW) and the bedroom meets the required volume criteria of Section 304.5.
5. Appliances installed in an enclosure in which all combustion air is taken from the outdoors, in accordance with Section 304.6. Access to such enclosure shall be through a solid weather-stripped door, equipped with an approved self-closing device.

**303.4 Protection from physical damage.** Appliances shall not be installed in a location where subject to physical damage unless protected by approved barriers meeting the requirements of the *International Fire Code*.

**303.5 Indoor locations.** Furnaces and boilers installed in closets and alcoves shall be listed for such installation.

**303.6 Outdoor locations.** Equipment installed in outdoor locations shall be either listed for outdoor installation or provided with protection from outdoor environmental factors that influence the operability, durability and safety of the equipment.

**303.7 Pit locations.** Appliances installed in pits or excavations shall not come in direct contact with the surrounding soil. The sides of the pit or excavation shall be held back a minimum of 12 inches (305 mm) from the appliance, and a minimum of 30 inches (762 mm) on the control side. Where the depth exceeds 12 inches (305 mm) below adjoining grade, the walls of the pit or excavation shall be lined with concrete or masonry, such concrete or masonry shall extend a minimum of 4 inches (102 mm) above adjoining grade and shall have sufficient lateral load-bearing capacity to resist collapse. The appliance shall be protected from flooding in an approved manner.

**[B] 303.8 Installation of Pipes or Ducts Conveying Gases, Vapors or Liquids in Hoistways, Machine Rooms, or Machinery Spaces.** Pipes conveying gases, vapors or liquids are not permitted to be installed in hoistways, machine rooms, and machinery spaces.

**Exceptions:**

1. Only ducts for heating, cooling, ventilating, and venting these spaces are permitted to be installed in the hoistway, machine room, and machinery space.
2. Ducts and electrical conduit may pass through an elevator machine room or machinery space provided they are separated from the room or space by construction equal to the rated construction of the room or space and located so that all required clearances are maintained.

If a vented machine room is not vented directly to the outside of the building, the vent shall be enclosed within a fire barrier with at least a one-hour fire-resistance-rating, or as required for shafts where it passes through occupied floors.
3. Standard sprinkler protection conforming to the requirements of NFPA 13 shall be permitted to be installed in these spaces, subject to rules promulgated by the code official.
4. Subject to the approval of the building official, pipes protected with double containment and pipes with threaded or welded joints may be permitted. Pipes shall not be located less than 7 feet above the floor in machine rooms.

**[B] 303.9 Exit Enclosures.** Mechanical systems shall not be located in exit enclosures. Penetrations passing entirely through both protective membranes are prohibited.

**Exceptions:**

1. Equipment allowed or required by the *International Building Code* to serve the exit enclosure such as ductwork and equipment necessary for independent stairway pressurization, sprinkler piping, standpipes, electrical conduit terminating in a listed box not exceeding 16 square inches (10,323 mm<sup>2</sup>) in area,

## GENERAL REGULATIONS

and piping used exclusively for the drainage of rainfall runoff from roof areas provided the roof shall not be used for a helistop or heliport.

2. Unfired heaters allowed by the *International Building Code* for freeze protection of fire protection equipment may penetrate one protective membrane. The conduit serving the heater may penetrate both protective membranes.

Penetrations and communicating openings between exit enclosures in the same building are not permitted regardless of their protection. Penetrations shall be protected as required by the *International Building Code*.

### SECTION 304 (IFGS)

#### COMBUSTION, VENTILATION AND DILUTION AIR

**304.1 General.** Air for combustion, ventilation and dilution of flue gases for gas utilization equipment installed in buildings shall be provided by application of one of the methods prescribed in Sections 304.5 through 304.9. Where the requirements of Section 304.5 are not met, outdoor air shall be introduced in accordance with one of the methods prescribed in Sections 304.6 through 304.9. Direct-vent appliances, gas appliances of other than natural draft design and vented gas appliances other than Category I shall be provided with combustion, ventilation and dilution air in accordance with the equipment manufacturer's instructions.

**Exception:** Type 1 clothes dryers that are provided with makeup air in accordance with Section 614.5.

**304.2 Appliance/equipment location.** Equipment shall be located so as not to interfere with proper circulation of combustion, ventilation and dilution air.

**304.3 Draft hood/regulator location.** Where used, a draft hood or a barometric draft regulator shall be installed in the same room or enclosure as the equipment served so as to prevent any difference in pressure between the hood or regulator and the combustion air supply.

**304.4 Makeup air provisions.** Makeup 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.

**304.5 Indoor combustion air.** The required volume of indoor air shall be determined in accordance with Section 304.5.1 or 304.5.2, except that where the air infiltration rate is known to be less than 0.40 air changes per hour (ACH), Section 304.5.2 shall be used. The total required volume shall be the sum of the required volume calculated for all appliances located within the space. Rooms communicating directly with the space in which the appliances are installed through openings not furnished with doors, and through combustion air openings sized and located in accordance

with Section 304.5.3, are considered to be part of the required volume.

**304.5.1 Standard method.** The minimum required volume shall be 50 cubic feet per 1,000 Btu/h (4.8m<sup>3</sup>/kW) of the appliance input rating.

**304.5.2 Known air-infiltration-rate method.** Where the air infiltration rate of a structure is known, the minimum required volume shall be determined as follows:

For appliances other than fan-assisted, calculate volume using Equation 3-1.

$$\text{Required Volume}_{\text{other}} \geq \frac{21 \text{ ft}^3}{\text{ACH}} \left( \frac{I_{\text{other}}}{1,000 \text{ BTU / hr}} \right)$$

(Equation 3-1)

For fan-assisted appliances, calculate volume using Equation 3-2.

$$\text{Required Volume}_{\text{fan}} \geq \frac{15 \text{ ft}^3}{\text{ACH}} \left( \frac{I_{\text{fan}}}{1,000 \text{ BTU / hr}} \right)$$

(Equation 3-2)

where:

$I_{\text{other}}$  = All appliances other than fan assisted (input in Btu/h).

$I_{\text{fan}}$  = Fan-assisted appliance (input in Btu/h).

$\text{ACH}$  = Air change per hour (percent of volume of space exchanged per hour, expressed as a decimal).

For purposes of this calculation, an infiltration rate greater than 0.60 ACH shall not be used in Equations 3-1 and 3-2.

**304.5.3 Indoor opening size and location.** Openings used to connect indoor spaces shall be sized and located in accordance with Sections 304.5.3.1 and 304.5.3.2 (see Figure 304.5.3).

**304.5.3.1 Combining spaces on the same story.** Each opening shall have a minimum free area of 1 square inch per 1,000 Btu/h (2,200mm<sup>2</sup>/kW) of the total input rating of all gas utilization equipment in the space, but not less than 100 square inches (0.06 m<sup>2</sup>). One opening shall commence within 12 inches (305 mm) of the top and one opening shall commence within 12 inches (305 mm) of the bottom of the enclosure. The minimum dimension of air openings shall be not less than 3 inches (76 mm).

**304.5.3.2 Combining spaces in different stories.** The volumes of spaces in different stories shall be considered as communicating spaces where such spaces

are connected by one or more openings in doors or floors having a total minimum free area of 2 square inches per 1,000 Btu/h (4402mm<sup>2</sup>/kW) of total input rating of all gas utilization equipment.

**304.6 Outdoor combustion air.** Outdoor combustion air shall be provided through opening(s) to the outdoors in accordance with Section 304.6.1 or 304.6.2. The minimum dimension of air openings shall be not less than 3 inches (76 mm).

**304.6.1 Two-permanent-openings method.** Two permanent openings, one commencing within 12 inches (305 mm) of the top and one commencing within 12 inches (305 mm) of the bottom of the enclosure, shall be provided. The openings shall communicate directly, or by ducts, with the outdoors or spaces that freely communicate with the outdoors.

Where directly communicating with the outdoors, or where communicating with the outdoors through vertical ducts, each opening shall have a minimum free area of 1 square inch per 4,000 Btu/h (550 mm<sup>2</sup>/kW) of total input rating of all equipment in the enclosure [see Figures 304.6.1(1) and 304.6.1(2)].

Where communicating with the outdoors through horizontal ducts, each opening shall have a minimum free area of not less than 1 square inch per 2,000 Btu/h (1,100 mm<sup>2</sup>/kW) of total input rating of all equipment in the enclosure [see Figure 304.6.1(3)].

**304.6.2 One-permanent-opening method.** One permanent opening, commencing within 12 inches (305 mm) of the top of the enclosure, shall be provided. The equipment shall have clearances of at least 1 inch (25 mm) from the sides and back and 6 inches (152 mm) from the front of the appliance. The opening shall directly communicate with the outdoors or through a vertical or horizontal duct to the outdoors or spaces that freely communicate with the outdoors [see Figure 304.6.2] and shall have a minimum free area of 1 square inch per 3,000 Btu/h (734mm<sup>2</sup>/kW) of the total input rating of all equipment located in the enclosure, and not less than the sum of the areas of all vent connectors in the space.

**304.7 Combination indoor and outdoor combustion air.** The use of a combination of indoor and outdoor combustion air shall be in accordance with Sections 304.7.1 through 304.7.3.

**304.7.1 Indoor openings.** Where used, openings connecting the interior spaces shall comply with Section 304.5.3.

**304.7.2 Outdoor opening location.** Outdoor opening(s) shall be located in accordance with Section 304.6.

**304.7.3 Outdoor opening(s) size.** The outdoor opening(s) size shall be calculated in accordance with the following:

1. The ratio of interior spaces shall be the available volume of all communicating spaces divided by the required volume.
2. The outdoor size reduction factor shall be one minus the ratio of interior spaces.
3. The minimum size of outdoor opening(s) shall be the full size of outdoor opening(s) calculated in accordance with Section 304.6, multiplied by the reduction factor. The minimum dimension of air openings shall be not less than 3 inches (76 mm).

**304.8 Engineered installations.** Engineered combustion air installations shall provide an adequate supply of combustion, ventilation and dilution air and shall be approved.

**304.9 Mechanical combustion air supply.** Where all combustion air is provided by a mechanical air supply system, the combustion air shall be supplied from the outdoors at a rate not less than 0.35 cubic feet per minute per 1,000 Btu/h (0.034 m<sup>3</sup>/min per kW) of total input rating of all appliances located within the space.

**304.9.1 Makeup air.** Where exhaust fans are installed, makeup air shall be provided to replace the exhausted air.

**304.9.2 Appliance interlock.** Each of the appliances served shall be interlocked with the mechanical air supply system to prevent main burner operation when the mechanical air supply system is not in operation.

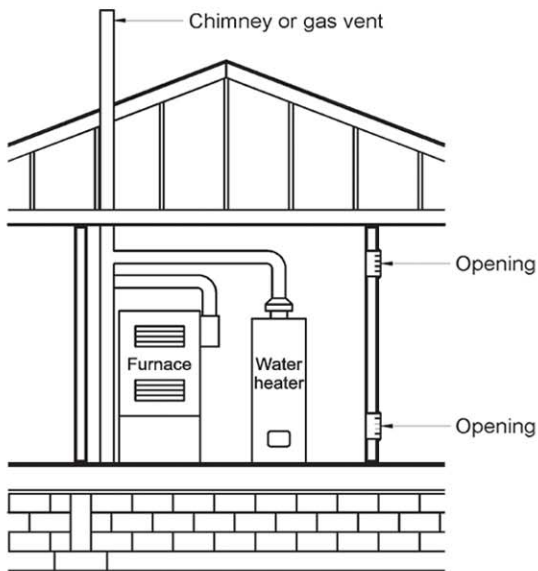
**304.9.3 Combined combustion air and ventilation air system.** Where combustion air is provided by the building's mechanical ventilation system, the system shall provide the specified combustion air rate in addition to the required ventilation air.

**304.10 Louvers and grilles.** The required size of openings for combustion, ventilation and dilution air shall be based on the net free area of each opening. Where the free area through a design of louver or grille is known, it shall be used in calculating the size opening required to provide the free area specified. Where the design and free area are not known, it shall be assumed that wood louvers will have 25-percent free area and metal louvers and grilles will have 75-percent free area. Nonmotorized louvers and grilles shall be fixed in the open position. Motorized louvers shall be interlocked with the equipment so that they are proven to be in the full open position prior to main burner ignition and during main burner operation. Means shall be provided to prevent the main burner from igniting if the louvers fail to open during burner start-up and to shut down the main burner if the louvers close during operation.

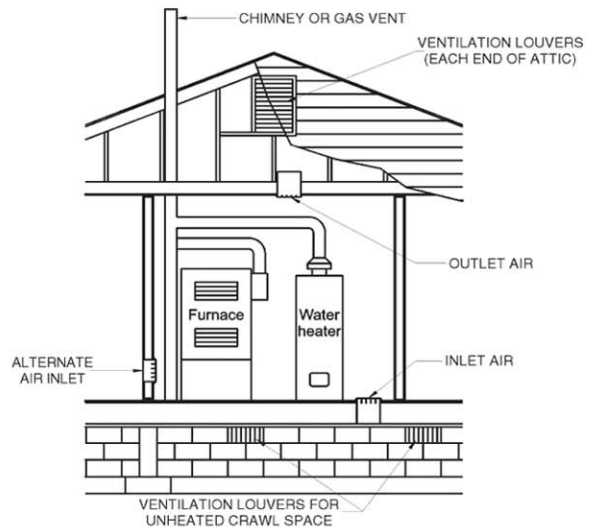
**304.11 Combustion air ducts.** Combustion air ducts shall comply with all of the following:

1. Ducts shall be of galvanized steel complying with Chapter 6 of the *International Mechanical Code* or of

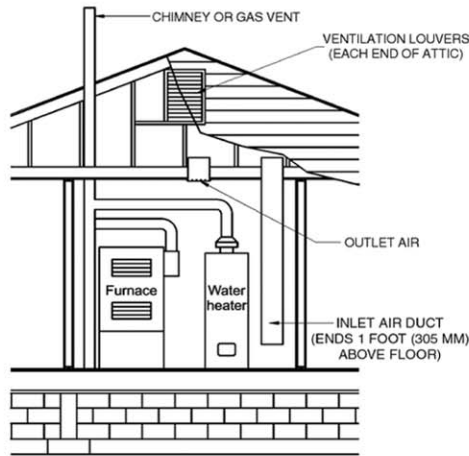
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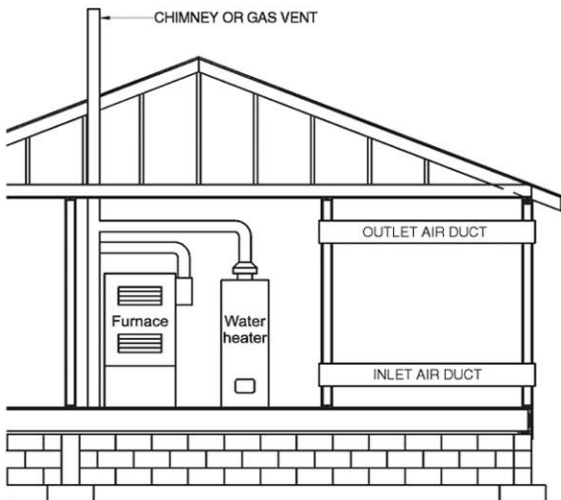
**FIGURE 304.5.3**  
**ALL AIR FROM INSIDE THE BUILDING** (see Section 304.5.3)



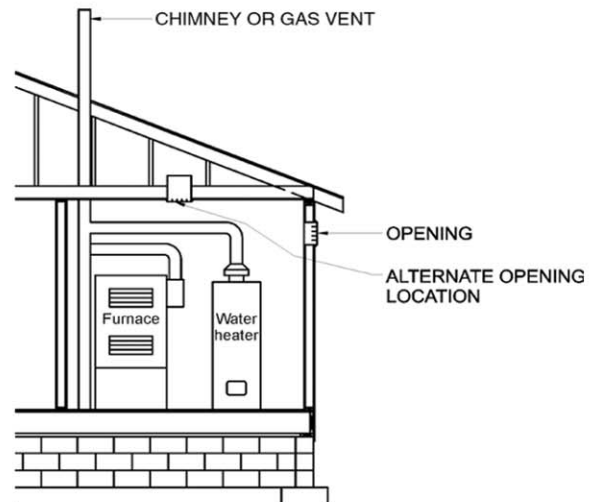
**FIGURE 304.6.1(1)**  
**ALL AIR FROM OUTDOORS—INLET AIR FROM VENTILATED CRAWL SPACE AND OUTLET AIR TO VENTILATED ATTIC** (see Section 304.6.1)



**FIGURE 304.6.1(2)**  
**ALL AIR FROM OUTDOORS THROUGH VENTILATED ATTIC** (see Section 304.6.1)



**FIGURE 304.6.1(3)**  
**ALL AIR FROM OUTDOORS** (see Section 304.6.1)



**FIGURE 304.6.2**  
**SINGLE COMBUSTION AIR OPENING, ALL AIR FROM THE OUTDOORS** (see Section 304.6.2)

equivalent corrosion-resistant material approved for this application.

**Exception:** Within dwellings units, unobstructed stud and joist spaces shall not be prohibited from conveying combustion air, provided that not more than one required fireblock is removed.

2. Ducts shall terminate in an unobstructed space allowing free movement of combustion air to the appliances.
3. Ducts shall serve a single enclosure.
4. Ducts shall not serve both upper and lower combustion air openings where both such openings are used. The separation between ducts serving upper and lower combustion air openings shall be maintained to the source of combustion air.
5. Ducts shall not be screened where terminating in an attic space.
6. Horizontal upper combustion air ducts shall not slope downward toward the source of combustion air.
7. The remaining space surrounding a chimney liner, gas vent, special gas vent or plastic piping installed within a masonry, metal or factory-built chimney shall not be used to supply combustion air.

**Exception:** Direct-vent gas-fired appliances designed for installation in a solid fuel-burning fireplace where installed in accordance with the listing and the manufacturer's instructions.

8. Combustion air intake openings located on the exterior of a building shall have the lowest side of such openings located not less than 12 inches (305 mm) vertically from the adjoining grade level.

**304.12 Protection from fumes and gases.** Where corrosive or flammable process fumes or gases, other than products of combustion, are present, means for the disposal of such fumes or gases shall be provided. Such fumes or gases include carbon monoxide, hydrogen sulfide, ammonia, chlorine and halogenated hydrocarbons.

In barbershops, beauty shops and other facilities where chemicals that generate corrosive or flammable products, such as aerosol sprays, are routinely used, nondirect-vent-type appliances shall be located in an equipment room separated or partitioned off from other areas with provisions for combustion air and dilution air from the outdoors. Direct-vent appliances shall be installed in accordance with the appliance manufacturer's installation instructions.

### SECTION 305 (IFGC) INSTALLATION

**305.1 General.** Equipment and appliances shall be installed as required by the terms of their approval, in accordance

with the conditions of listing, the manufacturer's instructions and this code. Manufacturers' installation instructions shall be available on the job site at the time of inspection. Where a code provision is less restrictive than the conditions of the listing of the equipment or appliance or the manufacturer's installation instructions, the conditions of the listing and the manufacturer's installation instructions shall apply.

Unlisted appliances approved in accordance with Section 301.3 shall be limited to uses recommended by the manufacturer and shall be installed in accordance with the manufacturer's instructions, the provisions of this code and the requirements determined by the code official.

**305.2 Hazardous area.** Equipment and appliances having an ignition source shall not be installed in Group H occupancies or control areas where open use, handling or dispensing of combustible, flammable or explosive materials occurs.

**305.3 Elevation of ignition source.** Equipment and appliances having an ignition source shall be elevated such that the source of ignition is not less than 18 inches (457 mm) above the floor in hazardous locations and public garages, private garages, repair garages, motor fuel-dispensing facilities and parking garages. For the purpose of this section, rooms or spaces that are not part of the living space of a dwelling unit and that communicate directly with a private garage through openings shall be considered to be part of the private garage.

**Exception:** Elevation of the ignition source is not required for appliances that are listed as flammable vapor resistant and for installation without elevation.

**305.4 Public garages.** Appliances located in public garages, motor fuel-dispensing facilities, repair garages or other areas frequented by motor vehicles shall be installed a minimum of 8 feet (2438 mm) above the floor. Where motor vehicles exceed 6 feet (1829 mm) in height and are capable of passing under an appliance, appliances shall be installed a minimum of 2 feet (610 mm) higher above the floor than the height of the tallest vehicle.

**Exception:** The requirements of this section shall not apply where the appliances are protected from motor vehicle impact and installed in accordance with Section 305.3 and NFPA 88B.

**305.5 Private garages.** Appliances located in private garages shall be installed with a minimum clearance of 6 feet (1829 mm) above the floor.

**Exception:** The requirements of this section shall not apply where the appliances are protected from motor vehicle impact and installed in accordance with Section 305.3.



**305.6 Construction and protection.** Boiler rooms and furnace rooms shall be protected as required by the *International Building Code*.

**305.7 Clearances from grade.** Equipment and appliances installed at grade level shall be supported on a level concrete slab or other approved material extending above adjoining grade or shall be suspended a minimum of 6 inches (152 mm) above adjoining grade.

**305.8 Clearances to combustible construction.** Heat-producing equipment and appliances shall be installed to maintain the required clearances to combustible construction as specified in the listing and manufacturer's instructions. Such clearances shall be reduced only in accordance with Section 308. Clearances to combustibles shall include such considerations as door swing, drawer pull, overhead projections or shelving and window swing. Devices, such as door stops or limits and closers, shall not be used to provide the required clearances.

**SECTION 306 (IFGC)  
ACCESS AND SERVICE SPACE**

**[M] 306.1 Clearances for maintenance and replacement.** Clearances around appliances to elements of permanent construction, including other installed appliances, shall be sufficient to allow inspection, service, repair or replacement without removing such elements of permanent construction or disabling the function of a required fire-resistance-rated assembly.

**[M] 306.2 Appliances in rooms.** Rooms containing appliances requiring access shall be provided with a door and an unobstructed passageway measuring not less than 36 inches (914 mm) wide and 80 inches (2032 mm) high.

**Exception:** Within a dwelling unit, appliances installed in a compartment, alcove, basement or similar space shall be provided with access by an opening or door and an unobstructed passageway measuring not less than 24 inches (610 mm) wide and large enough to allow removal of the largest appliance in the space, provided that a level service space of not less than 30 inches (762 mm) deep and the height of the appliance, but not less than 30 inches (762 mm), is present at the front or service side of the appliance with the door open.

**[M] 306.3 Appliances in attics.** Attics containing appliances requiring access shall be provided with an opening and unobstructed passageway large enough to allow removal of the largest component of the appliance. The passageway shall not be less than 30 inches (762 mm) high and 22 inches (559 mm) wide and not more than 20 feet (6096 mm) in length when measured along the centerline of the passageway from the opening to the equipment. The passageway shall have continuous solid flooring not less than 24 inches (610 mm) wide. A level service space not less than 30 inches (762 mm) deep and 30 inches (762 mm)

wide shall be present at the front or service side of the equipment. The clear access opening dimensions shall be a minimum of 20 inches by 30 inches (508 mm by 762 mm), where such dimensions are large enough to allow removal of the largest component of the appliance.

**Exceptions:**

1. The passageway and level service space are not required where the appliance is capable of being serviced and removed through the required opening.
2. Where the passageway is not less than 6 feet (1829 mm) high for its entire length, the passageway shall be not greater than 50 feet (15 250 mm) in length.

**[M] 306.3.1 Electrical requirements.** A lighting fixture controlled by a switch located at the required passageway opening and a receptacle outlet shall be provided at or near the equipment location in accordance with the *ICC Seattle Electrical Code*.

**[M] 306.4 Appliances under floors.** Under-floor spaces containing appliances requiring access shall be provided with an access opening and unobstructed passageway large enough to remove the largest component of the appliance. The passageway shall not be less than 30 inches (762 mm) high and 22 inches (559 mm) wide, nor more than 20 feet (6096 mm) in length when measured along the centerline of the passageway from the opening to the equipment. A level service space not less than 30 inches (762 mm) deep and 30 inches (762 mm) wide shall be present at the front or service side of the appliance. If the depth of the passageway or the service space exceeds 12 inches (305 mm) below the adjoining grade, the walls of the passageway shall be lined with concrete or masonry extending 4 inches (102 mm) above the adjoining grade and having sufficient lateral-bearing capacity to resist collapse. The clear access opening dimensions shall be a minimum of 22 inches by 30 inches (559 mm by 762 mm), where such dimensions are large enough to allow removal of the largest component of the appliance.

**Exceptions:**

1. The passageway is not required where the level service space is present when the access is open and the appliance is capable of being serviced and removed through the required opening.
2. Where the passageway is not less than 6 feet high (1829 mm) for its entire length, the passageway shall not be limited in length.

**[M] 306.4.1 Electrical requirements.** A lighting fixture controlled by a switch located at the required passageway opening and a receptacle outlet shall be provided at or near the equipment location in accordance with the *ICC Seattle Electrical Code*.

**[M] 306.5 Appliances on roofs or elevated structures.** Where appliances requiring access are installed on roofs or elevated structures at a height exceeding 16 feet (4877 mm), such access shall be provided by a permanent approved means of access, the extent of which shall be from grade or floor level to the appliance's level service space. Such access shall not require climbing over obstructions greater than 30 inches high (762 mm) or walking on roofs having a slope greater than four units vertical in 12 units horizontal (33-percent slope).

Permanent ladders installed to provide the required access shall comply with the following minimum design criteria.

1. The side railing shall extend above the parapet or roof edge not less than 30 inches (762 mm).
2. Ladders shall have a rung spacing not to exceed 14 inches (356 mm) on center.
3. Ladders shall have a toe spacing not less than 6 inches (152 mm) deep.
4. There shall be a minimum of 18 inches (457 mm) between rails.
5. Rungs shall have a minimum diameter of 0.75-inch (19 mm) and shall be capable of withstanding a 300-pound (136.1 kg) load.
6. Ladders over 30 feet (9144 mm) in height shall be provided with offset sections and landings capable of withstanding a load of 100 pounds per square foot (488.2 kg/m<sup>2</sup>).
7. Ladders shall be protected against corrosion by approved means.

Catwalks installed to provide the required access shall be not less than 24 inches wide (610 mm) and shall have railings as required for service platforms.

**Exception:** This section shall not apply to Group R-3 occupancies.

**[M] 306.5.1 Sloped roofs.** Where appliances are installed on a roof having a slope of three units vertical in 12 units horizontal (25-percent slope) or greater and having an edge more than 30 inches (762 mm) above grade at such edge, a level platform shall be provided on each side of the appliance to which access is required by the manufacturer's installation instructions for service, repair or maintenance. The platform shall not be less than 30 inches (762 mm) in any dimension and shall be provided with guards in accordance with Section 306.6.

**[M] 306.5.2 Electrical requirements.** A receptacle outlet shall be provided at or near the equipment location in accordance with the ICC Seattle Electrical Code.

**[M] 306.6 Guards.** Guards shall be provided where appliances, fans or other components that require service are

located within 10 feet (3048 mm) of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches (762 mm) above the floor, roof or grade below. The guard shall extend not less than 30 inches (762 mm) beyond each end of such appliances, fans or other components and the top of the guard shall be located not less than 42 inches (1067 mm) above the elevated surface adjacent to the guard. The guard shall be constructed so as to prevent the passage of a 21-inch-diameter (533 mm) sphere and shall comply with the loading requirements for guards specified in the *International Building Code*.

### SECTION 307 (IFGC) CONDENSATE DISPOSAL

**307.1 Fuel-burning appliances.** Liquid combustion by-products of condensing appliances shall be collected and discharged to an approved plumbing fixture or disposal area in accordance with the manufacturer's installation instructions. Condensate piping shall be of approved corrosion-resistant material and shall not be smaller than the drain connection on the appliance. Such piping shall maintain a minimum slope in the direction of discharge of not less than one-eighth unit vertical in 12 units horizontal (1-percent slope).

**[M] 307.2 Drain pipe materials and sizes.** Components of the condensate disposal system shall be cast iron, galvanized steel, copper, polybutylene, polyethylene, ABS, CPVC or PVC pipe or tubing. All components shall be selected for the pressure and temperature rating of the installation. Condensate waste and drain line size shall be not less than 3/4-inch internal diameter (19 mm) and shall not decrease in size from the drain connection to the place of condensate disposal. Where the drain pipes from more than one unit are manifolded together for condensate drainage, the pipe or tubing shall be sized in accordance with an approved method. All horizontal sections of drain piping shall be installed in uniform alignment at a uniform slope.

**307.3 Traps.** Condensate drains shall be trapped as required by the equipment or appliance manufacturer.

### SECTION 308 (IFGS) CLEARANCE REDUCTION

**308.1 Scope.** This section shall govern the reduction in required clearances to combustible materials and combustible assemblies for chimneys, vents, appliances, devices and equipment. Clearance requirements for air-conditioning equipment and central heating boilers and furnaces shall comply with Sections 308.3 and 308.4.

**308.2 Reduction table.** The allowable clearance reduction shall be based on one of the methods specified in Table 308.2 or shall utilize an assembly listed for such application. Where required clearances are not listed in Table 308.2, the reduced clearances shall be determined by linear interpolation between the distances listed in the table.

## GENERAL REGULATIONS

Reduced clearances shall not be derived by extrapolation below the range of the table. The reduction of the required clearances to combustibles for listed and labeled appliances and equipment shall be in accordance with the requirements of this section except that such clearances shall not be reduced where reduction is specifically prohibited by the terms of the appliance or equipment listing [see Figures 308.2(1) through 308.2(3)].

**308.3 Clearances for indoor air-conditioning equipment.** Clearance requirements for indoor air-conditioning equipment shall comply with Sections 308.3.1 through 308.3.5.

**308.3.1 Equipment installed in rooms that are large in comparison with the size of the equipment.** Air-conditioning equipment installed in rooms that are large in comparison with the size of the equipment shall be installed with clearances in accordance with the terms of their listing and the manufacturer's instructions.

**308.3.2 Equipment installed in rooms that are not large in comparison with the size of the equipment.** Air-conditioning equipment installed in rooms that are not large in comparison with the size of the equipment, such as alcoves and closets, shall be listed for such installations and installed in accordance with the manufacturer's instructions. Listed clearances shall not be reduced by the protection methods described in Table 308.2, regardless of whether the enclosure is of combustible or noncombustible material.

**308.3.3 Clearance reduction.** Air-conditioning equipment installed in rooms that are large in comparison with the size of the equipment shall be permitted to be installed with reduced clearances to combustible material provided the combustible material or equipment is protected as described in Table 308.2.

**308.3.4 Plenum clearances.** Where the furnace 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 where the clearance specified is 2 inches (51 mm) or less.

**308.3.5 Clearance from supply ducts.** Air-conditioning equipment shall have the clearance from supply ducts within 3 feet (914 mm) of the furnace plenum be not less than that specified from the furnace plenum. No clearance is necessary beyond this distance.

**308.4 Central-heating boilers and furnaces.** Clearance requirements for central-heating boilers and furnaces shall comply with Sections 308.4.1 through 308.4.6. The clearance to this equipment shall not interfere with combustion air, draft hood clearance and relief, and accessibility for servicing.

**308.4.1 Equipment installed in rooms that are large in comparison with the size of the equipment.** Central-heating furnaces and low-pressure boilers installed in

rooms large in comparison with the size of the equipment shall be installed with clearances in accordance with the terms of their listing and the manufacturer's instructions.

**308.4.2 Equipment installed in rooms that are not large in comparison with the size of the equipment.** Central-heating furnaces and low-pressure boilers installed in rooms that are not large in comparison with the size of the equipment, such as alcoves and closets, shall be listed for such installations. Listed clearances shall not be reduced by the protection methods described in Table 308.2 and illustrated in Figures 308.2(1) through 308.2(3), regardless of whether the enclosure is of combustible or noncombustible material.

**308.4.3 Clearance reduction.** Central-heating furnaces and low-pressure boilers installed in rooms that are large in comparison with the size of the equipment shall be permitted to be installed with reduced clearances to combustible material provided the combustible material or equipment is protected as described in Table 308.2.

**308.4.4 Clearance for servicing equipment.** Front clearance shall be sufficient for servicing the burner and the furnace or boiler.

**308.4.5 Plenum clearances.** Where the furnace 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 where the clearance specified is 2 inches (51 mm) or less.

**308.4.6 Clearance from supply ducts.** Central-heating furnaces shall have the clearance from supply ducts within 3 feet (914 mm) of the furnace plenum be not less than that specified from the furnace plenum. No clearance is necessary beyond this distance.

### SECTION 309 (IFGC) ELECTRICAL

**309.1 Grounding.** Gas piping shall not be used as a grounding electrode.

**309.2 Connections.** Electrical connections between equipment and the building wiring, including the grounding of the equipment, shall conform to the IEC Seattle Electrical Code.

### SECTION 310 (IFGS) ELECTRICAL BONDING

**310.1 Gas pipe bonding.** Each above-ground portion of a gas piping system that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping shall be considered to be bonded where it is connected to gas utilization equipment that is connected to the equipment grounding conductor of the circuit supplying that equipment.

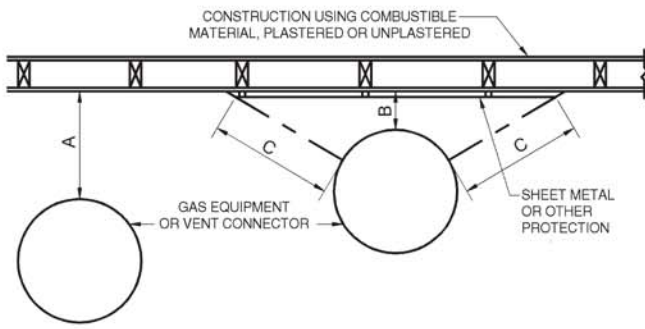
**TABLE 308.2<sup>a-k</sup>**  
**REDUCTION OF CLEARANCES WITH SPECIFIED FORMS OF PROTECTION**

TYPE OF PROTECTION APPLIED TO AND COVERING ALL SURFACES OF COMBUSTIBLE MATERIAL WITHIN THE DISTANCE SPECIFIED AS THE REQUIRED CLEARANCE WITH NO PROTECTION [see Figures 308.2(1), 308.2(2), and 308.2(3)]	WHERE THE REQUIRED CLEARANCE WITH NO PROTECTION FROM APPLIANCE, VENT CONNECTOR, OR SINGLE-WALL METAL PIPE IS: (inches)									
	36		18		12		9		6	
	Allowable clearances with specified protection (inches)									
	Use Column 1 for clearances above appliance or horizontal connector. Use Column 2 for clearances from appliance, vertical connector, and single-wall metal pipe.									
	Above Col. 1	Sides and rear Col. 2	Above Col. 1	Sides and rear Col. 2	Above Col. 1	Sides and rear Col. 2	Above Col. 1	Sides and rear Col. 2	Above Col. 1	Sides and rear Col. 2
1. 3/2-inch-thick masonry wall without ventilated airspace	—	24	—	12	—	9	—	6	—	5
2. 1/2-inch insulation board over 1-inch glass fiber or mineral wool batts	24	18	12	9	9	6	6	5	4	3
3. 0.024 sheet metal over 1-inch glass fiber or mineral wool batts reinforced with wire on rear face with ventilated airspace	18	12	9	6	6	4	5	3	3	3
4. 3/2-inch-thick masonry wall with ventilated airspace	—	12	—	6	—	6	—	6	—	6
5. 0.024 sheet metal with ventilated airspace	18	12	9	6	6	4	5	3	3	2
6. 1/2-inch-thick insulation board with ventilated airspace	18	12	9	6	6	4	5	3	3	3
7. 0.024 sheet metal with ventilated airspace over 0.024 sheet metal with ventilated airspace	18	12	9	6	6	4	5	3	3	3
8. 1-inch glass fiber or mineral wool batts sandwiched between two sheets 0.024 sheet metal with ventilated airspace	18	12	9	6	6	4	5	3	3	3

For SI: 1 inch = 25.4 mm, °C = [(°F - 32)/1.8], 1 pound per cubic foot = 16.02 kg/m<sup>3</sup>, 1 Btu per inch per square foot per hour per °F = 0.144 W/m<sup>2</sup> · K.

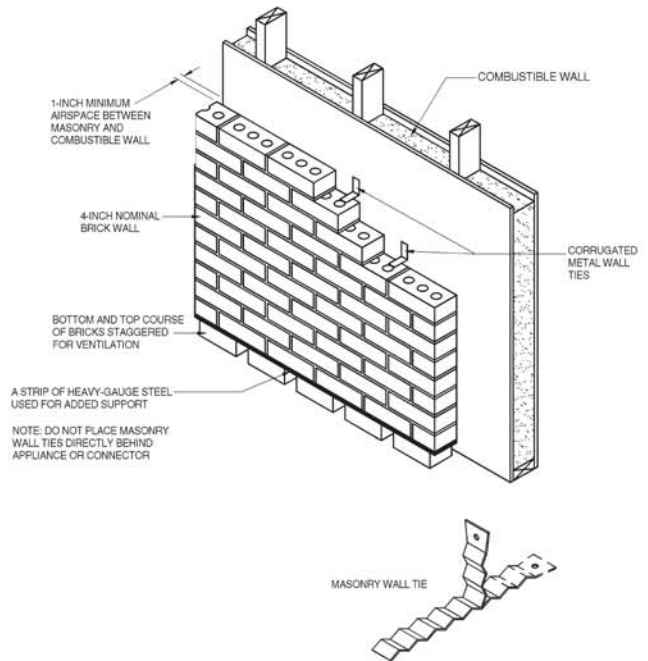
- a. Reduction of clearances from combustible materials shall not interfere with combustion air, draft hood clearance and relief, and accessibility of servicing.
- b. All clearances shall be measured from the outer surface of the combustible material to the nearest point on the surface of the appliance, disregarding any intervening protection applied to the combustible material.
- c. Spacers and ties shall be of noncombustible material. No spacer or tie shall be used directly opposite an appliance or connector.
- d. For all clearance reduction systems using a ventilated airspace, adequate provision for air circulation shall be provided as described [see Figures 308.2(2) and 308.2(3)].
- e. There shall be at least 1 inch between clearance reduction systems and combustible walls and ceilings for reduction systems using ventilated airspace.
- f. Where a wall protector is mounted on a single flat wall away from corners, it shall have a minimum 1-inch air gap. To provide air circulation, the bottom and top edges, or only the side and top edges, or all edges shall be left open.
- g. Mineral wool batts (blanket or board) shall have a minimum density of 8 pounds per cubic foot and a minimum melting point of 1500°F.
- h. Insulation material used as part of a clearance reduction system shall have a thermal conductivity of 1.0 Btu per inch per square foot per hour per °F or less.
- i. There shall be at least 1 inch between the appliance and the protector. In no case shall the clearance between the appliance and the combustible surface be reduced below that allowed in this table.
- j. All clearances and thicknesses are minimum; larger clearances and thicknesses are acceptable.
- k. Listed single-wall connectors shall be installed in accordance with the terms of their listing and the manufacturer’s instructions.

**GENERAL REGULATIONS**



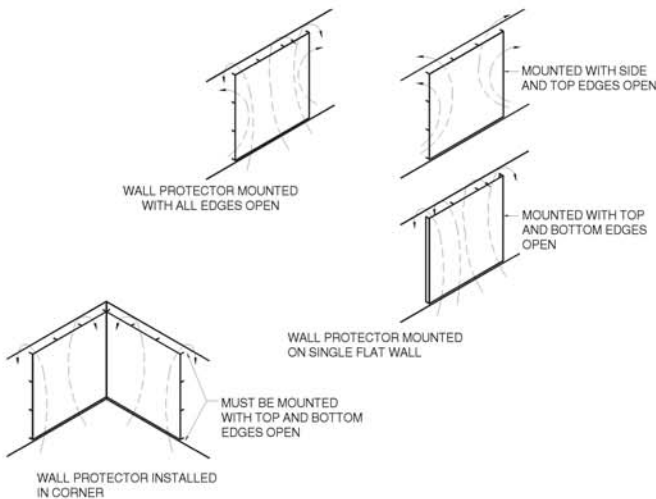
"A" equals the reduced clearance with no protection.  
 "B" equals the reduced clearance permitted in accordance with Table 308.2.  
 The protection applied to the construction using combustible material shall extend far enough in each direction to make "C" equal to "A."

**FIGURE 308.2(1)  
 EXTENT OF PROTECTION NECESSARY TO  
 REDUCE CLEARANCES FROM GAS EQUIPMENT OR  
 VENT CONNECTIONS**



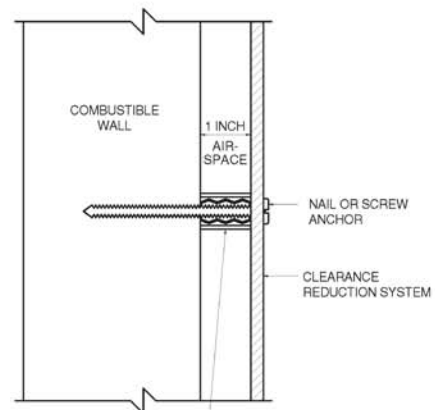
For SI: 1 inch = 25.4 mm.

**FIGURE 308.2(3)  
 MASONRY CLEARANCE REDUCTION SYSTEM**



For SI: 1 inch = 25.4 mm.

**FIGURE 308.2(2)  
 WALL PROTECTOR CLEARANCE REDUCTION SYSTEM**



1-INCH NONCOMBUSTIBLE SPACER SUCH AS STACKED WASHERS, SMALL-DIAMETER PIPE, TUBING OR ELECTRICAL CONDUIT.  
 MASONRY WALLS CAN BE ATTACHED TO COMBUSTIBLE WALLS USING WALL TIES.  
 DO NOT USE SPACERS DIRECTLY BEHIND APPLIANCE OR CONNECTOR.

# CHAPTER 4

## GAS PIPING INSTALLATIONS

### SECTION 401 (IFGC) GENERAL

**401.1 Scope.** This chapter shall govern the design, installation, modification and maintenance of piping systems. The applicability of this code to piping systems extends from the point of delivery to the connections with the equipment and includes the design, materials, components, fabrication, assembly, installation, testing, inspection, operation and maintenance of such piping systems.

**401.1.1 Utility piping systems located within buildings.** Utility service piping located within buildings shall be installed in accordance with the structural safety and fire protection provisions of the *International Building Code*.

**401.2 Liquefied petroleum gas storage.** The storage system for liquefied petroleum gas shall be designed and installed in accordance with the *International Fire Code* and NFPA 58.

**401.3 Modifications to existing systems.** In modifying or adding to existing piping systems, sizes shall be maintained in accordance with this chapter.

**401.4 Additional appliances.** Where an additional appliance is to be served, the existing piping shall be checked to determine if it has adequate capacity for all appliances served. If inadequate, the existing system shall be enlarged as required or separate piping of adequate capacity shall be provided.

**401.5 Identification.** For other than black steel pipe, exposed piping shall be identified by a yellow label marked "Gas" in black letters. The marking shall be spaced at intervals not exceeding 5 feet (1524 mm). The marking shall not be required on pipe located in the same room as the equipment served.

**401.6 Interconnections.** Where two or more meters are installed on the same premises but supply separate consumers, the piping systems shall not be interconnected on the outlet side of the meters.

**401.7 Piping meter identification.** Piping from multiple meter installations shall be marked with an approved permanent identification by the installer so that the piping system supplied by each meter is readily identifiable.

**401.8 Minimum sizes.** All pipe utilized for the installation, extension and alteration of any piping system shall be sized to supply the full number of outlets for the intended purpose and shall be sized in accordance with Section 402.

### SECTION 402 (IFGS) PIPE SIZING

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

**402.2 Maximum gas demand.** The volume of gas to be provided, in cubic feet per hour, shall be determined directly from the manufacturer's input ratings of the gas utilization equipment served. Where an input rating is not indicated, the gas supplier, equipment manufacturer or a qualified agency shall be contacted, or the rating from Table 402.2 shall be used for estimating the volume of gas to be supplied.

The total connected hourly load shall be used as the basis for pipe sizing, assuming that all equipment could be operating at full capacity simultaneously. Where a diversity of load can be established, pipe sizing shall be permitted to be based on such loads.

**TABLE 402.2  
APPROXIMATE GAS INPUT FOR TYPICAL APPLIANCES**

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

For SI: 1 British thermal unit per hour = 0.293 W, 1 gallon = 3.785 L,  
1 gallon per minute = 3.785 L/m.

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

1. Pipe sizing tables or sizing equations in accordance with Section 402.4.
2. The sizing tables included in a listed piping system’s manufacturer’s installation instructions.
3. Other approved engineering methods.

**402.4 Sizing tables and equations.** Where Tables 402.4(1) through 402.4(33) are used to size piping or tubing, the pipe length shall be determined in accordance with Section 402.4.1, 402.4.2 or 402.4.3.

Where Equations 4-1 and 4-2 are used to size piping or tubing, the pipe or tubing shall have smooth inside walls and the pipe length shall be determined in accordance with Section 402.4.1, 402.4.2 or 402.4.3. Before Equations 4-1 or 4-2 are permitted to be used, plans stamped by a mechanical engineer licensed in the State of Washington shall be submitted and approved by the code official.

1. Low-pressure gas equation [Less than 1.5 pounds per square inch (psi) (10.3 kPa)]:

$$D = \frac{Q^{0.381}}{19.17 \left( \frac{\Delta H}{C_r \times L} \right)^{0.206}} \quad \text{(Equation 4-1)}$$

2. High-pressure gas equation [1.5 psi (10.3 kPa) and above]:

$$D = \frac{Q^{0.381}}{18.93 \left[ \frac{(P_1^2 - P_2^2) \times Y}{C_r \times L} \right]^{0.206}} \quad \text{(Equation 4-2)}$$

where:

- D = Inside diameter of pipe, inches (mm).
- Q = Input rate appliance(s), cubic feet per hour at 60°F (16°C) and 30-inch mercury column
- P<sub>1</sub> = Upstream pressure, psia (P<sub>1</sub> + 14.7)
- P<sub>2</sub> = Downstream pressure, psia (P<sub>2</sub> + 14.7)
- L = Equivalent length of pipe, feet
- ΔH = Pressure drop, inch water column (27.7 inch water column = 1 psi)

**TABLE 402.4  
C<sub>r</sub> AND Y VALUES FOR NATURAL GAS AND UNDILUTED PROPANE AT STANDARD CONDITIONS**

GAS	EQUATION FACTORS	
	C <sub>r</sub>	Y
Natural gas	0.6094	0.9992
Undiluted propane	1.2462	0.9910

For SI: 1 cubic foot = 0.028 m<sup>3</sup>, 1 foot = 305 mm, 1-inch water column = 0.249 kPa, 1 pound per square inch = 6.895 kPa, 1 British thermal unit per hour = 0.293 W.

**402.4.1 Longest length method.** The pipe size of each section of gas piping shall be determined using the longest length of

piping from the point of delivery to the most remote outlet and the load of the section.

**402.4.2 Branch length method.** Pipe shall be sized as follows:

1. Pipe size of each section of the longest pipe run from the point of delivery to the most remote outlet shall be determined using the longest run of piping and the load of the section.
2. The pipe size of each section of branch piping not previously sized shall be determined using the length of piping from the point of delivery to the most remote outlet in each branch and the load of the section.

**402.4.3 Hybrid pressure.** The pipe size for each section of higher pressure gas piping shall be determined using the longest length of piping from the point of delivery to the most remote line pressure regulator. The pipe size from the line pressure regulator to each outlet shall be determined using the length of piping from the regulator to the most remote outlet served by the regulator.

**402.5 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 equipment, shall be such that the supply pressure at the equipment is greater than the minimum pressure required for proper equipment operation.

**402.6 Maximum design operating pressure.** The maximum design operating pressure for piping systems located inside buildings shall not exceed 5 pounds per square inch gauge (psig) (34 kPa gauge) except where one or more of the following conditions are met:

1. The piping system is welded.
2. The piping is located in a ventilated chase or otherwise enclosed for protection against accidental gas accumulation.
3. The piping is located inside buildings or separate areas of buildings used exclusively for:
  - 3.1. Industrial processing or heating;
  - 3.2. Research;
  - 3.3. Warehousing; or
  - 3.4. Boiler or mechanical equipment rooms.
4. The piping is a temporary installation for buildings under construction.

Plans for piping systems over 5 psig shall be stamped by an engineer licensed to practice in the State of Washington, and shall not be installed until approved by the code official.

**402.6.1 Liquefied petroleum gas systems.** The operating pressure for undiluted LP-gas systems shall not exceed 20 psig (140 kPa gauge). Buildings having systems designed to operate below -5°F (-21°C) or with butane or a propane-butane mix shall be designed to either accommodate liquid LP-gas or prevent LP-gas vapor from condensing into a liquid.

**Exception:** Buildings or separate areas of buildings constructed in accordance with Chapter 7 of NFPA 58, and used exclusively to house industrial processes, research and experimental laboratories, or equipment or processing having similar hazards.

**TABLE 402.4(1)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.50 psi or less
<b>Pressure Drop</b>	0.3 inch WC
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)											
Nominal	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Actual ID	0.364	0.493	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour										
10	32	72	132	278	520	1,050	1,600	3,050	4,800	8,500	17,500
20	22	49	92	190	350	730	1,100	2,100	3,300	5,900	12,000
30	18	40	73	152	285	590	890	1,650	2,700	4,700	9,700
40	15	34	63	130	245	500	760	1,450	2,300	4,100	8,300
50	14	30	56	115	215	440	670	1,270	2,000	3,600	7,400
60	12	27	50	105	195	400	610	1,150	1,850	3,250	6,800
70	11	25	46	96	180	370	560	1,050	1,700	3,000	6,200
80	11	23	43	90	170	350	530	990	1,600	2,800	5,800
90	10	22	40	84	160	320	490	930	1,500	2,600	5,400
100	9	21	38	79	150	305	460	870	1,400	2,500	5,100
125	8	18	34	72	130	275	410	780	1,250	2,200	4,500
150	8	17	31	64	120	250	380	710	1,130	2,000	4,100
175	7	15	28	59	110	225	350	650	1,050	1,850	3,800
200	6	14	26	55	100	210	320	610	980	1,700	3,500

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(2)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.50 psi or less
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)											
Nominal	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Actual ID	0.364	0.493	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour										
10	43	95	175	360	680	1,400	2,100	3,950	6,300	11,000	23,000
20	29	65	120	250	465	950	1,460	2,750	4,350	7,700	15,800
30	24	52	97	200	375	770	1,180	2,200	3,520	6,250	12,800
40	20	45	82	170	320	660	990	1,900	3,000	5,300	10,900
50	18	40	73	151	285	580	900	1,680	2,650	4,750	9,700
60	16	36	66	138	260	530	810	1,520	2,400	4,300	8,800
70	15	33	61	125	240	490	750	1,400	2,250	3,900	8,100
80	14	31	57	118	220	460	690	1,300	2,050	3,700	7,500
90	13	29	53	110	205	430	650	1,220	1,950	3,450	7,200
100	12	27	50	103	195	400	620	1,150	1,850	3,250	6,700
125	11	24	44	93	175	360	550	1,020	1,650	2,950	6,000
150	10	22	40	84	160	325	500	950	1,500	2,650	5,500
175	9	20	37	77	145	300	460	850	1,370	2,450	5,000
200	8	19	35	72	135	280	430	800	1,280	2,280	4,600

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.



**TABLE 402.4(3)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	2.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)									
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour								
10	1,506	3,041	5,561	11,415	17,106	32,944	52,505	92,819	189,326
20	1,065	2,150	3,932	8,072	12,096	23,295	37,127	65,633	133,873
30	869	1,756	3,211	6,591	9,876	19,020	30,314	53,589	109,307
40	753	1,521	2,781	5,708	8,553	16,472	26,253	46,410	94,663
50	673	1,360	2,487	5,105	7,650	14,733	23,481	41,510	84,669
60	615	1,241	2,270	4,660	6,983	13,449	21,435	37,893	77,292
70	569	1,150	2,102	4,315	6,465	12,452	19,845	35,082	71,558
80	532	1,075	1,966	4,036	6,048	11,647	18,563	32,817	66,937
90	502	1,014	1,854	3,805	5,702	10,981	17,502	30,940	63,109
100	462	934	1,708	3,508	5,257	10,125	16,138	28,530	58,194
125	414	836	1,528	3,138	4,702	9,056	14,434	25,518	52,050
150	372	751	1,373	2,817	4,222	8,130	12,960	22,911	46,732
175	344	695	1,271	2,608	3,909	7,527	11,999	21,211	43,265
200	318	642	1,174	2,413	3,613	6,959	11,093	19,608	39,997

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa.

**TABLE 402.4(4)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	5.0 psi
<b>Pressure Drop</b>	3.5 psi
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)									
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour								
10	3,185	6,434	11,766	24,161	36,206	69,727	111,133	196,468	400,732
20	2,252	4,550	8,320	17,084	25,602	49,305	78,583	138,924	283,361
30	1,839	3,715	6,793	13,949	20,904	40,257	64,162	113,431	231,363
40	1,593	3,217	5,883	12,080	18,103	34,864	55,566	98,234	200,366
50	1,425	2,878	5,262	10,805	16,192	31,183	49,700	87,863	179,213
60	1,301	2,627	4,804	9,864	14,781	28,466	45,370	80,208	163,598
70	1,204	2,432	4,447	9,132	13,685	26,354	42,004	74,258	151,463
80	1,153	2,330	4,260	8,542	12,801	24,652	39,291	69,462	141,680
90	1,062	2,145	3,922	8,054	12,069	23,242	37,044	65,489	133,577
100	979	1,978	3,617	7,427	11,128	21,433	34,159	60,387	123,173
125	876	1,769	3,235	6,643	9,953	19,170	30,553	54,012	110,169
150	786	1,589	2,905	5,964	8,937	17,211	27,431	48,494	98,911
175	728	1,471	2,690	5,522	8,274	15,934	25,396	44,897	91,574
200	673	1,360	2,487	5,104	7,649	14,729	23,478	41,504	84,656

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa.

**TABLE 402.4(5)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	1.0 psi or less
<b>Pressure Drop</b>	0.3 inch WC
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)													
Nominal	1	1 <sup>1</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub>	2	2 <sup>1</sup> / <sub>2</sub>	3	3 <sup>1</sup> / <sub>2</sub>	4	5	6	8	10	12
Actual ID	1.049	1.380	1.610	2.067	2.469	3.068	3.548	4.026	5.047	6.065	7.981	10.020	11.938
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour												
50	215	442	662	1,275	2,033	3,594	5,262	7,330	13,261	21,472	44,118	80,130	126,855
100	148	304	455	877	1,397	2,470	3,616	5,038	9,114	14,758	30,322	55,073	87,187
150	119	244	366	704	1,122	1,983	2,904	4,046	7,319	11,851	24,350	44,225	70,014
200	102	209	313	602	960	1,698	2,485	3,462	6,264	10,143	20,840	37,851	59,923
250	90	185	277	534	851	1,505	2,203	3,069	5,552	8,990	18,470	33,547	53,109
300	82	168	251	484	771	1,363	1,996	2,780	5,030	8,145	16,735	30,396	48,120
400	70	143	215	414	660	1,167	1,708	2,380	4,305	6,971	14,323	26,015	41,185
500	62	127	191	367	585	1,034	1,514	2,109	3,816	6,178	12,694	23,056	36,501
1,000	43	87	131	252	402	711	1,041	1,450	2,623	4,246	8,725	15,847	25,087
1,500	34	70	105	203	323	571	836	1,164	2,106	3,410	7,006	12,725	20,146
2,000	29	60	90	173	276	488	715	996	1,802	2,919	5,997	10,891	17,242

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(6)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	1.0 psi or less
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)													
Nominal	1	1 <sup>1</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub>	2	2 <sup>1</sup> / <sub>2</sub>	3	3 <sup>1</sup> / <sub>2</sub>	4	5	6	8	10	12
Actual ID	1.049	1.380	1.610	2.067	2.469	3.068	3.548	4.026	5.047	6.065	7.981	10.020	11.938
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour												
50	284	583	873	1,681	2,680	4,738	6,937	9,663	17,482	28,308	58,161	105,636	167,236
100	195	400	600	1,156	1,842	3,256	4,767	6,641	12,015	19,456	39,974	72,603	114,940
150	157	322	482	928	1,479	2,615	3,828	5,333	9,649	15,624	32,100	58,303	92,301
200	134	275	412	794	1,266	2,238	3,277	4,565	8,258	13,372	27,474	49,900	78,998
250	119	244	366	704	1,122	1,983	2,904	4,046	7,319	11,851	24,350	44,225	70,014
300	108	221	331	638	1,017	1,797	2,631	3,666	6,632	10,738	22,062	40,071	63,438
400	92	189	283	546	870	1,538	2,252	3,137	5,676	9,190	18,883	34,296	54,295
500	82	168	251	484	771	1,363	1,996	2,780	5,030	8,145	16,735	30,396	48,120
1,000	56	115	173	333	530	937	1,372	1,911	3,457	5,598	11,502	20,891	33,073
1,500	45	93	139	267	426	752	1,102	1,535	2,776	4,496	9,237	16,776	26,559
2,000	39	79	119	229	364	644	943	1,313	2,376	3,848	7,905	14,358	22,731

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(7)  
SEMI-RIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.5 psi or less
<b>Pressure Drop</b>	0.3 inch WC
<b>Specific Gravity</b>	0.60

Nominal	K & L ACR	TUBE SIZE (in.)									
		1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
		3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>		Maximum Capacity in Cubic Feet of Gas per Hour									
10		20	42	85	148	210	448	806	1,271	2,646	4,682
20		14	29	58	102	144	308	554	873	1,819	3,218
30		11	23	47	82	116	247	445	701	1,461	2,584
40		10	20	40	70	99	211	381	600	1,250	2,212
50		8.4	17	35	62	88	187	337	532	1,108	1,960
60		7.6	16	32	56	79	170	306	482	1,004	1,776
70		7.0	14	29	52	73	156	281	443	924	1,634
80		6.5	13	27	48	68	145	262	413	859	1,520
90		6.1	13	26	45	64	136	245	387	806	1,426
100		5.8	12	24	43	60	129	232	366	761	1,347
125		5.1	11	22	38	53	114	206	324	675	1,194
150		4.7	10	20	34	48	103	186	294	612	1,082
175		4.3	8.8	18	31	45	95	171	270	563	995
200		4.0	8.2	17	29	41	89	159	251	523	926
250		3.5	7.3	15	26	37	78	141	223	464	821
300		3.2	6.6	13	23	33	71	128	202	420	744

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.  
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(8)  
SEMI-RIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.5 psi or less
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	0.60

Nominal	K & L ACR	TUBE SIZE (in.)									
		1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
		3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>		<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>									
10		27	55	111	195	276	590	1,062	1,675	3,489	6,173
20		18	38	77	134	190	406	730	1,151	2,398	4,242
30		15	30	61	107	152	326	586	925	1,926	3,407
40		13	26	53	92	131	279	502	791	1,648	2,916
50		11	23	47	82	116	247	445	701	1,461	2,584
60		10	21	42	74	105	224	403	635	1,323	2,341
70		9.3	19	39	68	96	206	371	585	1,218	2,154
80		8.6	18	36	63	90	192	345	544	1,133	2,004
90		8.1	17	34	59	84	180	324	510	1,063	1,880
100		7.6	16	32	56	79	170	306	482	1,004	1,776
125		6.8	14	28	50	70	151	271	427	890	1,574
150		6.1	13	26	45	64	136	245	387	806	1,426
175		5.6	12	24	41	59	125	226	356	742	1,312
200		5.2	11	22	39	55	117	210	331	690	1,221
250		4.7	10	20	34	48	103	186	294	612	1,082
300		4.2	8.7	18	31	44	94	169	266	554	980

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.  
 For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**301.15 Prohibited location.** The appliances, equipment and systems regulated by this code shall not be located in an elevator shaft.

## SECTION 302 (IFGC) STRUCTURAL SAFETY

**[B] 302.1 Structural safety.** The building shall not be weakened by the installation of any gas piping. In the process of installing or repairing any gas piping, the finished floors, walls, ceilings, tile work or any other part of the building or premises which is required to be changed or replaced shall be left in a safe structural condition in accordance with the requirements of the *International Building Code*.

**[B] 302.2 Penetrations of floor/ceiling assemblies and fire-resistance-rated assemblies.** Penetrations of floor/ceiling assemblies and assemblies required to have a fire-resistance rating shall be protected in accordance with the *International Building Code*.

**[B] 302.3 Cutting, notching and boring in wood members.** The cutting, notching and boring of wood members shall comply with Sections 302.3.1 through 302.3.4.

**[B] 302.3.1 Engineered wood products.** Cuts, notches and holes bored in trusses, laminated veneer lumber, glued-laminated members and I-joists are prohibited except where the effects of such alterations are specifically considered in the design of the member.

**[B] 302.3.2 Joist notching.** Notching at the ends of joists shall not exceed one-fourth the joist depth. Holes bored in joists shall not be within 2 inches (51 mm) of the top and bottom of the joist and their diameter shall not exceed one-third the depth of the member. Notches in the top or bottom of the joist shall not exceed one-sixth the depth and shall not be located in the middle one-third of the span.

**[B] 302.3.3 Stud cutting and notching.** In exterior walls and bearing partitions, any wood stud is permitted to be cut or notched to a depth not exceeding 25 percent of its width. Cutting or notching of studs to a depth not greater than 40 percent of the width of the stud is permitted in nonload-bearing partitions supporting no loads other than the weight of the partition.

**[B] 302.3.4 Bored holes.** A hole not greater in diameter than 40 percent of the stud depth is permitted to be bored in any wood stud. Bored holes not greater than 60 percent of the depth of the stud are permitted in nonload-bearing partitions or in any wall where each bored stud is doubled, provided not more than two such successive doubled studs are so bored. In no case shall the edge of the bored hole be nearer than  $\frac{5}{8}$  inch (15.9 mm) to the edge of the stud. Bored holes shall not be located at the same section of stud as a cut or notch.

**[B] 302.4 Alterations to trusses.** Truss members and components shall not be cut, drilled, notched, spliced or otherwise altered in any way without the written concurrence and approval of a registered design professional. Alterations resulting in the addition of loads to any member (e.g., HVAC equipment, water heaters) shall not be permitted without verification that the truss is capable of supporting such additional loading.

**[B] 302.5 Cutting, notching and boring holes in structural steel framing.** The cutting, notching and boring of holes in structural steel framing members shall be as prescribed by the registered design professional.

**[B] 302.6 Cutting, notching and boring holes in cold-formed steel framing.** Flanges and lips of load-bearing, cold-formed steel framing members shall not be cut or notched. Holes in webs of load-bearing, cold-formed steel framing members shall be permitted along the centerline of the web of the framing member and shall not exceed the dimensional limitations, penetration spacing or minimum hole edge distance as prescribed by the registered design professional. Cutting, notching and boring holes of steel floor/roof decking shall be as prescribed by the registered design professional.

**[B] 302.7 Cutting, notching and boring holes in nonstructural cold-formed steel wall framing.** Flanges and lips of nonstructural cold-formed steel wall studs shall be permitted along the centerline of the web of the framing member, shall not exceed  $1\frac{1}{2}$  inches (38 mm) in width or 4 inches (102 mm) in length, and the holes shall not be spaced less than 24 inches (610 mm) center to center from another hole or less than 10 inches (254 mm) from the bearing end.

## SECTION 303 (IFGC) APPLIANCE LOCATION

**303.1 General.** Appliances shall be located as required by this section, specific requirements elsewhere in this code and the conditions of the equipment and appliance listing.

**303.2 Hazardous locations.** Appliances shall not be located in a hazardous location unless listed and approved for the specific installation.

**303.3 Prohibited locations.** Appliances shall not be located in, or obtain combustion air from, any of the following rooms or spaces:

1. Sleeping rooms.
2. Bathrooms.
3. Toilet rooms.
4. Storage closets.
5. Surgical rooms.

### Exceptions:

1. Direct-vent appliances that obtain all combustion air directly from the outdoors.
2. Vented room heaters, wall furnaces, vented decorative appliances and decorative appliances for installation in vented solid fuel-burning fireplaces, provided that the room meets the required volume criteria of Section 304.5.
3. A single wall-mounted unvented room heater equipped with an oxygen depletion safety shutoff system and installed in a bathroom, provided that the input rating does not exceed 6,000 Btu/h (1.76kW) and the bathroom meets the required volume criteria of Section 304.5.
4. A single wall-mounted unvented room heater equipped with an oxygen depletion safety shutoff sys-

tem and installed in a bedroom, provided that the input rating does not exceed 10,000 Btu/h (2.93 kW) and the bedroom meets the required volume criteria of Section 304.5.

5. Appliances installed in an enclosure in which all combustion air is taken from the outdoors, in accordance with Section 304.6. Access to such enclosure shall be through a solid weather-stripped door, equipped with an approved self-closing device.

**303.4 Protection from physical damage.** Appliances shall not be installed in a location where subject to physical damage unless protected by approved barriers meeting the requirements of the *International Fire Code*.

**303.5 Indoor locations.** Furnaces and boilers installed in closets and alcoves shall be listed for such installation.

**303.6 Outdoor locations.** Equipment installed in outdoor locations shall be either listed for outdoor installation or provided with protection from outdoor environmental factors that influence the operability, durability and safety of the equipment.

**303.7 Pit locations.** Appliances installed in pits or excavations shall not come in direct contact with the surrounding soil. The sides of the pit or excavation shall be held back a minimum of 12 inches (305 mm) from the appliance. Where the depth exceeds 12 inches (305 mm) below adjoining grade, the walls of the pit or excavation shall be lined with concrete or masonry, such concrete or masonry shall extend a minimum of 4 inches (102 mm) above adjoining grade and shall have sufficient lateral load-bearing capacity to resist collapse. The appliance shall be protected from flooding in an approved manner.

## SECTION 304 (IFGS) COMBUSTION, VENTILATION AND DILUTION AIR

**304.1 General.** Air for combustion, ventilation and dilution of flue gases for gas utilization equipment installed in buildings shall be provided by application of one of the methods prescribed in Sections 304.5 through 304.9. Where the requirements of Section 304.5 are not met, outdoor air shall be introduced in accordance with one of the methods prescribed in Sections 304.6 through 304.9. Direct-vent appliances, gas appliances of other than natural draft design and vented gas appliances other than Category I shall be provided with combustion, ventilation and dilution air in accordance with the equipment manufacturer's instructions.

**Exception:** Type 1 clothes dryers that are provided with makeup air in accordance with Section 614.5.

**304.2 Appliance/equipment location.** Equipment shall be located so as not to interfere with proper circulation of combustion, ventilation and dilution air.

**304.3 Draft hood/regulator location.** Where used, a draft hood or a barometric draft regulator shall be installed in the same room or enclosure as the equipment served so as to prevent any difference in pressure between the hood or regulator and the combustion air supply.

**304.4 Makeup air provisions.** Makeup 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.

**304.5 Indoor combustion air.** The required volume of indoor air shall be determined in accordance with Section 304.5.1 or 304.5.2, except that where the air infiltration rate is known to be less than 0.40 air changes per hour (ACH), Section 304.5.2 shall be used. The total required volume shall be the sum of the required volume calculated for all appliances located within the space. Rooms communicating directly with the space in which the appliances are installed through openings not furnished with doors, and through combustion air openings sized and located in accordance with Section 304.5.3, are considered to be part of the required volume.

**304.5.1 Standard method.** The minimum required volume shall be 50 cubic feet per 1,000 Btu/h (4.8 m<sup>3</sup>/kW) of the appliance input rating.

**304.5.2 Known air-infiltration-rate method.** Where the air infiltration rate of a structure is known, the minimum required volume shall be determined as follows:

For appliances other than fan-assisted, calculate volume using Equation 3-1.

$$\text{Required Volume}_{\text{other}} \geq \frac{21 \text{ ft}^3}{\text{ACH}} \left( \frac{I_{\text{other}}}{1,000 \text{ Btu / hr}} \right)$$

(Equation 3-1)

For fan-assisted appliances, calculate volume using Equation 3-2.

$$\text{Required Volume}_{\text{fan}} \geq \frac{15 \text{ ft}^3}{\text{ACH}} \left( \frac{I_{\text{fan}}}{1,000 \text{ Btu / hr}} \right)$$

(Equation 3-2)

where:

$I_{\text{other}}$  = All appliances other than fan assisted (input in Btu/h).

$I_{\text{fan}}$  = Fan-assisted appliance (input in Btu/h).

$\text{ACH}$  = Air change per hour (percent of volume of space exchanged per hour, expressed as a decimal).

For purposes of this calculation, an infiltration rate greater than 0.60 ACH shall not be used in Equations 3-1 and 3-2.

**304.5.3 Indoor opening size and location.** Openings used to connect indoor spaces shall be sized and located in accordance with Sections 304.5.3.1 and 304.5.3.2 (see Figure 304.5.3).

**304.5.3.1 Combining spaces on the same story.** Each opening shall have a minimum free area of 1 square inch per 1,000 Btu/h (2,200 mm<sup>2</sup>/kW) of the total input rating of all gas utilization equipment in the space, but not less than 100 square inches (0.06 m<sup>2</sup>). One opening shall commence within 12 inches (305 mm) of the top and one opening shall commence within 12 inches (305 mm) of the bottom of the enclosure. The minimum dimension of air openings shall be not less than 3 inches (76 mm).

**304.5.3.2 Combining spaces in different stories.** The volumes of spaces in different stories shall be considered as communicating spaces where such spaces are con-

ected by one or more openings in doors or floors having a total minimum free area of 2 square inches per 1,000 Btu/h (4402 mm<sup>2</sup>/kW) of total input rating of all gas utilization equipment.

**304.6 Outdoor combustion air.** Outdoor combustion air shall be provided through opening(s) to the outdoors in accordance with Section 304.6.1 or 304.6.2. The minimum dimension of air openings shall be not less than 3 inches (76 mm).

**304.6.1 Two-permanent-openings method.** Two permanent openings, one commencing within 12 inches (305 mm) of the top and one commencing within 12 inches (305 mm) of the bottom of the enclosure, shall be provided. The openings shall communicate directly, or by ducts, with the outdoors or spaces that freely communicate with the outdoors.

Where directly communicating with the outdoors, or where communicating with the outdoors through vertical ducts, each opening shall have a minimum free area of 1 square inch per 4,000 Btu/h (550 mm<sup>2</sup>/kW) of total input rating of all equipment in the enclosure [see Figures 304.6.1(1) and 304.6.1(2)].

Where communicating with the outdoors through horizontal ducts, each opening shall have a minimum free area of not less than 1 square inch per 2,000 Btu/h (1,100 mm<sup>2</sup>/kW) of total input rating of all equipment in the enclosure [see Figure 304.6.1(3)].

**304.6.2 One-permanent-opening method.** One permanent opening, commencing within 12 inches (305 mm) of the top of the enclosure, shall be provided. The equipment shall have clearances of at least 1 inch (25 mm) from the sides and back and 6 inches (152 mm) from the front of the appliance. The opening shall directly communicate with the outdoors or through a vertical or horizontal duct to the outdoors or spaces that freely communicate with the outdoors [see Figure 304.6.2] and shall have a minimum free area of 1 square inch per 3,000 Btu/h (734 mm<sup>2</sup>/kW) of the total input rating of all equipment located in the enclosure, and not less than the sum of the areas of all vent connectors in the space.

**304.7 Combination indoor and outdoor combustion air.** The use of a combination of indoor and outdoor combustion air shall be in accordance with Sections 304.7.1 through 304.7.3.

**304.7.1 Indoor openings.** Where used, openings connecting the interior spaces shall comply with Section 304.5.3.

**304.7.2 Outdoor opening location.** Outdoor opening(s) shall be located in accordance with Section 304.6.

**304.7.3 Outdoor opening(s) size.** The outdoor opening(s) size shall be calculated in accordance with the following:

1. The ratio of interior spaces shall be the available volume of all communicating spaces divided by the required volume.
2. The outdoor size reduction factor shall be one minus the ratio of interior spaces.
3. The minimum size of outdoor opening(s) shall be the full size of outdoor opening(s) calculated in accordance with Section 304.6, multiplied by the reduction factor. The minimum dimension of air openings shall be not less than 3 inches (76 mm).

**304.8 Engineered installations.** Engineered combustion air installations shall provide an adequate supply of combustion, ventilation and dilution air and shall be approved.

**304.9 Mechanical combustion air supply.** Where all combustion air is provided by a mechanical air supply system, the combustion air shall be supplied from the outdoors at a rate not less than 0.35 cubic feet per minute per 1,000 Btu/h (0.034 m<sup>3</sup>/min per kW) of total input rating of all appliances located within the space.

**304.9.1 Makeup air.** Where exhaust fans are installed, makeup air shall be provided to replace the exhausted air.

**304.9.2 Appliance interlock.** Each of the appliances served shall be interlocked with the mechanical air supply system to prevent main burner operation when the mechanical air supply system is not in operation.

**304.9.3 Combined combustion air and ventilation air system.** Where combustion air is provided by the building's mechanical ventilation system, the system shall provide the specified combustion air rate in addition to the required ventilation air.

**304.10 Louvers and grilles.** The required size of openings for combustion, ventilation and dilution air shall be based on the net free area of each opening. Where the free area through a design of louver or grille is known, it shall be used in calculating the size opening required to provide the free area specified. Where the design and free area are not known, it shall be assumed that wood louvers will have 25-percent free area and metal louvers and grilles will have 75-percent free area. Nonmotorized louvers and grilles shall be fixed in the open position. Motorized louvers shall be interlocked with the equipment so that they are proven to be in the full open position prior to main burner ignition and during main burner operation. Means shall be provided to prevent the main burner from igniting if the louvers fail to open during burner start-up and to shut down the main burner if the louvers close during operation.

**304.11 Combustion air ducts.** Combustion air ducts shall comply with all of the following:

1. Ducts shall be of galvanized steel complying with Chapter 6 of the *International Mechanical Code* or of equivalent corrosion-resistant material approved for this application.

**Exception:** Within dwellings units, unobstructed stud and joist spaces shall not be prohibited from conveying combustion air, provided that not more than one required fireblock is removed.

2. Ducts shall terminate in an unobstructed space allowing free movement of combustion air to the appliances.
3. Ducts shall serve a single enclosure.
4. Ducts shall not serve both upper and lower combustion air openings where both such openings are used. The separation between ducts serving upper and lower combustion air openings shall be maintained to the source of combustion air.
5. Ducts shall not be screened where terminating in an attic space.

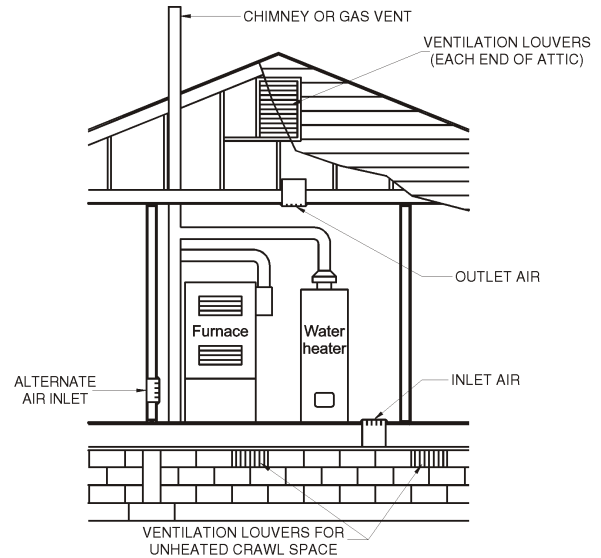
6. Horizontal upper combustion air ducts shall not slope downward toward the source of combustion air.
7. The remaining space surrounding a chimney liner, gas vent, special gas vent or plastic piping installed within a masonry, metal or factory-built chimney shall not be used to supply combustion air.

**Exception:** Direct-vent gas-fired appliances designed for installation in a solid fuel-burning fireplace where installed in accordance with the listing and the manufacturer's instructions.

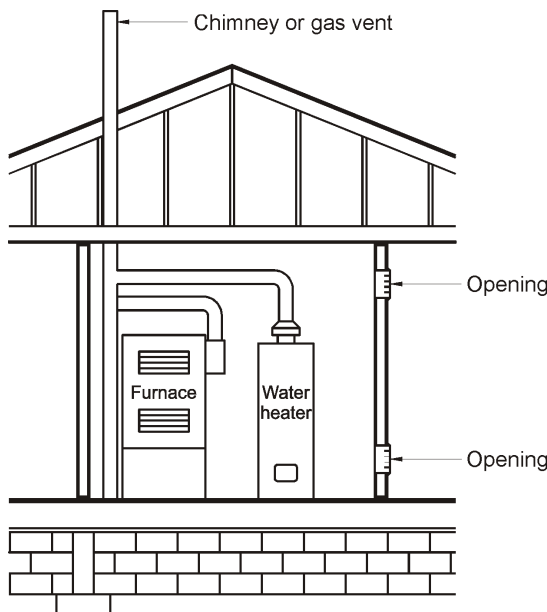
8. Combustion air intake openings located on the exterior of a building shall have the lowest side of such openings located not less than 12 inches (305 mm) vertically from the adjoining grade level.

**304.12 Protection from fumes and gases.** Where corrosive or flammable process fumes or gases, other than products of combustion, are present, means for the disposal of such fumes or gases shall be provided. Such fumes or gases include carbon monoxide, hydrogen sulfide, ammonia, chlorine and halogenated hydrocarbons.

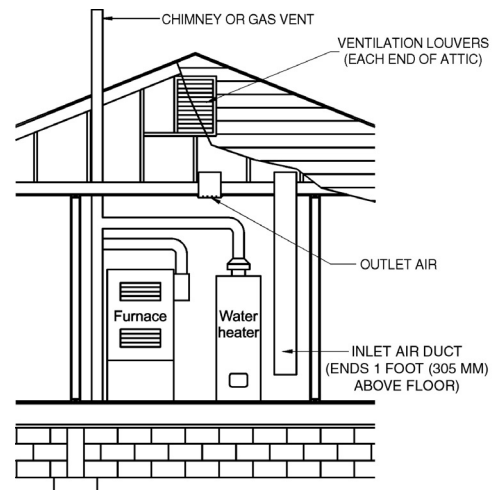
In barbershops, beauty shops and other facilities where chemicals that generate corrosive or flammable products, such as aerosol sprays, are routinely used, nondirect-vent-type appliances shall be located in an equipment room separated or partitioned off from other areas with provisions for combustion air and dilution air from the outdoors. Direct-vent appliances shall be installed in accordance with the appliance manufacturer's installation instructions.



**FIGURE 304.6.1(1)**  
**ALL AIR FROM OUTDOORS—INLET AIR FROM VENTILATED CRAWL SPACE AND OUTLET AIR TO VENTILATED ATTIC**  
 (see Section 304.6.1)



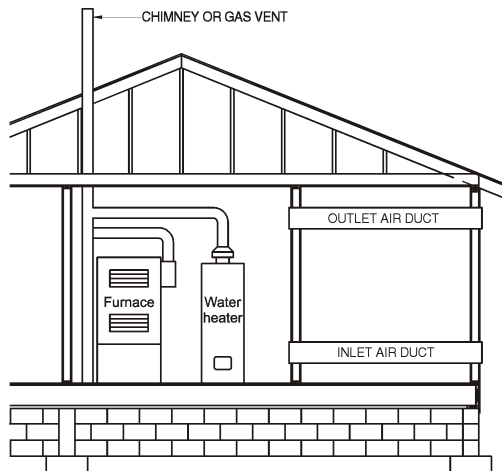
**FIGURE 304.5.3**  
**ALL AIR FROM INSIDE THE BUILDING** (see Section 304.5.3)



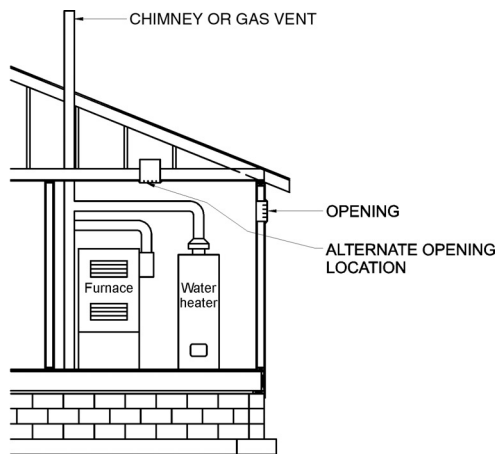
For SI: 1 foot = 304.8 mm.

**FIGURE 304.6.1(2)**  
**ALL AIR FROM OUTDOORS THROUGH VENTILATED ATTIC**  
 (see Section 304.6.1)





**FIGURE 304.6.1(3)**  
**ALL AIR FROM OUTDOORS**  
(see Section 304.6.1)



**FIGURE 304.6.2**  
**SINGLE COMBUSTION AIR OPENING,**  
**ALL AIR FROM THE OUTDOORS**  
(see Section 304.6.2)

**SECTION 305 (IFGC)**  
**INSTALLATION**

**305.1 General.** Equipment and appliances shall be installed as required by the terms of their approval, in accordance with the conditions of listing, the manufacturer's instructions and this code. Manufacturers' installation instructions shall be available on the job site at the time of inspection. Where a code provision is less restrictive than the conditions of the listing of the equipment or appliance or the manufacturer's installation instructions, the conditions of the listing and the manufacturer's installation instructions shall apply.

Unlisted appliances approved in accordance with Section 301.3 shall be limited to uses recommended by the manufacturer and shall be installed in accordance with the manufacturer's instructions, the provisions of this code and the requirements determined by the code official.

**305.2 Hazardous area.** Equipment and appliances having an ignition source shall not be installed in Group H occupancies or control areas where open use, handling or dispensing of combustible, flammable or explosive materials occurs.

**305.3 Elevation of ignition source.** Equipment and appliances having an ignition source shall be elevated such that the source of ignition is not less than 18 inches (457 mm) above the floor in hazardous locations and public garages, private garages, repair garages, motor fuel-dispensing facilities and parking garages. For the purpose of this section, rooms or spaces that are not part of the living space of a dwelling unit and that communicate directly with a private garage through openings shall be considered to be part of the private garage.

**Exception:** Elevation of the ignition source is not required for appliances that are listed as flammable vapor resistant and for installation without elevation.

**305.4 Public garages.** Appliances located in public garages, motor fuel-dispensing facilities, repair garages or other areas frequented by motor vehicles shall be installed a minimum of 8 feet (2438 mm) above the floor. Where motor vehicles exceed 6 feet (1829 mm) in height and are capable of passing under an appliance, appliances shall be installed a minimum of 2 feet (610 mm) higher above the floor than the height of the tallest vehicle.

**Exception:** The requirements of this section shall not apply where the appliances are protected from motor vehicle impact and installed in accordance with Section 305.3 and NFPA 88B.

**305.5 Private garages.** Appliances located in private garages shall be installed with a minimum clearance of 6 feet (1829 mm) above the floor.

**Exception:** The requirements of this section shall not apply where the appliances are protected from motor vehicle impact and installed in accordance with Section 305.3.

**305.6 Construction and protection.** Boiler rooms and furnace rooms shall be protected as required by the *International Building Code*.

**305.7 Clearances from grade.** Equipment and appliances installed at grade level shall be supported on a level concrete slab or other approved material extending above adjoining grade or shall be suspended a minimum of 6 inches (152 mm) above adjoining grade.

**305.8 Clearances to combustible construction.** Heat-producing equipment and appliances shall be installed to maintain the required clearances to combustible construction as specified in the listing and manufacturer's instructions. Such clearances shall be reduced only in accordance with Section 308. Clearances to combustibles shall include such considerations as door swing, drawer pull, overhead projections or shelving and window swing. Devices, such as door stops or limits and closers, shall not be used to provide the required clearances.

## SECTION 306 (IFGC) ACCESS AND SERVICE SPACE

**[M] 306.1 Clearances for maintenance and replacement.** Clearances around appliances to elements of permanent construction, including other installed appliances, shall be sufficient to allow inspection, service, repair or replacement without removing such elements of permanent construction or disabling the function of a required fire-resistance-rated assembly.

**[M] 306.2 Appliances in rooms.** Rooms containing appliances requiring access shall be provided with a door and an unobstructed passageway measuring not less than 36 inches (914 mm) wide and 80 inches (2032 mm) high.

**Exception:** Within a dwelling unit, appliances installed in a compartment, alcove, basement or similar space shall be provided with access by an opening or door and an unobstructed passageway measuring not less than 24 inches (610 mm) wide and large enough to allow removal of the largest appliance in the space, provided that a level service space of not less than 30 inches (762 mm) deep and the height of the appliance, but not less than 30 inches (762 mm), is present at the front or service side of the appliance with the door open.

**[M] 306.3 Appliances in attics.** Attics containing appliances requiring access shall be provided with an opening and unobstructed passageway large enough to allow removal of the largest component of the appliance. The passageway shall not be less than 30 inches (762 mm) high and 22 inches (559 mm) wide and not more than 20 feet (6096 mm) in length when measured along the centerline of the passageway from the opening to the equipment. The passageway shall have continuous solid flooring not less than 24 inches (610 mm) wide. A level service space not less than 30 inches (762 mm) deep and 30 inches (762 mm) wide shall be present at the front or service side of the equipment. The clear access opening dimensions shall be a minimum of 20 inches by 30 inches (508 mm by 762 mm), where such dimensions are large enough to allow removal of the largest component of the appliance.

### Exceptions:

1. The passageway and level service space are not required where the appliance is capable of being serviced and removed through the required opening.
2. Where the passageway is not less than 6 feet (1829 mm) high for its entire length, the passageway shall be not greater than 50 feet (15 250 mm) in length.

**[M] 306.3.1 Electrical requirements.** A lighting fixture controlled by a switch located at the required passageway opening and a receptacle outlet shall be provided at or near the equipment location in accordance with the ICC *Electrical Code*.

**[M] 306.4 Appliances under floors.** Under-floor spaces containing appliances requiring access shall be provided with an access opening and unobstructed passageway large enough to remove the largest component of the appliance. The passageway shall not be less than 30 inches (762 mm) high and 22 inches (559 mm) wide, nor more than 20 feet (6096 mm) in length when measured along the centerline of the passageway from the opening to the equipment. A level service space not less than 30 inches (762 mm) deep and 30 inches (762 mm)

wide shall be present at the front or service side of the appliance. If the depth of the passageway or the service space exceeds 12 inches (305 mm) below the adjoining grade, the walls of the passageway shall be lined with concrete or masonry extending 4 inches (102 mm) above the adjoining grade and having sufficient lateral-bearing capacity to resist collapse. The clear access opening dimensions shall be a minimum of 22 inches by 30 inches (559 mm by 762 mm), where such dimensions are large enough to allow removal of the largest component of the appliance.

### Exceptions:

1. The passageway is not required where the level service space is present when the access is open and the appliance is capable of being serviced and removed through the required opening.
2. Where the passageway is not less than 6 feet high (1829 mm) for its entire length, the passageway shall not be limited in length.

**[M] 306.4.1 Electrical requirements.** A lighting fixture controlled by a switch located at the required passageway opening and a receptacle outlet shall be provided at or near the equipment location in accordance with the ICC *Electrical Code*.

**[M] 306.5 Appliances on roofs or elevated structures.** Where appliances requiring access are installed on roofs or elevated structures at a height exceeding 16 feet (4877 mm), such access shall be provided by a permanent approved means of access, the extent of which shall be from grade or floor level to the appliance's level service space. Such access shall not require climbing over obstructions greater than 30 inches high (762 mm) or walking on roofs having a slope greater than four units vertical in 12 units horizontal (33-percent slope).

Permanent ladders installed to provide the required access shall comply with the following minimum design criteria.

1. The side railing shall extend above the parapet or roof edge not less than 30 inches (762 mm).
2. Ladders shall have a rung spacing not to exceed 14 inches (356 mm) on center.
3. Ladders shall have a toe spacing not less than 6 inches (152 mm) deep.
4. There shall be a minimum of 18 inches (457 mm) between rails.
5. Rungs shall have a minimum diameter of 0.75-inch (19 mm) and shall be capable of withstanding a 300-pound (136.1 kg) load.
6. Ladders over 30 feet (9144 mm) in height shall be provided with offset sections and landings capable of withstanding a load of 100 pounds per square foot (488.2 kg/m<sup>2</sup>).
7. Ladders shall be protected against corrosion by approved means.

Catwalks installed to provide the required access shall be not less than 24 inches wide (610 mm) and shall have railings as required for service platforms.

**Exception:** This section shall not apply to Group R-3 occupancies.

**[M] 306.5.1 Sloped roofs.** Where appliances are installed on a roof having a slope of three units vertical in 12 units horizontal (25-percent slope) or greater and having an edge more than 30 inches (762 mm) above grade at such edge, a level platform shall be provided on each side of the appliance to which access is required by the manufacturer's installation instructions for service, repair or maintenance. The platform shall not be less than 30 inches (762 mm) in any dimension and shall be provided with guards in accordance with Section 306.6.

**[M] 306.5.2 Electrical requirements.** A receptacle outlet shall be provided at or near the equipment location in accordance with the ICC *Electrical Code*.

**[M] 306.6 Guards.** Guards shall be provided where appliances, fans or other components that require service are located within 10 feet (3048 mm) of a roof edge or open side of a walking surface and such edge or open side is located more than 30 inches (762 mm) above the floor, roof or grade below. The guard shall extend not less than 30 inches (762 mm) beyond each end of such appliances, fans or other components and the top of the guard shall be located not less than 42 inches (1067 mm) above the elevated surface adjacent to the guard. The guard shall be constructed so as to prevent the passage of a 21-inch-diameter (533 mm) sphere and shall comply with the loading requirements for guards specified in the *International Building Code*.

## SECTION 307 (IFGC) CONDENSATE DISPOSAL

**307.1 Fuel-burning appliances.** Liquid combustion by-products of condensing appliances shall be collected and discharged to an approved plumbing fixture or disposal area in accordance with the manufacturer's installation instructions. Condensate piping shall be of approved corrosion-resistant material and shall not be smaller than the drain connection on the appliance. Such piping shall maintain a minimum slope in the direction of discharge of not less than one-eighth unit vertical in 12 units horizontal (1-percent slope).

**[M] 307.2 Drain pipe materials and sizes.** Components of the condensate disposal system shall be cast iron, galvanized steel, copper, polybutylene, polyethylene, ABS, CPVC or PVC pipe or tubing. All components shall be selected for the pressure and temperature rating of the installation. Condensate waste and drain line size shall be not less than  $\frac{3}{4}$ -inch internal diameter (19 mm) and shall not decrease in size from the drain connection to the place of condensate disposal. Where the drain pipes from more than one unit are manifolded together for condensate drainage, the pipe or tubing shall be sized in accordance with an approved method. All horizontal sections of drain piping shall be installed in uniform alignment at a uniform slope.

**307.3 Traps.** Condensate drains shall be trapped as required by the equipment or appliance manufacturer.

## SECTION 308 (IFGS) CLEARANCE REDUCTION

**308.1 Scope.** This section shall govern the reduction in required clearances to combustible materials and combustible assemblies for chimneys, vents, appliances, devices and equipment. Clearance requirements for air-conditioning equipment and central heating boilers and furnaces shall comply with Sections 308.3 and 308.4.

**308.2 Reduction table.** The allowable clearance reduction shall be based on one of the methods specified in Table 308.2 or shall utilize an assembly listed for such application. Where required clearances are not listed in Table 308.2, the reduced clearances shall be determined by linear interpolation between the distances listed in the table. Reduced clearances shall not be derived by extrapolation below the range of the table. The reduction of the required clearances to combustibles for listed and labeled appliances and equipment shall be in accordance with the requirements of this section except that such clearances shall not be reduced where reduction is specifically prohibited by the terms of the appliance or equipment listing [see Figures 308.2(1) through 308.2(3)].

**308.3 Clearances for indoor air-conditioning equipment.** Clearance requirements for indoor air-conditioning equipment shall comply with Sections 308.3.1 through 308.3.5.

**308.3.1 Equipment installed in rooms that are large in comparison with the size of the equipment.** Air-conditioning equipment installed in rooms that are large in comparison with the size of the equipment shall be installed with clearances in accordance with the terms of their listing and the manufacturer's instructions.

**308.3.2 Equipment installed in rooms that are not large in comparison with the size of the equipment.** Air-conditioning equipment installed in rooms that are not large in comparison with the size of the equipment, such as alcoves and closets, shall be listed for such installations and installed in accordance with the manufacturer's instructions. Listed clearances shall not be reduced by the protection methods described in Table 308.2, regardless of whether the enclosure is of combustible or noncombustible material.

**308.3.3 Clearance reduction.** Air-conditioning equipment installed in rooms that are large in comparison with the size of the equipment shall be permitted to be installed with reduced clearances to combustible material provided the combustible material or equipment is protected as described in Table 308.2.

**308.3.4 Plenum clearances.** Where the furnace 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 where the clearance specified is 2 inches (51 mm) or less.

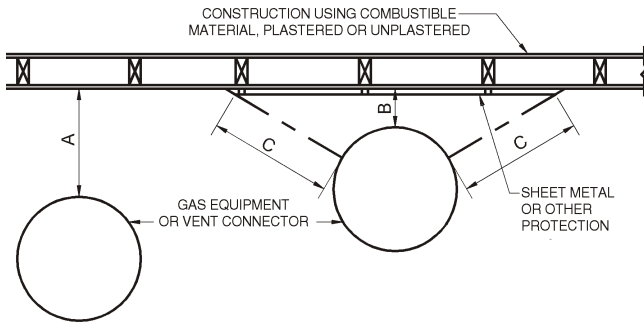
**308.3.5 Clearance from supply ducts.** Air-conditioning equipment shall have the clearance from supply ducts within 3 feet (914 mm) of the furnace plenum be not less than that specified from the furnace plenum. No clearance is necessary beyond this distance.

**TABLE 308.2<sup>a-k</sup>**  
**REDUCTION OF CLEARANCES WITH SPECIFIED FORMS OF PROTECTION**

TYPE OF PROTECTION APPLIED TO AND COVERING ALL SURFACES OF COMBUSTIBLE MATERIAL WITHIN THE DISTANCE SPECIFIED AS THE REQUIRED CLEARANCE WITH NO PROTECTION [see Figures 308.2(1), 308.2(2), and 308.2(3)]	WHERE THE REQUIRED CLEARANCE WITH NO PROTECTION FROM APPLIANCE, VENT CONNECTOR, OR SINGLE-WALL METAL PIPE IS: (inches)									
	36		18		12		9		6	
	Allowable clearances with specified protection (inches)									
	Use Column 1 for clearances above appliance or horizontal connector. Use Column 2 for clearances from appliance, vertical connector, and single-wall metal pipe.									
	Above Col. 1	Sides and rear Col. 2	Above Col. 1	Sides and rear Col. 2	Above Col. 1	Sides and rear Col. 2	Above Col. 1	Sides and rear Col. 2	Above Col. 1	Sides and rear Col. 2
1. 3 1/2-inch-thick masonry wall without ventilated airspace	—	24	—	12	—	9	—	6	—	5
2. 1/2-inch insulation board over 1-inch glass fiber or mineral wool batts	24	18	12	9	9	6	6	5	4	3
3. 0.024 sheet metal over 1-inch glass fiber or mineral wool batts reinforced with wire on rear face with ventilated airspace	18	12	9	6	6	4	5	3	3	3
4. 3 1/2-inch-thick masonry wall with ventilated airspace	—	12	—	6	—	6	—	6	—	6
5. 0.024 sheet metal with ventilated airspace	18	12	9	6	6	4	5	3	3	2
6. 1/2-inch-thick insulation board with ventilated airspace	18	12	9	6	6	4	5	3	3	3
7. 0.024 sheet metal with ventilated airspace over 0.024 sheet metal with ventilated airspace	18	12	9	6	6	4	5	3	3	3
8. 1-inch glass fiber or mineral wool batts sandwiched between two sheets 0.024 sheet metal with ventilated airspace	18	12	9	6	6	4	5	3	3	3

- For SI: 1 inch = 25.4 mm, °C = [(°F - 32)/1.8], 1 pound per cubic foot = 16.02 kg/m<sup>3</sup>, 1 Btu per inch per square foot per hour per °F = 0.144 W/m<sup>2</sup> · K.
- Reduction of clearances from combustible materials shall not interfere with combustion air, draft hood clearance and relief, and accessibility of servicing.
  - All clearances shall be measured from the outer surface of the combustible material to the nearest point on the surface of the appliance, disregarding any intervening protection applied to the combustible material.
  - Spacers and ties shall be of noncombustible material. No spacer or tie shall be used directly opposite an appliance or connector.
  - For all clearance reduction systems using a ventilated airspace, adequate provision for air circulation shall be provided as described [see Figures 308.2(2) and 308.2(3)].
  - There shall be at least 1 inch between clearance reduction systems and combustible walls and ceilings for reduction systems using ventilated airspace.
  - Where a wall protector is mounted on a single flat wall away from corners, it shall have a minimum 1-inch air gap. To provide air circulation, the bottom and top edges, or only the side and top edges, or all edges shall be left open.
  - Mineral wool batts (blanket or board) shall have a minimum density of 8 pounds per cubic foot and a minimum melting point of 1500°F.
  - Insulation material used as part of a clearance reduction system shall have a thermal conductivity of 1.0 Btu per inch per square foot per hour per °F or less.
  - There shall be at least 1 inch between the appliance and the protector. In no case shall the clearance between the appliance and the combustible surface be reduced below that allowed in this table.
  - All clearances and thicknesses are minimum; larger clearances and thicknesses are acceptable.
  - Listed single-wall connectors shall be installed in accordance with the terms of their listing and the manufacturer’s instructions.

**GENERAL REGULATIONS**

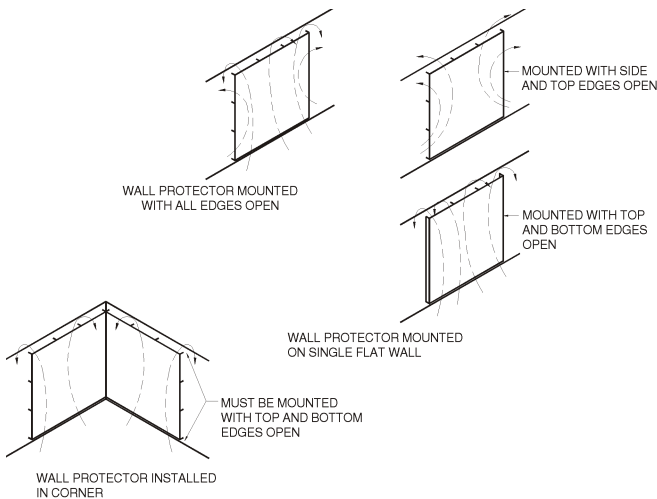


"A" equals the reduced clearance with no protection.  
 "B" equals the reduced clearance permitted in accordance with Table 308.2. The protection applied to the construction using combustible material shall extend far enough in each direction to make "C" equal to "A."

**FIGURE 308.2(1)  
 EXTENT OF PROTECTION NECESSARY TO  
 REDUCE CLEARANCES FROM GAS EQUIPMENT OR  
 VENT CONNECTIONS**

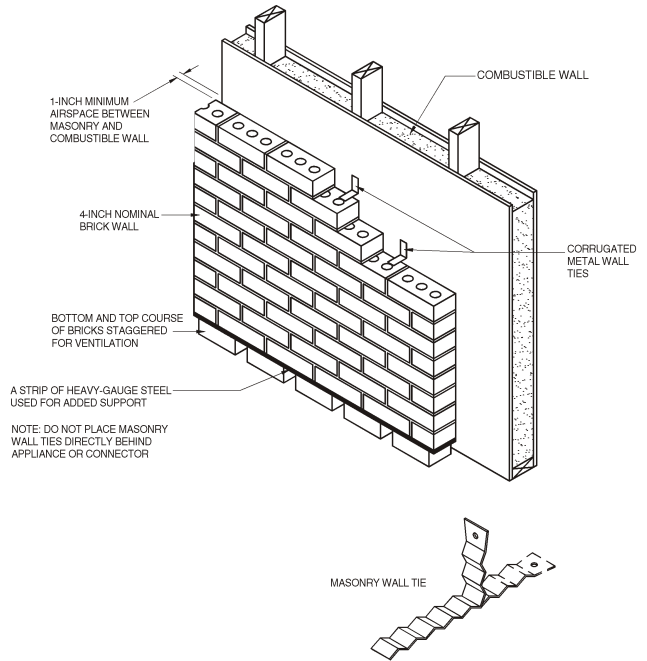
**308.4 Central-heating boilers and furnaces.** Clearance requirements for central-heating boilers and furnaces shall comply with Sections 308.4.1 through 308.4.6. The clearance to this equipment shall not interfere with combustion air, draft hood clearance and relief, and accessibility for servicing.

**308.4.1 Equipment installed in rooms that are large in comparison with the size of the equipment.** Central-heating furnaces and low-pressure boilers installed in rooms large in comparison with the size of the equipment shall be installed with clearances in accordance with the terms of their listing and the manufacturer's instructions.



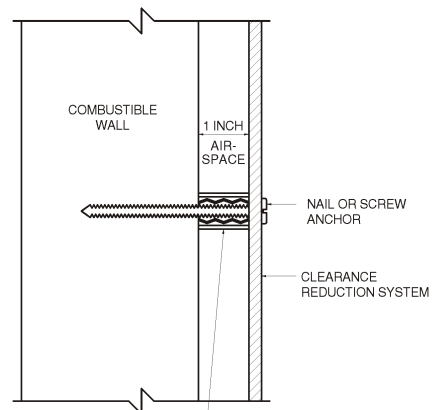
For SI: 1 inch = 25.4 mm.

**FIGURE 308.2(2)  
 WALL PROTECTOR CLEARANCE REDUCTION SYSTEM**



For SI: 1 inch = 25.4 mm.

**FIGURE 308.2(3)  
 MASONRY CLEARANCE REDUCTION SYSTEM**



1-INCH NONCOMBUSTIBLE SPACER SUCH AS STACKED WASHERS, SMALL-DIAMETER PIPE, TUBING OR ELECTRICAL CONDUIT.

MASONRY WALLS CAN BE ATTACHED TO COMBUSTIBLE WALLS USING WALL TIES.

DO NOT USE SPACERS DIRECTLY BEHIND APPLIANCE OR CONNECTOR.

**308.4.2 Equipment installed in rooms that are not large in comparison with the size of the equipment.** Central-heating furnaces and low-pressure boilers installed in rooms that are not large in comparison with the size of the equipment, such as alcoves and closets, shall be listed for such installations. Listed clearances shall not be reduced by the protection methods described in Table 308.2 and illustrated in Figures 308.2(1) through 308.2(3), regardless of whether the enclosure is of combustible or noncombustible material.

**308.4.3 Clearance reduction.** Central-heating furnaces and low-pressure boilers installed in rooms that are large in comparison with the size of the equipment shall be permitted to be installed with reduced clearances to combustible material provided the combustible material or equipment is protected as described in Table 308.2.

**308.4.4 Clearance for servicing equipment.** Front clearance shall be sufficient for servicing the burner and the furnace or boiler.

**308.4.5 Plenum clearances.** Where the furnace 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 where the clearance specified is 2 inches (51 mm) or less.

**308.4.6 Clearance from supply ducts.** Central-heating furnaces shall have the clearance from supply ducts within 3 feet (914 mm) of the furnace plenum be not less than that specified from the furnace plenum. No clearance is necessary beyond this distance.

## SECTION 309 (IFGC) ELECTRICAL

**309.1 Grounding.** Gas piping shall not be used as a grounding electrode.

**309.2 Connections.** Electrical connections between equipment and the building wiring, including the grounding of the equipment, shall conform to the ICC *Electrical Code*.

## SECTION 310 (IFGS) ELECTRICAL BONDING

**310.1 Gas pipe bonding.** Each above-ground portion of a gas piping system that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping shall be considered to be bonded where it is connected to gas utilization equipment that is connected to the equipment grounding conductor of the circuit supplying that equipment.



# CHAPTER 4

## GAS PIPING INSTALLATIONS

### SECTION 401 (IFGC) GENERAL

**401.1 Scope.** This chapter shall govern the design, installation, modification and maintenance of piping systems. The applicability of this code to piping systems extends from the point of delivery to the connections with the equipment and includes the design, materials, components, fabrication, assembly, installation, testing, inspection, operation and maintenance of such piping systems.

**401.1.1 Utility piping systems located within buildings.** Utility service piping located within buildings shall be installed in accordance with the structural safety and fire protection provisions of the *International Building Code*.

**401.2 Liquefied petroleum gas storage.** The storage system for liquefied petroleum gas shall be designed and installed in accordance with the *International Fire Code* and NFPA 58.

**401.3 Modifications to existing systems.** In modifying or adding to existing piping systems, sizes shall be maintained in accordance with this chapter.

**401.4 Additional appliances.** Where an additional appliance is to be served, the existing piping shall be checked to determine if it has adequate capacity for all appliances served. If inadequate, the existing system shall be enlarged as required or separate piping of adequate capacity shall be provided.

**401.5 Identification.** For other than black steel pipe, exposed piping shall be identified by a yellow label marked "Gas" in black letters. The marking shall be spaced at intervals not exceeding 5 feet (1524 mm). The marking shall not be required on pipe located in the same room as the equipment served.

**401.6 Interconnections.** Where two or more meters are installed on the same premises but supply separate consumers, the piping systems shall not be interconnected on the outlet side of the meters.

**401.7 Piping meter identification.** Piping from multiple meter installations shall be marked with an approved permanent identification by the installer so that the piping system supplied by each meter is readily identifiable.

**401.8 Minimum sizes.** All pipe utilized for the installation, extension and alteration of any piping system shall be sized to supply the full number of outlets for the intended purpose and shall be sized in accordance with Section 402.

### SECTION 402 (IFGS) PIPE SIZING

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

**402.2 Maximum gas demand.** The volume of gas to be provided, in cubic feet per hour, shall be determined directly from the manufacturer's input ratings of the gas utilization equipment served. Where an input rating is not indicated, the gas supplier, equipment manufacturer or a qualified agency shall be contacted, or the rating from Table 402.2 shall be used for estimating the volume of gas to be supplied.

The total connected hourly load shall be used as the basis for pipe sizing, assuming that all equipment could be operating at full capacity simultaneously. Where a diversity of load can be established, pipe sizing shall be permitted to be based on such loads.

**TABLE 402.2  
APPROXIMATE GAS INPUT FOR TYPICAL APPLIANCES**

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

For SI: 1 British thermal unit per hour = 0.293 W, 1 gallon = 3.785 L,  
1 gallon per minute = 3.785 L/m.



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

1. Pipe sizing tables or sizing equations in accordance with Section 402.4.
2. The sizing tables included in a listed piping system's manufacturer's installation instructions.
3. Other approved engineering methods.

**402.4 Sizing tables and equations.** Where Tables 402.4(1) through 402.4(33) are used to size piping or tubing, the pipe length shall be determined in accordance with Section 402.4.1, 402.4.2 or 402.4.3.

Where Equations 4-1 and 4-2 are used to size piping or tubing, the pipe or tubing shall have smooth inside walls and the pipe length shall be determined in accordance with Section 402.4.1, 402.4.2 or 402.4.3.

1. Low-pressure gas equation [Less than 1.5 pounds per square inch (psi) (10.3 kPa)]:

$$D = \frac{Q^{0.381}}{19.17 \left( \frac{\Delta H}{C_r \times L} \right)^{0.206}} \quad \text{(Equation 4-1)}$$

2. High-pressure gas equation [1.5 psi (10.3 kPa) and above]:

$$D = \frac{Q^{0.381}}{18.93 \left[ \frac{(P_1^2 - P_2^2) \times Y}{C_r \times L} \right]^{0.206}} \quad \text{(Equation 4-2)}$$

where:

- $D$  = Inside diameter of pipe, inches (mm).
- $Q$  = Input rate appliance(s), cubic feet per hour at 60°F (16°C) and 30-inch mercury column
- $P_1$  = Upstream pressure, psia ( $P_1 + 14.7$ )
- $P_2$  = Downstream pressure, psia ( $P_2 + 14.7$ )
- $L$  = Equivalent length of pipe, feet
- $\Delta H$  = Pressure drop, inch water column (27.7 inch water column = 1 psi)

**TABLE 402.4**  
 **$C_r$  AND  $Y$  VALUES FOR NATURAL GAS AND**  
**UNDILUTED PROPANE AT STANDARD CONDITIONS**

GAS	EQUATION FACTORS	
	$C_r$	$Y$
Natural gas	0.6094	0.9992
Undiluted propane	1.2462	0.9910

For SI: 1 cubic foot = 0.028 m<sup>3</sup>, 1 foot = 305 mm, 1-inch water column = 0.249 kPa, 1 pound per square inch = 6.895 kPa, 1 British thermal unit per hour = 0.293 W.

**402.4.1 Longest length method.** The pipe size of each section of gas piping shall be determined using the longest length of piping from the point of delivery to the most remote outlet and the load of the section.

**402.4.2 Branch length method.** Pipe shall be sized as follows:

1. Pipe size of each section of the longest pipe run from the point of delivery to the most remote outlet shall be determined using the longest run of piping and the load of the section.
2. The pipe size of each section of branch piping not previously sized shall be determined using the length of piping from the point of delivery to the most remote outlet in each branch and the load of the section.

**402.4.3 Hybrid pressure.** The pipe size for each section of higher pressure gas piping shall be determined using the longest length of piping from the point of delivery to the most remote line pressure regulator. The pipe size from the line pressure regulator to each outlet shall be determined using the length of piping from the regulator to the most remote outlet served by the regulator.

**402.5 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 equipment, shall be such that the supply pressure at the equipment is greater than the minimum pressure required for proper equipment operation.

**402.6 Maximum design operating pressure.** The maximum design operating pressure for piping systems located inside buildings shall not exceed 5 pounds per square inch gauge (psig) (34 kPa gauge) except where one or more of the following conditions are met:

1. The piping system is welded.
2. The piping is located in a ventilated chase or otherwise enclosed for protection against accidental gas accumulation.
3. The piping is located inside buildings or separate areas of buildings used exclusively for:
  - 3.1. Industrial processing or heating;
  - 3.2. Research;
  - 3.3. Warehousing; or
  - 3.4. Boiler or mechanical equipment rooms.
4. The piping is a temporary installation for buildings under construction.

**402.6.1 Liquefied petroleum gas systems.** The operating pressure for undiluted LP-gas systems shall not exceed 20 psig (140 kPa gauge). Buildings having systems designed to operate below -5°F (-21°C) or with butane or a propane-butane mix shall be designed to either accommodate liquid LP-gas or prevent LP-gas vapor from condensing into a liquid.

**Exception:** Buildings or separate areas of buildings constructed in accordance with Chapter 7 of NFPA 58, and used exclusively to house industrial processes, research and experimental laboratories, or equipment or processing having similar hazards.

**TABLE 402.4(1)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.50 psi or less
<b>Pressure Drop</b>	0.3 inch WC
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)											
Nominal	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Actual ID	0.364	0.493	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour										
10	32	72	132	278	520	1,050	1,600	3,050	4,800	8,500	17,500
20	22	49	92	190	350	730	1,100	2,100	3,300	5,900	12,000
30	18	40	73	152	285	590	890	1,650	2,700	4,700	9,700
40	15	34	63	130	245	500	760	1,450	2,300	4,100	8,300
50	14	30	56	115	215	440	670	1,270	2,000	3,600	7,400
60	12	27	50	105	195	400	610	1,150	1,850	3,250	6,800
70	11	25	46	96	180	370	560	1,050	1,700	3,000	6,200
80	11	23	43	90	170	350	530	990	1,600	2,800	5,800
90	10	22	40	84	160	320	490	930	1,500	2,600	5,400
100	9	21	38	79	150	305	460	870	1,400	2,500	5,100
125	8	18	34	72	130	275	410	780	1,250	2,200	4,500
150	8	17	31	64	120	250	380	710	1,130	2,000	4,100
175	7	15	28	59	110	225	350	650	1,050	1,850	3,800
200	6	14	26	55	100	210	320	610	980	1,700	3,500

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(2)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.50 psi or less
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)											
Nominal	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Actual ID	0.364	0.493	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour										
10	43	95	175	360	680	1,400	2,100	3,950	6,300	11,000	23,000
20	29	65	120	250	465	950	1,460	2,750	4,350	7,700	15,800
30	24	52	97	200	375	770	1,180	2,200	3,520	6,250	12,800
40	20	45	82	170	320	660	990	1,900	3,000	5,300	10,900
50	18	40	73	151	285	580	900	1,680	2,650	4,750	9,700
60	16	36	66	138	260	530	810	1,520	2,400	4,300	8,800
70	15	33	61	125	240	490	750	1,400	2,250	3,900	8,100
80	14	31	57	118	220	460	690	1,300	2,050	3,700	7,500
90	13	29	53	110	205	430	650	1,220	1,950	3,450	7,200
100	12	27	50	103	195	400	620	1,150	1,850	3,250	6,700
125	11	24	44	93	175	360	550	1,020	1,650	2,950	6,000
150	10	22	40	84	160	325	500	950	1,500	2,650	5,500
175	9	20	37	77	145	300	460	850	1,370	2,450	5,000
200	8	19	35	72	135	280	430	800	1,280	2,280	4,600

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(3)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	2.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)									
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour								
10	1,506	3,041	5,561	11,415	17,106	32,944	52,505	92,819	189,326
20	1,065	2,150	3,932	8,072	12,096	23,295	37,127	65,633	133,873
30	869	1,756	3,211	6,591	9,876	19,020	30,314	53,589	109,307
40	753	1,521	2,781	5,708	8,553	16,472	26,253	46,410	94,663
50	673	1,360	2,487	5,105	7,650	14,733	23,481	41,510	84,669
60	615	1,241	2,270	4,660	6,983	13,449	21,435	37,893	77,292
70	569	1,150	2,102	4,315	6,465	12,452	19,845	35,082	71,558
80	532	1,075	1,966	4,036	6,048	11,647	18,563	32,817	66,937
90	502	1,014	1,854	3,805	5,702	10,981	17,502	30,940	63,109
100	462	934	1,708	3,508	5,257	10,125	16,138	28,530	58,194
125	414	836	1,528	3,138	4,702	9,056	14,434	25,518	52,050
150	372	751	1,373	2,817	4,222	8,130	12,960	22,911	46,732
175	344	695	1,271	2,608	3,909	7,527	11,999	21,211	43,265
200	318	642	1,174	2,413	3,613	6,959	11,093	19,608	39,997

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa.

**TABLE 402.4(4)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	5.0 psi
<b>Pressure Drop</b>	3.5 psi
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)									
Nominal	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
Actual ID	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour								
10	3,185	6,434	11,766	24,161	36,206	69,727	111,133	196,468	400,732
20	2,252	4,550	8,320	17,084	25,602	49,305	78,583	138,924	283,361
30	1,839	3,715	6,793	13,949	20,904	40,257	64,162	113,431	231,363
40	1,593	3,217	5,883	12,080	18,103	34,864	55,566	98,234	200,366
50	1,425	2,878	5,262	10,805	16,192	31,183	49,700	87,863	179,213
60	1,301	2,627	4,804	9,864	14,781	28,466	45,370	80,208	163,598
70	1,204	2,432	4,447	9,132	13,685	26,354	42,004	74,258	151,463
80	1,153	2,330	4,260	8,542	12,801	24,652	39,291	69,462	141,680
90	1,062	2,145	3,922	8,054	12,069	23,242	37,044	65,489	133,577
100	979	1,978	3,617	7,427	11,128	21,433	34,159	60,387	123,173
125	876	1,769	3,235	6,643	9,953	19,170	30,553	54,012	110,169
150	786	1,589	2,905	5,964	8,937	17,211	27,431	48,494	98,911
175	728	1,471	2,690	5,522	8,274	15,934	25,396	44,897	91,574
200	673	1,360	2,487	5,104	7,649	14,729	23,478	41,504	84,656

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa.

**TABLE 402.4(5)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	1.0 psi or less
<b>Pressure Drop</b>	0.3 inch WC
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)													
Nominal	1	1 <sup>1</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub>	2	2 <sup>1</sup> / <sub>2</sub>	3	3 <sup>1</sup> / <sub>2</sub>	4	5	6	8	10	12
Actual ID	1.049	1.380	1.610	2.067	2.469	3.068	3.548	4.026	5.047	6.065	7.981	10.020	11.938
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour												
50	215	442	662	1,275	2,033	3,594	5,262	7,330	13,261	21,472	44,118	80,130	126,855
100	148	304	455	877	1,397	2,470	3,616	5,038	9,114	14,758	30,322	55,073	87,187
150	119	244	366	704	1,122	1,983	2,904	4,046	7,319	11,851	24,350	44,225	70,014
200	102	209	313	602	960	1,698	2,485	3,462	6,264	10,143	20,840	37,851	59,923
250	90	185	277	534	851	1,505	2,203	3,069	5,552	8,990	18,470	33,547	53,109
300	82	168	251	484	771	1,363	1,996	2,780	5,030	8,145	16,735	30,396	48,120
400	70	143	215	414	660	1,167	1,708	2,380	4,305	6,971	14,323	26,015	41,185
500	62	127	191	367	585	1,034	1,514	2,109	3,816	6,178	12,694	23,056	36,501
1,000	43	87	131	252	402	711	1,041	1,450	2,623	4,246	8,725	15,847	25,087
1,500	34	70	105	203	323	571	836	1,164	2,106	3,410	7,006	12,725	20,146
2,000	29	60	90	173	276	488	715	996	1,802	2,919	5,997	10,891	17,242

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(6)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	1.0 psi or less
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	0.60

PIPE SIZE (in.)													
Nominal	1	1 <sup>1</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub>	2	2 <sup>1</sup> / <sub>2</sub>	3	3 <sup>1</sup> / <sub>2</sub>	4	5	6	8	10	12
Actual ID	1.049	1.380	1.610	2.067	2.469	3.068	3.548	4.026	5.047	6.065	7.981	10.020	11.938
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour												
50	284	583	873	1,681	2,680	4,738	6,937	9,663	17,482	28,308	58,161	105,636	167,236
100	195	400	600	1,156	1,842	3,256	4,767	6,641	12,015	19,456	39,974	72,603	114,940
150	157	322	482	928	1,479	2,615	3,828	5,333	9,649	15,624	32,100	58,303	92,301
200	134	275	412	794	1,266	2,238	3,277	4,565	8,258	13,372	27,474	49,900	78,998
250	119	244	366	704	1,122	1,983	2,904	4,046	7,319	11,851	24,350	44,225	70,014
300	108	221	331	638	1,017	1,797	2,631	3,666	6,632	10,738	22,062	40,071	63,438
400	92	189	283	546	870	1,538	2,252	3,137	5,676	9,190	18,883	34,296	54,295
500	82	168	251	484	771	1,363	1,996	2,780	5,030	8,145	16,735	30,396	48,120
1,000	56	115	173	333	530	937	1,372	1,911	3,457	5,598	11,502	20,891	33,073
1,500	45	93	139	267	426	752	1,102	1,535	2,776	4,496	9,237	16,776	26,559
2,000	39	79	119	229	364	644	943	1,313	2,376	3,848	7,905	14,358	22,731

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(7)  
SEMI-RIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.5 psi or less
<b>Pressure Drop</b>	0.3 inch WC
<b>Specific Gravity</b>	0.60

Nominal	K & L ACR	TUBE SIZE (in.)									
		1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
		3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>		<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>									
10		20	42	85	148	210	448	806	1,271	2,646	4,682
20		14	29	58	102	144	308	554	873	1,819	3,218
30		11	23	47	82	116	247	445	701	1,461	2,584
40		10	20	40	70	99	211	381	600	1,250	2,212
50		8.4	17	35	62	88	187	337	532	1,108	1,960
60		7.6	16	32	56	79	170	306	482	1,004	1,776
70		7.0	14	29	52	73	156	281	443	924	1,634
80		6.5	13	27	48	68	145	262	413	859	1,520
90		6.1	13	26	45	64	136	245	387	806	1,426
100		5.8	12	24	43	60	129	232	366	761	1,347
125		5.1	11	22	38	53	114	206	324	675	1,194
150		4.7	10	20	34	48	103	186	294	612	1,082
175		4.3	8.8	18	31	45	95	171	270	563	995
200		4.0	8.2	17	29	41	89	159	251	523	926
250		3.5	7.3	15	26	37	78	141	223	464	821
300		3.2	6.6	13	23	33	71	128	202	420	744

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.  
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(8)  
SEMI-RIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.5 psi or less
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	0.60

Nominal	K & L ACR	TUBE SIZE (in.)									
		1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
		3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>		<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>									
10		27	55	111	195	276	590	1,062	1,675	3,489	6,173
20		18	38	77	134	190	406	730	1,151	2,398	4,242
30		15	30	61	107	152	326	586	925	1,926	3,407
40		13	26	53	92	131	279	502	791	1,648	2,916
50		11	23	47	82	116	247	445	701	1,461	2,584
60		10	21	42	74	105	224	403	635	1,323	2,341
70		9.3	19	39	68	96	206	371	585	1,218	2,154
80		8.6	18	36	63	90	192	345	544	1,133	2,004
90		8.1	17	34	59	84	180	324	510	1,063	1,880
100		7.6	16	32	56	79	170	306	482	1,004	1,776
125		6.8	14	28	50	70	151	271	427	890	1,574
150		6.1	13	26	45	64	136	245	387	806	1,426
175		5.6	12	24	41	59	125	226	356	742	1,312
200		5.2	11	22	39	55	117	210	331	690	1,221
250		4.7	10	20	34	48	103	186	294	612	1,082
300		4.2	8.7	18	31	44	94	169	266	554	980

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.  
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(9)  
SEMI-RIGID COPPER TUBING**

Use this Table to Size Tubing from House Line Regulator to the Appliance.

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.5 psi or less
<b>Pressure Drop</b>	1.0 inch WC
<b>Specific Gravity</b>	0.60

Nominal	TUBE SIZE (in.)										
	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>										
10	39	80	162	283	402	859	1,546	2,437	5,076	8,981	
20	27	55	111	195	276	590	1,062	1,675	3,489	6,173	
30	21	44	89	156	222	474	853	1,345	2,802	4,957	
40	18	38	77	134	190	406	730	1,151	2,398	4,242	
50	16	33	68	119	168	359	647	1,020	2,125	3,760	
60	15	30	61	107	152	326	586	925	1,926	3,407	
70	13	28	57	99	140	300	539	851	1,772	3,134	
80	13	26	53	92	131	279	502	791	1,648	2,916	
90	12	24	49	86	122	262	471	742	1,546	2,736	
100	11	23	47	82	116	247	445	701	1,461	2,584	
125	9.8	20	41	72	103	219	394	622	1,295	2,290	
150	8.9	18	37	65	93	198	357	563	1,173	2,075	
175	8.2	17	34	60	85	183	329	518	1,079	1,909	
200	7.6	16	32	56	79	170	306	482	1,004	1,776	
250	6.8	14	28	50	70	151	271	427	890	1,574	
300	6.1	13	26	45	64	136	245	387	806	1,426	

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.  
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(10)  
SEMI-RIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	2.0 psi or less
<b>Pressure Drop</b>	17.0 inch WC
<b>Specific Gravity</b>	0.60

		TUBE SIZE (in.)									
Nominal	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>		<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>									
10		190	391	796	1,391	1,974	4,216	7,591	11,968	24,926	44,100
20		130	269	547	956	1,357	2,898	5,217	8,226	17,132	30,310
30		105	216	439	768	1,089	2,327	4,189	6,605	13,757	24,340
40		90	185	376	657	932	1,992	3,586	5,653	11,775	20,832
50		79	164	333	582	826	1,765	3,178	5,010	10,436	18,463
60		72	148	302	528	749	1,599	2,879	4,540	9,455	16,729
70		66	137	278	486	689	1,471	2,649	4,177	8,699	15,390
80		62	127	258	452	641	1,369	2,464	3,886	8,093	14,318
90		58	119	243	424	601	1,284	2,312	3,646	7,593	13,434
100		55	113	229	400	568	1,213	2,184	3,444	7,172	12,689
125		48	100	203	355	503	1,075	1,936	3,052	6,357	11,246
150		44	90	184	321	456	974	1,754	2,765	5,760	10,190
175		40	83	169	296	420	896	1,614	2,544	5,299	9,375
200		38	77	157	275	390	834	1,501	2,367	4,930	8,721
250		33	69	140	244	346	739	1,330	2,098	4,369	7,730
300		30	62	126	221	313	670	1,205	1,901	3,959	7,004

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.  
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.



**TABLE 402.4(11)  
SEMI-RIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	2.0 psi or less
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	0.60

Nominal	TUBE SIZE (in.)										
	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>										
10	245	506	1,030	1,800	2,554	5,455	9,820	15,483	32,247	57,051	
20	169	348	708	1,237	1,755	3,749	6,749	10,641	22,163	39,211	
30	135	279	568	993	1,409	3,011	5,420	8,545	17,798	31,488	
40	116	239	486	850	1,206	2,577	4,639	7,314	15,232	26,949	
50	103	212	431	754	1,069	2,284	4,111	6,482	13,500	23,885	
60	93	192	391	683	969	2,069	3,725	5,873	12,232	21,641	
70	86	177	359	628	891	1,904	3,427	5,403	11,253	19,910	
80	80	164	334	584	829	1,771	3,188	5,027	10,469	18,522	
90	75	154	314	548	778	1,662	2,991	4,716	9,823	17,379	
100	71	146	296	518	735	1,570	2,826	4,455	9,279	16,416	
125	63	129	263	459	651	1,391	2,504	3,948	8,223	14,549	
150	57	117	238	416	590	1,260	2,269	3,577	7,451	13,183	
175	52	108	219	383	543	1,160	2,087	3,291	6,855	12,128	
200	49	100	204	356	505	1,079	1,942	3,062	6,377	11,283	
250	43	89	181	315	448	956	1,721	2,714	5,652	10,000	
300	39	80	164	286	406	866	1,559	2,459	5,121	9,060	

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.  
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa.

**TABLE 402.4(12)**  
**SEMI-RIGID COPPER TUBING**  
**Pipe Sizing Between Point of Delivery and the House Line Regulator. Total Load Supplied by a Single House Line Regulator Not Exceeding 150 Cubic Feet per Hour.<sup>2</sup>**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	2.0 psi
<b>Pressure Drop</b>	1.5 psi
<b>Specific Gravity</b>	0.60

Nominal	K & L ACR	TUBE SIZE (in.)									
		1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
		3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside<sup>1</sup></b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>		<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>									
10		303	625	1,272	2,224	3,155	6,739	12,131	19,127	39,837	70,481
20		208	430	874	1,528	2,168	4,631	8,338	13,146	27,380	48,441
30		167	345	702	1,227	1,741	3,719	6,696	10,557	21,987	38,900
40		143	295	601	1,050	1,490	3,183	5,731	9,035	18,818	33,293
50		127	262	533	931	1,321	2,821	5,079	8,008	16,678	29,507
60		115	237	483	843	1,197	2,556	4,602	7,256	15,112	26,736
70		106	218	444	776	1,101	2,352	4,234	6,675	13,903	24,597
80		98	203	413	722	1,024	2,188	3,939	6,210	12,934	22,882
90		92	191	388	677	961	2,053	3,695	5,826	12,135	21,470
100		87	180	366	640	908	1,939	3,491	5,504	11,463	20,280
125		77	159	324	567	804	1,718	3,094	4,878	10,159	17,974
150		70	145	294	514	729	1,557	2,803	4,420	9,205	16,286
175		64	133	270	473	671	1,432	2,579	4,066	8,469	14,983
200		60	124	252	440	624	1,333	2,399	3,783	7,878	13,938
250		53	110	223	390	553	1,181	2,126	3,352	6,982	12,353
300		48	99	202	353	501	1,070	1,927	3,038	6,327	11,193

Notes:

1. Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
2. When this table is used to size the tubing upstream of a line pressure regulator, the pipe or tubing downstream of the line pressure regulator shall be sized using a pressure drop no greater than 1 inch w.c.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa.

**TABLE 402.4(13)  
SEMI-RIGID COPPER TUBING**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	5.0 psi or less
<b>Pressure Drop</b>	3.5 psi
<b>Specific Gravity</b>	0.60

Nominal	K & L ACR	TUBE SIZE (in.)									
		1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
		3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>		<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>									
10		511	1,054	2,144	3,747	5,315	11,354	20,441	32,229	67,125	118,758
20		351	724	1,473	2,575	3,653	7,804	14,049	22,151	46,135	81,622
30		282	582	1,183	2,068	2,934	6,267	11,282	17,788	37,048	65,545
40		241	498	1,013	1,770	2,511	5,364	9,656	15,224	31,708	56,098
50		214	441	898	1,569	2,225	4,754	8,558	13,493	28,102	49,719
60		194	400	813	1,421	2,016	4,307	7,754	12,225	25,463	45,049
70		178	368	748	1,308	1,855	3,962	7,134	11,247	23,425	41,444
80		166	342	696	1,216	1,726	3,686	6,636	10,463	21,793	38,556
90		156	321	653	1,141	1,619	3,459	6,227	9,817	20,447	36,176
100		147	303	617	1,078	1,529	3,267	5,882	9,273	19,315	34,172
125		130	269	547	955	1,356	2,896	5,213	8,219	17,118	30,286
150		118	243	495	866	1,228	2,624	4,723	7,447	15,510	27,441
175		109	224	456	796	1,130	2,414	4,345	6,851	14,269	25,245
200		101	208	424	741	1,051	2,245	4,042	6,374	13,275	23,486
250		90	185	376	657	932	1,990	3,583	5,649	11,765	20,815
300		81	167	340	595	844	1,803	3,246	5,118	10,660	18,860

Note: Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.  
For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa.

**TABLE 402.4(14)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.5 psi or less
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	0.60

Flow Designation	TUBE SIZE (EHD*)										
	13	15	18	19	23	25	30	31	37	46	62
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>										
5	46	63	115	134	225	270	471	546	895	1,790	4,142
10	32	44	82	95	161	192	330	383	639	1,261	2,934
15	25	35	66	77	132	157	267	310	524	1,027	2,398
20	22	31	58	67	116	137	231	269	456	888	2,078
25	19	27	52	60	104	122	206	240	409	793	1,860
30	18	25	47	55	96	112	188	218	374	723	1,698
40	15	21	41	47	83	97	162	188	325	625	1,472
50	13	19	37	42	75	87	144	168	292	559	1,317
60	12	17	34	38	68	80	131	153	267	509	1,203
70	11	16	31	36	63	74	121	141	248	471	1,114
80	10	15	29	33	60	69	113	132	232	440	1,042
90	10	14	28	32	57	65	107	125	219	415	983
100	9	13	26	30	54	62	101	118	208	393	933
150	7	10	20	23	42	48	78	91	171	320	762
200	6	9	18	21	38	44	71	82	148	277	661
250	5	8	16	19	34	39	63	74	133	247	591
300	5	7	15	17	32	36	57	67	95	226	540

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

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

For SI: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa, 1 degree = 0.01745 rad.

**TABLE 402.4(15)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.5 psi or less
<b>Pressure Drop</b>	3.0 inch WC
<b>Specific Gravity</b>	0.60

Flow Designation	TUBE SIZE (EHD*)										
	13	15	18	19	23	25	30	31	37	46	62
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour										
5	120	160	277	327	529	649	1,182	1,365	2,141	4,428	10,103
10	83	112	197	231	380	462	828	958	1,528	3,199	7,156
15	67	90	161	189	313	379	673	778	1,254	2,541	5,848
20	57	78	140	164	273	329	580	672	1,090	2,197	5,069
25	51	69	125	147	245	295	518	599	978	1,963	4,536
30	46	63	115	134	225	270	471	546	895	1,790	4,142
40	39	54	100	116	196	234	407	471	778	1,548	3,590
50	35	48	89	104	176	210	363	421	698	1,383	3,213
60	32	44	82	95	161	192	330	383	639	1,261	2,934
70	29	41	76	88	150	178	306	355	593	1,166	2,717
80	27	38	71	82	141	167	285	331	555	1,090	2,543
90	26	36	67	77	133	157	268	311	524	1,027	2,398
100	24	34	63	73	126	149	254	295	498	974	2,276
150	19	27	52	60	104	122	206	240	409	793	1,860
200	17	23	45	52	91	106	178	207	355	686	1,612
250	15	21	40	46	82	95	159	184	319	613	1,442
300	13	19	37	42	75	87	144	168	234	559	1,317

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

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

For SI: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa, 1 degree = 0.01745 rad.

**TABLE 402.4(16)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	0.5 psi or less
<b>Pressure Drop</b>	6.0 inch WC
<b>Specific Gravity</b>	0.60

Flow Designation	TUBE SIZE (EHD*)										
	13	15	18	19	23	25	30	31	37	46	62
Length (ft)	Maximum Capacity in Cubic Feet of Gas per Hour										
5	173	229	389	461	737	911	1,687	1,946	3,000	6,282	14,263
10	120	160	277	327	529	649	1,182	1,365	2,141	4,428	10,103
15	96	130	227	267	436	532	960	1,110	1,758	3,607	8,257
20	83	112	197	231	380	462	828	958	1,528	3,119	7,156
25	74	99	176	207	342	414	739	855	1,371	2,786	6,404
30	67	90	161	189	313	379	673	778	1,254	2,541	5,848
40	57	78	140	164	273	329	580	672	1,090	2,197	5,069
50	51	69	125	147	245	295	518	599	978	1,963	4,536
60	46	63	115	134	225	270	471	546	895	1,790	4,142
70	42	58	106	124	209	250	435	505	830	1,656	3,837
80	39	54	100	116	196	234	407	471	778	1,548	3,590
90	37	51	94	109	185	221	383	444	735	1,458	3,386
100	35	48	89	104	176	210	363	421	698	1,383	3,213
150	28	39	73	85	145	172	294	342	573	1,126	2,626
200	24	34	63	73	126	149	254	295	498	974	2,276
250	21	30	57	66	114	134	226	263	447	870	2,036
300	19	27	52	60	104	122	206	240	409	793	1,860

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

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

For SI: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa, 1 degree = 0.01745 rad.

**TABLE 402.4(17)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	2.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	0.60

Flow Designation	TUBE SIZE (EHD*)										
	13	15	18	19	23	25	30	31	37	46	62
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>										
10	270	353	587	700	1,098	1,372	2,592	2,986	4,509	9,599	21,637
25	166	220	374	444	709	876	1,620	1,869	2,887	6,041	13,715
30	151	200	342	405	650	801	1,475	1,703	2,642	5,509	12,526
40	129	172	297	351	567	696	1,273	1,470	2,297	4,763	10,855
50	115	154	266	314	510	624	1,135	1,311	2,061	4,255	9,715
75	93	124	218	257	420	512	922	1,066	1,692	3,467	7,940
80	89	120	211	249	407	496	892	1,031	1,639	3,355	7,689
100	79	107	189	222	366	445	795	920	1,471	2,997	6,881
150	64	87	155	182	302	364	646	748	1,207	2,442	5,624
200	55	75	135	157	263	317	557	645	1,049	2,111	4,874
250	49	67	121	141	236	284	497	576	941	1,886	4,362
300	44	61	110	129	217	260	453	525	862	1,720	3,983
400	38	52	96	111	189	225	390	453	749	1,487	3,452
500	34	46	86	100	170	202	348	404	552	1,329	3,089

Notes:

1. Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds  $\frac{3}{4}$  psi, DO NOT USE THIS TABLE. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator may vary with flow rate.
  2. CAUTION: Capacities shown in table may exceed maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.
  3. Table includes losses for four 90-degree bends and two end fittings. Tubing runs with larger numbers of bends and/or fittings shall be increased by an equivalent length of tubing to the following equation:  $L = 1.3n$  where  $L$  is additional length (ft) of tubing and  $n$  is the number of additional fittings and/or bends.
- \*EHD—Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

For SI: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1 degree = 0.01745 rad.

**TABLE 402.4(18)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	5.0 psi
<b>Pressure Drop</b>	3.5 psi
<b>Specific Gravity</b>	0.60

Flow Designation	TUBE SIZE (EHD*)										
	13	15	18	19	23	25	30	31	37	46	62
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>										
10	523	674	1,084	1,304	1,995	2,530	4,923	5,659	8,295	18,080	40,353
25	322	420	691	827	1,289	1,616	3,077	3,543	5,311	11,378	25,580
30	292	382	632	755	1,181	1,478	2,803	3,228	4,860	10,377	23,361
40	251	329	549	654	1,031	1,284	2,418	2,786	4,225	8,972	20,246
50	223	293	492	586	926	1,151	2,157	2,486	3,791	8,015	18,119
75	180	238	403	479	763	944	1,752	2,021	3,112	6,530	14,809
80	174	230	391	463	740	915	1,694	1,955	3,016	6,320	14,341
100	154	205	350	415	665	820	1,511	1,744	2,705	5,646	12,834
150	124	166	287	339	548	672	1,228	1,418	2,221	4,600	10,489
200	107	143	249	294	478	584	1,060	1,224	1,931	3,977	9,090
250	95	128	223	263	430	524	945	1,092	1,732	3,553	8,135
300	86	116	204	240	394	479	860	995	1,585	3,240	7,430
400	74	100	177	208	343	416	742	858	1,378	2,802	6,439
500	66	89	159	186	309	373	662	766	1,035	2,503	5,762

Notes:

1. Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds  $\frac{3}{4}$  psi, DO NOT USE THIS TABLE. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator may vary with flow rate.
  2. CAUTION: Capacities shown in table may exceed maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.
  3. Table includes losses for four 90-degree bends and two end fittings. Tubing runs with larger numbers of bends and/or fittings shall be increased by an equivalent length of tubing to the following equation:  $L = 1.3n$  where  $L$  is additional length (ft) of tubing and  $n$  is the number of additional fittings and/or bends.
- \*EHD— Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

For SI: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1 degree = 0.01745 rad.



**TABLE 402.4(19)  
POLYETHYLENE PLASTIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	1.0 psi or less
<b>Pressure Drop</b>	0.3 inch WC
<b>Specific Gravity</b>	0.60

Nominal OD	PIPE SIZE (in.)					
	1/2	3/4	1	1 1/4	1 1/2	2
<b>Designation</b>	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	SDR 11.00
<b>Actual ID</b>	0.660	0.860	1.077	1.328	1.554	1.943
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>					
10	153	305	551	955	1,442	2,590
20	105	210	379	656	991	1,780
30	84	169	304	527	796	1,430
40	72	144	260	451	681	1,224
50	64	128	231	400	604	1,084
60	58	116	209	362	547	983
70	53	107	192	333	503	904
80	50	99	179	310	468	841
90	46	93	168	291	439	789
100	44	88	159	275	415	745
125	39	78	141	243	368	661
150	35	71	127	221	333	598
175	32	65	117	203	306	551
200	30	60	109	189	285	512

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(20)  
POLYETHYLENE PLASTIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	1.0 psi or less
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	0.60

Nominal OD	PIPE SIZE (in.)					
	1/2	3/4	1	1 1/4	1 1/2	2
<b>Designation</b>	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	SDR 11.00
<b>Actual ID</b>	0.660	0.860	1.077	1.328	1.554	1.943
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>					
10	201	403	726	1,258	1,900	3,415
20	138	277	499	865	1,306	2,347
30	111	222	401	695	1,049	1,885
40	95	190	343	594	898	1,613
50	84	169	304	527	796	1,430
60	76	153	276	477	721	1,295
70	70	140	254	439	663	1,192
80	65	131	236	409	617	1,109
90	61	123	221	383	579	1,040
100	58	116	209	362	547	983
125	51	103	185	321	485	871
150	46	93	168	291	439	789
175	43	86	154	268	404	726
200	40	80	144	249	376	675

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa.

**TABLE 402.4(21)  
POLYETHYLENE PLASTIC PIPE**

<b>Gas</b>	Natural
<b>Inlet Pressure</b>	2.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	0.60

Nominal OD	PIPE SIZE (in.)					
	1/2	3/4	1	1 1/4	1 1/2	2
<b>Designation</b>	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	SDR 11.00
<b>Actual ID</b>	0.660	0.860	1.077	1.328	1.554	1.943
<b>Length (ft)</b>	<b>Maximum Capacity in Cubic Feet of Gas per Hour</b>					
10	1,858	3,721	6,714	11,631	17,565	31,560
20	1,277	2,557	4,614	7,994	12,072	21,691
30	1,026	2,054	3,706	6,420	9,695	17,419
40	878	1,758	3,172	5,494	8,297	14,908
50	778	1,558	2,811	4,869	7,354	13,213
60	705	1,412	2,547	4,412	6,663	11,972
70	649	1,299	2,343	4,059	6,130	11,014
80	603	1,208	2,180	3,776	5,703	10,246
90	566	1,134	2,045	3,543	5,351	9,614
100	535	1,071	1,932	3,347	5,054	9,081
125	474	949	1,712	2,966	4,479	8,048
150	429	860	1,551	2,688	4,059	7,292
175	395	791	1,427	2,473	3,734	6,709
200	368	736	1,328	2,300	3,474	6,241

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m<sup>3</sup>/h, 1 pound per square inch = 6.895 kPa.

**TABLE 402.4(22)**  
**SCHEDULE 40 METALLIC PIPE**  
**Pipe Sizing Between First Stage (High Pressure Regulator)**  
**and Second Stage (Low Pressure Regulator)**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	10.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	1.50

Nominal Inside	PIPE SIZE (in.)								
	1/2	3/4	1	1 1/4	1 1/2	2	3	3 1/2	4
<b>Actual</b>	0.622	0.824	1.049	1.38	1.61	2.067	3.068	3.548	4.026
<b>Length (ft)</b>	Maximum Capacity in Thousands of Btu/h								
30	1,834	3,835	7,225	14,834	22,225	42,804	120,604	176,583	245,995
40	1,570	3,283	6,184	12,696	19,022	36,634	103,222	151,132	210,539
50	1,391	2,909	5,480	11,252	16,859	32,468	91,484	133,946	186,597
60	1,261	2,636	4,966	10,195	15,275	29,419	82,891	121,364	169,071
70	1,160	2,425	4,568	9,379	14,053	27,065	76,258	111,654	155,543
80	1,079	2,256	4,250	8,726	13,074	25,179	70,944	103,872	144,703
90	1,012	2,117	3,988	8,187	12,267	23,624	66,564	97,460	135,770
100	956	2,000	3,767	7,733	11,587	22,315	62,876	92,060	128,247
150	768	1,606	3,025	6,210	9,305	17,920	50,492	73,927	102,987
200	657	1,374	2,589	5,315	7,964	15,337	43,214	63,272	88,144
250	582	1,218	2,294	4,711	7,058	13,593	38,300	56,077	78,120
300	528	1,104	2,079	4,268	6,395	12,316	34,703	50,810	70,782
350	486	1,015	1,913	3,927	5,883	11,331	31,926	46,744	65,119
400	452	945	1,779	3,653	5,473	10,541	29,701	43,487	60,581
450	424	886	1,669	3,428	5,135	9,890	27,867	40,802	56,841
500	400	837	1,577	3,238	4,851	9,342	26,323	38,541	53,691
600	363	759	1,429	2,934	4,395	8,465	23,851	34,921	48,648
700	334	698	1,314	2,699	4,044	7,788	21,943	32,127	44,756
800	310	649	1,223	2,511	3,762	7,245	20,413	29,888	41,637
900	291	609	1,147	2,356	3,530	6,798	19,153	28,043	39,066
1,000	275	575	1,084	2,225	3,334	6,421	18,092	26,489	36,902
1,500	221	462	870	1,787	2,677	5,156	14,528	21,272	29,633
2,000	189	395	745	1,529	2,291	4,413	12,435	18,206	25,362

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 British thermal unit per hour = 0.2931 W.

**TABLE 402.4(23)  
SCHEDULE 40 METALLIC PIPE**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	2.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	1.50

Nominal	PIPE SIZE (in.)								
	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	4
<b>Actual ID</b>	0.622	0.824	1.049	1.380	1.610	2.067	2.469	3.068	4.026
<b>Length (ft)</b>	Maximum Capacity in Thousands of Btu/h								
10	2,676	5,595	10,539	21,638	32,420	62,438	99,516	175,927	358,835
20	1,839	3,845	7,243	14,872	22,282	42,913	68,397	120,914	246,625
30	1,477	3,088	5,817	11,942	17,893	34,461	54,925	97,098	198,049
40	1,264	2,643	4,978	10,221	15,314	29,494	47,009	83,103	169,504
50	1,120	2,342	4,412	9,059	13,573	26,140	41,663	73,653	150,229
60	1,015	2,122	3,998	8,208	12,298	23,685	37,750	66,735	136,118
70	934	1,952	3,678	7,551	11,314	21,790	34,729	61,395	125,227
80	869	1,816	3,422	7,025	10,526	20,271	32,309	57,116	116,499
90	815	1,704	3,210	6,591	9,876	19,020	30,314	53,590	109,307
100	770	1,610	3,033	6,226	9,329	17,966	28,635	50,621	103,251
125	682	1,427	2,688	5,518	8,268	15,923	25,378	44,865	91,510
150	618	1,293	2,435	5,000	7,491	14,427	22,995	40,651	82,914
175	569	1,189	2,240	4,600	6,892	13,273	21,155	37,398	76,280
200	529	1,106	2,084	4,279	6,411	12,348	19,681	34,792	70,964

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 British thermal unit per hour = 0.2931 W.

**TABLE 402.4(24)**  
**SCHEDULE 40 METALLIC PIPE**  
**Pipe Sizing Between Single or Second Stage**  
**(Low Pressure Regulator) and Appliance**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	11.0 inch WC
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	1.50

	PIPE SIZE (in.)								
Nominal Inside	1/2	3/4	1	1 1/4	1 1/2	2	3	3 1/2	4
Actual	0.622	0.824	1.049	1.38	1.61	2.067	3.068	3.548	4.026
Length (ft)	Maximum Capacity in Thousands of Btu/h								
10	291	608	1,145	2,352	3,523	6,786	19,119	27,993	38,997
20	200	418	787	1,616	2,422	4,664	13,141	19,240	26,802
30	160	336	632	1,298	1,945	3,745	10,552	15,450	21,523
40	137	287	541	1,111	1,664	3,205	9,031	13,223	18,421
50	122	255	480	984	1,475	2,841	8,004	11,720	16,326
60	110	231	434	892	1,337	2,574	7,253	10,619	14,793
80	94	197	372	763	1,144	2,203	6,207	9,088	12,661
100	84	175	330	677	1,014	1,952	5,501	8,055	11,221
125	74	155	292	600	899	1,730	4,876	7,139	9,945
150	67	140	265	543	814	1,568	4,418	6,468	9,011
200	58	120	227	465	697	1,342	3,781	5,536	7,712
250	51	107	201	412	618	1,189	3,351	4,906	6,835
300	46	97	182	373	560	1,078	3,036	4,446	6,193
350	42	89	167	344	515	991	2,793	4,090	5,698
400	40	83	156	320	479	922	2,599	3,805	5,301

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1-inch water column = 0.2488 kPa, 1 British thermal unit per hour = 0.2931 W.

**TABLE 402.4(25)**  
**SEMI-RIGID COPPER TUBING**  
**Sizing Between First Stage (High Pressure Regulator)**  
**and Second Stage (Low Pressure Regulator)**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	10.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	1.50

Nominal	TUBE SIZE (in.)										
	K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
	ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>	<b>Maximum Capacity in Thousands of Btu/h</b>										
10	513	1,058	2,152	3,760	5,335	11,396	20,516	32,347	67,371	119,193	
20	352	727	1,479	2,585	3,667	7,832	14,101	22,232	46,303	81,921	
30	283	584	1,188	2,075	2,944	6,290	11,323	17,853	37,183	65,785	
40	242	500	1,016	1,776	2,520	5,383	9,691	15,280	31,824	56,304	
50	215	443	901	1,574	2,234	4,771	8,589	13,542	28,205	49,901	
60	194	401	816	1,426	2,024	4,323	7,782	12,270	25,556	45,214	
70	179	369	751	1,312	1,862	3,977	7,160	11,288	23,511	41,596	
80	166	343	699	1,221	1,732	3,700	6,661	10,502	21,873	38,697	
90	156	322	655	1,145	1,625	3,471	6,250	9,853	20,522	36,308	
100	147	304	619	1,082	1,535	3,279	5,903	9,307	19,385	34,297	
125	131	270	549	959	1,361	2,906	5,232	8,249	17,181	30,396	
150	118	244	497	869	1,233	2,633	4,741	7,474	15,567	27,541	
175	109	225	457	799	1,134	2,423	4,361	6,876	14,321	25,338	
200	101	209	426	744	1,055	2,254	4,057	6,397	13,323	23,572	
225	95	196	399	698	990	2,115	3,807	6,002	12,501	22,117	
250	90	185	377	659	935	1,997	3,596	5,669	11,808	20,891	
275	85	176	358	626	888	1,897	3,415	5,385	11,215	19,841	
300	81	168	342	597	847	1,810	3,258	5,137	10,699	18,929	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 British thermal unit per hour = 0.2931 W.

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

**TABLE 402.4(26)**  
**SEMI-RIGID COPPER TUBING**  
**Sizing Between Single or Second Stage**  
**(Low Pressure Regulator) and Appliance**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	11.0 inch WC
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	1.50

Nominal	K & L ACR	TUBE SIZE (in.)									
		1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
		3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>		0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>		0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>		Maximum Capacity in Thousands of Btu/h									
10		45	93	188	329	467	997	1,795	2,830	5,895	10,429
20		31	64	129	226	321	685	1,234	1,945	4,051	7,168
30		25	51	104	182	258	550	991	1,562	3,253	5,756
40		21	44	89	155	220	471	848	1,337	2,784	4,926
50		19	39	79	138	195	417	752	1,185	2,468	4,366
60		17	35	71	125	177	378	681	1,074	2,236	3,956
70		16	32	66	115	163	348	626	988	2,057	3,639
80		15	30	61	107	152	324	583	919	1,914	3,386
90		14	28	57	100	142	304	547	862	1,796	3,177
100		13	27	54	95	134	287	517	814	1,696	3,001
125		11	24	48	84	119	254	458	722	1,503	2,660
150		10	21	44	76	108	230	415	654	1,362	2,410
175		10	20	40	70	99	212	382	602	1,253	2,217
200		8.9	18	37	65	92	197	355	560	1,166	2,062
225		8.3	17	35	61	87	185	333	525	1,094	1,935
250		7.9	16	33	58	82	175	315	496	1,033	1,828
275		7.5	15	31	55	78	166	299	471	981	1,736
300		7.1	15	30	52	74	158	285	449	936	1,656

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1-inch water column = 0.2488 kPa, 1 British thermal unit per hour = 0.2931 W.

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



**TABLE 402.4(27)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	2.0. psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	1.50

Nominal		TUBE SIZE (in.)										
		K & L	1/4	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2	2	2 1/2
		ACR	3/8	1/2	5/8	3/4	7/8	1 1/8	1 3/8	1 5/8	2 1/8	2 5/8
<b>Outside</b>			0.375	0.500	0.625	0.750	0.875	1.125	1.375	1.625	2.125	2.625
<b>Inside</b>			0.305	0.402	0.527	0.652	0.745	0.995	1.245	1.481	1.959	2.435
<b>Length (ft)</b>		<b>Maximum Capacity in Thousands of Btu/h</b>										
10		413	852	1,732	3,027	4,295	9,175	16,517	26,042	54,240	95,962	
20		284	585	1,191	2,081	2,952	6,306	11,352	17,899	37,279	65,954	
30		228	470	956	1,671	2,371	5,064	9,116	14,373	29,936	52,963	
40		195	402	818	1,430	2,029	4,334	7,802	12,302	25,621	45,330	
50		173	356	725	1,267	1,798	3,841	6,915	10,903	22,708	40,175	
60		157	323	657	1,148	1,629	3,480	6,266	9,879	20,575	36,401	
70		144	297	605	1,057	1,499	3,202	5,764	9,088	18,929	33,489	
80		134	276	562	983	1,394	2,979	5,363	8,455	17,609	31,155	
90		126	259	528	922	1,308	2,795	5,031	7,933	16,522	29,232	
100		119	245	498	871	1,236	2,640	4,753	7,493	15,607	27,612	
125		105	217	442	772	1,095	2,340	4,212	6,641	13,832	24,472	
150		95	197	400	700	992	2,120	3,817	6,017	12,533	22,173	
175		88	181	368	644	913	1,950	3,511	5,536	11,530	20,399	
200		82	168	343	599	849	1,814	3,267	5,150	10,727	18,978	
225		77	158	321	562	797	1,702	3,065	4,832	10,064	17,806	
250		72	149	304	531	753	1,608	2,895	4,564	9,507	16,819	
275		69	142	288	504	715	1,527	2,750	4,335	9,029	15,974	
300		66	135	275	481	682	1,457	2,623	4,136	8,614	15,240	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 British thermal unit per hour = 0.2931 W.

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

**TABLE 402.4(28)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	11.0 inch WC
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	1.50

Flow Designation	TUBE SIZE (EHD*)										
	13	15	18	19	23	25	30	31	37	46	62
Length (ft)	Maximum Capacity in Thousands of Btu/h										
5	72	99	181	211	355	426	744	863	1,415	2,830	6,547
10	50	69	129	150	254	303	521	605	971	1,993	4,638
15	39	55	104	121	208	248	422	490	775	1,623	3,791
20	34	49	91	106	183	216	365	425	661	1,404	3,285
25	30	42	82	94	164	192	325	379	583	1,254	2,940
30	28	39	74	87	151	177	297	344	528	1,143	2,684
40	23	33	64	74	131	153	256	297	449	988	2,327
50	20	30	58	66	118	137	227	265	397	884	2,082
60	19	26	53	60	107	126	207	241	359	805	1,902
70	17	25	49	57	99	117	191	222	330	745	1,761
80	15	23	45	52	94	109	178	208	307	696	1,647
90	15	22	44	50	90	102	169	197	286	656	1,554
100	14	20	41	47	85	98	159	186	270	621	1,475
150	11	15	31	36	66	75	123	143	217	506	1,205
200	9	14	28	33	60	69	112	129	183	438	1,045
250	8	12	25	30	53	61	99	117	163	390	934
300	8	11	23	26	50	57	90	107	147	357	854

For SI: 1 foot = 304.8 mm, 1-inch water column = 0.2488 kPa, 1 British thermal unit per hour = 0.2931 W, 1 degree = 0.01745 rad.

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

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

**TABLE 402.4(29)  
CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	2.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	1.50

Flow Designation	TUBE SIZE (EHD*)										
	13	15	18	19	23	25	30	31	37	46	62
<b>Length (ft)</b>	<b>Maximum Capacity in Thousands of Btu/h</b>										
10	426	558	927	1,106	1,735	2,168	4,097	4,720	7,128	15,174	34,203
25	262	347	591	701	1,120	1,384	2,560	2,954	4,564	9,549	21,680
30	238	316	540	640	1,027	1,266	2,331	2,692	4,176	8,708	19,801
40	203	271	469	554	896	1,100	2,012	2,323	3,631	7,529	17,159
50	181	243	420	496	806	986	1,794	2,072	3,258	6,726	15,357
75	147	196	344	406	663	809	1,457	1,685	2,675	5,480	12,551
80	140	189	333	393	643	768	1,410	1,629	2,591	5,303	12,154
100	124	169	298	350	578	703	1,256	1,454	2,325	4,738	10,877
150	101	137	245	287	477	575	1,021	1,182	1,908	3,860	8,890
200	86	118	213	248	415	501	880	1,019	1,658	3,337	7,705
250	77	105	191	222	373	448	785	910	1,487	2,981	6,895
300	69	96	173	203	343	411	716	829	1,363	2,719	6,296
400	60	82	151	175	298	355	616	716	1,163	2,351	5,457
500	53	72	135	158	268	319	550	638	1,027	2,101	4,883

For SI: 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa, 1 British thermal unit per hour = 0.2931 W, 1 degree = 0.01745 rad.

Notes:

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

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

**TABLE 402.4(30)**  
**CORRUGATED STAINLESS STEEL TUBING (CSST)**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	5.0 psi
<b>Pressure Drop</b>	3.5 psi
<b>Specific Gravity</b>	1.50

Flow Designation	TUBE SIZE (EHD*)										
	13	15	18	19	23	25	30	31	37	46	62
<b>Length (ft)</b>	<b>Maximum Capacity in Thousands of Btu/h</b>										
10	826	1,065	1,713	2,061	3,153	3,999	7,829	8,945	13,112	28,580	63,788
25	509	664	1,092	1,307	2,037	2,554	4,864	5,600	8,395	17,986	40,436
30	461	603	999	1,193	1,866	2,336	4,430	5,102	7,682	16,403	36,928
40	396	520	867	1,033	1,629	2,029	3,822	4,404	6,679	14,183	32,004
50	352	463	777	926	1,463	1,819	3,409	3,929	5,993	12,670	28,642
75	284	376	637	757	1,206	1,492	2,769	3,194	4,919	10,322	23,409
80	275	363	618	731	1,169	1,446	2,677	3,090	4,768	9,990	22,670
100	243	324	553	656	1,051	1,296	2,388	2,756	4,276	8,925	20,287
150	196	262	453	535	866	1,062	1,941	2,241	3,511	7,271	16,581
200	169	226	393	464	755	923	1,675	1,934	3,052	6,287	14,369
250	150	202	352	415	679	828	1,493	1,726	2,738	5,616	12,859
300	136	183	322	379	622	757	1,359	1,572	2,505	5,122	11,745
400	117	158	279	328	542	657	1,173	1,356	2,178	4,429	10,178
500	104	140	251	294	488	589	1,046	1,210	1,954	3,957	9,108

For SI: 1 foot = 305 mm, 1 pound per square inch = 6.895 kPa, 1 British thermal unit per hour = 0.2931 W, 1 degree = 0.01745 rad.

Notes:

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

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

**TABLE 402.4(31)  
POLYETHYLENE PLASTIC PIPE**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	11.0 inch WC
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	1.50

Nominal OD	PIPE SIZE (in.)					
	1/2	3/4	1	1 1/4	1 1/2	2
<b>Designation</b>	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	SDR 11.00
<b>Actual ID</b>	0.660	0.860	1.077	1.328	1.554	1.943
Length (ft)	Maximum Capacity in Thousands of Btu/h					
10	340	680	1,227	2,126	3,211	5,769
20	233	467	844	1,461	2,207	3,965
30	187	375	677	1,173	1,772	3,184
40	160	321	580	1,004	1,517	2,725
50	142	285	514	890	1,344	2,415
60	129	258	466	807	1,218	2,188
70	119	237	428	742	1,121	2,013
80	110	221	398	690	1,042	1,873
90	103	207	374	648	978	1,757
100	98	196	353	612	924	1,660
125	87	173	313	542	819	1,471
150	78	157	284	491	742	1,333
175	72	145	261	452	683	1,226
200	67	135	243	420	635	1,141

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa, 1 British thermal unit per hour = 0.2931 W, 1 degree = 0.01745 rad.

Notes:

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

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

**TABLE 402.4(32)  
POLYETHYLENE PLASTIC PIPE**

<b>Gas</b>	Undiluted propane
<b>Inlet Pressure</b>	2.0 psi
<b>Pressure Drop</b>	1.0 psi
<b>Specific Gravity</b>	1.50

Nominal OD	PIPE SIZE (in.)					
	1/2	3/4	1	1 1/4	1 1/2	2
<b>Designation</b>	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	SDR 11.00
<b>Actual ID</b>	0.660	0.860	1.077	1.328	1.554	1.943
<b>Length (ft)</b>	Maximum Capacity in Thousands of Btu/h					
10	3,126	6,259	11,293	19,564	29,545	53,085
20	2,148	4,302	7,762	13,446	20,306	36,485
30	1,725	3,454	6,233	10,798	16,307	29,299
40	1,477	2,957	5,335	9,242	13,956	25,076
50	1,309	2,620	4,728	8,191	12,369	22,225
60	1,186	2,374	4,284	7,421	11,207	20,137
70	1,091	2,184	3,941	6,828	10,311	18,526
80	1,015	2,032	3,666	6,352	9,592	17,235
90	952	1,907	3,440	5,960	9,000	16,171
100	899	1,801	3,249	5,629	8,501	15,275
125	797	1,596	2,880	4,989	7,535	13,538
150	722	1,446	2,609	4,521	6,827	12,266
175	664	1,331	2,401	4,159	6,281	11,285
200	618	1,238	2,233	3,869	5,843	10,498

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 British thermal unit per hour = 0.2931 W.

**TABLE 402.4(33)  
POLYETHYLENE PLASTIC TUBING**

<b>Gas</b>	Undiluted propane
<b>Inlet pressure</b>	11.0 inch WC
<b>Pressure Drop</b>	0.5 inch WC
<b>Specific Gravity</b>	1.50

Nominal OD	PLASTIC TUBING SIZE (CTS) (in.)	
	$\frac{1}{2}$	$\frac{3}{4}$
<b>Designation</b>	SDR 7.00	SDR 11.00
<b>Actual ID</b>	0.445	0.927
<b>Length (ft)</b>	Maximum Capacity in Thousands of Btu/h	
10	121	828
20	83	569
30	67	457
40	57	391
50	51	347
60	46	314
70	42	289
80	39	269
90	37	252
100	35	238
125	31	211
150	28	191
175	26	176
200	24	164
225	22	154
250	21	145
275	20	138
300	19	132
350	18	121
400	16	113

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W, 1-inch water column = 0.2488 kPa.

**SECTION 403 (IFGS)  
PIPING MATERIALS**

**403.1 General.** Materials used for piping systems shall comply with the requirements of this chapter or shall be approved.

**403.2 Used materials.** Pipe, fittings, valves and other materials shall not be used again except where they are free of foreign materials and have been ascertained to be adequate for the service intended.

**403.3 Other materials.** Material not covered by the standards specifications listed herein shall be investigated and tested to determine that it is safe and suitable for the proposed service, and, in addition, shall be recommended for that service by the manufacturer and shall be approved by the code official.

**403.4 Metallic pipe.** Metallic pipe shall comply with Sections 403.4.1 through 403.4.4.

**403.4.1 Cast iron.** Cast-iron pipe shall not be used.

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

1. ASME B 36.10, 10M
2. ASTM A 53; or
3. ASTM A 106.

**403.4.3 Copper and brass.** 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 (0.7 milligrams per 100 liters). Threaded copper, brass and aluminum-alloy pipe shall not be used with gases corrosive to such materials.

**403.4.4 Aluminum.** Aluminum-alloy pipe shall comply with ASTM B241 (except that the use of alloy 5456 is prohibited), and shall be marked at each end of each length indicating compliance. Aluminum-alloy pipe shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation, or is subject to repeated wettings by such liquids as water, detergents, or sewage. Aluminum-alloy pipe shall not be used in exterior locations or underground.

**403.5 Metallic tubing.** Seamless copper, aluminum alloy and steel tubing shall not be used with gases corrosive to such materials.

**403.5.1 Steel tubing.** Steel tubing shall comply with ASTM A 254 or ASTM A 539.

**403.5.2 Copper and brass tubing.** Copper tubing shall comply with Standard Type K or L of ASTM B 88 or ASTM B 280.

Copper and brass 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 (0.7 milligrams per 100 liters).

**403.5.3 Aluminum tubing.** Aluminum-alloy tubing shall comply with ASTM B 210 or ASTM B 241. Aluminum-alloy tubing shall be coated to protect against external corrosion where it is in contact with masonry, plaster or insulation, or is subject to repeated wettings by such liquids as water, detergent or sewage.

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

**403.5.4 Corrugated stainless steel tubing.** Corrugated stainless steel tubing shall be tested and listed in compliance with the construction, installation and performance requirements of ANSI LC 1/CSA 6.26.

**403.6 Plastic pipe, tubing and fittings.** Plastic pipe, tubing and fittings shall be used outside, underground, only, and shall conform

to ASTM D 2513. Pipe shall be marked “gas” and “ASTM D 2513.”

**403.6.1 Anodeless risers.** Plastic pipe, tubing and anodeless risers shall comply with the following:

1. Factory-assembled anodeless risers shall be recommended by the manufacturer for the gas used and shall be leak tested by the manufacturer in accordance with written procedures.
2. Service head adapters and field-assembled anodeless risers incorporating service head adapters shall be recommended by the manufacturer for the gas used, and shall be designed and certified to meet the requirements of Category I of ASTM D 2513, and U.S. Department of Transportation, Code of Federal Regulations, Title 49, Part 192.281(e). The manufacturer shall provide the user with qualified installation instructions as prescribed by the U.S. Department of Transportation, Code of Federal Regulations, Title 49, Part 192.283(b).

**403.6.2 LP-gas systems.** The use of plastic pipe, tubing and fittings in undiluted liquefied petroleum gas piping systems shall be in accordance with NFPA 58.

**403.7 Workmanship and defects.** Pipe, tubing and fittings shall be clear and free from cutting burrs and defects in structure or threading, and shall be thoroughly brushed, and chip and scale blown.

Defects in pipe, tubing and fittings shall not be repaired. Defective pipe, tubing and fittings shall be replaced (see Section 406.1.2).

No gas piping shall be strained or pinched, and no appliance shall be supported by, or develop any strain or stress on its supply piping.

**403.8 Protective coating.** Where in contact with material or atmosphere exerting a corrosive action, metallic piping and fittings coated with a corrosion-resistant material shall be used. External or internal coatings or linings used on piping or components shall not be considered as adding strength.

**403.9 Metallic pipe threads.** Metallic pipe and fitting threads shall be taper pipe threads and shall comply with ASME B1.20.1.

**403.9.1 Damaged threads.** Pipe with threads that are stripped, chipped, corroded or otherwise damaged shall not be used. Where a weld opens during the operation of cutting or threading, that portion of the pipe shall not be used.

**403.9.2 Number of threads.** Field threading of metallic pipe shall be in accordance with Table 403.9.2.

**TABLE 403.9.2  
SPECIFICATIONS FOR THREADING METALLIC PIPE**

IRON PIPE SIZE (inches)	APPROXIMATE LENGTH OF THREADED PORTION (inches)	APPROXIMATE NUMBER OF THREADS TO BE CUT
1/2	3/4	10
3/4	3/4	10
1	7/8	10
1 1/4	1	11
1 1/2	1	11
2	1	11
2 1/2	1 1/2	12
3	1 1/2	12
4	1 5/8	13

For SI: 1 inch = 25.4 mm.

**403.9.3 Thread compounds.** Thread (joint) compounds (pipe dope) shall be resistant to the action of liquefied petroleum gas



## GAS PIPING INSTALLATIONS

or to any other chemical constituents of the gases to be conducted through the piping.

**403.10 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 caused by the internal pressure and any additional forces caused by temperature expansion or contraction, vibration, fatigue or the weight of the pipe and its contents.

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

**403.10.1.1 All welding in the piping system shall be done in accordance with ASME Boiler and Pressure Vessel Code Section IX.**

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

**403.10.3 Flared joints.** Flared joints shall be used only in systems constructed from nonferrous pipe and tubing where experience or tests have demonstrated that the joint is suitable for the conditions and where provisions are made in the design to prevent separation of the joints.

**403.10.4 Metallic fittings.** Metallic fittings, including valves, strainers and filters, shall comply with the following:

1. Threaded fittings in sizes larger than 4 inches (102 mm) shall not be used except where approved.
2. Fittings used with steel or wrought-iron pipe shall be steel, brass, bronze, malleable iron or cast iron.
3. Fittings used with copper or brass pipe shall be copper, brass or bronze.
4. Fittings used with aluminum-alloy pipe shall be of aluminum alloy.
5. Cast-iron fittings:
  - 5.1. Flanges shall be permitted.
  - 5.2. Bushings shall not be used.
  - 5.3. Fittings shall not be used in systems containing flammable gas-air mixtures.
  - 5.4. Fittings in sizes 4 inches (102 mm) and larger shall not be used indoors except where approved.
  - 5.5. Fittings in sizes 6 inches (152 mm) and larger shall not be used except where approved.
6. Aluminum-alloy fittings. Threads shall not form the joint seal.
7. Zinc aluminum-alloy fittings. Fittings shall not be used in systems containing flammable gas-air mixtures.
8. Special fittings. Fittings such as couplings, proprietary-type joints, saddle tees, gland-type compression fittings, and flared, flareless or compression-type tubing fittings shall be: used within the fitting manufacturer's pressure-temperature recommendations; used within the service conditions anticipated with respect to vibration, fatigue, thermal expansion or contraction; installed or braced to prevent separation of the joint by gas pressure or external physical damage; and shall be approved.

**403.11 Plastic pipe, joints and fittings.** Plastic pipe, tubing and fittings shall be joined in accordance with the manufacturer's instructions. Such joint shall comply with the following:

1. 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.
2. Heat-fusion joints shall be made in accordance with qualified procedures that have been established and proven by test to produce gas-tight joints at least as strong as the pipe or tubing being joined. Joints shall be made with the joining method recommended by the pipe manufacturer. Heat fusion fittings shall be marked "ASTM D 2513."
3. Where compression-type mechanical joints are used, the gasket material in the fitting shall be compatible with the plastic piping and with the gas distributed by the system. An internal tubular rigid stiffener shall be used in conjunction with the fitting. The stiffener shall be flush with the end of the pipe or tubing and shall extend at least to the outside end of the pipe or tubing and at least to the outside end of the compression fitting when installed. The stiffener shall be free of rough or sharp edges and shall not be a force fit in the plastic. Split tubular stiffeners shall not be used.
4. Plastic piping joints and fittings for use in liquefied petroleum gas piping systems shall be in accordance with NFPA 58.

**403.12 Flanges.** All flanges shall comply with ASME B16.1, ASME B16.20, AWWA C111/A21.11 or MSS SP-6. The pressure-temperature ratings shall equal or exceed that required by the application.

**403.12.1 Flange facings.** Standard facings shall be permitted for use under this code. Where 150-pound (1034 kPa) pressure-rated steel flanges are bolted to Class 125 cast-iron flanges, the raised face on the steel flange shall be removed.

**403.12.2 Lapped flanges.** Lapped flanges shall be used only above ground or in exposed locations accessible for inspection.

**403.13 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. Acceptable materials include metal or metal-jacketed asbestos (plain or corrugated), asbestos, and aluminum "O" rings and spiral wound metal gaskets. When a flanged joint is opened, the gasket shall be replaced. Full-face gaskets shall be used with all bronze and cast-iron flanges.

### SECTION 404 (IFGC) PIPING SYSTEM INSTALLATION

**404.1 Prohibited locations.** Piping shall not be installed in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumbwaiter or elevator shaft.

**404.2 Piping in solid partitions and walls.** Concealed piping shall not be located in solid partitions and solid walls, unless installed in a chase or casing.

**404.3 Piping in concealed locations.** Portions of a piping system installed in concealed locations shall not have unions, tubing fittings, right and left couplings, bushings, compression couplings and swing joints made by combinations of fittings.

**Exceptions:**

1. Tubing joined by brazing.
2. Fittings listed for use in concealed locations.

**404.4 Piping through foundation wall.** Underground piping, where installed below grade through the outer foundation or basement wall of a building, shall be encased in a protective pipe

sleeve. The annular space between the gas piping and the sleeve shall be sealed.

**404.5 Protection against physical damage.** In concealed locations, where piping other than black or galvanized steel is installed through holes or notches in wood studs, joists, rafters or similar members less than 1 inch (25 mm) from the nearest edge of the member, the pipe shall be protected by shield plates. Shield plates shall be a minimum of 1/16-inch-thick (1.6 mm) steel, shall cover the area of the pipe where the member is notched or bored, and shall extend a minimum of 4 inches (102 mm) above sole plates, below top plates and to each side of a stud, joist or rafter.

**404.6 Piping in solid floors.** Piping in solid floors shall be laid in channels in the floor and covered in a manner that will allow access to the piping with a minimum amount of damage to the building. Where such piping is subject to exposure to excessive moisture or corrosive substances, the piping shall be protected in an approved manner. As an alternative to installation in channels, the piping shall be installed in a casing of Schedule 40 steel, wrought iron, PVC or ABS pipe with tightly sealed ends and joints. Both ends of such casing shall extend not less than 2 inches (51 mm) beyond the point where the pipe emerges from the floor. Piping shall not be installed in solid floors without prior approval of the code official.

**404.7 Above-ground outdoor piping.** All piping installed outdoors shall be elevated not less than 31/2 inches (152 mm) above ground and where installed across roof surfaces, shall be elevated not less than 31/2 inches (152 mm) above the roof surface. Piping installed above ground, outdoors, and installed across the surface of roofs shall be securely supported and located where it will be protected from physical damage. Where passing through an outside wall, the piping shall also be protected against corrosion by coating or wrapping with an inert material. Where piping is encased in a protective pipe sleeve, the annular space between the piping and the sleeve shall be sealed.

**404.8 Protection against corrosion.** Metallic pipe or tubing exposed to corrosive action, such as soil condition or moisture, shall be protected in an approved manner. Zinc coatings (galvanizing) shall not be deemed adequate protection for gas piping underground. Ferrous metal exposed in exterior locations shall be protected from corrosion in a manner satisfactory to the code official. Where dissimilar metals are joined underground, an insulating coupling or fitting shall be used. Piping shall not be laid in contact with cinders.

**404.8.1 Prohibited use.** Uncoated threaded or socket welded joints shall not be used in piping in contact with soil or where internal or external crevice corrosion is known to occur.

**404.8.2 Protective coatings and wrapping.** Pipe protective coatings and wrappings shall be approved for the application and shall be factory applied.

**Exception:** Where installed in accordance with the manufacturer's installation instructions, field application of coatings and wrappings shall be permitted for pipe nipples, fittings and locations where the factory coating or wrapping has been damaged or necessarily removed at joints.

**404.9 Minimum burial depth.** Underground piping systems shall be installed a minimum depth of 12 inches (305 mm) below grade, except as provided for in Section 404.9.1.

**404.9.1 Individual outside appliances.** Individual lines to outside lights, grills or other appliances shall be installed a minimum of 8 inches (203 mm) below finished grade, provided that such installation is approved and is installed in locations not susceptible to physical damage.

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

**404.11 Piping underground beneath buildings.** ~~Piping installed underground beneath buildings is prohibited except where the piping is encased in a conduit of wrought iron, plastic pipe, or steel pipe designed to withstand the superimposed loads. Such conduit shall extend into an occupiable portion of the building and, at the point where the conduit terminates in the building, the space between the conduit and the gas piping shall be sealed to prevent the possible entrance of any gas leakage. Where the end sealing is capable of withstanding the full pressure of the gas pipe, the conduit shall be designed for the same pressure as the pipe. Such conduit shall extend not less than 4 inches (102 mm) outside the building, shall be vented above grade to the outdoors, and shall be installed so as to prevent the entrance of water and insects. The conduit shall be protected from corrosion in accordance with Section 404.8.~~

Where the installation of gas piping underground beneath buildings is unavoidable, the piping shall be encased in Schedule 40 steel, wrought iron, PVC or ABS pipe or other material approved by the building official. The casing shall be designed to withstand the superimposed loads. The casing shall extend into a normally usable and accessible portion of the building and, at the point where the casing terminates in the building, the space between the casing and the gas piping shall be sealed to prevent the possible entrance of any gas leakage. Where the end sealing is of a type that will retain the full pressure of the pipe, the casing shall be designed for the same pressure as the pipe. The casing shall extend at least 4 in. (100 mm) outside the building, be vented above grade to the outside, and be installed so as to prevent the entrance of water and insects. Piping shall not be installed underground beneath buildings without prior approval of the code official.

**404.12 Outlet closures.** Gas outlets that do not connect to appliances shall be capped gas tight.

**Exception:** Listed and labeled flush-mounted-type quick-disconnect devices and listed and labeled gas convenience outlets shall be installed in accordance with the manufacturer's installation instructions.

**404.13 Location of outlets.** The unthreaded portion of piping outlets shall extend not less than 1 inch (25 mm) through finished ceilings and walls and where extending through floors or outdoor patios and slabs, shall not be less than 2 inches (51 mm) above them. The outlet fitting or piping shall be securely supported. Outlets shall not be placed behind doors. Outlets shall be located in the room or space where the appliance is installed.

**Exception:** Listed and labeled flush-mounted-type quick-disconnect devices and listed and labeled gas convenience outlets shall be installed in accordance with the manufacturer's installation instructions.

**404.14 Plastic pipe.** The installation of plastic pipe shall comply with Sections 404.14.1 through 404.14.3.

**404.14.1 Limitations.** Plastic pipe shall be installed outside underground only. Plastic pipe shall not be used within or under any building or slab or be operated at pressures greater than 100 psig (689 kPa) for natural gas or 30 psig (207 kPa) for LP-gas.

**Exceptions:**

- ± Plastic pipe shall be permitted to terminate above ground outside of buildings where installed in premanufactured anodeless risers or service head adapter risers that are installed in accordance with the manufacturer's installation instructions.

~~2. Plastic pipe shall be permitted to terminate with a wall head adapter within buildings where the plastic pipe is inserted in a piping material for fuel gas use in buildings.~~

**404.14.2 Connections.** Connections made outside and underground between metallic and plastic piping shall be made only with transition fittings categorized as Category I in accordance with ASTM D 2513.

**404.14.3 Tracer.** A yellow insulated copper tracer wire or other approved conductor shall be installed adjacent to underground nonmetallic piping. Access shall be provided to the tracer wire or the tracer wire shall terminate above ground at each end of the nonmetallic piping. The tracer wire size shall not be less than 18 AWG and the insulation type shall be suitable for direct burial.

**404.15 Prohibited devices.** A device shall not be placed inside the piping or fittings that will reduce the cross-sectional area or otherwise obstruct the free flow of gas.

**Exception:** Approved gas filters.

**404.16 Testing of piping.** Before any system of piping is put in service or concealed, it shall be tested to ensure that it is gas tight. Testing, inspection and purging of piping systems shall comply with Section 406.

**SECTION 405 (IFGS)**

**PIPING BENDS AND CHANGES IN DIRECTION**

**405.1 General.** Changes in direction of pipe shall be permitted to be made by the use of fittings, factory bends, or field bends.

**405.2 Metallic pipe.** Metallic pipe bends shall comply with the following:

1. Bends shall be made only with bending equipment and procedures intended for that purpose.
2. All bends shall be smooth and free from buckling, cracks, or other evidence of mechanical damage.
3. The longitudinal weld of the pipe shall be near the neutral axis of the bend.
4. Pipe shall not be bent through an arc of more than 90 degrees (1.6 rad).
5. The inside radius of a bend shall be not less than six times the outside diameter of the pipe.

**405.3 Plastic pipe.** Plastic pipe bends shall comply with the following:

1. The pipe shall not be damaged and the internal diameter of the pipe shall not be effectively reduced.
2. Joints shall not be located in pipe bends.
3. The radius of the inner curve of such bends shall not be less than 25 times the inside diameter of the pipe.
4. Where the piping manufacturer specifies the use of special bending equipment or procedures, such equipment or procedures shall be used.

**405.4 Mitered bends.** Mitered bends are permitted subject to the following limitations:

1. Miters shall not be used in systems having a design pressure greater than 50 psig (340 kPa gauge). Deflections caused by misalignments up to 3 degrees (0.05 rad) shall not be considered as miters.
2. The total deflection angle at each miter shall not exceed 90 degrees (1.6 rad).

**405.5 Elbows.** Factory-made welding elbows or transverse segments cut therefrom shall have an arc length measured along the crotch at least 1 inch (25 mm) in pipe sizes 2 inches (51 mm) and larger.

**SECTION 406 (IFGS)**

**INSPECTION, TESTING AND PURGING**

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

**406.1.1 Inspections.** 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., shall not be required unless specifically listed herein or in the engineering design.

**406.1.2 Repairs and additions.** In the event repairs or additions are made after the pressure test, the affected piping shall be tested.

Minor repairs and additions, as determined by the building official, are not required to be pressure tested provided that the work is inspected and connections are tested with a noncorrosive leak-detecting fluid or other approved leak-detecting methods.

**406.1.3 New branches.** Where new branches are installed from the point of delivery to new appliances, only the newly installed branches shall be required to be pressure tested. Connections between the new piping and the existing piping shall be tested with a noncorrosive leak-detecting fluid or other approved leak-detecting methods.

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

**406.1.5 Regulators and valve assemblies.** Regulator and valve assemblies fabricated independently of the piping system in which they are to be installed shall be permitted to be tested with inert gas or air at the time of fabrication.

**406.2 Test medium.** The test medium shall be air, nitrogen, carbon dioxide or an inert gas. Oxygen shall not be used.

**406.3 Test preparation.** Pipe joints, including welds, shall be left exposed for examination during the test.

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

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

**406.3.2 Equipment isolation.** Equipment that 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 shall not be required to be tested.

**406.3.3 Equipment disconnection.** Where the piping system is connected to equipment or components designed for operating pressures of less than the test pressure, such equipment or equipment components shall be isolated from the piping system by disconnecting them and capping the outlet(s).

**406.3.4 Valve isolation.** Where 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 the individual equipment shutoff valve(s).

**406.3.5 Testing precautions.** 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.

**406.4 Test pressure measurement.** ~~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 caused by leakage during the pressure test period. The source of pressure shall be isolated before the pressure tests are made. Mechanical gauges used to measure test pressures shall have a range such that the highest end of the scale is not greater than five times the test pressure.~~

**406.4.1 Test pressure.** ~~The test pressure to be used shall be no less than 1 1/2 times the proposed maximum working pressure, but not less than 3 psig (20 kPa gauge), irrespective of design pressure. Where the test pressure exceeds 125 psig (862 kPa gauge), the test pressure shall not exceed a value that produces a hoop stress in the piping greater than 50 percent of the specified minimum yield strength of the pipe.~~

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

The test pressure for gas piping systems less than 14 inch (356 mm) water column shall be fifteen psig. The test gauge shall have a pressure range of 30 psig. The test pressure shall be held for a length of time satisfactory to the code official, but in no case less than fifteen minutes, with no perceptible drop in pressure.

For welded pipe and for pipe carrying gas at pressures in excess of 14 inch (356 mm) water column, the test pressure shall be 60 psig (413.4 mm). The test gauge shall have a pressure range of 100 psig. The test pressure shall be held for a length of time satisfactory to the code official, but in no case less than 30 minutes.

**406.5 Detection of leaks and defects.** The piping system shall withstand the test pressure specified without showing any evidence of leakage or other defects.

Any reduction of test pressures as indicated by pressure gauges shall be deemed to indicate the presence of a leak unless such reduction can be readily attributed to some other cause.

**406.5.1 Detection methods.** The leakage shall be located by means of an approved gas detector, a noncorrosive leak detection fluid, or other approved leak detection methods. Matches, candles, open flames, or other methods that could provide a source of ignition shall not be used.

**406.5.2 Corrections.** Where leakage or other defects are located, the affected portion of the piping system shall be repaired or replaced and retested.

**406.6 System and equipment leakage test.** Leakage testing of systems and equipment shall be in accordance with Sections 406.6.1 through 406.6.4.

**406.6.1 Test gases.** Leak checks using fuel gas shall be permitted in piping systems that have been pressure tested in accordance with Section 406.

**406.6.2 Before turning gas on.** Before gas is introduced into a system of new gas piping, the entire system shall be inspected to determine that there are no open fittings or ends and that all valves at unused outlets are closed and plugged or capped.

**406.6.3 Test for leakage.** Immediately after the gas is turned on into a new system or into a system that has been initially restored after an interruption of service, the piping system shall be tested for leakage. Where leakage is indicated, the gas supply shall be shut off until the necessary repairs have been made.

**406.6.4 Placing equipment in operation.** Gas utilization equipment shall be permitted to be placed in operation after the piping system has been tested and determined to be free of leakage and purged in accordance with Section 406.7.2.

**406.7 Purging.** Purging of piping shall comply with Sections 406.7.1 through 406.7.4.

**406.7.1 Removal from service.** Where gas piping is to be opened for servicing, addition, or modification, the section to be worked on shall be turned off from the gas supply at the nearest convenient point, and the line pressure vented to the outdoors, or to ventilated areas of sufficient size to prevent accumulation of flammable mixtures.

The remaining gas in this section of pipe shall be displaced with an inert gas as required by Table 406.7.1.

**TABLE 406.7.1  
LENGTH OF PIPING REQUIRING PURGING WITH INERT GAS  
FOR SERVICING OR MODIFICATION**

NOMINAL PIPE SIZE (inches)	LENGTH OF PIPING REQUIRING PURGING
2 1/2	> 50 feet
3	> 30 feet
4	> 15 feet
6	> 10 feet
8 or larger	Any length

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**406.7.2 Placing in operation.** Where piping full of air is placed in operation, the air in the piping shall be displaced with fuel gas, except where such piping is required by Table 406.7.2 to be purged with an inert gas prior to introduction of fuel gas. The air can be safely displaced with fuel gas provided that a moderately rapid and continuous flow of fuel gas is introduced at one end of the line and air is vented out at the other end. The fuel gas flow shall be continued without interruption until the vented gas is free of air. The point of discharge shall not be left unattended during purging. After purging, the vent shall then be closed. Where required by Table 406.7.2, the air in the piping shall first be displaced with an inert gas, and the inert gas shall then be displaced with fuel gas.

**TABLE 406.7.2  
LENGTH OF PIPING REQUIRING PURGING WITH INERT GAS  
BEFORE PLACING IN OPERATION**

NOMINAL PIPE SIZE (inches)	LENGTH OF PIPING REQUIRING PURGING
3	> 30 feet
4	> 15 feet
6	> 10 feet
8 or larger	Any length

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**406.7.3 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.

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

### SECTION 407 (IFGC) PIPING SUPPORT

**407.1 General.** Piping shall be provided with support in accordance with Section 407.2.

**407.2 Design and installation.** Piping shall be supported with pipe hooks, metal pipe straps, bands, brackets, or hangers suitable for the size of piping, of adequate strength and quality, and located at intervals so as to prevent or damp out excessive vibration. Piping shall be anchored to prevent undue strains on connected equipment and shall not be supported by other piping. Pipe hangers and supports shall conform to the requirements of MSS SP-58 and shall be spaced in accordance with Section 415. Supports, hangers, and anchors shall be installed so as not to interfere with the free expansion and contraction of the piping between anchors. All parts of the supporting equipment shall be designed and installed so they will not be disengaged by movement of the supported piping.

### SECTION 408 (IFGC) DRIPS AND SLOPED PIPING

**408.1 Slopes.** Piping for other than dry gas conditions shall be sloped not less than 1/4 inch in 15 feet (6.3 mm in 4572 mm) to prevent traps.

**408.2 Drips.** Where wet gas exists, a drip shall be provided at any point in the line of pipe where condensate could collect. A drip shall also be provided at the outlet of the meter and shall be installed so as to constitute a trap wherein an accumulation of condensate will shut off the flow of gas before the condensate will run back into the meter.

**408.3 Location of drips.** Drips shall be provided with ready access to permit cleaning or emptying. A drip shall not be located where the condensate is subject to freezing.

**408.4 Sediment trap.** Where a sediment trap is not incorporated as part of the gas utilization equipment, a sediment trap shall be installed downstream of the equipment shutoff valve as close to the inlet of the equipment as practical. The sediment trap shall be either a tee fitting with a capped nipple in the bottom opening of the run of the tee or other device approved as an effective sediment trap. Illuminating appliances, ranges, clothes dryers and outdoor grills need not be so equipped.

### SECTION 409 (IFGC) SHUTOFF VALVES

**409.1 General.** Piping systems shall be provided with shutoff valves in accordance with this section.

**409.1.1 Valve approval.** Shutoff valves shall be of an approved type. Shutoff valves shall be constructed of materials compatible with the piping. Shutoff valves installed in a portion of a piping system operating above 0.5 psig shall comply with ASME B 16.33. Shutoff valves installed in a portion of a piping system operating at 0.5 psig or less shall comply with ANSI Z 21.15 or ASME B 16.33.

**409.1.2 Prohibited locations.** Shutoff valves shall be prohibited in concealed locations and furnace plenums.

**409.1.3 Access to shutoff valves.** Shutoff valves shall be located in places so as to provide access for operation and shall be installed so as to be protected from damage.

**409.2 Meter valve.** Every meter shall be equipped with a shutoff valve located on the supply side of the meter.

**409.3 Shutoff valves for multiple-house line systems.** Where a single meter is used to supply gas to more than one building or tenant, a separate shutoff valve shall be provided for each building or tenant.

**409.3.1 Multiple tenant buildings.** In multiple tenant buildings, where a common piping system is installed to supply other than

one- and two-family dwellings, shutoff valves shall be provided for each tenant. Each tenant shall have access to the shutoff valve serving that tenant's space.

**409.3.2 Individual buildings.** In a common system serving more than one building, shutoff valves shall be installed outdoors at each building.

**409.3.3 Identification of shutoff valves.** Each house line shutoff valve shall be plainly marked with an identification tag attached by the installer so that the piping systems supplied by such valves are readily identified.

**409.4 MP Regulator valves.** A listed shutoff valve shall be installed immediately ahead of each MP regulator.

**409.5 Equipment shutoff valve.** Each appliance shall be provided with a shutoff valve separate from the appliance. The shutoff valve shall be located in the same room as the appliance, not further than 6 feet (1829 mm) from the appliance, and shall be installed upstream from the union, connector or quick disconnect device it serves. Such shutoff valves shall be provided with access.

**Exception:** Shutoff valves for vented decorative appliances and decorative appliances for installation in vented fireplaces shall not be prohibited from being installed in an area remote from the appliance where such valves are provided with ready access. Such valves shall be permanently identified and shall serve no other equipment. Piping from the shutoff valve to within 3 feet (914 mm) of the appliance connection shall be sized in accordance with Section 402.

**409.5.1 Shutoff valve in fireplace.** Equipment shutoff valves located in the firebox of a fireplace shall be installed in accordance with the appliance manufacturer's instructions.

### SECTION 410 (IFGC) FLOW CONTROLS

**410.1 Pressure regulators.** A line pressure regulator shall be installed where the appliance is designed to operate at a lower pressure than the supply pressure. Access shall be provided to pressure regulators. Pressure regulators shall be protected from physical damage. Regulators installed on the exterior of the building shall be approved for outdoor installation.

**410.2 MP regulators.** MP pressure regulators shall comply with the following:

1. The MP regulator shall be approved and shall be suitable for the inlet and outlet gas pressures for the application.
2. The MP regulator shall maintain a reduced outlet pressure under lockup (no-flow) conditions.
3. The capacity of the MP regulator, determined by published ratings of its manufacturer, shall be adequate to supply the appliances served.
4. The MP pressure regulator shall be provided with access. Where located indoors, the regulator shall be vented to the outdoors or shall be equipped with a leak-limiting device, in either case complying with Section 410.3.
5. A tee fitting with one opening capped or plugged shall be installed between the MP regulator and its upstream shutoff valve. Such tee fitting shall be positioned to allow connection of a pressure-measuring instrument and to serve as a sediment trap.
6. A tee fitting with one opening capped or plugged shall be installed not less than 10 pipe diameters downstream of the MP regulator outlet. Such tee fitting shall be positioned to allow connection of a pressure-measuring instrument.

**410.3 Venting of regulators.** Pressure regulators that require a vent shall have an independent vent to the outside of the building.

The vent shall be designed to prevent the entry of water or foreign objects.

**Exception:** ~~A vent to the outside of the building is not required for regulators equipped with and labeled for utilization with approved vent limiting devices installed in accordance with the manufacturer's instructions.~~

Regulators equipped with limiting orifices capable of releasing not more than 5 cubic feet of gas per hour (0.04 L/sec), when supplied with medium pressure, need not be vented to an outside location when the regulators have been approved by the code official. The regulators shall:

1. Have an approved gas valve in the line upstream of the regulator;
2. Be accessible;
3. Have upstream pressure identified by a metal tag permanently attached to the regulator that states: "WARNING 1/2 to 5 pounds (3.4- 34.5 kPa) natural gas pressure. DO NOT REMOVE"; and
4. Be in an area approved by the code official that communicates with a naturally ventilated area.

#### **SECTION 411 (IFGC) APPLIANCE CONNECTIONS**

**411.1 Connecting appliances.** Appliances shall be connected to the piping system by one of the following:

1. Rigid metallic pipe and fittings.
2. Semirigid metallic tubing and metallic fittings. Lengths shall not exceed 6 feet (1829 mm) and shall be located entirely in the same room as the appliance. Semirigid metallic tubing shall not enter a motor-operated appliance through an unprotected knockout opening.
3. Listed and labeled appliance connectors installed in accordance with the manufacturer's installation instructions and located entirely in the same room as the appliance.
4. Listed and labeled quick-disconnect devices used in conjunction with listed and labeled appliance connectors.
5. Listed and labeled convenience outlets used in conjunction with listed and labeled appliance connectors.
6. Listed and labeled appliance connectors complying with ANSI Z21.69 and listed for use with food service equipment having casters, or that is otherwise subject to movement for cleaning, and other large movable equipment.

**411.1.1 Protection from damage.** Connectors and tubing shall be installed so as to be protected against physical damage.

**411.1.2 Appliance fuel connectors.** Connectors shall have an overall length not to exceed 3 feet (914 mm), except for range and domestic clothes dryer connectors, which shall not exceed 6 feet (1829 mm) in length. Connectors shall not be concealed within, or extended through, walls, floors, partitions, ceilings or appliance housings. A shutoff valve not less than the nominal size of the connector shall be installed ahead of the connector in accordance with Section 409.5. Connectors shall be sized to provide the total demand of the connected appliance.

**Exception:** Fireplace inserts factory equipped with grommets, sleeves, or other means of protection in accordance with the listing of the appliance.

**Note:** This exception applies to grommets that are included in the listing of the appliance.

**411.1.3 Movable appliances.** Where appliances are equipped with casters or are otherwise subject to periodic movement or relocation for purposes such as routine cleaning and maintenance, such appliances shall be connected to the supply system piping by means of an approved flexible connector

designed and labeled for the application. Such flexible connectors shall be installed and protected against physical damage in accordance with the manufacturer's installation instructions.

#### **SECTION 412 (IFGC) LIQUEFIED PETROLEUM GAS MOTOR VEHICLE FUEL- DISPENSING STATIONS**

**412.1 General.** Motor fuel-dispensing facilities for LP-gas fuel shall be in accordance with this section and the *International Fire Code*. The operation of LP-gas motor fuel-dispensing facilities shall be regulated by the *International Fire Code*.

**412.2 Storage and dispensing.** Storage vessels and equipment used for the storage or dispensing of LP-gas shall be approved or listed in accordance with Sections 412.3 and 412.4.

**412.3 Approved equipment.** Containers; pressure-relief devices, including pressure-relief valves; and pressure regulators and piping used for LP-gas shall be approved.

**412.4 Listed equipment.** Hoses, hose connections, vehicle fuel connections, dispensers, LP-gas pumps and electrical equipment used for LP-gas shall be listed.

**412.5 Attendants.** Motor vehicle fueling operations shall be conducted by qualified attendants or in accordance with Section 412.8 by persons trained in the proper handling of LP-gas.

**412.6 Location.** In addition to the fuel dispensing requirements of the *International Fire Code*, the point of transfer for dispensing operations shall be 25 feet (7620 mm) or more from buildings having combustible exterior wall surfaces, buildings having noncombustible exterior wall surfaces that are not part of a 1-hour fire-resistance-rated assembly or buildings having combustible overhangs, property which could be built on public streets, or sidewalks and railroads; and at least 10 feet (3048 mm) from driveways and buildings having noncombustible exterior wall surfaces that are part of a fire-resistance-rated assembly having a rating of 1 hour or more.

**Exception:** The point of transfer for dispensing operations need not be separated from canopies providing weather protection for the dispensing equipment constructed in accordance with the *International Building Code*.

Liquefied petroleum gas containers shall be located in accordance with the *International Fire Code*. Liquefied petroleum gas storage and dispensing equipment shall be located outdoors and in accordance with the *International Fire Code*.

**412.7 Installation of dispensing devices and equipment.** The installation and operation of LP-gas dispensing systems shall be in accordance with this section and the *International Fire Code*. Liquefied petroleum gas dispensers and dispensing stations shall be installed in accordance with manufacturers' specifications and their listing.

**412.7.1 Valves.** A manual shutoff valve and an excess flow-control check valve shall be located in the liquid line between the pump and the dispenser inlet where the dispensing device is installed at a remote location and is not part of a complete storage and dispensing unit mounted on a common base.

An excess flow-control check valve or an emergency shutoff valve shall be installed in or on the dispenser at the point at which the dispenser hose is connected to the liquid piping. A differential backpressure valve shall be considered equivalent protection. A listed shutoff valve shall be located at the discharge end of the transfer hose.

**412.7.2 Hoses.** Hoses and piping for the dispensing of LP-gas shall be provided with hydrostatic relief valves. The hose length

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shall not exceed 18 feet (5486 mm). An approved method shall be provided to protect the hose against mechanical damage.

**412.7.3 Vehicle impact protection.** Vehicle impact protection for LP-gas storage containers, pumps and dispensers shall be provided in accordance with the *International Fire Code*.

**412.8 Private fueling of motor vehicles.** Self-service LP-gas dispensing systems, including key, code and card lock dispensing systems, shall not be open to the public and shall be limited to the filling of permanently mounted fuel containers on LP-gas powered vehicles. In addition to the requirements in the *International Fire Code*, self-service LP-gas dispensing systems shall be provided with an emergency shutoff switch located within 100 feet (30 480 mm) of, but not less than 20 feet (6096 mm) from, dispensers and the owner of the dispensing facility shall ensure the safe operation of the system and the training of users.

### SECTION 413 (IFGC)

#### COMPRESSED NATURAL GAS MOTOR VEHICLE FUEL-DISPENSING STATIONS

**413.1 General.** Motor fuel-dispensing facilities for CNG fuel shall be in accordance with this section and the *International Fire Code*. The operation of CNG motor fuel-dispensing facilities shall be regulated by the *International Fire Code*.

**413.2 General.** Storage vessels and equipment used for the storage, compression or dispensing of CNG shall be approved or listed in accordance with Sections 413.2.1 and 413.2.2.

**413.2.1 Approved equipment.** Containers; compressors; pressure-relief devices, including pressure-relief valves; and pressure regulators and piping used for CNG shall be approved.

**413.2.2 Listed equipment.** Hoses, hose connections, dispensers, gas detection systems and electrical equipment used for CNG shall be listed. Vehicle fueling connections shall be listed and labeled.

**413.3 Location of dispensing operations and equipment.** Compression, storage and dispensing equipment shall be located above ground outside.

##### Exceptions:

1. Compression, storage or dispensing equipment is allowed in buildings of noncombustible construction, as set forth in the *International Building Code*, which are unenclosed for three-quarters or more of the perimeter.
2. Compression, storage and dispensing equipment is allowed to be located indoors in accordance with the *International Fire Code*.

**413.3.1 Location on property.** In addition to the fuel-dispensing requirements of the *International Fire Code*, compression, storage and dispensing equipment shall not be installed:

1. Beneath power lines,
2. Less than 10 feet (3048 mm) from the nearest building or property line which could be built on, public street, sidewalk, or source of ignition.

**Exception:** Dispensing equipment need not be separated from canopies providing weather protection for the dispensing equipment constructed in accordance with the *International Building Code*.

3. Less than 25 feet (7620 mm) from the nearest rail of any railroad track.
4. Less than 50 feet (15 240 mm) from the nearest rail of any railroad main track or any railroad or transit line where power for train propulsion is provided by an outside electrical source such as third rail or overhead catenary.

5. Less than 50 feet (15 240 mm) from the vertical plane below the nearest overhead wire of a trolley bus line.

**413.4 Private fueling of motor vehicles.** Self-service CNG-dispensing systems, including key, code and card lock dispensing systems, shall be limited to the filling of permanently mounted fuel containers on CNG-powered vehicles.

In addition to the requirements in the *International Fire Code*, the owner of a self-service CNG-dispensing facility shall ensure the safe operation of the system and the training of users.

**413.5 Pressure regulators.** Pressure regulators shall be designed, installed or protected so their operation will not be affected by the elements (freezing rain, sleet, snow, ice, mud or debris). This protection is allowed to be integral with the regulator.

**413.6 Valves.** Piping to equipment shall be provided with a manual shutoff valve. Such valve shall be provided with ready access.

**413.7 Emergency shutdown equipment.** An emergency shutdown device shall be located within 75 feet (22 860 mm) of, but not less than 25 feet (7620 mm) from, dispensers and shall also be provided in the compressor area. Upon activation, the emergency shutdown shall automatically shut off the power supply to the compressor and close valves between the main gas supply and the compressor and between the storage containers and dispensers.

**413.8 Discharge of CNG from motor vehicle fuel storage containers.** The discharge of CNG from motor vehicle fuel cylinders for the purposes of maintenance, cylinder certification, calibration of dispensers or other activities shall be in accordance with this section. The discharge of CNG from motor vehicle fuel cylinders shall be accomplished through a closed transfer system or an approved method of atmospheric venting in accordance with Section 413.8.1 or 413.8.2.

**413.8.1 Closed transfer system.** A documented procedure which explains the logical sequence for discharging the cylinder shall be provided to the code official for review and approval. The procedure shall include what actions the operator will take in the event of a low-pressure or high-pressure natural gas release during the discharging activity. A drawing illustrating the arrangement of piping, regulators and equipment settings shall be provided to the code official for review and approval. The drawing shall illustrate the piping and regulator arrangement and shall be shown in spatial relation to the location of the compressor, storage vessels and emergency shutdown devices.

**413.8.2 Atmospheric venting.** Atmospheric venting of motor vehicle fuel cylinders shall be in accordance with Sections 413.8.2.1 through 413.8.2.6.

**413.8.2.1 Plans and specifications.** A drawing illustrating the location of the vessel support, piping, the method of grounding and bonding, and other requirements specified herein shall be provided to the code official for review and approval.

**413.8.2.2 Cylinder stability.** A method of rigidly supporting the vessel during the venting of CNG shall be provided. The selected method shall provide not less than two points of support and shall prevent the horizontal and lateral movement of the vessel. The system shall be designed to prevent the movement of the vessel based on the highest gas-release velocity through valve orifices at the vessel's rated pressure and volume. The structure or appurtenance shall be constructed of noncombustible materials.

**413.8.2.3 Separation.** The structure or appurtenance used for stabilizing the cylinder shall be separated from the site

equipment, features and exposures and shall be located in accordance with Table 413.8.2.3.

**TABLE 413.8.2.3  
SEPARATION DISTANCE FOR ATMOSPHERIC VENTING OF  
CNG**

EQUIPMENT OR FEATURE	MINIMUM SEPARATION (feet)
Buildings	25
Building openings	25
Lot lines	15
Public ways	15
Vehicles	25
CNG compressor and storage vessels	25
CNG dispensers	25

For SI: 1 foot = 304.8 mm.

**413.8.2.4 Grounding and bonding.** The structure or appurtenance used for supporting the cylinder shall be grounded in accordance with the ~~ICC~~ *Seattle Electrical Code*. The cylinder valve shall be bonded prior to the commencement of venting operations.

**413.8.2.5 Vent tube.** A vent tube that will divert the gas flow to the atmosphere shall be installed on the cylinder prior to the commencement of the venting and purging operation. The vent tube shall be constructed of pipe or tubing materials approved for use with CNG in accordance with the *International Fire Code*.

The vent tube shall be capable of dispersing the gas a minimum of 10 feet (3048 mm) above grade level. The vent tube shall not be provided with a rain cap or other feature which would limit or obstruct the gas flow.

At the connection fitting of the vent tube and the CNG cylinder, a listed bidirectional detonation flame arrester shall be provided.

**413.8.2.6 Signage.** Approved NO SMOKING signs shall be posted within 10 feet (3048 mm) of the cylinder support structure or appurtenance. Approved CYLINDER SHALL BE BONDED signs shall be posted on the cylinder support structure or appurtenance.

**SECTION 414 (IFGC)  
SUPPLEMENTAL AND STANDBY GAS SUPPLY**

**414.1 Use of air or oxygen under pressure.** Where 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. Where oxygen is used, installation shall be in accordance with NFPA 51.

**414.2 Interconnections for standby fuels.** Where supplementary gas for standby use is connected downstream from a meter or a service regulator where a meter is not provided, a device to prevent backflow shall be installed. A three-way valve installed to admit the standby supply and at the same time shut off the regular supply shall be permitted to be used for this purpose.

**SECTION 415 (IFGS)  
PIPING SUPPORT INTERVALS**

**415.1 Interval of support.** Piping shall be supported at intervals not exceeding the spacing specified in Table 415.1. Spacing of supports for CSST shall be in accordance with the CSST manufacturer's instructions.

**TABLE 415.1  
SUPPORT OF PIPING**

STEEL PIPE, NOMINAL SIZE OF PIPE (inches)	SPACING OF SUPPORTS (feet)	NOMINAL SIZE OF TUBING (SMOOTH-WALL) (inch O.D.)	SPACING OF SUPPORTS (feet)
1/2	6	1/2	4
3/4 or 1	8	5/8 or 3/4	6
1 1/4 or larger (horizontal)	10	7/8 or 1 (Horizontal)	8
1 1/4 or larger (vertical)	Every floor level	1 or Larger (vertical)	Every floor level

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.





## CHAPTER 5

# CHIMNEYS AND VENTS

### SECTION 501 (IFGC) GENERAL

**501.1 Scope.** This chapter shall govern the installation, maintenance, repair and approval of factory-built chimneys, chimney liners, vents and connectors and the utilization of masonry chimneys serving gas-fired appliances. The requirements for the installation, maintenance, repair and approval of factory-built chimneys, chimney liners, vents and connectors serving appliances burning fuels other than fuel gas shall be regulated by the *International Mechanical Code*. The construction, repair, maintenance and approval of masonry chimneys shall be regulated by the *International Building Code*.

**501.2 General.** Every appliance shall discharge the products of combustion to the outdoors, except for appliances exempted by Section 501.8.

**501.3 Masonry chimneys.** Masonry chimneys shall be constructed in accordance with Section 503.5.3 and the *International Building Code*.

**501.4 Minimum size of chimney or vent.** Chimneys and vents shall be sized in accordance with Section 504.

**501.5 Abandoned inlet openings.** Abandoned inlet openings in chimneys and vents shall be closed by an approved method.

**501.6 Positive pressure.** Where an appliance equipped with a mechanical forced draft system creates a positive pressure in the venting system, the venting system shall be designed for positive pressure applications.

**501.7 Connection to fireplace.** Connection of appliances to chimney flues serving fireplaces shall be in accordance with Sections 501.7.1 through 501.7.3.

**501.7.1 Closure and access.** A noncombustible seal shall be provided below the point of connection to prevent entry of room air into the flue. Means shall be provided for access to the flue for inspection and cleaning.

**501.7.2 Connection to factory-built fireplace flue.** An appliance shall not be connected to a flue serving a factory-built fireplace unless the appliance is specifically listed for such installation. The connection shall be made in accordance with the appliance manufacturer's installation instructions.

**501.7.3 Connection to masonry fireplace flue.** A connector shall extend from the appliance to the flue serving a masonry fireplace such that the flue gases are exhausted directly into the flue. The connector shall be accessible or removable for inspection and cleaning of both the connector and the flue. Listed direct connection devices shall be installed in accordance with their listing.

**501.8 Equipment not required to be vented.** The following appliances shall not be required to be vented.

1. Ranges.

2. Built-in domestic cooking units listed and marked for optional venting.
3. Hot plates and laundry stoves.
4. Type 1 clothes dryers (Type 1 clothes dryers shall be exhausted in accordance with the requirements of Section 613).
5. A single booster-type automatic instantaneous water heater, where designed and used solely for the sanitizing rinse requirements of a dishwashing machine, provided that the heater is installed in a commercial kitchen having a mechanical exhaust system. Where installed in this manner, the draft hood, if required, shall be in place and unaltered and the draft hood outlet shall be not less than 36 inches (914 mm) vertically and 6 inches (152 mm) horizontally from any surface other than the heater.
6. Refrigerators.
7. Counter appliances.
8. Room heaters listed for unvented use.
9. Direct-fired make-up air heaters.
10. Other equipment listed for unvented use and not provided with flue collars.
11. Specialized equipment of limited input such as laboratory burners and gas lights.

Where the appliances and equipment listed in Items 5 through 11 above are installed so that the aggregate input rating exceeds 20 British thermal units (Btu) per hour per cubic foot (207 watts per m<sup>3</sup>) of volume of the room or space in which such appliances and equipment are installed, one or more shall be provided with venting systems or other approved means for conveying the vent gases to the outdoor atmosphere so that the aggregate input rating of the remaining unvented appliances and equipment does not exceed the 20 Btu per hour per cubic foot (207 watts per m<sup>3</sup>) figure. Where 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 that cannot be closed, the volume of such adjacent room or space shall be permitted to be included in the calculations.

**501.9 Chimney entrance.** Connectors shall connect to a masonry chimney flue at a point not less than 12 inches (305 mm) above the lowest portion of the interior of the chimney flue.

**501.10 Connections to exhauster.** Appliance connections to a chimney or vent equipped with a power exhauster shall be made on the inlet side of the exhauster. Joints on the positive pressure side of the exhauster shall be sealed to prevent flue-gas leakage as specified by the manufacturer's installation instructions for the exhauster.

**501.11 Masonry chimneys.** Masonry chimneys utilized to vent appliances shall be located, constructed and sized as speci-

fied in the manufacturer's installation instructions for the appliances being vented and Section 503.

**501.12 Residential and low-heat appliances flue lining systems.** Flue lining systems for use with residential-type and low-heat appliances shall be limited to the following:

1. Clay flue lining complying with the requirements of ASTM C 315 or equivalent. Clay flue lining shall be installed in accordance with the *International Building Code*.
2. Listed chimney lining systems complying with UL 1777.
3. Other approved materials that will resist, without cracking, softening or corrosion, flue gases and condensate at temperatures up to 1,800°F (982°C).

**501.13 Category I appliance flue lining systems.** Flue lining systems for use with Category I appliances shall be limited to the following:

1. Flue lining systems complying with Section 501.12.
2. Chimney lining systems listed and labeled for use with gas appliances with draft hoods and other Category I gas appliances listed and labeled for use with Type B vents.

**501.14 Category II, III and IV appliance venting systems.** The design, sizing and installation of vents for Category II, III and IV appliances shall be in accordance with the appliance manufacturer's installation instructions.

**501.15 Existing chimneys and vents.** Where an appliance is permanently disconnected from an existing chimney or vent, or where an appliance is connected to an existing chimney or vent during the process of a new installation, the chimney or vent shall comply with Sections 501.15.1 through 501.15.4.

**501.15.1 Size.** The chimney or vent shall be resized as necessary to control flue gas condensation in the interior of the chimney or vent and to provide the appliance or appliances served with the required draft. For Category I appliances, the resizing shall be in accordance with Section 502.

**501.15.2 Flue passageways.** The flue gas passageway shall be free of obstructions and combustible deposits and shall be cleaned if previously used for venting a solid or liquid fuel-burning appliance or fireplace. The flue liner, chimney inner wall or vent inner wall shall be continuous and shall be free of cracks, gaps, perforations or other damage or deterioration which would allow the escape of combustion products, including gases, moisture and creosote.

**501.15.3 Cleanout.** Masonry chimney flues shall be provided with a cleanout opening having a minimum height of 6 inches (152 mm). The upper edge of the opening shall be located not less than 6 inches (152 mm) below the lowest chimney inlet opening. The cleanout shall be provided with a tight-fitting, noncombustible cover.

**501.15.4 Clearances.** Chimneys and vents shall have air-space clearance to combustibles in accordance with the *International Building Code* and the chimney or vent manufacturer's installation instructions. Noncombustible firestopping or fireblocking shall be provided in accordance with the *International Building Code*.

**Exception:** Masonry chimneys equipped with a chimney lining system tested and listed for installation in

chimneys in contact with combustibles in accordance with UL 1777, and installed in accordance with the manufacturer's instructions, shall not be required to have clearance between combustible materials and exterior surfaces of the masonry chimney.

## SECTION 502 (IFGC) VENTS

**502.1 General.** All vents, except as provided in Section 503.7, shall be listed and labeled. Type B and BW vents shall be tested in accordance with UL 441. Type L vents shall be tested in accordance with UL 641. Vents for Category II and III appliances shall be tested in accordance with UL 1738. Plastic vents for Category IV appliances shall not be required to be listed and labeled where such vents are as specified by the appliance manufacturer and are installed in accordance with the appliance manufacturer's installation instructions.

**502.2 Connectors required.** Connectors shall be used to connect appliances to the vertical chimney or vent, except where the chimney or vent is attached directly to the appliance. Vent connector size, material, construction and installation shall be in accordance with Section 503.

**502.3 Vent application.** The application of vents shall be in accordance with Table 503.4.

**502.4 Insulation shield.** Where vents pass through insulated assemblies, an insulation shield constructed of not less than 26 gage sheet (0.016 inch) (0.4 mm) metal shall be installed to provide clearance between the vent and the insulation material. The clearance shall not be less than the clearance to combustibles specified by the vent manufacturer's installation instructions. Where vents pass through attic space, the shield shall terminate not less than 2 inches (51 mm) above the insulation materials and shall be secured in place to prevent displacement. Insulation shields provided as part of a listed vent system shall be installed in accordance with the manufacturer's installation instructions.

**502.5 Installation.** Vent systems shall be sized, installed and terminated in accordance with the vent and appliance manufacturer's installation instructions and Section 503.

**502.6 Support of vents.** All portions of vents shall be adequately supported for the design and weight of the materials employed.

## SECTION 503 (IFGS) VENTING OF EQUIPMENT

**503.1 General.** This section recognizes that the choice of venting materials and the methods of installation of venting systems are dependent on the operating characteristics of the equipment being vented. The operating characteristics of vented equipment can be categorized with respect to (1) positive or negative pressure within the venting system; and (2) whether or not the equipment generates flue or vent gases that might condense in the venting system. See Section 202 for the definition of these vented appliance categories.

**503.2 Venting systems required.** Except as permitted in Sections 503.2.1 through 503.2.4 and 501.8, all equipment shall be connected to venting systems.

**503.2.1 Ventilating hoods.** Ventilating hoods and exhaust systems shall be permitted to be used to vent equipment installed in commercial applications (see Section 503.3.4) and to vent industrial equipment, such as where the process itself requires fume disposal.

**503.2.2 Well-ventilated spaces.** Where located in a large and well-ventilated space, industrial equipment shall be permitted to be operated by discharging the flue gases directly into the space.

**503.2.3 Direct-vent equipment.** Listed direct-vent equipment shall be considered properly vented where installed in accordance with the terms of its listing, the manufacturer's instructions, and Section 503.8, Item 3.

**503.2.4 Equipment with integral vents.** Equipment incorporating integral venting means shall be considered properly vented when installed in accordance with its listing, the manufacturer's instructions, and Section 503.8, Items 1 and 2.

**503.3 Design and construction.** A venting system shall be designed and constructed so as to develop a positive flow adequate to convey flue or vent gases to the outdoor atmosphere.

**503.3.1 Equipment draft requirements.** A venting system shall satisfy the draft requirements of the equipment in accordance with the manufacturer's instructions.

**503.3.2 Design and construction.** Gas utilization equipment required to be vented shall be connected to a venting system designed and installed in accordance with the provisions of Sections 503.4 through 503.15.

**503.3.3 Mechanical draft systems.** Mechanical draft systems shall comply with the following:

1. Mechanical draft systems shall be listed and shall be installed in accordance with the terms of their listing and both the appliance and the mechanical draft system manufacturer's instructions.
2. Equipment, except incinerators, requiring venting shall be permitted to be vented by means of mechanical draft systems of either forced or induced draft design.
3. 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.
4. Vent connectors serving equipment vented by natural draft shall not be connected into any portion of mechanical draft systems operating under positive pressure.
5. 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.

6. The exit terminals of mechanical draft systems shall be not less than 7 feet (2134 mm) above grade where located adjacent to public walkways and shall be located as specified in Section 503.8, Items 1 and 2.

**503.3.4 Ventilating hoods and exhaust systems.** Ventilating hoods and exhaust systems shall be permitted to be used to vent gas utilization equipment installed in commercial applications. Where automatically operated equipment is vented through a ventilating hood or exhaust system equipped with a damper or with a power means of exhaust, provisions shall be made to allow the flow of gas to the main burners only when the damper is open to a position to properly vent the equipment and when the power means of exhaust is in operation.

**503.3.5 Circulating air ducts and furnace plenums.** No portion of a venting system shall extend into or pass through any circulating air duct or furnace plenum.

**503.4 Type of venting system to be used.** The type of venting system to be used shall be in accordance with Table 503.4.

**503.4.1 Plastic piping.** Plastic piping used for venting equipment listed for use with such venting materials shall be approved.

**503.4.2 Special gas vent.** Special gas vent shall be listed and installed in accordance with the terms of the special gas vent listing and the manufacturers' instructions.

**503.5 Masonry, metal, and factory-built chimneys.** Masonry, metal and factory-built chimneys shall comply with Sections 503.5.1 through 503.5.10.

**503.5.1 Factory-built chimneys.** Factory-built chimneys shall be installed in accordance with their listing and the manufacturers' instructions. Factory-built chimneys used to vent appliances that operate at positive vent pressure shall be listed for such application.

**503.5.2 Metal chimneys.** Metal chimneys shall be built and installed in accordance with NFPA 211.

**503.5.3 Masonry chimneys.** Masonry chimneys shall be built and installed in accordance with NFPA 211 and shall be lined with approved clay flue lining, a listed chimney lining system, or other approved material that will resist corrosion, erosion, softening, or cracking from vent gases at temperatures up to 1800°F (982°C).

**Exception:** Masonry chimney flues serving listed gas appliances with draft hoods, Category I appliances, and other gas appliances listed for use with Type B vent shall be permitted to be lined with a chimney lining system specifically listed for use only with such appliances. The liner shall be installed in accordance with the liner manufacturer's instructions and the terms of the listing. A permanent identifying label shall be attached at the point where the connection is to be made to the liner. The label shall read: "This chimney liner is for appliances that burn gas only. Do not connect to solid or liquid fuel-burning appliances or incinerators."

For information on installation of gas vents in existing masonry chimneys, see Section 503.6.5.

**TABLE 503.4  
TYPE OF VENTING SYSTEM TO BE USED**

GAS UTILIZATION EQUIPMENT	TYPE OF VENTING SYSTEM
Listed Category I equipment Listed equipment equipped with draft hood Equipment listed for use with Type B gas vent	Type B gas vent (Section 503.6) Chimney (Section 503.5) Single-wall metal pipe (Section 503.7) Listed chimney lining system for gas venting (Section 503.5.3) Special gas vent listed for this equipment (Section 503.4.2)
Listed vented wall furnaces	Type B-W gas vent (Sections 503.6, 607)
Category II equipment	As specified or furnished by manufacturers of listed equipment (Sections 503.4.1, 503.4.2)
Category III equipment	As specified or furnished by manufacturers of listed equipment (Sections 503.4.1, 503.4.2)
Category IV equipment	As specified or furnished by manufacturers of listed equipment (Sections 503.4.1, 503.4.2)
Incinerators, indoors	Chimney (Section 503.5)
Incinerators, outdoors	Single-wall metal pipe (Sections 503.7, 503.7.6)
Equipment which may be converted to use of solid fuel	Chimney (Section 503.5)
Unlisted combination gas and oil-burning equipment	Chimney (Section 503.5)
Listed combination gas and oil-burning equipment	Type L vent (Section 503.6) or chimney (Section 503.5)
Combination gas and solid fuel-burning equipment	Chimney (Section 503.5)
Equipment listed for use with chimneys only	Chimney (Section 503.5)
Unlisted equipment	Chimney (Section 503.5)
Decorative appliance in vented fireplace	Chimney
Gas-fired toilets	Single-wall metal pipe (Section 625)
Direct vent equipment	See Section 503.2.3
Equipment with integral vent	See Section 503.2.4

**503.5.4 Chimney termination.** Chimneys for residential-type or low-heat gas utilization equipment shall extend at least 3 feet (914 mm) above the highest point where it passes through a roof of a building and at least 2 feet (610 mm) higher than any portion of a building within a horizontal distance of 10 feet (3048 mm) (see Figure 503.5.4). Chimneys for medium-heat equipment shall extend at least 10 feet (3048 mm) higher than any portion of any building within 25 feet (7620 mm). Chimneys shall extend at least 5 feet (1524 mm) above the highest connected equipment draft hood outlet or flue collar. Decorative shrouds shall not be installed at the termination of factory-built chimneys except where such shrouds are listed and labeled for use with the specific factory-built chimney system and are installed in accordance with the manufacturers' installation instructions.

**503.5.5 Size of chimneys.** The effective area of a chimney venting system serving listed appliances with draft hoods, Category I appliances, and other appliances listed for use with Type B vents shall be determined in accordance with one of the following methods:

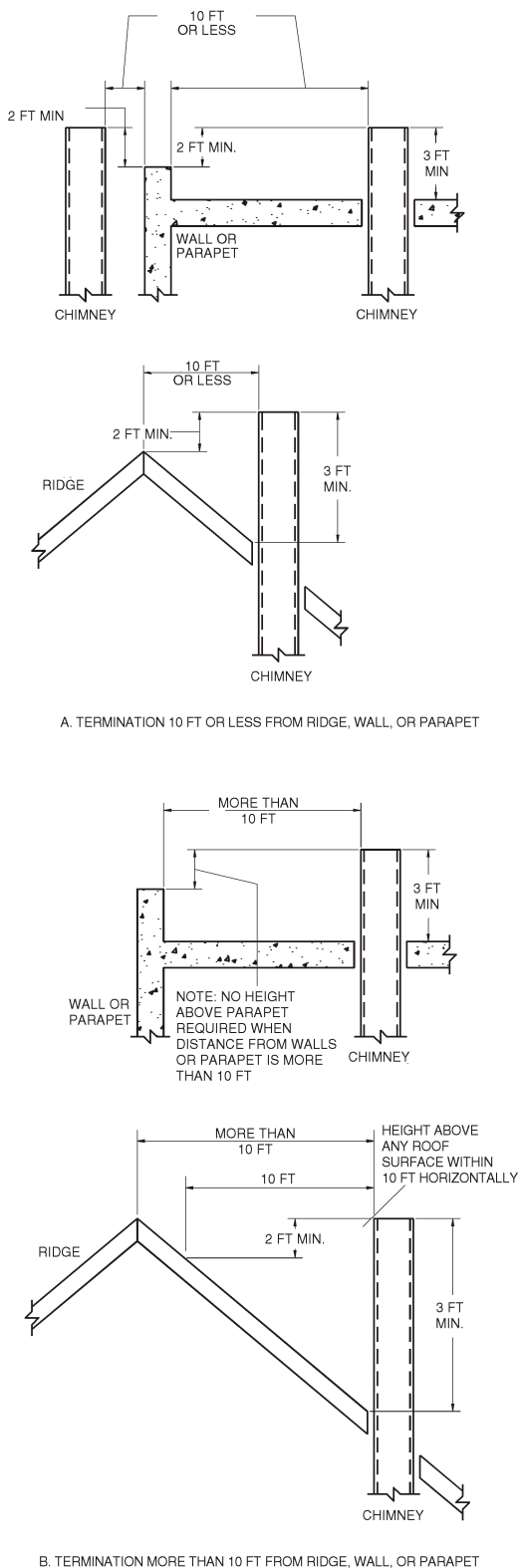
1. The provisions of Section 504.
2. For sizing an individual chimney venting system for a single appliance with a draft hood, the effective areas of the vent connector and chimney flue shall be not

less than the area of the appliance flue collar or draft hood outlet, nor greater than seven times the draft hood outlet area.

3. For sizing a chimney venting system connected to two appliances with draft hoods, the effective area of the chimney flue shall be not less than the area of the larger draft hood outlet plus 50 percent of the area of the smaller draft hood outlet, nor greater than seven times the smallest draft hood outlet area.
4. Chimney venting systems using mechanical draft shall be sized in accordance with approved engineering methods.
5. Other approved engineering methods.

**503.5.5.1 Incinerator venting.** Where an incinerator is vented by a chimney serving other gas utilization equipment, the gas input to the incinerator shall not be included in calculating chimney size, provided the chimney flue diameter is not less than 1 inch (25 mm) larger in equivalent diameter than the diameter of the incinerator flue outlet.

**503.5.6 Inspection of chimneys.** Before replacing an existing appliance or connecting a vent connector to a chimney, the chimney passageway shall be examined to ascertain that



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE 503.5.4**  
**TYPICAL TERMINATION LOCATIONS FOR**  
**CHIMNEYS AND SINGLE-WALL METAL PIPES SERVING**  
**RESIDENTIAL-TYPE AND LOW-HEAT EQUIPMENT**

it is clear and free of obstructions and it shall be cleaned if previously used for venting solid or liquid fuel-burning appliances or fireplaces.

**503.5.6.1 Chimney lining.** Chimneys shall be lined in accordance with NFPA 211.

**Exception:** Existing chimneys shall be permitted to have their use continued when an appliance is replaced by an appliance of similar type, input rating, and efficiency.

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

**503.5.6.3 Unsafe chimneys.** Where inspection reveals that an existing chimney is not safe for the intended application, it shall be repaired, rebuilt, lined, relined, or replaced with a vent or chimney to conform to NFPA 211 and it shall be suitable for the equipment to be vented.

**503.5.7 Chimneys serving equipment burning other fuels.** Chimneys serving equipment burning other fuels shall comply with Sections 503.5.7.1 through 503.5.7.4.

**503.5.7.1 Solid fuel-burning appliances.** Gas utilization equipment shall not be connected to a chimney flue serving a separate appliance designed to burn solid fuel.

**503.5.7.2 Liquid fuel-burning appliances.** Where one chimney flue serves gas utilization equipment and equipment burning liquid fuel, the equipment shall be connected through separate openings or shall be connected through a single opening where joined by a suitable fitting located as close as practical to the chimney. Where two or more openings are provided into one chimney flue, they shall be at different levels. Where the gas utilization equipment is automatically controlled, it shall be equipped with a safety shutoff device.

**503.5.7.3 Combination gas and solid fuel-burning appliances.** A combination gas- and solid fuel-burning appliance shall be permitted to be connected to a single chimney flue where equipped with a manual reset device to shut off gas to the main burner in the event of sustained backdraft or flue gas spillage. The chimney flue shall be sized to properly vent the appliance.

**503.5.7.4 Combination gas- and oil fuel-burning appliances.** A listed combination gas- and oil fuel-burning appliance shall be permitted to be connected to a single chimney flue. The chimney flue shall be sized to properly vent the appliance.

**503.5.8 Support of chimneys.** All portions of chimneys shall be supported for the design and weight of the materials employed. Factory-built chimneys shall be supported and spaced in accordance with their listings and the manufacturer's instructions.

**503.5.9 Cleanouts.** Where a chimney that formerly carried flue products from liquid or solid fuel-burning appliances is used with an appliance using fuel gas, an accessible cleanout shall be provided. The cleanout shall have a tight-fitting cover and shall be installed so its upper edge is at least 6 inches (152 mm) below the lower edge of the lowest chimney inlet opening.

**503.5.10 Space surrounding lining or vent.** The remaining space surrounding a chimney liner, gas vent, special gas vent, or plastic piping installed within a masonry chimney flue shall not be used to vent another appliance. The insertion of another liner or vent within the chimney as provided in this code and the liner or vent manufacturer’s instructions shall not be prohibited.

The remaining space surrounding a chimney liner, gas vent, special gas vent, or plastic piping installed within a masonry, metal or factory-built chimney, shall not be used to supply combustion air. Such space shall not be prohibited from supplying combustion air to direct-vent appliances designed for installation in a solid fuel-burning fireplace and installed in accordance with the listing and the manufacturer’s instructions.

**503.6 Gas vents.** Gas vents shall comply with Sections 503.6.1 through 503.6.12 (see Section 202, Definitions).

**503.6.1 Installation, general.** Gas vents shall be installed in accordance with the terms of their listings and the manufacturer’s instructions.

**503.6.2 Type B-W vent capacity.** A Type B-W gas vent shall have a listed capacity not less than that of the listed vented wall furnace to which it is connected.

**503.6.3 Roof penetration.** A gas vent passing through a roof shall extend through the roof flashing, roof jack, or roof thimble and shall be terminated by a listed termination cap.

**503.6.4 Offsets.** Type B and Type L vents shall extend in a generally vertical direction with offsets not exceeding 45 degrees (0.79 rad), except that a vent system having not more than one 60-degree (1.04 rad) offset shall be permitted. Any angle greater than 45 degrees (0.79 rad) from the vertical is considered horizontal. The total horizontal length of a vent plus the horizontal vent connector length serving draft-hood-equipped appliances shall not be greater than 75 percent of the vertical height of the vent.

**Exception:** Systems designed and sized as provided in Section 504 or in accordance with other approved engineering methods.

Vents serving Category I fan-assisted appliances shall be installed in accordance with the appliance manufacturer’s instructions and Section 504 or other approved engineering methods.

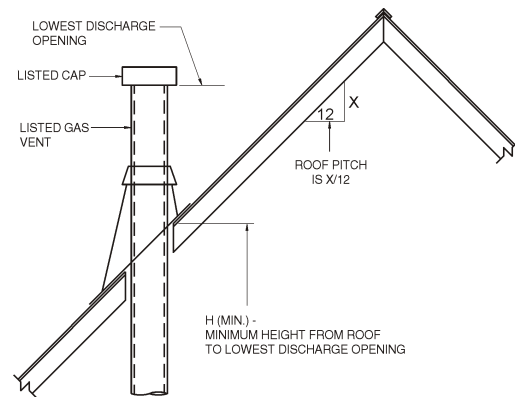
**503.6.5 Gas vents installed within masonry chimneys.** Gas vents installed within masonry chimneys shall be installed in accordance with the terms of their listing and the manufacturer’s installation instructions. Gas vents installed within masonry chimneys shall be identified with a permanent label installed at the point where the vent enters the chimney. The label shall contain the following language: “This gas vent is for appliances that burn gas. Do not connect to solid or liquid fuel-burning appliances or incinerators.”

**503.6.6 Gas vent terminations.** A gas vent shall terminate in accordance with one of the following:

1. Above the roof surface with a listed cap or listed roof assembly. Gas vents 12 inches (305 mm) in size or smaller with listed caps shall be permitted to be termi-

nated in accordance with Figure 503.6.6, provided that such vents are at least 8 feet (2438 mm) from a vertical wall or similar obstruction. All other gas vents shall terminate not less than 2 feet (610 mm) above the highest point where they pass through the roof and at least 2 feet (610 mm) higher than any portion of a building within 10 feet (3048 mm).

2. As provided for industrial equipment in Section 503.2.2.
3. As provided for direct-vent systems in Section 503.2.3.
4. As provided for equipment with integral vents in Section 503.2.4.
5. As provided for mechanical draft systems in Section 503.3.3.
6. As provided for ventilating hoods and exhaust systems in Section 503.3.4.



ROOF PITCH	H (min) ft
Flat to 6/12	1.0
Over 6/12 to 7/12	1.25
Over 7/12 to 8/12	1.5
Over 8/12 to 9/12	2.0
Over 9/12 to 10/12	2.5
Over 10/12 to 11/12	3.25
Over 11/12 to 12/12	4.0
Over 12/12 to 14/12	5.0
Over 14/12 to 16/12	6.0
Over 16/12 to 18/12	7.0
Over 18/12 to 20/12	7.5
Over 20/12 to 21/12	8.0

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**FIGURE 503.6.6**  
**GAS VENT TERMINATION LOCATIONS FOR LISTED CAPS 12 INCHES OR LESS IN SIZE AT LEAST 8 FEET FROM A VERTICAL WALL**

**503.6.6.1 Decorative shrouds.** Decorative shrouds shall not be installed at the termination of gas vents except where such shrouds are listed for use with the specific gas venting system and are installed in accordance with manufacturer's installation instructions.

**503.6.6.7 Minimum height.** A Type B or a Type L gas vent shall terminate at least 5 feet (1524 mm) in vertical height above the highest connected equipment draft hood or flue collar. A Type B-W gas vent shall terminate at least 12 feet (3658 mm) in vertical height above the bottom of the wall furnace.

**503.6.6.8 Exterior wall penetrations.** A gas vent extending through an exterior wall shall not terminate adjacent to the wall or below eaves or parapets, except as provided in Sections 503.2.3 and 503.3.3.

**503.6.6.9 Size of gas vents.** Venting systems shall be sized and constructed in accordance with Section 504 or other approved engineering methods and the gas vent and gas equipment manufacturers' instructions.

**503.6.6.9.1 Category I appliances.** 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 gas vent, installed in a single story of a building, shall be in accordance with one of the following methods:

**Exceptions:**

1. The provisions of Section 504.
2. For sizing an individual gas vent for a single, draft-hood-equipped appliance, the effective area of the vent connector and the gas vent shall be not less than the area of the appliance draft hood outlet, nor greater than seven times the draft hood outlet area.
3. For sizing a gas vent connected to two appliances with draft hoods, the effective area of the vent shall be not less than the area of the larger draft hood outlet plus 50 percent of the area of the smaller draft hood outlet, nor greater than seven times the smaller draft hood outlet area.
4. Approved engineering practices.

**503.6.6.9.2 Category II, III, and IV appliances.** The sizing of gas vents for Category II, III, and IV equipment shall be in accordance with the equipment manufacturer's instructions.

**503.6.6.9.3 Mechanical draft.** Chimney venting systems using mechanical draft shall be sized in accordance with approved engineering methods.

**503.6.10 Gas vents serving equipment on more than one floor.** A single or common gas vent shall be permitted in multistory installations to vent Category I equipment located on more than one floor level, provided the venting system is designed and installed in accordance with this section and approved engineering methods.

**503.6.10.1 Equipment separation.** All equipment connected to the common vent shall be located in rooms sep-

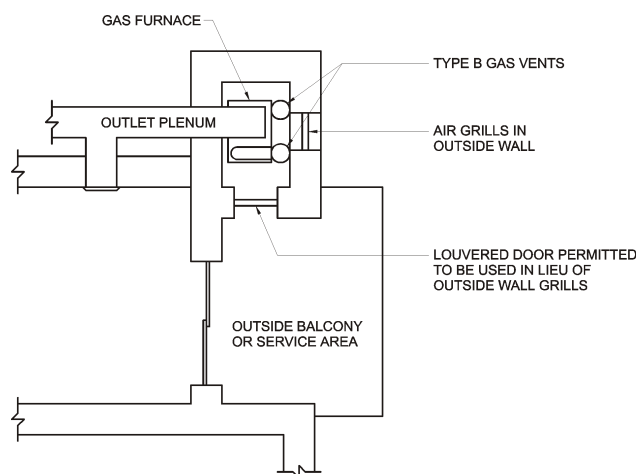
arated from habitable space. Each of these rooms shall have provisions for an adequate supply of combustion, ventilation, and dilution air that is not supplied from habitable space (see Figure 503.6.10.1).

**503.6.10.2 Sizing.** The size of the connectors and common segments of multistory venting systems for equipment listed for use with Type B double-wall gas vent shall be in accordance with Table 504.3(1) and Figures B-13 and B-14 in Appendix B, provided:

1. The available total height (H) for each segment of a multistory venting system is the vertical distance between the level of the highest draft hood outlet or flue collar on that floor and the centerline of the next highest interconnection tee (see Figure B-13).
2. The size of the connector for a segment is determined from its gas utilization equipment heat input and available connector rise, and shall not be smaller than the draft hood outlet or flue collar size.
3. The size of the common vertical segment, and of the interconnection tee at the base of that segment, shall be based on the total gas utilization equipment heat input entering that segment and its available total height.

**503.6.11 Support of gas vents.** Gas vents shall be supported and spaced in accordance with their listings and the manufacturer's instructions.

**503.6.12 Marking.** In those localities where solid and liquid fuels are used extensively, gas vents shall be permanently identified by a label attached to the wall or ceiling at a point where the vent connector enters the gas vent. The de-



**FIGURE 503.6.10.1**  
PLAN VIEW OF PRACTICAL SEPARATION METHOD  
FOR MULTISTORY GAS VENTING



termination of where such localities exist shall be made by the code official. The label shall read:

“This gas vent is for appliances that burn gas. Do not connect to solid or liquid fuel-burning appliances or incinerators.”

**503.7 Single-wall metal pipe.** Single-wall metal pipe vents shall comply with Sections 503.7.1 through 503.7.12.

**503.7.1 Construction.** Single-wall metal pipe shall be constructed of galvanized sheet steel not less than 0.0304 inch (0.7 mm) thick, or other approved, noncombustible, corrosion-resistant material.

**503.7.2 Cold climate.** Uninsulated single-wall metal pipe shall not be used outdoors in cold climates for venting gas utilization equipment.

**503.7.3 Termination.** Single-wall metal pipe shall terminate at least 5 feet (1524 mm) in vertical height above the highest connected equipment draft hood outlet or flue collar. Single-wall metal pipe shall extend at least 2 feet (610 mm) above the highest point where it passes through a roof of a building and at least 2 feet (610 mm) higher than any portion of a building within a horizontal distance of 10 feet (3048 mm) (see Figure 503.5.4). An approved cap or roof assembly shall be attached to the terminus of a single-wall metal pipe (see also Section 503.7.8, Item 3).

**503.7.4 Limitations of use.** Single-wall metal pipe shall be used only for runs directly from the space in which the equipment is located through the roof or exterior wall to the outdoor atmosphere.

**503.7.5 Roof penetrations.** A pipe passing through a roof shall extend without interruption through the roof flashing, roof jacket, or roof thimble. Where 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 (457 mm) above and 6 inches (152 mm) 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 Section 503.10.16.

**503.7.6 Installation.** Single-wall metal pipe shall not originate in any unoccupied attic or concealed space and shall not pass through any attic, inside wall, concealed space, or floor. The installation of a single-wall metal pipe through an exterior combustible wall shall comply with Section 503.10.15. Single-wall metal pipe used for venting an incinerator shall be exposed and readily examinable for its full length and shall have suitable clearances maintained.

**503.7.7 Clearances.** Minimum clearances from single-wall metal pipe to combustible material shall be in accordance with Table 503.7.7. The clearance from single-wall metal pipe to combustible material shall be permitted to be reduced where the combustible material is protected as specified for vent connectors in Table 308.2.

**503.7.8 Size of single-wall metal pipe.** A venting system constructed of single-wall metal pipe shall be sized in accordance with one of the following methods and the equipment manufacturer’s instructions:

1. For a draft-hood-equipped appliance, in accordance with Section 504.
2. For a venting system for a single appliance with a draft hood, the areas of the connector and the pipe each shall be not less than the area of the appliance flue collar or draft hood outlet, whichever is smaller. The vent area shall not be greater than seven times the draft hood outlet area.
3. Other approved engineering methods.

**503.7.9 Pipe geometry.** Any shaped single-wall metal pipe shall be permitted to be used, provided that its equivalent effective area is equal to the effective area of the round pipe for which it is substituted, and provided that the minimum internal dimension of the pipe is not less than 2 inches (51 mm).

**TABLE 503.7.7<sup>a</sup>**  
**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
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 above	Not permitted	9 inches	18 inches	As listed
Medium-heat equipment	Not permitted	Not permitted	36 inches	As listed

For SI: 1 inch = 25.4 mm.

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

**503.7.10 Termination capacity.** The vent cap or a roof assembly shall have a venting capacity not less than that of the pipe to which it is attached.

**503.7.11 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.

**503.7.12 Marking.** Single-wall metal pipe shall comply with the marking provisions of Section 503.6.12.

**503.8 Venting system termination location.** The location of venting system terminations shall comply with the following (see Appendix C):

1. A mechanical draft venting system shall terminate at least 3 feet (914 mm) above any forced-air inlet located within 10 feet (3048 mm).

**Exceptions:**

1. This provision shall not apply to the combustion air intake of a direct-vent appliance.
  2. This provision shall not apply to the separation of the integral outdoor air inlet and flue gas discharge of listed outdoor appliances.
2. A mechanical draft venting system, excluding direct-vent appliances, shall terminate at least 4 feet (1219 mm) below, 4 feet (1219 mm) horizontally from, or 1 foot (305 mm) above any door, operable window, or gravity air inlet into any building. The bottom of the vent terminal shall be located at least 12 inches (305 mm) above grade.
  3. The vent terminal of a direct-vent appliance with an input of 10,000 Btu per hour (3 kW) or less shall be located at least 6 inches (152 mm) from any air opening into a building, and such an appliance with an input over 10,000 Btu per hour (3 kW) but not over 50,000 Btu per hour (14.7 kW) shall be installed with a 9-inch (230 mm) vent termination clearance, and an appliance with an input over 50,000 Btu/h (14.7 kw) shall have at least a 12-inch (305 mm) vent termination clearance. The bottom of the vent terminal and the air intake shall be located at least 12 inches (305 mm) above grade.
  4. Through-the-wall vents for Category II and IV appliances and noncategorized condensing appliances shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of regulators, relief valves, or other equipment. Where local experience indicates that condensate is a problem with Category I and III appliances, this provision shall also apply.

**503.9 Condensation drainage.** Provision shall be made to collect and dispose of condensate from venting systems serving Category II and IV equipment and noncategorized condensing appliances in accordance with Section 503.8, Item 4. Where local experience indicates that condensation is a problem, provision shall be made to drain off and dispose of condensate from venting systems serving Category I and III equipment in accordance with Section 503.8, Item 4.

**503.10 Vent connectors for Category I equipment.** Vent connectors for Category I equipment shall comply with Sections 503.10.1 through 503.10.16.

**503.10.1 Where required.** A vent connector shall be used to connect equipment to a gas vent, chimney, or single-wall metal pipe, except where the gas vent, chimney, or single-wall metal pipe is directly connected to the equipment.

**503.10.2 Materials.** Vent connectors shall be constructed in accordance with Sections 503.10.2.1 through 503.10.2.5.

**503.10.2.1 General.** A vent connector shall be made of noncombustible corrosion-resistant material capable of withstanding the vent gas temperature produced by the equipment and of sufficient thickness to withstand physical damage.

**503.10.2.2 Vent connectors located in unconditioned areas.** Where the vent connector used for equipment having a draft hood or a Category I appliance is located in or passes through attics, crawl spaces or other unconditioned spaces, that portion of the vent connector shall be listed Type B or Type L or listed vent material or listed material having equivalent insulation properties.

**Exception:** Single-wall metal pipe located within the exterior walls of the building in areas having a local 99 percent winter design temperature of 5°F (-15°C) or higher shall be permitted to be used in unconditioned spaces other than attics and crawl spaces.

**503.10.2.3 Residential-type appliance connectors.** Where vent connectors for residential-type appliances are not installed in attics or other unconditioned spaces, connectors for listed appliances having draft hoods and for appliances having draft hoods and equipped with listed conversion burners shall be one of the following:

1. Type B or Type L vent material;
2. Galvanized sheet steel not less than 0.018 inch (0.46 mm) thick;
3. Aluminum (1100 or 3003 alloy or equivalent) sheet not less than 0.027 inch (0.69 mm) thick;
4. Stainless steel sheet not less than 0.012 inch (0.31 mm) thick;
5. Smooth interior wall metal pipe having resistance to heat and corrosion equal to or greater than that of Item 2, 3 or 4 above; or
6. A listed vent connector.

Vent connectors shall not be covered with insulation.

**Exception:** Listed insulated vent connectors shall be installed according to the terms of their listing.

**503.10.2.4 Low-heat equipment.** 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 503.10.2.4. Factory-built chimney sections shall be joined together in accordance with the chimney manufacturers' instructions.

**TABLE 503.10.2.4  
MINIMUM THICKNESS FOR GALVANIZED STEEL VENT  
CONNECTORS FOR LOW-HEAT APPLIANCES**

DIAMETER OF CONNECTOR (inches)	MINIMUM THICKNESS (inch)
Less than 6	0.019
6 to less than 10	0.023
10 to 12 inclusive	0.029
14 to 16 inclusive	0.034
Over 16	0.056

For SI: 1 inch = 25.4 mm.

**503.10.2.5 Medium-heat appliances.** 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 that specified in Table 503.10.2.5 and shall comply with the following:

1. A steel vent connector for equipment with a vent gas temperature in excess of 1000°F (538°C), measured at the entrance to the connector shall be lined with medium-duty fire brick (ASTM C 64, Type F), or the equivalent.
2. The lining shall be at least 2½ inches (64 mm) thick for a vent connector having a diameter or greatest cross-sectional dimension of 18 inches (457 mm) or less.
3. The lining shall be at least 4½ inches (114 mm) thick laid on the 4½-inch (114 mm) bed for a vent connector having a diameter or greatest cross-sectional dimension greater than 18 inches (457 mm).
4. Factory-built chimney sections, if employed, shall be joined together in accordance with the chimney manufacturers' instructions.

**TABLE 503.10.2.5  
MINIMUM THICKNESS FOR STEEL VENT CONNECTORS FOR  
MEDIUM-HEAT EQUIPMENT AND COMMERCIAL AND  
INDUSTRIAL INCINERATORS VENT CONNECTOR SIZE**

DIAMETER (inches)	AREA (square inches)	MINIMUM THICKNESS (inch)
Up to 14	Up to 154	0.053
Over 14 to 16	154 to 201	0.067
Over 16 to 18	201 to 254	0.093
Over 18	Larger than 254	0.123

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm².

**503.10.3 Size of vent connector.** Vent connectors shall be sized in accordance with Sections 503.10.3.1 through 503.10.3.5.

**503.10.3.1 Single draft hood and fan-assisted.** A vent connector for equipment with a single draft hood or for a Category I fan-assisted combustion system appliance shall be sized and installed in accordance with Section 504 or other approved engineering methods.

**503.10.3.2 Multiple draft hood.** For a single appliance having more than one draft hood outlet or flue collar, the

manifold shall be constructed according to the instructions of the appliance manufacturer. Where there are no instructions, the manifold shall be designed and constructed in accordance with approved engineering practices. As an alternate method, the effective area of the manifold shall equal the combined area of the flue collars or draft hood outlets and the vent connectors shall have a minimum 1-foot (305 mm) rise.

**503.10.3.3 Multiple appliances.** Where two or more appliances are connected to a common vent or chimney, each vent connector shall be sized in accordance with Section 504 or other approved engineering methods.

As an alternative method applicable only when all of the appliances are draft hood equipped, 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.

**503.10.3.4 Common connector/manifold.** Where two or more gas appliances are vented through a common vent connector or vent manifold, the common vent connector or vent manifold shall be located at the highest level consistent with available headroom and the required clearance to combustible materials and shall be sized in accordance with Section 504 or other approved engineering methods.

As an alternate method applicable only where there are two draft hood equipped appliances, the effective area of the common vent connector or vent manifold and all junction fittings shall be not less than the area of the larger vent connector plus 50 percent of the area of the smaller flue collar outlet.

**503.10.3.5 Size increase.** Where 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.

**503.10.4 Two or more appliances connected to a single vent.** Where 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. Vent connectors serving Category I appliances shall not be connected to any portion of a mechanical draft system operating under positive static pressure, such as those serving Category III or IV appliances.

**503.10.5 Clearance.** Minimum clearances from vent connectors to combustible material shall be in accordance with Table 503.7.7.

**Exception:** The clearance between a vent connector and combustible material shall be permitted to be reduced where the combustible material is protected as specified for vent connectors in Table 308.2.

**503.10.6 Flow resistance.** A vent connector shall be installed so as to avoid turns or other construction features that create excessive resistance to flow of vent gases.

**503.10.7 Joints.** Joints between sections of connector piping and connections to flue collars and hood outlets shall be fastened by one of the following methods:

1. Sheet metal screws.
2. Vent connectors of listed vent material assembled and connected to flue collars or draft hood outlets in accordance with the manufacturers' instructions.
3. Other approved means.

**503.10.8 Slope.** A vent connector shall be installed without dips or sags and shall slope upward toward the vent or chimney at least  $\frac{1}{4}$  inch per foot (21 mm/m).

**Exception:** Vent connectors attached to a mechanical draft system installed in accordance with the manufacturers' instructions.

**503.10.9 Length of vent connector.** A vent connector shall be as short as practical and the equipment located as close as practical to the chimney or vent. Except as provided for in Section 503.10.3, the maximum horizontal length of a single-wall connector shall be 75 percent of the height of the chimney or vent. Except as provided for in Section 503.10.3, the maximum horizontal length of a Type B double-wall connector shall be 100 percent of the height of the chimney or vent. For a chimney or vent system serving multiple appliances, the maximum length of an individual connector, from the appliance outlet to the junction with the common vent or another connector, shall be 100 percent of the height of the chimney or vent.

**503.10.10 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.

**503.10.11 Chimney connection.** Where entering a flue in a masonry or metal chimney, the vent connector shall be installed above the extreme bottom to avoid stoppage. Where a thimble or slip joint is 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 to prevent the connector from entering so far as to restrict the space between its end and the opposite wall of the chimney flue (see Section 501.9).

**503.10.12 Inspection.** The entire length of a vent connector shall be provided with ready access for inspection, cleaning, and replacement.

**503.10.13 Fireplaces.** A vent connector shall not be connected to a chimney flue serving a fireplace unless the fireplace flue opening is permanently sealed.

**503.10.14 Passage through ceilings, floors, or walls.** A vent connector shall not pass through any ceiling, floor or fire-resistance-rated wall. A single-wall metal pipe connector shall not pass through any interior wall.

**Exception:** Vent connectors made of listed Type B or Type L vent material and serving listed equipment with draft hoods and other equipment listed for use with Type B gas vents shall be permitted to pass through walls or partitions constructed of combustible material if the con-

nectors are installed with not less than the listed clearance to combustible material.

**503.10.15 Single-wall connector penetrations of combustible walls.** 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 appliances equipped with draft hoods and appliances listed for use with Type B gas vents, the thimble shall be not less than 4 inches (102 mm) larger in diameter than the vent connector. Where there is a run of not less than 6 feet (1829 mm) of vent connector in the open between the draft hood outlet and the thimble, the thimble shall be permitted to be not less than 2 inches (51 mm) larger in diameter than the vent connector.
2. For unlisted appliances having draft hoods, the thimble shall be not less than 6 inches (152 mm) larger in diameter than the vent connector.
3. For residential and low-heat appliances, the thimble shall be not less than 12 inches (305 mm) larger in diameter than the vent connector.

**Exception:** In lieu of thimble protection, all combustible material in the wall shall be removed 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.

**503.10.16 Medium-heat connectors.** Vent connectors for medium-heat equipment shall not pass through walls or partitions constructed of combustible material.

**503.11 Vent connectors for Category II, III, and IV appliances.** Vent connectors for Category II, III and IV appliances shall be as specified for the venting systems in accordance with Section 503.4.

**503.12 Draft hoods and draft controls.** The installation of draft hoods and draft controls shall comply with Sections 503.12.1 through 503.12.7.

**503.12.1 Equipment requiring draft hoods.** Vented equipment shall be installed with draft hoods.

**Exception:** Dual oven-type combination ranges, incinerators, direct-vent equipment, fan-assisted combustion system appliances, equipment requiring chimney draft for operation, single firebox boilers equipped with conversion burners with inputs greater than 400,000 Btu per hour (117 kw), equipment equipped with blast, power, or pressure burners that are not listed for use with draft hoods, and equipment designed for forced venting.

**503.12.2 Installation.** A draft hood supplied with or forming a part of listed vented equipment shall be installed without alteration, exactly as furnished and specified by the equipment manufacturer.

**503.12.2.1 Draft hood required.** If a draft hood is not supplied by the equipment manufacturer where one is required, a draft hood shall be installed, shall be of a listed or approved type and, in the absence of other instruc-

tions, shall be of the same size as the equipment flue collar. Where a draft hood is required with a conversion burner, it shall be of a listed or approved type.

**503.12.2.2 Special design draft hood.** Where it is determined that a draft hood of special design is needed or preferable for a particular installation, the installation shall be in accordance with the recommendations of the equipment manufacturer and shall be approved.

**503.12.3 Draft control devices.** Where a draft control device is part of the equipment or is supplied by the equipment manufacturer, it shall be installed in accordance with the manufacturers' instructions. In the absence of manufacturers' instructions, the device shall be attached to the flue collar of the equipment or as near to the equipment as practical.

**503.12.4 Additional devices.** Equipment (except incinerators) requiring controlled chimney draft shall be permitted to be equipped with a listed double-acting barometric-draft regulator installed and adjusted in accordance with the manufacturers' instructions.

**503.12.5 Location.** Draft hoods and barometric draft regulators 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.

**503.12.6 Positioning.** Draft hoods and draft regulators shall be installed in the position for which they were 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 equipment or adjacent construction. The equipment and its draft hood shall be located so that the relief opening is accessible for checking vent operation.

**503.12.7 Clearance.** A draft hood shall be located so its relief opening is not less than 6 inches (152 mm) from any surface except that of the equipment it serves and the venting system to which the draft hood is connected. Where a greater or lesser clearance is indicated on the equipment label, the clearance shall be not less than that specified on the label. Such clearances shall not be reduced.

**503.13 Manually operated dampers.** A manually operated damper shall not be placed in the vent connector for any equipment. Fixed baffles shall not be classified as manually operated dampers.

**503.14 Automatically operated vent dampers.** An automatically operated vent damper shall be of a listed type.

**503.15 Obstructions.** Devices that retard the flow of vent gases shall not be installed in a vent connector, chimney, or vent. The following shall not be considered as obstructions:

1. Draft regulators and safety controls specifically listed for installation in venting systems and installed in accordance with the terms of their listing.
2. Approved draft regulators and safety controls that are designed and installed in accordance with approved engineering methods.
3. Listed heat reclaimers and automatically operated vent dampers installed in accordance with the terms of their listing.

4. Approved economizers, heat reclaimers, and recuperators installed in venting systems of equipment not required to be equipped with draft hoods, provided that the gas utilization equipment manufacturer's instructions cover the installation of such a device in the venting system and performance in accordance with Sections 503.3 and 503.3.1 is obtained.
5. Vent dampers serving listed appliances installed in accordance with Sections 504.2.1 and 504.3.1 or other approved engineering methods.

## SECTION 504 (IFGS) SIZING OF CATEGORY I APPLIANCE VENTING SYSTEMS

**504.1 Definitions.** The following definitions apply to the tables in this section.

**APPLIANCE CATEGORIZED VENT DIAMETER/AREA.** The minimum vent area/diameter permissible for Category I appliances to maintain a nonpositive vent static pressure when tested in accordance with nationally recognized standards.

**FAN-ASSISTED COMBUSTION SYSTEM.** An appliance equipped with an integral mechanical means to either draw or force products of combustion through the combustion chamber or heat exchanger.

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

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

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

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

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

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

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

**504.2 Application of single-appliance vent Tables 504.2(1) through 504.2(5).** The application of Tables 504.2(1) through 504.2(5) shall be subject to the requirements of Sections 504.2.1 through 504.2.15.

**TABLE 504.2(1)  
TYPE B DOUBLE-WALL GAS VENT**

Number of Appliances	Single
Appliance Type	Category I
Appliance Vent Connection	Connected directly to vent

HEIGHT (H) (feet)	LATERAL (L) (feet)	VENT DIAMETER—(D) inches																						
		3			4			5			6			7			8			9				
		FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT		
Min		Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
APPLIANCE INPUT RATING IN THOUSANDS OF BTU/H																								
6	0	0	78	46	86	0	152	86	0	251	141	0	375	205	0	524	285	0	698	370	0	897	470	
	2	13	51	36	97	67	18	97	67	27	157	105	32	232	157	44	321	217	53	425	285	63	543	370
	4	21	49	34	30	94	30	94	64	39	153	103	50	227	153	66	316	211	79	419	279	93	536	362
	6	25	46	32	36	91	61	47	149	100	59	223	149	78	310	205	93	413	273	110	530	354	354	
8	0	0	84	50	165	94	0	165	94	0	276	155	0	415	235	0	583	320	0	780	415	0	1,006	537
	2	12	57	40	16	109	16	109	75	25	178	120	28	263	180	42	365	247	50	483	322	60	619	418
	5	23	53	38	32	103	71	42	171	115	53	255	173	70	356	237	83	473	313	99	607	407	407	
	8	28	49	35	39	98	66	51	164	109	64	247	165	84	347	227	99	463	303	117	596	396	396	
10	0	0	88	53	175	100	0	175	100	0	295	166	0	447	255	0	631	345	0	847	450	0	1,096	585
	2	12	61	42	17	118	17	118	81	23	194	129	26	289	195	40	402	273	48	533	355	57	684	457
	5	23	57	40	32	113	77	41	187	124	52	280	188	68	392	263	81	522	346	95	671	446	446	
	10	30	51	36	41	104	70	54	176	115	67	267	175	88	376	245	104	504	330	122	651	427	427	
15	0	0	94	58	0	191	112	0	327	187	0	502	285	0	716	390	0	970	525	0	1,263	682		
	2	11	69	48	15	136	93	20	226	150	22	339	225	38	475	316	45	633	414	53	815	544		
	5	22	65	45	30	130	87	39	219	142	49	330	217	64	463	300	76	620	403	90	800	529		
	10	29	59	41	40	121	82	51	206	135	64	315	208	84	445	288	99	600	386	116	777	507		
20	15	35	53	37	48	112	76	61	195	128	76	301	198	98	429	275	115	580	373	134	755	491		
	0	0	97	61	0	202	119	0	349	202	0	540	307	0	776	430	0	1,057	575	0	1,384	752		
	2	10	75	51	14	149	100	18	250	166	20	377	249	33	531	346	41	711	470	50	917	612		
	5	21	71	48	29	143	96	38	242	160	47	367	241	62	519	337	73	697	460	86	902	599		
20	10	28	64	44	38	133	89	50	229	150	62	351	228	81	499	321	95	675	443	112	877	576		
	15	34	58	40	46	124	84	59	217	142	73	337	217	94	481	308	111	654	427	129	853	557		
20	48	52	35	55	116	78	69	206	134	84	322	206	107	464	295	125	634	410	145	830	537			

(continued)

TABLE 504.2(1)—continued  
TYPE B DOUBLE-WALL GAS VENT

		VENT DIAMETER—(D) inches																					
		3			4			5			6			7			8			9			
HEIGHT (H) (feet)	LATERAL (L) (feet)	APPLIANCE INPUT RATING IN THOUSANDS OF BTU/H																					
		FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	NAT	Max
30	0	0	100	64	0	213	128	0	374	220	0	587	336	0	853	475	0	1,173	650	0	1,548	855	
	2	9	81	56	13	166	112	14	283	185	18	432	280	27	613	394	33	826	535	42	1,072	700	
	5	21	77	54	28	160	108	36	275	176	45	421	273	58	600	385	69	811	524	82	1,055	688	
	10	27	70	50	37	150	102	48	262	171	59	405	261	77	580	371	91	788	507	107	1,028	668	
	15	33	64	NA	44	141	96	57	249	163	70	389	249	90	560	357	105	765	490	124	1,002	648	
	20	56	58	NA	53	132	90	66	237	154	80	374	237	102	542	343	119	743	473	139	977	628	
	30	NA	NA	NA	73	113	NA	88	214	NA	104	346	219	131	507	321	149	702	444	171	929	594	
	0	0	101	67	0	216	134	0	397	232	0	633	363	0	932	518	0	1,297	708	0	1,730	952	
	2	8	86	61	11	183	122	14	320	206	15	497	314	22	715	445	26	975	615	33	1,276	813	
	5	20	82	NA	27	177	119	35	312	200	43	487	308	55	702	438	65	960	605	77	1,259	798	
50	10	26	76	NA	35	168	114	45	299	190	56	471	298	73	681	426	86	935	589	101	1,230	773	
	15	59	70	NA	42	158	NA	54	287	180	66	455	288	85	662	413	100	911	572	117	1,203	747	
	20	NA	NA	NA	50	149	NA	63	275	169	76	440	278	97	642	401	113	888	556	131	1,176	722	
	30	NA	NA	NA	69	131	NA	84	250	NA	99	410	259	123	605	376	141	844	522	161	1,125	670	
	0	NA	NA	NA	0	218	NA	0	407	NA	0	665	400	0	997	560	0	1,411	770	0	1,908	1,040	
	2	NA	NA	NA	10	194	NA	12	354	NA	13	566	375	18	831	510	21	1,155	700	25	1,536	935	
	5	NA	NA	NA	26	189	NA	33	347	NA	40	557	369	52	820	504	60	1,141	692	71	1,519	926	
	10	NA	NA	NA	33	182	NA	43	335	NA	53	542	361	68	801	493	80	1,118	679	94	1,492	910	
	15	NA	NA	NA	40	174	NA	50	321	NA	62	528	353	80	782	482	93	1,095	666	109	1,465	895	
	20	NA	NA	NA	47	166	NA	59	311	NA	71	513	344	90	763	471	105	1,073	653	122	1,438	880	
30	NA	NA	NA	NA	NA	NA	78	290	NA	92	483	NA	115	726	449	131	1,029	627	149	1,387	849		
50	NA	NA	NA	NA	NA	NA	NA	NA	NA	147	428	NA	180	651	405	197	944	575	217	1,288	787		

(continued)

Number of Appliances		Single
Appliance Type		Category I
Appliance Vent Connection		Connected directly to vent

TABLE 504.2(1)—continued  
TYPE B DOUBLE-WALL GAS VENT

HEIGHT (H) (feet)		VENT DIAMETER—(D) inches																							
		10		12		14		16		18		20		22		24									
		LATERAL (L) (feet)		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT			
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max		
6	0	0	1,121	570	0	1,645	850	0	2,267	1,170	0	2,983	1,530	0	3,802	1,960	0	4,721	2,430	0	5,737	2,950	0	6,853	3,520
	2	75	675	455	103	982	650	138	1,346	890	178	1,769	1,170	225	2,250	1,480	296	2,782	1,850	360	3,377	2,220	426	4,030	2,670
	4	110	668	445	147	975	640	191	1,338	880	242	1,761	1,160	300	2,242	1,475	390	2,774	1,835	469	3,370	2,215	555	4,023	2,660
	6	128	661	435	171	967	630	219	1,330	870	276	1,753	1,150	341	2,235	1,470	437	2,767	1,820	523	3,363	2,210	618	4,017	2,650
	0	0	1,261	660	0	1,858	970	0	2,571	1,320	0	3,399	1,740	0	4,333	2,220	0	5,387	2,750	0	6,555	3,360	0	7,838	4,010
	2	71	770	515	98	1,124	745	130	1,543	1,020	168	2,030	1,340	212	2,584	1,700	278	3,196	2,110	336	3,882	2,560	401	4,634	3,050
8	5	115	758	503	154	1,110	733	199	1,528	1,010	251	2,013	1,330	311	2,563	1,685	398	3,180	2,090	476	3,863	2,545	562	4,612	3,040
	8	137	746	490	180	1,097	720	231	1,514	1,000	289	2,000	1,320	354	2,552	1,670	450	3,163	2,070	537	3,850	2,530	630	4,602	3,030
	0	0	1,377	720	0	2,036	1,060	0	2,825	1,450	0	3,742	1,925	0	4,782	2,450	0	5,955	3,050	0	7,254	3,710	0	8,682	4,450
	2	68	852	560	93	1,244	850	124	1,713	1,130	161	2,256	1,480	202	2,868	1,890	264	3,556	2,340	319	4,322	2,840	378	5,153	3,390
10	5	112	839	547	149	1,229	829	192	1,696	1,105	243	2,238	1,461	300	2,849	1,871	382	3,536	2,318	458	4,301	2,818	540	5,132	3,371
	10	142	817	525	187	1,204	795	238	1,669	1,080	298	2,209	1,430	364	2,818	1,840	459	3,504	2,280	546	4,268	2,780	641	5,099	3,340
	0	0	1,596	840	0	2,380	1,240	0	3,323	1,720	0	4,423	2,270	0	5,678	2,900	0	7,099	3,620	0	8,665	4,410	0	10,393	5,300
	2	63	1,019	675	86	1,495	985	114	2,062	1,350	147	2,719	1,770	186	3,467	2,260	239	4,304	2,800	290	5,232	3,410	346	6,251	4,080
15	5	105	1,003	660	140	1,476	967	182	2,041	1,327	229	2,696	1,748	283	3,442	2,235	355	4,278	2,777	426	5,204	3,385	501	6,222	4,057
	10	135	977	635	177	1,446	936	227	2,009	1,289	283	2,659	1,712	346	3,402	2,193	432	4,234	2,739	510	5,159	3,343	599	6,175	4,019
	15	155	953	610	202	1,418	905	257	1,976	1,250	318	2,623	1,675	385	3,363	2,150	479	4,192	2,700	564	5,115	3,300	665	6,129	3,980
	0	0	1,756	930	0	2,637	1,350	0	3,701	1,900	0	4,948	2,520	0	6,376	3,250	0	7,988	4,060	0	9,785	4,980	0	11,753	6,000
20	2	59	1,150	755	81	1,694	1,100	107	2,343	1,520	139	3,097	2,000	175	3,955	2,570	220	4,916	3,200	269	5,983	3,910	321	7,154	4,700
	5	101	1,133	738	135	1,674	1,079	174	2,320	1,498	219	3,071	1,978	270	3,926	2,544	337	4,885	3,174	403	5,950	3,880	475	7,119	4,662
	10	130	1,105	710	172	1,641	1,045	220	2,282	1,460	273	3,029	1,940	334	3,880	2,500	413	4,835	3,130	489	5,896	3,830	573	7,063	4,600
	15	150	1,078	688	195	1,609	1,018	248	2,245	1,425	306	2,988	1,910	372	3,835	2,465	459	4,786	3,090	541	5,844	3,795	631	7,007	4,575
	20	167	1,052	665	217	1,578	990	273	2,210	1,390	335	2,948	1,880	404	3,791	2,430	495	4,737	3,050	585	5,792	3,760	689	6,953	4,550

(continued)



Number of Appliances	Single
Appliance Type	Category I
Appliance Vent Connection	Connected directly to vent

TABLE 504.2(1)—continued  
TYPE B DOUBLE-WALL GAS VENT

HEIGHT (H) (feet)	LATERAL (L) (feet)	VENT DIAMETER—(D) inches																							
		10		12		14		16		18		20		22		24									
		APPLIANCE INPUT RATING IN THOUSANDS OF BTU/H																							
FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT								
Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max								
30	0	0	1,977	1,060	0	3,004	1,550	0	4,252	2,170	0	5,725	2,920	0	7,420	3,770	0	9,341	4,750	0	11,483	5,850	0	13,848	7,060
	2	54	1,351	865	74	2,004	1,310	98	2,786	1,800	127	3,696	2,380	159	4,734	3,050	199	5,900	3,810	241	7,194	4,650	285	8,617	5,600
	5	96	1,332	851	127	1,981	1,289	164	2,759	1,775	206	3,666	2,350	252	4,701	3,020	312	5,863	3,783	373	7,155	4,622	439	8,574	5,552
	10	125	1,301	829	164	1,944	1,254	209	2,716	1,733	259	3,617	2,300	316	4,647	2,970	386	5,803	3,739	456	7,090	4,574	535	8,505	5,471
	15	143	1,272	807	187	1,908	1,220	237	2,674	1,692	292	3,570	2,250	354	4,594	2,920	431	5,744	3,695	507	7,026	4,527	590	8,437	5,391
	20	160	1,243	784	207	1,873	1,185	260	2,633	1,650	319	3,523	2,200	384	4,542	2,870	467	5,686	3,650	548	6,964	4,480	639	8,370	5,310
	30	195	1,189	745	246	1,807	1,130	305	2,555	1,585	369	3,433	2,130	440	4,442	2,785	540	5,574	3,565	635	6,842	4,375	739	8,239	5,225
	0	0	2,231	1,195	0	3,441	1,825	0	4,934	2,550	0	6,711	3,440	0	8,774	4,460	0	11,129	5,635	0	13,767	6,940	0	16,694	8,430
	2	41	1,620	1,010	66	2,431	1,513	86	3,409	2,125	113	4,554	2,840	141	5,864	3,670	171	7,339	4,630	209	8,980	5,695	251	10,788	6,860
	5	90	1,600	996	118	2,406	1,495	151	3,380	2,102	191	4,520	2,813	234	5,826	3,639	283	7,295	4,597	336	8,933	5,654	394	10,737	6,818
50	10	118	1,567	972	154	2,366	1,466	196	3,332	2,064	243	4,464	2,767	295	5,763	3,585	355	7,224	4,542	419	8,855	5,585	491	10,652	6,749
	15	136	1,536	948	177	2,327	1,437	222	3,285	2,026	274	4,409	2,721	330	5,701	3,534	396	7,155	4,511	465	8,779	5,546	542	10,570	6,710
	20	151	1,505	924	195	2,288	1,408	244	3,239	1,987	300	4,356	2,675	361	5,641	3,481	433	7,086	4,479	506	8,704	5,506	586	10,488	6,670
	30	183	1,446	876	232	2,214	1,349	287	3,150	1,910	347	4,253	2,631	412	5,523	3,431	494	6,953	4,421	577	8,557	5,444	672	10,328	6,603
	0	0	2,491	1,310	0	3,925	2,050	0	5,729	2,950	0	7,914	4,050	0	10,485	5,300	0	13,454	6,700	0	16,817	8,600	0	20,578	10,300
	2	30	1,975	1,170	44	3,027	1,820	72	4,313	2,550	95	5,834	3,500	120	7,591	4,600	138	9,577	5,800	169	11,803	7,200	204	14,264	8,800
	5	82	1,955	1,159	107	3,002	1,803	136	4,282	2,531	172	5,797	3,475	208	7,548	4,566	245	9,528	5,769	293	11,748	7,162	341	14,204	8,756
	10	108	1,923	1,142	142	2,961	1,775	180	4,231	2,500	223	5,737	3,434	268	7,478	4,509	318	9,447	5,717	374	11,658	7,100	436	14,105	8,683
	15	126	1,892	1,124	163	2,920	1,747	206	4,182	2,469	252	5,678	3,392	304	7,409	4,451	358	9,367	5,665	418	11,569	7,037	487	14,007	8,610
	20	141	1,861	1,107	181	2,880	1,719	226	4,133	2,438	277	5,619	3,351	330	7,341	4,394	387	9,289	5,613	452	11,482	6,975	523	13,910	8,537
100	30	170	1,802	1,071	215	2,803	1,663	265	4,037	2,375	319	5,505	3,267	378	7,209	4,279	446	9,136	5,509	514	11,310	6,850	592	13,720	8,391
	50	241	1,688	1,000	292	2,657	1,550	350	3,856	2,250	415	5,289	3,100	486	6,956	4,050	572	8,841	5,300	659	10,979	6,600	752	13,354	8,100

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.

TABLE 504.2(2)  
TYPE B DOUBLE-WALL GAS VENT

Number of Appliances	Single
Appliance Type	Category I
Appliance Vent Connection	Single-wall metal connector

HEIGHT (H) (feet)	LATERAL (L) (feet)	VENT DIAMETER—(D) inches																										
		3		4		5		6		7		8		9		10		12										
		FAN Min	FAN Max	NAT Min	NAT Max	FAN Min	FAN Max	NAT Min	NAT Max	FAN Min	FAN Max	NAT Min	NAT Max	FAN Min	FAN Max	NAT Min	NAT Max	FAN Min	FAN Max	NAT Min	NAT Max							
6	0	38	77	45	59	151	85	85	249	140	126	373	204	165	522	284	211	695	369	267	894	469	371	1,118	569	537	1,639	849
	2	39	51	36	60	96	66	85	156	104	123	231	156	159	320	213	201	423	284	251	541	368	347	673	453	498	979	648
	4	NA	NA	33	74	92	63	102	152	102	146	225	152	187	313	208	237	416	277	295	533	360	409	664	443	584	971	638
	6	NA	NA	31	83	89	60	114	147	99	163	220	148	207	307	203	263	409	271	327	526	352	449	656	433	638	962	627
	0	37	83	50	58	164	93	83	273	154	123	412	234	161	580	319	206	777	414	258	1,002	536	360	1,257	658	521	1,852	967
	2	39	56	39	59	108	75	83	176	119	121	261	179	155	363	246	197	482	321	246	617	417	339	768	513	486	1,120	743
8	5	NA	NA	37	77	102	69	107	168	114	151	252	171	193	352	235	245	470	311	305	604	404	418	754	500	598	1,104	730
	8	NA	NA	33	90	95	64	122	161	107	175	243	163	223	342	225	280	458	300	344	591	392	470	740	486	665	1,089	715
	0	37	87	53	57	174	99	82	293	165	120	444	254	158	628	344	202	844	449	253	1,093	584	351	1,373	718	507	2,031	1,057
10	2	39	61	41	59	117	80	82	193	128	119	287	194	153	400	272	193	531	354	242	681	456	332	849	559	475	1,242	848
	5	52	56	39	76	111	76	105	185	122	148	277	186	190	388	261	241	518	344	299	667	443	409	834	544	584	1,224	825
	10	NA	NA	34	97	100	68	132	171	112	188	261	171	237	369	241	296	497	325	363	643	423	492	808	520	688	1,194	788
15	0	36	93	57	56	190	111	80	325	186	116	499	283	153	713	388	195	966	523	244	1,259	681	336	1,591	838	488	2,374	1,237
	2	38	69	47	57	136	93	80	225	149	115	337	224	148	473	314	187	631	413	232	812	543	319	1,015	673	457	1,491	983
	5	51	63	44	75	128	86	102	216	140	144	326	217	182	459	298	231	616	400	287	795	526	392	997	657	562	1,469	963
	10	NA	NA	39	95	116	79	128	201	131	182	308	203	228	438	284	284	592	381	349	768	501	470	966	628	664	1,433	928
	15	NA	NA	NA	NA	NA	72	158	186	124	220	290	192	272	418	269	334	568	367	404	742	484	540	937	601	750	1,399	894
	0	35	96	60	54	200	118	78	346	201	114	537	306	149	772	428	190	1,053	573	238	1,379	750	326	1,751	927	473	2,631	1,346
20	2	37	74	50	56	148	99	78	248	165	113	375	248	144	528	344	182	708	468	227	914	611	309	1,146	754	443	1,689	1,098
	5	50	68	47	73	140	94	100	239	158	141	363	239	178	514	334	224	692	457	279	896	596	381	1,126	734	547	1,665	1,074
	10	NA	NA	41	93	129	86	125	223	146	177	344	224	222	491	316	277	666	437	339	866	570	457	1,092	702	646	1,626	1,037
	15	NA	NA	NA	NA	NA	80	155	208	136	216	325	210	264	469	301	325	640	419	393	838	549	526	1,060	677	730	1,587	1,005
	20	NA	NA	NA	NA	NA	NA	186	192	126	254	306	196	309	448	285	374	616	400	448	810	526	592	1,028	651	808	1,550	973

(continued)

TABLE 504.2(2)—continued  
TYPE B DOUBLE-WALL GAS VENT

HEIGHT (H) (feet)	LATERAL (L) (feet)	VENT DIAMETER—(D) inches																											
		3			4			5			6			7			8			9			10			12			
		FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	
30	0	34	99	63	53	211	127	NA	NA	NA	NA	110	584	334	144	849	472	184	1,168	647	229	1,542	852	312	1,971	1,056	454	2,996	1,545
	2	37	80	56	55	164	111	76	281	183	109	429	279	139	610	392	175	823	533	219	1,069	698	296	1,346	863	424	1,999	1,308	
	5	49	74	52	72	157	106	98	271	173	136	417	271	171	595	382	215	806	521	269	1,049	684	366	1,324	846	524	1,971	1,283	
	10	NA	NA	NA	91	144	98	122	255	168	171	397	257	213	570	367	265	777	501	327	1,017	662	440	1,287	821	620	1,927	1,234	
	15	NA	NA	NA	115	131	NA	151	239	157	208	377	242	255	547	349	312	750	481	379	985	638	507	1,251	794	702	1,884	1,205	
	20	NA	NA	NA	NA	NA	NA	181	223	NA	246	357	228	298	524	333	360	723	461	433	955	615	570	1,216	768	780	1,841	1,166	
50	30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	389	477	305	461	670	426	541	895	574	704	1,147	720	937	1,759	1,101
	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515	176	1,292	704	220	1,724	948	295	2,223	1,189	428	3,432	1,818	
	2	36	84	61	53	181	121	73	318	205	104	495	312	133	712	443	168	971	613	209	1,273	811	280	1,615	1,007	401	2,426	1,509	
	5	48	80	NA	70	174	117	94	308	198	131	482	305	164	696	435	204	953	602	257	1,252	795	347	1,591	991	496	2,396	1,490	
	10	NA	NA	NA	89	160	NA	118	292	186	162	461	292	203	671	420	253	923	583	313	1,217	765	418	1,551	963	589	2,347	1,455	
	15	NA	NA	NA	112	148	NA	145	275	174	199	441	280	244	646	405	299	894	562	363	1,183	736	481	1,512	934	668	2,299	1,421	
100	20	NA	NA	NA	NA	NA	NA	NA	NA	NA	236	420	267	285	622	389	345	866	543	415	1,150	708	544	1,473	906	741	2,251	1,387	
	30	NA	NA	NA	NA	NA	NA	NA	NA	NA	315	376	NA	373	573	NA	442	809	502	521	1,086	649	674	1,399	848	892	2,159	1,318	
	0	NA	NA	NA	49	214	NA	69	403	NA	100	659	395	131	991	555	166	1,404	765	207	1,900	1,033	273	2,479	1,300	395	3,912	2,042	
	2	NA	NA	NA	51	192	NA	70	351	NA	98	563	373	125	828	508	158	1,152	698	196	1,532	933	259	1,970	1,168	371	3,021	1,817	
	5	NA	NA	NA	67	186	NA	90	342	NA	125	551	366	156	813	501	194	1,134	688	240	1,511	921	322	1,945	1,153	460	2,990	1,796	
	10	NA	NA	NA	85	175	NA	113	324	NA	153	532	354	191	789	486	238	1,104	672	293	1,477	902	389	1,905	1,133	547	2,938	1,763	
300	15	NA	NA	NA	132	162	NA	138	310	NA	188	511	343	230	764	473	281	1,075	656	342	1,443	884	447	1,865	1,110	618	2,888	1,730	
	20	NA	NA	NA	NA	NA	NA	168	295	NA	224	487	NA	270	739	458	325	1,046	639	391	1,410	864	507	1,825	1,087	690	2,838	1,696	
	30	NA	NA	NA	NA	NA	NA	231	264	NA	301	448	NA	355	685	NA	418	988	NA	491	1,343	824	631	1,747	1,041	834	2,739	1,627	
	50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	540	584	NA	617	866	NA	711	1,205	NA	895	1,591	NA	1,138	2,547	1,489	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.

TABLE 504.2(3)  
MASONRY CHIMNEY

Number of Appliances	Single
Appliance Type	Category I
Appliance Vent Connection	Type B double-wall connector

HEIGHT (H) (feet)		LATERAL (L) (feet)		APPLIANCE INPUT RATING IN THOUSANDS OF BTU/H																							
				3		4		5		6		7		8		9		10		12							
				FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT				
6	2	Min	NA	28	NA	NA	52	NA	NA	NA	86	NA	NA	130	NA	180	NA	NA	247	NA	320	NA	NA	401	NA	NA	581
		Max	NA	25	NA	49	NA	82	NA	117	NA	165	NA	231	NA	298	NA	NA	298	NA	350	NA	446	139	1,024	651	
		Min	NA	29	NA	55	NA	93	NA	145	NA	198	NA	266	84	590	100	728	446	139	1,024	651					
8	5	Min	NA	26	NA	NA	52	NA	NA	88	NA	134	NA	183	NA	247	NA	328	149	711	423	201	1,007	640			
		Max	NA	24	NA	48	NA	83	NA	127	NA	175	NA	239	NA	318	173	695	410	231	990	623					
		Min	NA	31	NA	61	NA	103	NA	162	NA	221	68	519	298	82	655	388	98	810	491	136	1,144	724			
10	5	Min	NA	28	NA	NA	57	NA	NA	96	NA	148	NA	204	NA	277	124	638	365	146	791	466	196	1,124	712		
		Max	NA	25	NA	50	NA	87	NA	139	NA	191	NA	263	155	610	347	182	762	444	240	1,093	668				
		Min	NA	35	NA	67	NA	114	NA	179	53	475	250	64	613	336	77	779	441	92	968	562	127	1,376	841		
15	5	Min	NA	35	NA	NA	62	NA	NA	107	NA	164	NA	231	118	759	416	139	946	533	186	1,352	828				
		Max	NA	28	NA	55	NA	97	NA	153	NA	216	126	565	296	148	727	394	173	912	567	229	1,315	777			
		Min	NA	NA	NA	48	NA	89	NA	141	NA	201	NA	281	171	698	375	198	880	485	259	1,280	742				
20	2	Min	NA	38	NA	NA	74	NA	NA	124	NA	201	51	522	274	61	678	375	73	867	491	87	1,083	627	121	1,548	953
		Max	NA	36	NA	68	NA	116	NA	184	80	503	254	95	658	350	113	845	463	133	1,059	597	179	1,523	933		
		Min	NA	NA	NA	60	NA	107	NA	172	NA	237	332	143	811	440	167	1,022	566	221	1,482	879					
20	15	Min	NA	NA	NA	NA	NA	NA	NA	97	NA	159	NA	220	NA	314	165	780	418	191	987	541	251	1,443	840		
		Max	NA	NA	NA	NA	NA	NA	NA	NA	83	NA	148	NA	206	NA	296	186	750	397	214	955	513	277	1,406	807	
		Min	NA	NA	NA	NA	NA	NA	NA	NA	83	NA	148	NA	206	NA	296	186	750	397	214	955	513	277	1,406	807	

(continued)

TABLE 504.2(3)—continued  
MASONRY CHIMNEY

Number of Appliances	Single
Appliance Type	Category I
Appliance Vent Connection	Type B double-wall connector

HEIGHT (H) (feet)	LATERAL (L) (feet)	APPLIANCE INPUT RATING IN THOUSANDS OF BTU/H																										
		3		4		5		6		7		8		9		10		12										
		FAN Min	FAN Max	NAT Min	NAT Max	FAN Min	FAN Max	NAT Min	NAT Max	FAN Min	FAN Max	NAT Min	NAT Max	FAN Min	FAN Max	NAT Min	NAT Max	FAN Min	FAN Max	NAT Min	NAT Max							
30	2	NA	NA	41	NA	NA	82	NA	NA	137	NA	NA	216	NA	NA	303	57	762	421	68	985	558	81	1,240	717	111	1,793	1,112
	5	NA	NA	NA	NA	NA	76	NA	NA	128	NA	NA	198	NA	NA	281	90	741	393	106	962	526	125	1,216	683	169	1,766	1,094
	10	NA	NA	NA	NA	NA	67	NA	NA	115	NA	NA	184	NA	NA	263	115	709	373	135	927	500	158	1,176	648	210	1,721	1,025
	15	NA	NA	NA	NA	NA	NA	NA	NA	107	NA	NA	171	NA	NA	243	NA	NA	353	156	893	476	181	1,139	621	239	1,679	981
	20	NA	NA	NA	NA	NA	NA	NA	NA	91	NA	NA	159	NA	NA	227	NA	NA	332	176	860	450	203	1,103	592	264	1,638	940
	30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	188	NA	NA	288	NA	NA	416	249	1,035	555	318	1,560	877
50	2	NA	NA	NA	NA	NA	92	NA	NA	161	NA	NA	251	NA	NA	351	51	840	477	61	1,106	633	72	1,413	812	99	2,080	1,243
	5	NA	NA	NA	NA	NA	NA	NA	NA	151	NA	NA	230	NA	NA	323	83	819	445	98	1,083	596	116	1,387	774	155	2,052	1,225
	10	NA	NA	NA	NA	NA	NA	NA	NA	138	NA	NA	215	NA	NA	304	NA	NA	424	126	1,047	567	147	1,347	733	195	2,006	1,147
	15	NA	NA	NA	NA	NA	NA	NA	NA	127	NA	NA	199	NA	NA	282	NA	NA	400	146	1,010	539	170	1,307	702	222	1,961	1,099
	20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	185	NA	NA	264	NA	NA	376	165	977	511	190	1,269	669	246	1,916	1,050
	30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	327	NA	NA	468	233	1,196	623	295	1,832	984
Minimum Internal Area of Chimney (square inches)	12	19	28	38	50	63	78	95	132																			
Maximum Internal Area of Chimney (square inches)	49	88	137	198	269	352	445	550	792																			

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm<sup>2</sup>, 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.

TABLE 504.2(4)  
MASONRY CHIMNEY

Number of Appliances	Single
Appliance Type	Category I
Appliance Vent Connection	Single-wall metal connector

HEIGHT (H) (feet)	LATERAL (L) (feet)	TYPE B DOUBLE-WALL CONNECTOR DIAMETER—(D) inches to be used with chimney areas within the size limits at bottom																											
		APPLIANCE INPUT RATING IN THOUSANDS OF BTU/H																											
		3		4		5		6		7		8		9		10		12											
FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT							
Min		Max		Min		Max		Min		Max		Min		Max		Min		Max		Min		Max							
6	2	NA	NA	28	NA	NA	NA	52	NA	NA	86	NA	NA	130	NA	NA	180	NA	NA	247	NA	NA	319	NA	NA	400	NA	NA	580
	5	NA	NA	25	NA	NA	48	NA	NA	81	NA	NA	116	NA	NA	164	NA	NA	230	NA	NA	297	NA	NA	375	NA	NA	560	
8	2	NA	NA	29	NA	NA	55	NA	NA	93	NA	NA	145	NA	NA	197	NA	NA	265	NA	NA	349	NA	NA	445	549	1,021	650	
	5	NA	NA	26	NA	NA	51	NA	NA	87	NA	NA	133	NA	NA	182	NA	NA	246	NA	NA	327	NA	NA	422	673	1,003	638	
10	8	NA	NA	23	NA	NA	47	NA	NA	82	NA	NA	126	NA	NA	174	NA	NA	237	NA	NA	317	NA	NA	408	747	985	621	
	2	NA	NA	31	NA	NA	61	NA	NA	102	NA	NA	161	NA	NA	220	216	518	297	271	654	387	373	808	490	536	1,142	722	
15	5	NA	NA	28	NA	NA	56	NA	NA	95	NA	NA	147	NA	NA	203	NA	NA	276	334	635	364	459	789	465	657	1,121	710	
	10	NA	NA	24	NA	NA	49	NA	NA	86	NA	NA	137	NA	NA	189	NA	NA	261	NA	NA	345	547	758	441	771	1,088	665	
20	2	NA	NA	35	NA	NA	67	NA	NA	113	NA	NA	178	166	473	249	211	611	335	264	776	440	362	965	560	520	1,373	840	
	5	NA	NA	32	NA	NA	61	NA	NA	106	NA	NA	163	NA	NA	230	261	591	312	325	775	414	444	942	531	637	1,348	825	
15	10	NA	NA	27	NA	NA	54	NA	NA	96	NA	NA	151	NA	NA	214	NA	NA	294	392	722	392	531	907	504	749	1,309	774	
	15	NA	NA	NA	NA	NA	46	NA	NA	87	NA	NA	138	NA	NA	198	NA	NA	278	452	692	372	606	873	481	841	1,272	738	
20	2	NA	NA	38	NA	NA	73	NA	NA	123	NA	NA	200	163	520	273	206	675	374	258	864	490	252	1,079	625	508	1,544	950	
	5	NA	NA	35	NA	NA	67	NA	NA	115	NA	NA	183	80	NA	252	255	655	348	317	842	461	433	1,055	594	623	1,518	930	
20	10	NA	NA	NA	NA	NA	59	NA	NA	105	NA	NA	170	NA	NA	235	312	622	330	382	806	437	517	1,016	562	733	1,475	875	
	15	NA	NA	NA	NA	NA	NA	NA	NA	95	NA	NA	156	NA	NA	217	NA	NA	311	442	773	414	591	979	539	823	1,434	835	
20	20	NA	NA	NA	NA	NA	NA	NA	NA	80	NA	NA	144	NA	NA	202	NA	NA	292	NA	NA	392	663	944	510	911	1,394	800	

(continued)

TABLE 504.2(4)—continued  
MASONRY CHIMNEY

Number of Appliances	Single
Appliance Type	Category I
Appliance Vent Connection	Single-wall metal connector

HEIGHT (H) (feet)	LATERAL (L) (feet)	TYPE B DOUBLE-WALL CONNECTOR DIAMETER—(D) inches to be used with chimney areas within the size limits at bottom																												
		APPLIANCE INPUT RATING IN THOUSANDS OF BTU/H																												
		3		4		5		6		7		8		9		10		12												
FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT								
Min		Max		Min		Max		Min		Max		Min		Max		Min		Max		Min		Max								
30	2	NA	NA	41	NA	NA	81	NA	NA	NA	136	NA	NA	215	158	578	302	302	200	759	420	249	982	556	340	1,237	715	489	1,789	1,110
	5	NA	NA	NA	NA	75	NA	NA	196	NA	127	NA	NA	196	NA	NA	279	245	737	391	306	958	524	417	1,210	680	600	1,760	1,090	
	10	NA	NA	NA	NA	66	NA	NA	182	NA	113	NA	NA	182	NA	NA	260	300	703	370	370	920	496	500	1,168	644	708	1,713	1,020	
	15	NA	NA	NA	NA	NA	NA	NA	168	NA	105	NA	NA	168	NA	NA	240	NA	NA	349	428	884	471	572	1,128	615	798	1,668	975	
	20	NA	NA	NA	NA	NA	NA	NA	155	NA	88	NA	NA	155	NA	NA	223	NA	NA	327	NA	NA	NA	445	643	1,089	585	883	1,624	932
	30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	182	NA	NA	281	NA	NA	NA	408	NA	NA	544	1,055	1,539	865
50	2	NA	NA	NA	NA	91	NA	NA	250	NA	160	NA	NA	250	191	837	475	238	1,103	631	323	1,408	810	463	2,076	1,240				
	5	NA	NA	NA	NA	NA	NA	228	NA	149	NA	NA	228	NA	NA	321	NA	NA	442	293	1,078	593	398	1,381	770	571	2,044	1,220		
	10	NA	NA	NA	NA	NA	NA	212	NA	136	NA	NA	212	NA	NA	301	NA	NA	420	355	1,038	562	447	1,337	728	674	1,994	1,140		
	15	NA	NA	NA	NA	NA	NA	195	NA	124	NA	NA	195	NA	NA	278	NA	NA	395	NA	NA	533	546	1,294	695	761	1,945	1,090		
	20	NA	NA	NA	NA	NA	NA	180	NA	NA	NA	NA	180	NA	NA	258	NA	NA	370	NA	NA	504	616	1,251	660	844	1,898	1,040		
	30	NA	NA	NA	NA	48	NA	NA	NA	NA	NA	NA	NA	NA	NA	318	NA	NA	458	NA	NA	610	1,009	1,805	970					
Minimum Internal Area of Chimney (square inches)	12	19	28	38	50	63	78	95	132																					
Maximum Internal Area of Chimney (square inches)	49	88	137	198	269	352	445	550	792																					

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm<sup>2</sup>, 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.

**TABLE 504.2(5)  
SINGLE-WALL METAL PIPE OR TYPE B  
ASBESTOS CEMENT VENT**

<b>Number of Appliances</b>	Single
<b>Appliance Type</b>	Category I
<b>Appliance Vent Connection</b>	Connected directly to pipe or vent

HEIGHT (H) (feet)	LATERAL (L) (feet)	VENT DIAMETER—(D) inches							
		3	4	5	6	7	8	10	12
		MAXIMUM APPLIANCE INPUT RATING IN THOUSANDS OF BTU/H							
6	0	39	70	116	170	232	312	500	750
	2	31	55	94	141	194	260	415	620
	5	28	51	88	128	177	242	390	600
8	0	42	76	126	185	252	340	542	815
	2	32	61	102	154	210	284	451	680
	5	29	56	95	141	194	264	430	648
10	10	24	49	86	131	180	250	406	625
	0	45	84	138	202	279	372	606	912
	2	35	67	111	168	233	311	505	760
15	5	32	61	104	153	215	289	480	724
	10	27	54	94	143	200	274	455	700
	15	NA	46	84	130	186	258	432	666
	0	49	91	151	223	312	420	684	1,040
	2	39	72	122	186	260	350	570	865
	5	35	67	110	170	240	325	540	825
20	10	30	58	103	158	223	308	514	795
	15	NA	50	93	144	207	291	488	760
	20	NA	NA	82	132	195	273	466	726
	0	53	101	163	252	342	470	770	1,190
	2	42	80	136	210	286	392	641	990
	5	38	74	123	192	264	364	610	945
30	10	32	65	115	178	246	345	571	910
	15	NA	55	104	163	228	326	550	870
	20	NA	NA	91	149	214	306	525	832
	0	56	108	183	276	384	529	878	1,370
	2	44	84	148	230	320	441	730	1,140
	5	NA	78	137	210	296	410	694	1,080
50	10	NA	68	125	196	274	388	656	1,050
	15	NA	NA	113	177	258	366	625	1,000
	20	NA	NA	99	163	240	344	596	960
	0	NA	120	210	310	443	590	980	1,550
	2	NA	95	171	260	370	492	820	1,290
	5	NA	NA	159	234	342	474	780	1,230
50	10	NA	NA	146	221	318	456	730	1,190
	15	NA	NA	NA	200	292	407	705	1,130
	20	NA	NA	NA	185	276	384	670	1,080
	30	NA	NA	NA	NA	222	330	605	1,010

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.



**504.2.1 Vent obstructions.** These venting tables shall not be used where obstructions, as described in Section 503.15, are installed in the venting system. The installation of vents serving listed appliances with vent dampers shall be in accordance with the appliance manufacturer's instructions or in accordance with the following:

1. The maximum capacity of the vent system shall be determined using the "NAT Max" column.
2. The minimum capacity shall be determined as if the appliance were a fan-assisted appliance, using the "FAN Min" column to determine the minimum capacity of the vent system. Where the corresponding "FAN Min" is "NA," the vent configuration shall not be permitted and an alternative venting configuration shall be utilized.

**504.2.2 Minimum size.** Where the vent size determined from the tables is smaller than the appliance draft hood outlet or flue collar, the smaller size shall be permitted to be used provided that all of the following requirements are met:

1. The total vent height (H) is at least 10 feet (3048 mm).
2. Vents for appliance draft hood outlets or flue collars 12 inches (305 mm) in diameter or smaller are not reduced more than one table size.
3. Vents for appliance draft hood outlets or flue collars larger than 12 inches (305 mm) in diameter are not reduced more than two table sizes.
4. The maximum capacity listed in the tables for a fan-assisted appliance is reduced by 10 percent ( $0.90 \times$  maximum table capacity).
5. The draft hood outlet is greater than 4 inches (102 mm) in diameter. Do not connect a 3-inch-diameter (76 mm) vent to a 4-inch-diameter (102 mm) draft hood outlet. This provision shall not apply to fan-assisted appliances.

**504.2.3 Vent offsets.** Single-appliance venting configurations with zero (0) lateral lengths in Tables 504.2(1), 504.2(2), and 504.2(5) shall not have elbows in the venting system. For vent configurations with lateral lengths, the venting tables include allowance for two 90-degree (1.57 rad) turns. For each elbow up to and including 45 degrees (0.79 rad), the maximum capacity listed in the venting tables shall be reduced by 5 percent. For each elbow greater than 45 degrees (0.79 rad) up to and including 90 degrees (1.57 rad), the maximum capacity listed in the venting tables shall be reduced by 10 percent.

**504.2.4 Zero lateral.** Zero (0) lateral (L) shall apply only to a straight vertical vent attached to a top outlet draft hood or flue collar.

**504.2.5 High-altitude installations.** Sea-level input ratings shall be used when determining maximum capacity for high altitude installation. Actual input (derated for altitude) shall be used for determining minimum capacity for high altitude installation.

**504.2.6 Multiple input rate appliances.** For appliances with more than one input rate, the minimum vent capacity (FAN Min) determined from the tables shall be less than the lowest appliance input rating, and the maximum vent capacity

(FAN Max/NAT Max) determined from the tables shall be greater than the highest appliance rating input.

**504.2.7 Liner system sizing.** Listed corrugated metallic chimney liner systems in masonry chimneys shall be sized by using Table 504.2(1) or 504.2(2) for Type B vents with the maximum capacity reduced by 20 percent ( $0.80 \times$  maximum capacity) and the minimum capacity as shown in Table 504.2(1) or 504.2(2). Corrugated metallic liner systems installed with bends or offsets shall have their maximum capacity further reduced in accordance with Section 504.2.3. The 20-percent reduction for corrugated metallic chimney liner systems includes an allowance for one long-radius 90-degree (157 rad) turn at the bottom of the liner.

**504.2.8 Vent area and diameter.** Where the vertical vent has a larger diameter than the vent connector, the vertical vent diameter shall be used to determine the minimum vent capacity, and the connector diameter shall be used to determine the maximum vent capacity. The flow area of the vertical vent shall not exceed seven times the flow area of the listed appliance categorized vent area, flue collar area, or draft hood outlet area unless designed in accordance with approved engineering methods.

**504.2.9 Chimney and vent locations.** Tables 504.2(1), 504.2(2), 504.2(3), 504.2(4) and 504.2(5) shall be used for chimneys and vents not exposed to the outdoors below the roof line. A Type B vent or listed chimney lining system passing through an unused masonry chimney flue shall not be considered to be exposed to the outdoors. Table 504.2(3) in combination with Table 504.3(6) shall be used for clay-tile-lined exterior masonry chimneys, provided all of the following are met:

1. Vent connector is Type B double-wall.
2. Vent connector length is limited to  $1\frac{1}{2}$  feet for each inch (18 mm per mm) of vent connector diameter.
3. The appliance is draft hood equipped.
4. The input rating is less than the maximum capacity given by Table 504.2(3).
5. For a water heater, the outdoor design temperature is not less than 5°F (-15°C).
6. For a space-heating appliance, the input rating is greater than the minimum capacity given by Table 504.3(6).

Where these conditions cannot be met, an alternative venting design shall be used, such as a listed chimney lining system.

**Exception:** The installation of vents serving listed appliances shall be permitted to be in accordance with the appliance manufacturer's instructions and the terms of the listing.

**504.2.10 Corrugated vent connector size.** Corrugated vent connectors shall be not smaller than the listed appliance categorized vent diameter, flue collar diameter, or draft hood outlet diameter.

**504.2.11 Vent connector size limitation.** Vent connectors shall not be increased in size more than two sizes greater

than the listed appliance categorized vent diameter, flue collar diameter, or draft hood outlet diameter.

**504.2.12 Component commingling.** In a single run of vent or vent connector, different diameters and types of vent and connector components shall be permitted to be used, provided that all such sizes and types are permitted by the tables.

**504.2.13 Table interpolation.** Interpolation shall be permitted in calculating capacities for vent dimensions that fall between the table entries (see Example 3, Appendix B).

**504.2.14 Extrapolation prohibited.** Extrapolation beyond the table entries shall not be permitted.

**504.2.15 Engineering calculations.** For vent heights less than 6 feet (1829 mm) and greater than shown in the tables, engineering methods shall be used to calculate vent capacities.

**504.3 Application of multiple appliance vent Tables 504.3(1) through 504.3(8).** The application of Tables 504.3(1) through 504.3(8) shall be subject to the requirements of Sections 504.3.1 through 504.3.26.

**504.3.1 Vent obstructions.** These venting tables shall not be used where obstructions, as described in Section 503.15, are installed in the venting system. The installation of vents serving listed appliances with vent dampers shall be in accordance with the appliance manufacturer's instructions or in accordance with the following:

1. The maximum capacity of the vent connector shall be determined using the NAT Max column.
2. The maximum capacity of the vertical vent or chimney shall be determined using the FAN+NAT column when the second appliance is a fan-assisted appliance, or the NAT+NAT column when the second appliance is equipped with a draft hood.
3. The minimum capacity shall be determined as if the appliance were a fan-assisted appliance.
  - 3.1. The minimum capacity of the vent connector shall be determined using the FAN Min column.
  - 3.2. The FAN+FAN column shall be used where the second appliance is a fan-assisted appliance, and the FAN+NAT column shall be used where the second appliance is equipped with a draft hood, to determine whether the vertical vent or chimney configuration is not permitted (NA). Where the vent configuration is NA, the vent configuration shall not be permitted and an alternative venting configuration shall be utilized.

**504.3.2 Connector length limit.** The vent connector shall be routed to the vent utilizing the shortest possible route. Except as provided in Section 504.3.3, the maximum vent connector horizontal length shall be 1½ feet for each inch (457 mm per mm) of connector diameter as shown in Table 504.3.2.

**TABLE 504.3.2  
MAXIMUM VENT CONNECTOR LENGTH**

CONNECTOR DIAMETER MAXIMUM (inches)	CONNECTOR HORIZONTAL LENGTH (feet)
3	4½
4	6
5	7½
6	9
7	10½
8	12
9	13½
10	15
12	18
14	21
16	24
18	27
20	30
22	33
24	36

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

**504.3.3 Connectors with longer lengths.** Connectors with longer horizontal lengths than those listed in Section 504.3.2 are permitted under the following conditions:

1. The maximum capacity (FAN Max or NAT Max) of the vent connector shall be reduced 10 percent for each additional multiple of the length listed above. For example, the maximum length listed above for a 4-inch (102 mm) connector is 6 feet (1829 mm). With a connector length greater than 6 feet (1829 mm) but not exceeding 12 feet (3658 mm), the maximum capacity must be reduced by 10 percent (0.90 × maximum vent connector capacity). With a connector length greater than 12 feet (3658 mm) but not exceeding 18 feet (5486 mm), the maximum capacity must be reduced by 20 percent (0.80 × maximum vent capacity).
2. For a connector serving a fan-assisted appliance, the minimum capacity (FAN Min) of the connector shall be determined by referring to the corresponding single appliance table. For Type B double-wall connectors, Table 504.2(1) shall be used. For single-wall connectors, Table 504.2(2) shall be used. The height (H) and lateral (L) shall be measured according to the procedures for a single-appliance vent, as if the other appliances were not present.

**504.3.4 Vent connector manifold.** Where the vent connectors are combined prior to entering the vertical portion of the common vent to form a common vent manifold, the size of the common vent manifold and the common vent shall be determined by applying a 10-percent reduction (0.90 × maximum common vent capacity) to the common vent capacity part of the common vent tables. The length of the common vent connector manifold (LM) shall not exceed

1½ feet for each inch (457 mm per mm) of common vent connector manifold diameter (D) (see Figure B-11).

**504.3.5 Common vertical vent offset.** Where the common vertical vent is offset, the maximum capacity of the common vent shall be reduced in accordance with Section 504.3.6. The horizontal length of the common vent offset ( $L_o$ ) shall not exceed 1½ feet for each inch (457 mm per mm) of common vent diameter.

**504.3.6 Elbows in vents.** For each elbow up to and including 45 degrees (0.79 rad) in the common vent, the maximum common vent capacity listed in the venting tables shall be reduced by 5 percent. For each elbow greater than 45 degrees (0.79 rad) up to and including 90 degrees (1.57 rad), the maximum common vent capacity listed in the venting tables shall be reduced by 10 percent.

**504.3.7 Elbows in connectors.** The vent connector capacities listed in the common vent sizing tables include allowance for two 90-degree (1.57 rad) elbows. For each additional elbow up to and including 45 degrees (0.79 rad), the maximum vent connector capacity listed in the venting tables shall be reduced by 5 percent. For each elbow greater than 45 degrees (0.79 rad) up to and including 90 degrees (1.57 rad), the maximum vent connector capacity listed in the venting tables shall be reduced by 10 percent.

**504.3.8 Common vent minimum size.** The cross-sectional area of the common vent shall be equal to or greater than the cross-sectional area of the largest connector.

**504.3.9 Common vent fittings.** At the point where tee or wye fittings connect to a common vent, the opening size of the fitting shall be equal to the size of the common vent. Such fittings shall not be prohibited from having reduced-size openings at the point of connection of appliance vent connectors.

**504.3.10 High-altitude installations.** Sea-level input ratings shall be used when determining maximum capacity for high-altitude installation. Actual input (derated for altitude) shall be used for determining minimum capacity for high-altitude installation.

**504.3.11 Connector rise measurement.** Connector rise (R) for each appliance connector shall be measured from the draft hood outlet or flue collar to the centerline where the vent gas streams come together.

**504.3.12 Vent height measurement.** For multiple units of equipment all located on one floor, available total height (H) shall be measured from the highest draft hood outlet or flue collar up to the level of the outlet of the common vent.

**504.3.13 Multistory height measurement.** For multistory installations, available total height (H) for each segment of the system shall be the vertical distance between the highest draft hood outlet or flue collar entering that segment and the centerline of the next higher interconnection tee (see Figure B-13).

**504.3.14 Multistory lowest portion sizing.** The size of the lowest connector and of the vertical vent leading to the lowest interconnection of a multistory system shall be in accordance with Table 504.2(1) or 504.2(2) for available total

height (H) up to the lowest interconnection (see Figure B-14).

**504.3.15 Multistory common vent offsets.** Where used in multistory systems, vertical common vents shall be Type B double wall and shall be installed with a listed vent cap.

**504.3.16 Multistory common vent offsets.** Offsets in multistory common vent systems shall be limited to a single offset in each system, and systems with an offset shall comply with all of the following:

1. The offset angle shall not exceed 45 degrees (0.79 rad) from vertical.
2. The horizontal length of the offset shall not exceed 1½ feet for each inch (457 mm per mm) of common vent diameter of the segment in which the offset is located.
3. For the segment of the common vertical vent containing the offset, the common vent capacity listed in the common venting tables shall be reduced by 20 percent ( $0.80 \times$  maximum common vent capacity).
4. A multistory common vent shall not be reduced in size above the offset.

**504.3.17 Vertical vent maximum size.** Where two or more appliances are connected to a vertical vent or chimney, the flow area of the largest section of vertical vent or chimney shall not exceed seven times the smallest listed appliance categorized vent areas, flue collar area, or draft hood outlet area unless designed in accordance with approved engineering methods.

**504.3.18 Multiple input rate appliances.** For appliances with more than one input rate, the minimum vent connector capacity (FAN Min) determined from the tables shall be less than the lowest appliance input rating, and the maximum vent connector capacity (FAN Max or NAT Max) determined from the tables shall be greater than the highest appliance input rating.

**504.3.19 Liner system sizing.** Listed, corrugated metallic chimney liner systems in masonry chimneys shall be sized by using Table 504.3(1) or 504.3(2) for Type B vents, with the maximum capacity reduced by 20 percent ( $0.80 \times$  maximum capacity) and the minimum capacity as shown in Table 504.3(1) or 504.3(2). Corrugated metallic liner systems installed with bends or offsets shall have their maximum capacity further reduced in accordance with Sections 504.3.5 and 504.3.6. The 20-percent reduction for corrugated metallic chimney liner systems includes an allowance for one long-radius 90-degree (1.57 rad) turn at the bottom of the liner.

**504.3.20 Chimney and vent location.** Tables 504.3(1), 504.3(2), 504.3(3), 504.3(4), and 504.3(5) shall be used for chimneys and vents not exposed to the outdoors below the roof line. A Type B vent or listed chimney lining system passing through an unused masonry chimney flue shall not be considered to be exposed to the outdoors. Tables 504.3(7) and 504.3(8) shall be used for clay-tile-lined exterior masonry chimneys, provided all of the following conditions are met:

1. Vent connector is Type B double-wall.

2. At least one appliance is draft hood equipped.
3. The combined appliance input rating is less than the maximum capacity given by Table 504.3(7a) for NAT+NAT or Table 504.3(8a) for FAN+NAT.
4. The input rating of each space-heating appliance is greater than the minimum input rating given by Table 504.3(7b) for NAT+NAT or Table 504.3(8b) for FAN+NAT.
5. The vent connector sizing is in accordance with Table 504.3(3).

Where these conditions cannot be met, an alternative venting design shall be used, such as a listed chimney lining system.

**Exception:** Vents serving listed appliances installed in accordance with the appliance manufacturer's instructions and the terms of the listing.

**504.3.21 Connector maximum and minimum size.** Vent connectors shall not be increased in size more than two sizes greater than the listed appliance categorized vent diameter, flue collar diameter, or draft hood outlet diameter. Vent connectors for draft hood-equipped appliances shall not be smaller than the draft hood outlet diameter. Where a vent connector size(s) determined from the tables for a fan-assisted appliance(s) is smaller than the flue collar diameter, the use of the smaller size(s) shall be permitted provided that the installation complies with all of the following conditions:

1. Vent connectors for fan-assisted appliance flue collars 12 inches (305 mm) in diameter or smaller are not reduced by more than one table size [e.g., 12 inches to 10 inches (305 mm to 254 mm) is a one-size reduction] and those larger than 12 inches (305 mm) in diameter are not reduced more than two table sizes [e.g., 24 inches to 20 inches (610 mm to 508 mm) is a two-size reduction].
2. The fan-assisted appliance(s) is common vented with a draft-hood-equipped appliances(s).
3. The vent connector has a smooth interior wall.

**504.3.22 Component commingling.** All combinations of pipe sizes, single-wall, and double-wall metal pipe shall be allowed within any connector run(s) or within the common vent, provided all of the appropriate tables permit all of the desired sizes and types of pipe, as if they were used for the entire length of the subject connector or vent. Where single-wall and Type B double-wall metal pipes are used for vent connectors within the same venting system, the common vent must be sized using Table 504.3(2) or 504.3(4), as appropriate.

**504.3.23 Multiple sizes permitted.** Where a table permits more than one diameter of pipe to be used for a connector or vent, all the permitted sizes shall be permitted to be used.

**504.3.24 Table interpolation.** Interpolation shall be permitted in calculating capacities for vent dimensions that fall between table entries (see Appendix B, Example 3).

**504.3.25 Extrapolation prohibited.** Extrapolation beyond the table entries shall not be permitted.

**504.3.26 Engineering calculations.** For vent heights less than 6 feet (1829 mm) and greater than shown in the tables, engineering methods shall be used to calculate vent capacities.

### SECTION 505 (IFGC) DIRECT-VENT, INTEGRAL VENT, MECHANICAL VENT AND VENTILATION/EXHAUST HOOD VENTING

**505.1 General.** The installation of direct-vent and integral vent appliances shall be in accordance with Section 503. Mechanical venting systems and exhaust hood venting systems shall be designed and installed in accordance with Section 503.

**505.1.1 Commercial cooking appliances vented by exhaust hoods.** Where commercial cooking appliances are vented by means of the Type I or Type II kitchen exhaust hood system that serves such appliances, the exhaust system shall be fan powered and the appliances shall be interlocked with the exhaust hood system to prevent appliance operation when the exhaust hood system is not operating. Dampers shall not be installed in the exhaust system.

### SECTION 506 (IFGC) FACTORY-BUILT CHIMNEYS

**506.1 Building heating appliances.** Factory-built chimneys for building heating appliances producing flue gases having a temperature not greater than 1,000°F (538°C), measured at the entrance to the chimney, shall be listed and labeled in accordance with UL 103 and shall be installed and terminated in accordance with the manufacturer's installation instructions.

**506.2 Support.** Where factory-built chimneys are supported by structural members, such as joists and rafters, such members shall be designed to support the additional load.

**506.3 Medium-heat appliances.** Factory-built chimneys for medium-heat appliances producing flue gases having a temperature above 1,000°F (538°C), measured at the entrance to the chimney, shall be listed and labeled in accordance with UL 959 and shall be installed and terminated in accordance with the manufacturer's installation instructions.

**TABLE 504.3(1)  
TYPE B DOUBLE-WALL VENT**

<b>Number of Appliances</b>	Two or more
<b>Appliance Type</b>	Category I
<b>Appliance Vent Connection</b>	Type B double-wall connector

**VENT CONNECTOR CAPACITY**

VENT HEIGHT (H) (feet)	CONNECTOR RISE (R) (feet)	TYPE B DOUBLE-WALL VENT AND CONNECTOR DIAMETER—(D) inches																											
		3			4			5			6			7			8			9			10						
		APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU/H																											
		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT	
Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	22	37	26	35	66	46	46	106	72	58	164	104	77	225	142	92	296	185	109	376	237	128	466	289				
	2	23	41	31	37	75	55	48	121	86	60	183	124	79	253	168	95	333	220	112	424	282	131	526	345				
	3	24	44	35	38	81	62	49	132	96	62	199	139	82	275	189	97	363	248	114	463	317	134	575	386				
8	1	22	40	27	35	72	48	49	114	76	64	176	109	84	243	148	100	320	194	118	408	248	138	507	303				
	2	23	44	32	36	80	57	51	128	90	66	195	129	86	269	175	103	356	230	121	454	294	141	564	358				
	3	24	47	36	37	87	64	53	139	101	67	210	145	88	290	198	105	384	258	123	492	330	143	612	402				
10	1	22	43	28	34	78	50	49	123	78	65	189	113	89	257	154	106	341	200	125	436	257	146	542	314				
	2	23	47	33	36	86	59	51	136	93	67	206	134	91	282	182	109	374	238	128	479	305	149	596	372				
	3	24	50	37	37	92	67	52	146	104	69	220	150	94	303	205	111	402	268	131	515	342	152	642	417				
15	1	21	50	30	33	89	53	47	142	83	64	220	120	88	298	163	110	389	214	134	493	273	162	609	333				
	2	22	53	35	35	96	63	49	153	99	66	235	142	91	320	193	112	419	253	137	532	323	165	658	394				
	3	24	55	40	36	102	71	51	163	111	68	248	160	93	339	218	115	445	286	140	565	365	167	700	444				
20	1	21	54	31	33	99	56	46	157	87	62	246	125	86	334	171	107	436	224	131	552	285	158	681	347				
	2	22	57	37	34	105	66	48	167	104	64	259	149	89	354	202	110	463	265	134	587	339	161	725	414				
	3	23	60	42	35	110	74	50	176	116	66	271	168	91	371	228	113	486	300	137	618	383	164	764	466				
30	1	20	62	33	31	113	59	45	181	93	60	288	134	83	391	182	103	512	238	125	649	305	151	802	372				
	2	21	64	39	33	118	70	47	190	110	62	299	158	85	408	215	105	535	282	129	679	360	155	840	439				
	3	22	66	44	34	123	79	48	198	124	64	309	178	88	423	242	108	555	317	132	706	405	158	874	494				
50	1	19	71	36	30	133	64	43	216	101	57	349	145	78	477	197	97	627	257	120	797	330	144	984	403				
	2	21	73	43	32	137	76	45	223	119	59	358	172	81	490	234	100	645	306	123	820	392	148	1,014	478				
	3	22	75	48	33	141	86	46	229	134	61	366	194	83	502	263	103	661	343	126	842	441	151	1,043	538				
100	1	18	82	37	28	158	66	40	262	104	53	442	150	73	611	204	91	810	266	112	1,038	341	135	1,285	417				
	2	19	83	44	30	161	79	42	267	123	55	447	178	75	619	242	94	822	316	115	1,054	405	139	1,306	494				
	3	20	84	50	31	163	89	44	272	138	57	452	109	78	627	272	97	834	355	118	1,069	455	142	1,327	555				

**COMMON VENT CAPACITY**

VENT HEIGHT (H) (feet)	TYPE B DOUBLE-WALL COMMON VENT DIAMETER (D)—inches																				
	4			5			6			7			8			9			10		
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU/H																				
	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	92	81	65	140	116	103	204	161	147	309	248	200	404	314	260	547	434	335	672	520	410
8	101	90	73	155	129	114	224	178	163	339	275	223	444	348	290	602	480	378	740	577	465
10	110	97	79	169	141	124	243	194	178	367	299	242	477	377	315	649	522	405	800	627	495
15	125	112	91	195	164	144	283	228	206	427	352	280	556	444	365	753	612	465	924	733	565
20	136	123	102	215	183	160	314	255	229	475	394	310	621	499	405	842	688	523	1,035	826	640
30	152	138	118	244	210	185	361	297	266	547	459	360	720	585	470	979	808	605	1,209	975	740
50	167	153	134	279	244	214	421	353	310	641	547	423	854	706	550	1,164	977	705	1,451	1,188	860
100	175	163	NA	311	277	NA	489	421	NA	751	658	479	1,025	873	625	1,408	1,215	800	1,784	1,502	975

(continued)

TABLE 504.3(1)—continued  
TYPE B DOUBLE-WALL VENT

Number of Appliances	Two or more
Appliance Type	Category I
Appliance Vent Connection	Type B double-wall connector

VENT CONNECTOR CAPACITY

VENT HEIGHT (H) (feet)	CONNECTOR RISE (R) (feet)	TYPE B DOUBLE-WALL VENT AND DIAMETER—(D) inches																				
		12			14			16			18			20			22			24		
		APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU/H																				
		FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT	FAN		NAT
Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max		
6	2	174	764	496	223	1,046	653	281	1,371	853	346	1,772	1,080	NA	NA	NA	NA	NA	NA	NA	NA	
	4	180	897	616	230	1,231	827	287	1,617	1,081	352	2,069	1,370	NA	NA	NA	NA	NA	NA	NA	NA	
	6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	
8	2	186	822	516	238	1,126	696	298	1,478	910	365	1,920	1,150	NA	NA	NA	NA	NA	NA	NA	NA	
	4	192	952	644	244	1,307	884	305	1,719	1,150	372	2,211	1,460	471	2,737	1,800	560	3,319	2,180	662	3,957	2,590
	6	198	1,050	772	252	1,445	1,072	313	1,902	1,390	380	2,434	1,770	478	3,018	2,180	568	3,665	2,640	669	4,373	3,130
10	2	196	870	536	249	1,195	730	311	1,570	955	379	2,049	1,205	NA	NA	NA	NA	NA	NA	NA	NA	
	4	201	997	664	256	1,371	924	318	1,804	1,205	387	2,332	1,535	486	2,887	1,890	581	3,502	2,280	686	4,175	2,710
	6	207	1,095	792	263	1,509	1,118	325	1,989	1,455	395	2,556	1,865	494	3,169	2,290	589	3,849	2,760	694	4,593	3,270
15	2	214	967	568	272	1,334	790	336	1,760	1,030	408	2,317	1,305	NA	NA	NA	NA	NA	NA	NA	NA	
	4	221	1,085	712	279	1,499	1,006	344	1,978	1,320	416	2,579	1,665	523	3,197	2,060	624	3,881	2,490	734	4,631	2,960
	6	228	1,181	856	286	1,632	1,222	351	2,157	1,610	424	2,796	2,025	533	3,470	2,510	634	4,216	3,030	743	5,035	3,600
20	2	223	1,051	596	291	1,443	840	357	1,911	1,095	430	2,533	1,385	NA	NA	NA	NA	NA	NA	NA	NA	
	4	230	1,162	748	298	1,597	1,064	365	2,116	1,395	438	2,778	1,765	554	3,447	2,180	661	4,190	2,630	772	5,005	3,130
	6	237	1,253	900	307	1,726	1,288	373	2,287	1,695	450	2,984	2,145	567	3,708	2,650	671	4,511	3,190	785	5,392	3,790
30	2	216	1,217	632	286	1,664	910	367	2,183	1,190	461	2,891	1,540	NA	NA	NA	NA	NA	NA	NA	NA	
	4	223	1,316	792	294	1,802	1,160	376	2,366	1,510	474	3,110	1,920	619	3,840	2,365	728	4,861	2,860	847	5,606	3,410
	6	231	1,400	952	303	1,920	1,410	384	2,524	1,830	485	3,299	2,340	632	4,080	2,875	741	4,976	3,480	860	5,961	4,150
50	2	206	1,479	689	273	2,023	1,007	350	2,659	1,315	435	3,548	1,665	NA	NA	NA	NA	NA	NA	NA	NA	
	4	213	1,561	860	281	2,139	1,291	359	2,814	1,685	447	3,730	2,135	580	4,601	2,633	709	5,569	3,185	851	6,633	3,790
	6	221	1,631	1,031	290	2,242	1,575	369	2,951	2,055	461	3,893	2,605	594	4,808	3,208	724	5,826	3,885	867	6,943	4,620
100	2	192	1,923	712	254	2,644	1,050	326	3,490	1,370	402	4,707	1,740	NA	NA	NA	NA	NA	NA	NA	NA	
	4	200	1,984	888	263	2,731	1,346	336	3,606	1,760	414	4,842	2,220	523	5,982	2,750	639	7,254	3,330	769	8,650	3,950
	6	208	2,035	1,064	272	2,811	1,642	346	3,714	2,150	426	4,968	2,700	539	6,143	3,350	654	7,453	4,070	786	8,892	4,810

COMMON VENT CAPACITY

VENT HEIGHT (H) (feet)	TYPE B DOUBLE-WALL COMMON VENT DIAMETER—(D) inches																				
	12			14			16			18			20			22			24		
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU/H																				
	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	900	696	588	1,284	990	815	1,735	1,336	1,065	2,253	1,732	1,345	2,838	2,180	1,660	3,488	2,677	1,970	4,206	3,226	2,390
8	994	773	652	1,423	1,103	912	1,927	1,491	1,190	2,507	1,936	1,510	3,162	2,439	1,860	3,890	2,998	2,200	4,695	3,616	2,680
10	1,076	841	712	1,542	1,200	995	2,093	1,625	1,300	2,727	2,113	1,645	3,444	2,665	2,030	4,241	3,278	2,400	5,123	3,957	2,920
15	1,247	986	825	1,794	1,410	1,158	2,440	1,910	1,510	3,184	2,484	1,910	4,026	3,133	2,360	4,971	3,862	2,790	6,016	4,670	3,400
20	1,405	1,116	916	2,006	1,588	1,290	2,722	2,147	1,690	3,561	2,798	2,140	4,548	3,552	2,640	5,573	4,352	3,120	6,749	5,261	3,800
30	1,658	1,327	1,025	2,373	1,892	1,525	3,220	2,558	1,990	4,197	3,326	2,520	5,303	4,193	3,110	6,539	5,157	3,680	7,940	6,247	4,480
50	2,024	1,640	1,280	2,911	2,347	1,863	3,964	3,183	2,430	5,184	4,149	3,075	6,567	5,240	3,800	8,116	6,458	4,500	9,837	7,813	5,475
100	2,569	2,131	1,670	3,732	3,076	2,450	5,125	4,202	3,200	6,749	5,509	4,050	8,597	6,986	5,000	10,681	8,648	5,920	13,004	10,499	7,200

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.

**TABLE 504.3(2)  
TYPE B DOUBLE-WALL VENT**

Number of Appliances	Two or more
Appliance Type	Category I
Appliance Vent Connection	Single-wall metal connector

**VENT CONNECTOR CAPACITY**

VENT HEIGHT (H) (feet)	CONNECTOR RISE (R) (feet)	SINGLE-WALL METAL VENT CONNECTOR DIAMETER—(D) inches																							
		3		4		5		6		7		8		9		10									
		APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU/H																							
		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT	
Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max		
6	1	NA	NA	26	NA	NA	46	NA	NA	71	NA	NA	102	207	223	140	262	293	183	325	373	234	447	463	286
	2	NA	NA	31	NA	NA	55	NA	NA	85	168	182	123	215	251	167	271	331	219	334	422	281	458	524	344
	3	NA	NA	34	NA	NA	62	121	131	95	175	198	138	222	273	188	279	361	247	344	462	316	468	574	385
8	1	NA	NA	27	NA	NA	48	NA	NA	75	NA	NA	106	226	240	145	285	316	191	352	403	244	481	502	299
	2	NA	NA	32	NA	NA	57	125	126	89	184	193	127	234	266	173	293	353	228	360	450	292	492	560	355
	3	NA	NA	35	NA	NA	64	130	138	100	191	208	144	241	287	197	302	381	256	370	489	328	501	609	400
10	1	NA	NA	28	NA	NA	50	119	121	77	182	186	110	240	253	150	302	335	196	372	429	252	506	534	308
	2	NA	NA	33	84	85	59	124	134	91	189	203	132	248	278	183	311	369	235	381	473	302	517	589	368
	3	NA	NA	36	89	91	67	129	144	102	197	217	148	257	299	203	320	398	265	391	511	339	528	637	413
15	1	NA	NA	29	79	87	52	116	138	81	177	214	116	238	291	158	312	380	208	397	482	266	556	596	324
	2	NA	NA	34	83	94	62	121	150	97	185	230	138	246	314	189	321	411	248	407	522	317	568	646	387
	3	NA	NA	39	87	100	70	127	160	109	193	243	157	255	333	215	331	438	281	418	557	360	579	690	437
20	1	49	56	30	78	97	54	115	152	84	175	238	120	233	325	165	306	425	217	390	538	276	546	664	336
	2	52	59	36	82	103	64	120	163	101	182	252	144	243	346	197	317	453	259	400	574	331	558	709	403
	3	55	62	40	87	107	72	125	172	113	190	264	164	252	363	223	326	476	294	412	607	375	570	750	457
30	1	47	60	31	77	110	57	112	175	89	169	278	129	226	380	175	296	497	230	378	630	294	528	779	358
	2	51	62	37	81	115	67	117	185	106	177	290	152	236	397	208	307	521	274	389	662	349	541	819	425
	3	54	64	42	85	119	76	122	193	120	185	300	172	244	412	235	316	542	309	400	690	394	555	855	482
50	1	46	69	34	75	128	60	109	207	96	162	336	137	217	460	188	284	604	245	364	768	314	507	951	384
	2	49	71	40	79	132	72	114	215	113	170	345	164	226	473	223	294	623	293	376	793	375	520	983	458
	3	52	72	45	83	136	82	119	221	123	178	353	186	235	486	252	304	640	331	387	816	423	535	1,013	518
100	1	45	79	34	71	150	61	104	249	98	153	424	140	205	585	192	269	774	249	345	993	321	476	1,236	393
	2	48	80	41	75	153	73	110	255	115	160	428	167	212	593	228	279	788	299	358	1,011	383	490	1,259	469
	3	51	81	46	79	157	85	114	260	129	168	433	190	222	603	256	289	801	339	368	1,027	431	506	1,280	527

**COMMON VENT CAPACITY**

VENT HEIGHT (H) (feet)	TYPE B DOUBLE-WALL COMMON VENT DIAMETER— (D) inches																				
	4			5			6			7			8			9			10		
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU/H																				
	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	NA	78	64	NA	113	99	200	158	144	304	244	196	398	310	257	541	429	332	665	515	407
8	NA	87	71	NA	126	111	218	173	159	331	269	218	436	342	285	592	473	373	730	569	460
10	NA	94	76	163	137	120	237	189	174	357	292	236	467	369	309	638	512	398	787	617	487
15	121	108	88	189	159	140	275	221	200	416	343	274	544	434	357	738	599	456	905	718	553
20	131	118	98	208	177	156	305	247	223	463	383	302	606	487	395	824	673	512	1,013	808	626
30	145	132	113	236	202	180	350	286	257	533	446	349	703	570	459	958	790	593	1,183	952	723
50	159	145	128	268	233	208	406	337	296	622	529	410	833	686	535	1,139	954	689	1,418	1,157	838
100	166	153	NA	297	263	NA	469	398	NA	726	633	464	999	846	606	1,378	1,185	780	1,741	1,459	948

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.

**TABLE 504.3(3)  
MASONRY CHIMNEY**

<b>Number of Appliances</b>	Two or more
<b>Appliance Type</b>	Category I
<b>Appliance Vent Connection</b>	Type B double-wall connector

**VENT CONNECTOR CAPACITY**

VENT HEIGHT (H) (feet)	CONNECTOR RISE (R) (feet)	TYPE B DOUBLE-WALL VENT CONNECTOR DIAMETER—(D) inches																											
		3			4			5			6			7			8			9			10						
		APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU/H																											
		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT	
Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	24	33	21	39	62	40	52	106	67	65	194	101	87	274	141	104	370	201	124	479	253	145	599	319				
	2	26	43	28	41	79	52	53	133	85	67	230	124	89	324	173	107	436	232	127	562	300	148	694	378				
	3	27	49	34	42	92	61	55	155	97	69	262	143	91	369	203	109	491	270	129	633	349	151	795	439				
8	1	24	39	22	39	72	41	55	117	69	71	213	105	94	304	148	113	414	210	134	539	267	156	682	335				
	2	26	47	29	40	87	53	57	140	86	73	246	127	97	350	179	116	473	240	137	615	311	160	776	394				
	3	27	52	34	42	97	62	59	159	98	75	269	145	99	383	206	119	517	276	139	672	358	163	848	452				
10	1	24	42	22	38	80	42	55	130	71	74	232	108	101	324	153	120	444	216	142	582	277	165	739	348				
	2	26	50	29	40	93	54	57	153	87	76	261	129	103	366	184	123	498	247	145	652	321	168	825	407				
	3	27	55	35	41	105	63	58	170	100	78	284	148	106	397	209	126	540	281	147	705	366	171	893	463				
15	1	24	48	23	38	93	44	54	154	74	72	277	114	100	384	164	125	511	229	153	658	297	184	824	375				
	2	25	55	31	39	105	55	56	174	89	74	299	134	103	419	192	128	558	260	156	718	339	187	900	432				
	3	26	59	35	41	115	64	57	189	102	76	319	153	105	448	215	131	597	292	159	760	382	190	960	486				
20	1	24	52	24	37	102	46	53	172	77	71	313	119	98	437	173	123	584	239	150	752	312	180	943	397				
	2	25	58	31	39	114	56	55	190	91	73	335	138	101	467	199	126	625	270	153	805	354	184	1,011	452				
	3	26	63	35	40	123	65	57	204	104	75	353	157	104	493	222	129	661	301	156	851	396	187	1,067	505				
30	1	24	54	25	37	111	48	52	192	82	69	357	127	96	504	187	119	680	255	145	883	337	175	1,115	432				
	2	25	60	32	38	122	58	54	208	95	72	376	145	99	531	209	122	715	287	149	928	378	179	1,171	484				
	3	26	64	36	40	131	66	56	221	107	74	392	163	101	554	233	125	746	317	152	968	418	182	1,220	535				
50	1	23	51	25	36	116	51	51	209	89	67	405	143	92	582	213	115	798	294	140	1,049	392	168	1,334	506				
	2	24	59	32	37	127	61	53	225	102	70	421	161	95	604	235	118	827	326	143	1,085	433	172	1,379	558				
	3	26	64	36	39	135	69	55	237	115	72	435	180	98	624	260	121	854	357	147	1,118	474	176	1,421	611				
100	1	23	46	24	35	108	50	49	208	92	65	428	155	88	640	237	109	907	334	134	1,222	454	161	1,589	596				
	2	24	53	31	37	120	60	51	224	105	67	444	174	92	660	260	113	933	368	138	1,253	497	165	1,626	651				
	3	25	59	35	38	130	68	53	237	118	69	458	193	94	679	285	116	956	399	141	1,282	540	169	1,661	705				

**COMMON VENT CAPACITY**

VENT HEIGHT (H) (feet)	MINIMUM INTERNAL AREA OF MASONRY CHIMNEY FLUE (square inches)																																							
	12					19					28					38					50					63					78					113				
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU/H																																							
	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT										
6	NA	74	25	NA	119	46	NA	178	71	NA	257	103	NA	351	143	NA	458	188	NA	582	246	1,041	853	NA																
8	NA	80	28	NA	130	53	NA	193	82	NA	279	119	NA	384	163	NA	501	218	724	636	278	1,144	937	408																
10	NA	84	31	NA	138	56	NA	207	90	NA	299	131	NA	409	177	606	538	236	776	686	302	1,226	1,010	454																
15	NA	NA	36	NA	152	67	NA	233	106	NA	334	152	523	467	212	682	611	283	874	781	365	1,374	1,156	546																
20	NA	NA	41	NA	NA	75	NA	250	122	NA	368	172	565	508	243	742	668	325	955	858	419	1,513	1,286	648																
30	NA	NA	NA	NA	NA	NA	NA	270	137	NA	404	198	615	564	278	816	747	381	1,062	969	496	1,702	1,473	749																
50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	620	328	879	831	461	1,165	1,089	606	1,905	1,692	922																
100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	348	NA	NA	499	NA	NA	669	2,053	1,921	1,058																

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm<sup>2</sup>, 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.



**TABLE 504.3(4)  
MASONRY CHIMNEY**

<b>Number of Appliances</b>	Two or more
<b>Appliance Type</b>	Category I
<b>Appliance Vent Connection</b>	Single-wall metal connector

**VENT CONNECTOR CAPACITY**

VENT HEIGHT (H) (feet)	CONNECTOR RISE (R) (feet)	SINGLE-WALL METAL VENT CONNECTOR DIAMETER (D)—inches																							
		3		4		5		6		7		8		9		10									
		APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU/H																							
		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT	
		Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max
6	1	NA	NA	21	NA	NA	39	NA	NA	66	179	191	100	231	271	140	292	366	200	362	474	252	499	594	316
	2	NA	NA	28	NA	NA	52	NA	NA	84	186	227	123	239	321	172	301	432	231	373	557	299	509	696	376
	3	NA	NA	34	NA	NA	61	134	153	97	193	258	142	247	365	202	309	491	269	381	634	348	519	793	437
8	1	NA	NA	21	NA	NA	40	NA	NA	68	195	208	103	250	298	146	313	407	207	387	530	263	529	672	331
	2	NA	NA	28	NA	NA	52	137	139	85	202	240	125	258	343	177	323	465	238	397	607	309	540	766	391
	3	NA	NA	34	NA	NA	62	143	156	98	210	264	145	266	376	205	332	509	274	407	663	356	551	838	450
10	1	NA	NA	22	NA	NA	41	130	151	70	202	225	106	267	316	151	333	434	213	410	571	273	558	727	343
	2	NA	NA	29	NA	NA	53	136	150	86	210	255	128	276	358	181	343	489	244	420	640	317	569	813	403
	3	NA	NA	34	97	102	62	143	166	99	217	277	147	284	389	207	352	530	279	430	694	363	580	880	459
15	1	NA	NA	23	NA	NA	43	129	151	73	199	271	112	268	376	161	349	502	225	445	646	291	623	808	366
	2	NA	NA	30	92	103	54	135	170	88	207	295	132	277	411	189	359	548	256	456	706	334	634	884	424
	3	NA	NA	34	96	112	63	141	185	101	215	315	151	286	439	213	368	586	289	466	755	378	646	945	479
20	1	NA	NA	23	87	99	45	128	167	76	197	303	117	265	425	169	345	569	235	439	734	306	614	921	347
	2	NA	NA	30	91	111	55	134	185	90	205	325	136	274	455	195	355	610	266	450	787	348	627	986	443
	3	NA	NA	35	96	119	64	140	199	103	213	343	154	282	481	219	365	644	298	461	831	391	639	1,042	496
30	1	NA	NA	24	86	108	47	126	187	80	193	347	124	259	492	183	338	665	250	430	864	330	600	1,089	421
	2	NA	NA	31	91	119	57	132	203	93	201	366	142	269	518	205	348	699	282	442	908	372	613	1,145	473
	3	NA	NA	35	95	127	65	138	216	105	209	381	160	277	540	229	358	729	312	452	946	412	626	1,193	524
50	1	NA	NA	24	85	113	50	124	204	87	188	392	139	252	567	208	328	778	287	417	1,022	383	582	1,302	492
	2	NA	NA	31	89	123	60	130	218	100	196	408	158	262	588	230	339	806	320	429	1,058	425	596	1,346	545
	3	NA	NA	35	94	131	68	136	231	112	205	422	176	271	607	255	349	831	351	440	1,090	466	610	1,386	597
100	1	NA	NA	23	84	104	49	122	200	89	182	410	151	243	617	232	315	875	328	402	1,181	444	560	1,537	580
	2	NA	NA	30	88	115	59	127	215	102	190	425	169	253	636	254	326	899	361	415	1,210	488	575	1,570	634
	3	NA	NA	34	93	124	67	133	228	115	199	438	188	262	654	279	337	921	392	427	1,238	529	589	1,604	687

**COMMON VENT CAPACITY**

VENT HEIGHT (H) (feet)	MINIMUM INTERNAL AREA OF MASONRY CHIMNEY FLUE (square inches)																								
	12		19		28		38		50		63		78		113										
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU/H																								
		FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT
6	NA	NA	25	NA	118	45	NA	176	71	NA	255	102	NA	348	142	NA	455	187	NA	579	245	NA	846	NA	
8	NA	NA	28	NA	128	52	NA	190	81	NA	276	118	NA	380	162	NA	497	217	NA	633	277	1,136	928	405	
10	NA	NA	31	NA	136	56	NA	205	89	NA	295	129	NA	405	175	NA	532	234	171	680	300	1,216	1,000	450	
15	NA	NA	36	NA	NA	66	NA	230	105	NA	335	150	NA	400	210	677	602	280	866	772	360	1,359	1,139	540	
20	NA	NA	NA	NA	NA	74	NA	247	120	NA	362	170	NA	503	240	765	661	321	947	849	415	1,495	1,264	640	
30	NA	NA	NA	NA	NA	NA	NA	NA	135	NA	398	195	NA	558	275	808	739	377	1,052	957	490	1,682	1,447	740	
50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	612	325	NA	821	456	1,152	1,076	600	1,879	1,672	910	
100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	494	NA	NA	663	2,006	1,885	1,046	

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm<sup>2</sup>, 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.

**TABLE 504.3(5)**  
**SINGLE-WALL METAL PIPE OR TYPE ASBESTOS CEMENT VENT**

<b>Number of Appliances</b>	Two or more
<b>Appliance Type</b>	Draft hood-equipped
<b>Appliance Vent Connection</b>	Direct to pipe or vent

**VENT CONNECTOR CAPACITY**

TOTAL VENT HEIGHT ( <i>H</i> ) (feet)	CONNECTOR RISE ( <i>R</i> ) (feet)	VENT CONNECTOR DIAMETER—( <i>D</i> ) inches					
		3	4	5	6	7	8
		MAXIMUM APPLIANCE INPUT RATING IN THOUSANDS OF BTU/H					
6-8	1	21	40	68	102	146	205
	2	28	53	86	124	178	235
	3	34	61	98	147	204	275
15	1	23	44	77	117	179	240
	2	30	56	92	134	194	265
	3	35	64	102	155	216	298
30 and up	1	25	49	84	129	190	270
	2	31	58	97	145	211	295
	3	36	68	107	164	232	321

**COMMON VENT CAPACITY**

TOTAL VENT HEIGHT ( <i>H</i> ) (feet)	COMMON VENT DIAMETER—( <i>D</i> ) inches						
	4	5	6	7	8	10	12
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU/H						
6	48	78	111	155	205	320	NA
8	55	89	128	175	234	365	505
10	59	95	136	190	250	395	560
15	71	115	168	228	305	480	690
20	80	129	186	260	340	550	790
30	NA	147	215	300	400	650	940
50	NA	NA	NA	360	490	810	1,190

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.

CHIMNEYS AND VENTS

**TABLE 504.3(6)  
EXTERIOR MASONRY CHIMNEY**

<b>Number of Appliances</b>	One
<b>Appliance Type</b>	NAT
<b>Appliance Vent Connection</b>	Type B double-wall connector

MINIMUM ALLOWABLE INPUT RATING OF SPACE-HEATING APPLIANCE IN THOUSANDS OF BTU PER HOUR								
VENT HEIGHT (feet)	Internal area of chimney (square inches)							
	12	19	28	38	50	63	78	113
37°F or Greater Local 99% Winter Design Temperature: 37°F or Greater								
6	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
15	NA	0	0	0	0	0	0	0
20	NA	NA	123	190	249	184	0	0
30	NA	NA	NA	NA	NA	393	334	0
50	NA	NA	NA	NA	NA	NA	NA	579
27 to 36°F Local 99% Winter Design Temperature: 27 to 36°F								
6	0	0	68	116	156	180	212	266
8	0	0	82	127	167	187	214	263
10	0	51	97	141	183	201	225	265
15	NA	NA	NA	NA	233	253	274	305
20	NA	NA	NA	NA	NA	307	330	362
30	NA	NA	NA	NA	NA	419	445	485
50	NA	NA	NA	NA	NA	NA	NA	763
17 to 26°F Local 99% Winter Design Temperature: 17 to 26°F								
6	NA	NA	NA	NA	NA	215	259	349
8	NA	NA	NA	NA	197	226	264	352
10	NA	NA	NA	NA	214	245	278	358
15	NA	NA	NA	NA	NA	296	331	398
20	NA	NA	NA	NA	NA	352	387	457
30	NA	NA	NA	NA	NA	NA	507	581
50	NA	NA	NA	NA	NA	NA	NA	NA
5 to 16°F Local 99% Winter Design Temperature: 5 to 16°F								
6	NA	NA	NA	NA	NA	NA	NA	416
8	NA	NA	NA	NA	NA	NA	312	423
10	NA	NA	NA	NA	NA	289	331	430
15	NA	NA	NA	NA	NA	NA	393	485
20	NA	NA	NA	NA	NA	NA	450	547
30	NA	NA	NA	NA	NA	NA	NA	682
50	NA	NA	NA	NA	NA	NA	NA	972
-10 to 4°F Local 99% Winter Design Temperature: -10 to 4°F								
6	NA	NA	NA	NA	NA	NA	NA	484
8	NA	NA	NA	NA	NA	NA	NA	494
10	NA	NA	NA	NA	NA	NA	NA	513
15	NA	NA	NA	NA	NA	NA	NA	586
20	NA	NA	NA	NA	NA	NA	NA	650
30	NA	NA	NA	NA	NA	NA	NA	805
50	NA	NA	NA	NA	NA	NA	NA	1,003
-11°F or Lower Local 99% Winter Design Temperature: -11°F or Lower								
Not recommended for any vent configurations								

Note: See Figure B-19 in Appendix B for a map showing local 99 percent winter design temperatures in the United States.  
For SI: °C = [(°F - 32)/1.8, 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.

**TABLE 504.3(7a)  
EXTERIOR MASONRY CHIMNEY**

<b>Number of Appliances</b>	Two or more
<b>Appliance Type</b>	NAT + NAT
<b>Appliance Vent Connection</b>	Type B double-wall connector

**Combined Appliance Maximum  
Input Rating in Thousands of Btu per Hour**

VENT HEIGHT (feet)	INTERNAL AREA OF CHIMNEY (square inches)							
	12	19	28	38	50	63	78	113
6	25	46	71	103	143	188	246	NA
8	28	53	82	119	163	218	278	408
10	31	56	90	131	177	236	302	454
15	NA	67	106	152	212	283	365	546
20	NA	NA	NA	NA	NA	325	419	648
30	NA	NA	NA	NA	NA	NA	496	749
50	NA	NA	NA	NA	NA	NA	NA	922
100	NA	NA	NA	NA	NA	NA	NA	NA

**TABLE 504.3(7b)  
EXTERIOR MASONRY CHIMNEY**

<b>Number of Appliances</b>	Two or more
<b>Appliance Type</b>	NAT + NAT
<b>Appliance Vent Connection</b>	Type B double-wall connector

**Minimum Allowable Input Rating of  
Space-Heating Appliance in Thousands of Btu per Hour**

VENT HEIGHT (feet)	INTERNAL AREA OF CHIMNEY (square inches)							
	12	19	28	38	50	63	78	113
<b>37°F or Greater Local 99% Winter Design Temperature: 37°F or Greater</b>								
6	0	0	0	0	0	0	0	NA
8	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
15	NA	0	0	0	0	0	0	0
20	NA	NA	NA	NA	NA	184	0	0
30	NA	NA	NA	NA	NA	393	334	0
50	NA	NA	NA	NA	NA	NA	NA	579
100	NA	NA	NA	NA	NA	NA	NA	NA
<b>27 to 36°F Local 99% Winter Design Temperature: 27 to 36°F</b>								
6	0	0	68	NA	NA	180	212	NA
8	0	0	82	NA	NA	187	214	263
10	0	51	NA	NA	NA	201	225	265
15	NA	NA	NA	NA	NA	253	274	305
20	NA	NA	NA	NA	NA	307	330	362
30	NA	NA	NA	NA	NA	NA	445	485
50	NA	NA	NA	NA	NA	NA	NA	763
100	NA	NA	NA	NA	NA	NA	NA	NA

**TABLE 504.3(7b)  
EXTERIOR MASONRY CHIMNEY—continued**

**Minimum Allowable Input Rating of  
Space-Heating Appliance in Thousands of Btu per Hour**

VENT HEIGHT (feet)	INTERNAL AREA OF CHIMNEY (square inches)							
	12	19	28	38	50	63	78	113
<b>17 to 26°F Local 99% Winter Design Temperature: 17 to 26°F</b>								
6	NA	NA	NA	NA	NA	NA	NA	NA
8	NA	NA	NA	NA	NA	NA	264	352
10	NA	NA	NA	NA	NA	NA	278	358
15	NA	NA	NA	NA	NA	NA	331	398
20	NA	NA	NA	NA	NA	NA	387	457
30	NA	NA	NA	NA	NA	NA	NA	581
50	NA	NA	NA	NA	NA	NA	NA	862
100	NA	NA	NA	NA	NA	NA	NA	NA
<b>5 to 16°F Local 99% Winter Design Temperature: 5 to 16°F</b>								
6	NA	NA	NA	NA	NA	NA	NA	NA
8	NA	NA	NA	NA	NA	NA	NA	NA
10	NA	NA	NA	NA	NA	NA	NA	430
15	NA	NA	NA	NA	NA	NA	NA	485
20	NA	NA	NA	NA	NA	NA	NA	547
30	NA	NA	NA	NA	NA	NA	NA	682
50	NA	NA	NA	NA	NA	NA	NA	NA
100	NA	NA	NA	NA	NA	NA	NA	NA
<b>4°F or Lower Local 99% Winter Design Temperature: 4°F or Lower</b>								
<b>Not recommended for any vent configurations</b>								

Note: See Figure B-19 in Appendix B for a map showing local 99 percent winter design temperatures in the United States.

For SI: °C = [(°F - 32)/1.8], 1 inch = 25.4 mm, 1 square inch = 645.16 mm<sup>2</sup>, 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.

CHIMNEYS AND VENTS

**TABLE 504.3(8a)  
EXTERIOR MASONRY CHIMNEY**

Number of Appliances	Two or more
Appliance Type	FAN + NAT
Appliance Vent Connection	Type B double-wall connector

**Combined Appliance Maximum  
Input Rating in Thousands of Btu per Hour**

VENT HEIGHT (feet)	INTERNAL AREA OF CHIMNEY (square inches)							
	12	19	28	38	50	63	78	113
6	74	119	178	257	351	458	582	853
8	80	130	193	279	384	501	636	937
10	84	138	207	299	409	538	686	1,010
15	NA	152	233	334	467	611	781	1,156
20	NA	NA	250	368	508	668	858	1,286
30	NA	NA	NA	404	564	747	969	1,473
50	NA	NA	NA	NA	NA	831	1,089	1,692
100	NA	NA	NA	NA	NA	NA	NA	1,921

**TABLE 504.3(8b)  
EXTERIOR MASONRY CHIMNEY**

Number of Appliances	Two or more
Appliance Type	FAN + NAT
Appliance Vent Connection	Type B double-wall connector

**Minimum Allowable Input Rating of  
Space-Heating Appliance in Thousands of Btu per Hour**

VENT HEIGHT (feet)	INTERNAL AREA OF CHIMNEY (square inches)							
	12	19	28	38	50	63	78	113
<b>37°F or Greater</b> Local 99% Winter Design Temperature: 37°F or Greater								
6	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0
15	NA	0	0	0	0	0	0	0
20	NA	NA	123	190	249	184	0	0
30	NA	NA	NA	334	398	393	334	0
50	NA	NA	NA	NA	NA	714	707	579
100	NA	NA	NA	NA	NA	NA	NA	1,600
<b>27 to 36°F</b> Local 99% Winter Design Temperature: 27 to 36°F								
6	0	0	68	116	156	180	212	266
8	0	0	82	127	167	187	214	263
10	0	51	97	141	183	210	225	265
15	NA	111	142	183	233	253	274	305
20	NA	NA	187	230	284	307	330	362
30	NA	NA	NA	330	319	419	445	485
50	NA	NA	NA	NA	NA	672	705	763
100	NA	NA	NA	NA	NA	NA	NA	1,554

**TABLE 504.3(8b)  
EXTERIOR MASONRY CHIMNEY—continued**

**Minimum Allowable Input Rating of  
Space-Heating Appliance in Thousands of Btu per Hour**

VENT HEIGHT (feet)	INTERNAL AREA OF CHIMNEY (square inches)							
	12	19	28	38	50	63	78	113
<b>17 to 26°F</b> Local 99% Winter Design Temperature: 17 to 26°F								
6	0	55	99	141	182	215	259	349
8	52	74	111	154	197	226	264	352
10	NA	90	125	169	214	245	278	358
15	NA	NA	167	212	263	296	331	398
20	NA	NA	212	258	316	352	387	457
30	NA	NA	NA	362	429	470	507	581
50	NA	NA	NA	NA	NA	723	766	862
100	NA	NA	NA	NA	NA	NA	NA	1,669
<b>5 to 16°F</b> Local 99% Winter Design Temperature: 5 to 16°F								
6	NA	78	121	166	214	252	301	416
8	NA	94	135	182	230	269	312	423
10	NA	111	149	198	250	289	331	430
15	NA	NA	193	247	305	346	393	485
20	NA	NA	NA	293	360	408	450	547
30	NA	NA	NA	377	450	531	580	682
50	NA	NA	NA	NA	NA	797	853	972
100	NA	NA	NA	NA	NA	NA	NA	1,833
<b>-10 to 4°F</b> Local 99% Winter Design Temperature: -10 to 4°F								
6	NA	NA	145	196	249	296	349	484
8	NA	NA	159	213	269	320	371	494
10	NA	NA	175	231	292	339	397	513
15	NA	NA	NA	283	351	404	457	586
20	NA	NA	NA	333	408	468	528	650
30	NA	NA	NA	NA	NA	603	667	805
50	NA	NA	NA	NA	NA	NA	955	1,003
100	NA	NA	NA	NA	NA	NA	NA	NA
<b>-11°F or Lower</b> Local 99% Winter Design Temperature: -11°F or Lower <b>Not recommended for any vent configurations</b>								

Note: See Figure B-19 in Appendix B for a map showing local 99 percent winter design temperatures in the United States.

For SI: °C = [(°F - 32)/1.8], 1 inch = 25.4 mm, 1 square inch = 645.16 mm<sup>2</sup>, 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.

## CHAPTER 6

# SPECIFIC APPLIANCES

### SECTION 601 (IFGC) GENERAL

**601.1 Scope.** This chapter shall govern the approval, design, installation, construction, maintenance, alteration and repair of the appliances and equipment specifically identified herein.

### SECTION 602 (IFGC) DECORATIVE APPLIANCES FOR INSTALLATION IN FIREPLACES

**602.1 General.** Decorative appliances for installation in approved solid fuel-burning fireplaces shall be tested in accordance with ANSI Z21.60 and shall be installed in accordance with the manufacturer's installation instructions. Manually lighted natural gas decorative appliances shall be tested in accordance with ANSI Z21.84.

**602.2 Flame safeguard device.** Decorative appliances for installation in approved solid fuel-burning fireplaces, with the exception of those tested in accordance with ANSI Z21.84, shall utilize a direct ignition device, an ignitor or a pilot flame to ignite the fuel at the main burner, and shall be equipped with a flame safeguard device. The flame safeguard device shall automatically shut off the fuel supply to a main burner or group of burners when the means of ignition of such burners becomes inoperative.

**602.3 Prohibited installations.** Decorative appliances for installation in fireplaces shall not be installed where prohibited by Section 303.3.

### SECTION 603 (IFGC) LOG LIGHTERS

**603.1 General.** Log lighters shall be tested in accordance with IAS 8 and installed in accordance with the manufacturer's installation instructions.

### SECTION 604 (IFGC) VENTED GAS FIREPLACES (DECORATIVE APPLIANCES)

**604.1 General.** Vented gas fireplaces shall be tested in accordance with ANSI Z21.50, shall be installed in accordance with the manufacturer's installation instructions and shall be designed and equipped as specified in Section 602.2.

**604.2 Access.** Panels, grilles and access doors that are required to be removed for normal servicing operations shall not be attached to the building.

### SECTION 605 (IFGC) VENTED GAS FIREPLACE HEATERS

**605.1 General.** Vented gas fireplace heaters shall be installed in accordance with the manufacturer's installation instructions, shall be tested in accordance with ANSI Z21.88 and shall be designed and equipped as specified in Section 602.2.

### SECTION 606 (IFGC) INCINERATORS AND CREMATORIES

**606.1 General.** Incinerators and crematories shall be installed in accordance with the manufacturer's installation instructions.

### SECTION 607 (IFGC) COMMERCIAL-INDUSTRIAL INCINERATORS

**607.1 Incinerators, commercial-industrial.** Commercial-industrial-type incinerators shall be constructed and installed in accordance with NFPA 82.

### SECTION 608 (IFGC) VENTED WALL FURNACES

**608.1 General.** Vented wall furnaces shall be tested in accordance with ANSI Z21.49 or Z21.86/CSA 2.32 and shall be installed in accordance with the manufacturer's installation instructions.

**608.2 Venting.** Vented wall furnaces shall be vented in accordance with Section 503.

**608.3 Location.** Vented wall furnaces shall be located so as not to cause a fire hazard to walls, floors, combustible furnishings or doors. Vented wall furnaces installed between bathrooms and adjoining rooms shall not circulate air from bathrooms to other parts of the building.

**608.4 Door swing.** Vented wall furnaces shall be located so that a door cannot swing within 12 inches (305 mm) of an air inlet or air outlet of such furnace measured at right angles to the opening. Doorstops or door closers shall not be installed to obtain this clearance.

**608.5 Ducts prohibited.** Ducts shall not be attached to wall furnaces. Casing extension boots shall not be installed unless listed as part of the appliance.

**608.6 Access.** Vented wall furnaces shall be provided with access for cleaning of heating surfaces, removal of burners, replacement of sections, motors, controls, filters and other working parts, and for adjustments and lubrication of parts requiring such attention. Panels, grilles and access doors that are

required to be removed for normal servicing operations shall not be attached to the building construction.

### SECTION 609 (IFGC) FLOOR FURNACES

**609.1 General.** Floor furnaces shall be tested in accordance with ANSI Z21.48 or Z21.86/CSA 2.32 and shall be installed in accordance with the manufacturer's installation instructions.

**609.2 Placement.** The following provisions apply to floor furnaces.

1. 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.
2. Walls and corners. The register of a floor furnace with a horizontal warm-air outlet shall not be placed closer than 6 inches (152 mm) to the nearest wall. A distance of at least 18 inches (457 mm) 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 shall be permitted to be placed not closer than 6 inches (152 mm) to a wall. Wall-register models shall not be placed closer than 6 inches (152 mm) to a corner.
3. Draperies. The furnace shall be placed so that a door, drapery or similar object cannot be nearer than 12 inches (305 mm) to any portion of the register of the furnace.
4. Floor construction. Floor furnaces shall not be installed in concrete floor construction built on grade.
5. Thermostat. The controlling thermostat for a floor furnace shall be located within the same room or space as the floor furnace or shall be located in an adjacent room or space that is permanently open to the room or space containing the floor furnace.

**609.3 Bracing.** The floor around the furnace shall be braced and headed with a support framework designed in accordance with the *International Building Code*.

**609.4 Clearance.** The lowest portion of the floor furnace shall have not less than a 6-inch (152 mm) clearance from the grade level; except where the lower 6-inch (152 mm) portion of the floor furnace is sealed by the manufacturer to prevent entrance of water, the minimum clearance shall be not less than 2 inches (51 mm). Where such clearances cannot be provided, the ground below and to the sides shall be excavated to form a pit under the furnace so that the required clearance is provided beneath the lowest portion of the furnace. A 12-inch (305 mm) minimum clearance shall be provided on all sides except the control side, which shall have an 18-inch (457 mm) minimum clearance.

**609.5 First floor installation.** Where the basement story level below the floor in which a floor furnace is installed is utilized as habitable space, such floor furnaces shall be enclosed as specified in Section 608.6 and shall project into a nonhabitable space.

**609.6 Upper floor installations.** Floor furnaces installed in upper stories of buildings shall project below into nonhabitable

space and shall be separated from the nonhabitable space by an enclosure constructed of noncombustible materials. The floor furnace shall be provided with access, clearance to all sides and bottom of not less than 6 inches (152 mm) and combustion air in accordance with Section 304.

### SECTION 610 (IFGC) DUCT FURNACES

**610.1 General.** Duct furnaces shall be tested in accordance with ANSI Z83.9 or UL 795 and shall be installed in accordance with the manufacturer's installation instructions.

**610.2 Access panels.** Ducts connected to duct furnaces shall have removable access panels on both the upstream and downstream sides of the furnace.

**610.3 Location of draft hood and controls.** The controls, combustion air inlets and draft hoods for duct furnaces shall be located outside of the ducts. The draft hood shall be located in the same enclosure from which combustion air is taken.

**610.4 Circulating air.** Where a duct furnace is installed so that supply ducts convey air to areas outside the space containing the furnace, the return air shall also be conveyed by a duct(s) sealed to the furnace casing and terminating outside the space containing the furnace.

The duct furnace shall be installed on the positive pressure side of the circulating air blower.

### SECTION 611 (IFGC) NONRECIRCULATING DIRECT-FIRED INDUSTRIAL AIR HEATERS

**611.1 General.** Nonrecirculating direct-fired industrial air heaters shall be listed to ANSI Z83.4/CSA 3.7 and shall be installed in accordance with the manufacturer's instructions.

**611.2 Installation.** Nonrecirculating direct-fired industrial air heaters shall not be used to supply any area containing sleeping quarters. Nonrecirculating direct-fired industrial air heaters shall be installed only in industrial or commercial occupancies. Nonrecirculating direct-fired industrial air heaters shall be permitted to provide ventilation air.

**611.3 Clearance from combustible materials.** Nonrecirculating direct-fired industrial air heaters shall be installed with a clearance from combustible materials of not less than that shown on the rating plate and in the manufacturer's instructions.

**611.4 Supply air.** All air handled by a nonrecirculating direct-fired industrial air heater, including combustion air, shall be ducted directly from the outdoors.

**611.5 Outdoor air louvers.** If outdoor air louvers of either the manual or automatic type are used, such devices shall be proven to be in the open position prior to allowing the main burners to operate.

**611.6 Atmospheric vents and gas reliefs or bleeds.** Nonrecirculating direct-fired industrial air heaters with valve train components equipped with atmospheric vents or gas reliefs or bleeds shall have their atmospheric vent lines or gas reliefs or bleeds lead to the outdoors. Means shall be employed on

these lines to prevent water from entering and to prevent blockage by insects and foreign matter. An atmospheric vent line shall not be required to be provided on a valve train component equipped with a listed vent limiter.

**611.7 Relief opening.** The design of the installation shall include provisions to permit nonrecirculating direct-fired industrial air heaters to operate at rated capacity without overpressurizing the space served by the heaters by taking into account the structure's designed infiltration rate, providing properly designed relief openings or an interlocked power exhaust system, or a combination of these methods. The structure's designed infiltration rate and the size of relief openings shall be determined by approved engineering methods. Relief openings shall be permitted to be louvers or counterbalanced gravity dampers. Motorized dampers or closable louvers shall be permitted to be used, provided they are verified to be in their full open position prior to main burner operation.

**611.8 Access.** Nonrecirculating direct-fired industrial air heaters shall be provided with access for removal of burners; replacement of motors, controls, filters and other working parts; and for adjustment and lubrication of parts requiring maintenance.

**611.9 Purging.** Inlet ducting, where used, shall be purged by not less than four air changes prior to an ignition attempt.

#### SECTION 612 (IFGC) RECIRCULATING DIRECT-FIRED INDUSTRIAL AIR HEATERS

**612.1 General.** Recirculating direct-fired industrial air heaters shall be listed to ANSI Z83.18 and shall be installed in accordance with the manufacturer's installation instructions.

**612.2 Location.** Recirculating direct-fired industrial air heaters shall be installed only in industrial and commercial occupancies. Recirculating direct-fired air heaters shall not serve any area containing sleeping quarters. Recirculating direct-fired industrial air heaters shall not be installed in hazardous locations or in buildings that contain flammable solids, liquids or gases, explosive materials or substances that can become toxic when exposed to flame or heat.

**612.3 Installation.** Direct-fired industrial air heaters shall be permitted to be installed in accordance with their listing and the manufacturer's instructions. Direct-fired industrial air heaters shall be installed only in industrial or commercial occupancies. Direct-fired industrial air heaters shall be permitted to provide fresh air ventilation.

**612.4 Clearance from combustible materials.** Direct-fired industrial air heaters shall be installed with a clearance from combustible material of not less than that shown on the label and in the manufacturer's instructions.

**612.5 Air supply.** Air to direct-fired industrial air heaters shall be taken from the building, ducted directly from outdoors, or a combination of both. Direct-fired industrial air heaters shall incorporate a means to supply outside ventilation air to the space at a rate of not less than 4 cubic feet per minute per 1,000 Btu per hour (0.38m<sup>3</sup>per min per kW) of rated input of the heater. If a separate means is used to supply ventilation air, an interlock shall be provided so as to lock out the main burner operation until the mechanical means is verified. Where outside air dampers or closing louvers are used, they shall be verified to be in the open position prior to main burner operation.

**612.6 Atmospheric vents, gas reliefs or bleeds.** Direct-fired industrial air heaters with valve train components equipped with atmospheric vents, gas reliefs or bleeds shall have their atmospheric vent lines and gas reliefs or bleeds lead to the outdoors.

Means shall be employed on these lines to prevent water from entering and to prevent blockage by insects and foreign matter. An atmospheric vent line shall not be required to be provided on a valve train component equipped with a listed vent limiter.

**612.7 Relief opening.** The design of the installation shall include adequate provision to permit direct-fired industrial air heaters to operate at rated capacity by taking into account the structure's designed infiltration rate, providing properly designed relief openings or an interlocked power exhaust system, or a combination of these methods. The structure's designed infiltration rate and the size of relief openings shall be determined by approved engineering methods. Relief openings shall be permitted to be louvers or counterbalanced gravity dampers. Motorized dampers or closable louvers shall be permitted to be used, provided they are verified to be in their full open position prior to main burner operation.

#### SECTION 613 (IFGC) CLOTHES DRYERS

**613.1 General.** Clothes dryers shall be tested in accordance with ANSI Z21.5.1 or ANSI Z21.5.2 and shall be installed in accordance with the manufacturer's installation instructions.

#### SECTION 614 (IFGC) CLOTHES DRYER EXHAUST

**614.1 Installation.** Clothes dryers shall be exhausted in accordance with the manufacturer's instructions. Dryer exhaust systems shall be independent of all other systems and shall convey the moisture and any products of combustion to the outside of the building.

**614.2 Duct penetrations.** Ducts that exhaust clothes dryers shall not penetrate or be located within any fireblocking, draftstopping or any wall, floor/ceiling or other assembly required by the *International Building Code* to be fire-resistance rated, unless such duct is constructed of galvanized steel or aluminum of the thickness specified in Table 603.3 of the *International Mechanical Code* and the fire-resistance rating is maintained in accordance with the *International Building Code*. Fire dampers shall not be installed in clothes dryer exhaust duct systems.

Clothes dryer exhaust ducts shall be protected by a steel plate or clip not less than 1/16 inch (1.59 mm) in thickness and of sufficient width to fully protect the duct. Plates or clips shall be placed on the finish face of all framing members which the clothes dryer exhaust duct passes through when there is less than 1/4 inch (32 mm) of framing material between the duct and the finish face. Plates or clips shall also be placed where nails or screws from finish or other work are likely to penetrate the clothes dryer exhaust duct.

**614.3 Cleaning access.** Each vertical duct riser for dryers listed to ANSI Z21.5.2 shall be provided with a cleanout or other means for cleaning the interior of the duct.

**614.4 Exhaust material.** Exhaust ducts for clothes dryers shall terminate on the outside of the building and shall be equipped with a backdraft damper. Screens shall not be installed at the duct termination. Ducts shall not be connected or installed with



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sheet metal screws or other fasteners that will obstruct the flow. Clothes dryer exhaust ducts shall not be connected to a vent connector, vent or chimney. Clothes dryer exhaust ducts shall not extend into or through ducts or plenums.

**614.5 Makeup air.** Installations exhausting more than 200 cfm (0.09 m<sup>3</sup>/s) shall be provided with makeup air. Where a closet is designed for the installation of a clothes dryer, an opening having an area of not less than 100 square inches (645 mm<sup>2</sup>) for makeup air shall be provided in the closet enclosure, or makeup air shall be provided by other approved means.

**614.6 Domestic clothes dryer ducts.** Exhaust ducts for domestic clothes dryers shall be constructed of metal and shall have a smooth interior finish. The exhaust duct shall be a minimum nominal size of 4 inches (102 mm) in diameter. The entire exhaust system shall be supported and secured in place. The male end of the duct at overlapped duct joints shall extend in the direction of airflow. Clothes dryer transition ducts used to connect the appliance to the exhaust duct system shall be metal and limited to a single length not to exceed 8 feet (2438 mm) and shall be listed and labeled for the application. Transition ducts shall not be concealed within construction.

**614.6.1 Maximum length.** The maximum length of a clothes dryer exhaust duct shall not exceed 25 feet (7620 mm) from the dryer location to the outlet terminal. The maximum length of the duct shall be reduced 2.5 feet (762 mm) for each 45-degree (0.79 rad) bend and 5 feet (1524 mm) for each 90-degree (1.6 rad) bend.

**Exception:** Where the make and model of the clothes dryer to be installed is known and the manufacturer's installation instructions for such dryer are provided to the code official, the maximum length of the exhaust duct, including any transition duct, shall be permitted to be in accordance with the dryer manufacturer's installation instructions.

**614.6.2 Rough-in required.** Where a compartment or space for a domestic clothes dryer is provided, an exhaust duct system shall be installed.

**614.7 Commercial clothes dryers.** The installation of dryer exhaust ducts serving Type 2 clothes dryers shall comply with the appliance manufacturer's installation instructions. Exhaust fan motors installed in exhaust systems shall be located outside of the airstream. In multiple installations, the fan shall operate continuously or be interlocked to operate when any individual unit is operating. Ducts shall have a minimum clearance of 6 inches (152 mm) to combustible materials.

## SECTION 615 (IFGC) SAUNA HEATERS

**615.1 General.** Sauna heaters shall be installed in accordance with the manufacturer's installation instructions.

**615.2 Location and protection.** Sauna heaters shall be located so as to minimize the possibility of accidental contact by a person in the room.

**615.2.1 Guards.** Sauna heaters shall be protected from accidental contact by an approved guard or barrier of material having a low coefficient of thermal conductivity. The guard

shall not substantially affect the transfer of heat from the heater to the room.

**615.3 Access.** Panels, grilles and access doors that are required to be removed for normal servicing operations shall not be attached to the building.

**615.4 Combustion and dilution air intakes.** Sauna heaters of other than the direct-vent type shall be installed with the draft hood and combustion air intake located outside the sauna room. Where the combustion air inlet and the draft hood are in a dressing room adjacent to the sauna room, there shall be provisions to prevent physically 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 1/4 inch (6.4 mm) high.

**615.5 Combustion and ventilation air.** Combustion air shall not be taken from inside the sauna room. Combustion and ventilation air for a sauna heater not of the direct-vent type shall be provided to the area in which the combustion air inlet and draft hood are located in accordance with Section 304.

**615.6 Heat and time controls.** Sauna heaters shall be equipped with a thermostat which will limit room temperature to 194°F (90°C). If the thermostat is not an integral part of the sauna heater, the heat-sensing element shall be located within 6 inches (152 mm) 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.

**615.6.1 Timers.** 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.

**615.7 Sauna room.** A ventilation opening into the sauna room shall be provided. The opening shall be not less than 4 inches by 8 inches (102 mm by 203 mm) located near the top of the door into the sauna room.

**615.7.1 Warning notice.** The following permanent notice, constructed of approved 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.

The words shall contrast with the background and the wording shall be in letters not less than 1/4 inch (6.4 mm) high.

**Exception:** This section shall not apply to one- and two-family dwellings.

### SECTION 616 (IFGC) ENGINE AND GAS TURBINE- POWERED EQUIPMENT

**616.1 Powered equipment.** Permanently installed equipment powered by internal combustion engines and turbines shall be installed in accordance with the manufacturer's installation instructions and NFPA 37.

### SECTION 617 (IFGC) POOL AND SPA HEATERS

**617.1 General.** Pool and spa heaters shall be tested in accordance with ANSI Z21.56 and shall be installed in accordance with the manufacturer's installation instructions.

### SECTION 618 (IFGC) FORCED-AIR WARM-AIR FURNACES

**618.1 General.** Forced-air warm-air furnaces shall be tested in accordance with ANSI Z21.47 or UL 795 and shall be installed in accordance with the manufacturer's installation instructions.

**618.2 Forced-air furnaces.** The minimum unobstructed total area of the outside and return air ducts or openings to a forced-air warm-air furnace shall be not less than 2 square inches for each 1,000 Btu/h (4402 mm<sup>2</sup>/W) output rating capacity of the furnace and not less than that specified in the furnace manufacturer's installation instructions. The minimum unobstructed total area of supply ducts from a forced-air warm-air furnace shall be not less than 2 square inches for each 1,000 Btu/h (4402 mm<sup>2</sup>/W) output rating capacity of the furnace and not less than that specified in the furnace manufacturer's installation instructions.

**Exception:** The total area of the supply air ducts and outside and return air ducts shall not be required to be larger than the minimum size required by the furnace manufacturer's installation instructions.

**618.3 Dampers.** Volume dampers shall not be placed in the air inlet to a furnace in a manner that will reduce the required air to the furnace.

**618.4 Circulating air ducts for forced-air warm-air furnaces.** Circulating air for fuel-burning, forced-air-type, warm-air furnaces shall be conducted into the blower housing from outside the furnace enclosure by continuous air-tight ducts.

**618.5 Prohibited sources.** Outside or return air for a forced-air heating system shall not be taken from the following locations:

1. Closer than 10 feet (3048 mm) from an appliance vent outlet, a vent opening from a plumbing drainage system or the discharge outlet of an exhaust fan, unless the outlet is 3 feet (914 mm) above the outside air inlet.
2. Where there is the presence of objectionable odors, fumes or flammable vapors; or where located less than 10 feet (3048 mm) above the surface of any abutting public way or driveway; or where located at grade level by a sidewalk, street, alley or driveway.
3. A hazardous or insanitary location or a refrigeration machinery room as defined in the *International Mechanical Code*.

4. A room or space, the volume of which is less than 25 percent of the entire volume served by such system. Where connected by a permanent opening having an area sized in accordance with Section 618.2, adjoining rooms or spaces shall be considered as a single room or space for the purpose of determining the volume of such rooms or spaces.

**Exception:** The minimum volume requirement shall not apply where the amount of return air taken from a room or space is less than or equal to the amount of supply air delivered to such room or space.

5. A room or space containing an appliance where such a room or space serves as the sole source of return air.

**Exception:** This shall not apply where:

1. The appliance is a direct-vent appliance or an appliance not requiring a vent in accordance with Section 501.8.
2. The room or space complies with the following requirements:
  - 2.1. The return air shall be taken from a room or space having a volume exceeding 1 cubic foot for each 10 Btu/h (9.6 L/W) of combined input rating of all fuel-burning appliances therein.
  - 2.2. The volume of supply air discharged back into the same space shall be approximately equal to the volume of return air taken from the space.
  - 2.3. Return-air inlets shall not be located within 10 feet (3048 mm) of any appliance firebox or draft hood in the same room or space.
3. Rooms or spaces containing solid fuel-burning appliances, provided that return-air inlets are located not less than 10 feet (3048 mm) from the firebox of such appliances.
6. A closet, bathroom, toilet room, kitchen, garage, mechanical room, boiler room or furnace room.

**618.6 Screen.** Required outdoor air inlets for residential portions of a building shall be covered with a screen having 1/4-inch (6.4 mm) openings. Required outdoor air inlets serving a non-residential portion of a building shall be covered with screen having openings larger than 1/4 inch (6.4 mm) and not larger than 1 inch (25 mm).

**618.7 Return-air limitation.** Return air from one dwelling unit shall not be discharged into another dwelling unit.

### SECTION 619 (IFGC) CONVERSION BURNERS

**619.1 Conversion burners.** The installation of conversion burners shall conform to ANSI Z21.8.

### SECTION 620 (IFGC) UNIT HEATERS

**620.1 General.** Unit heaters shall be tested in accordance with ANSI Z83.8 and shall be installed in accordance with the manufacturer's installation instructions.

**620.2 Support.** Suspended-type unit heaters shall be supported by elements that are designed and constructed to accommodate the weight and dynamic loads. Hangers and brackets shall be of noncombustible material.

**620.3 Ductwork.** Ducts shall not be connected to a unit heater unless the heater is listed for such installation.

**620.4 Clearance.** Suspended-type unit heaters shall be installed with clearances to combustible materials of not less than 18 inches (457 mm) at the sides, 12 inches (305 mm) at the bottom and 6 inches (152 mm) above the top where the unit heater has an internal draft hood or 1 inch (25 mm) above the top of the sloping side of the vertical draft hood.

Floor-mounted-type unit heaters shall be installed with clearances to combustible materials at the back and one side only of not less than 6 inches (152 mm). Where the flue gases are vented horizontally, the 6-inch (152 mm) clearance shall be measured from the draft hood or vent instead of the rear wall of the unit heater. Floor-mounted-type unit heaters shall not be installed on combustible floors unless listed for such installation.

Clearances for servicing all unit heaters shall be in accordance with the manufacturer's installation instructions.

**Exception:** Unit heaters listed for reduced clearance shall be permitted to be installed with such clearances in accordance with their listing and the manufacturer's instructions.

### SECTION 621 (IFGC) UNVENTED ROOM HEATERS

**621.1 General.** Unvented room heaters shall be tested in accordance with ANSI Z21.11.2 and shall be installed in accordance with the conditions of the listing and the manufacturer's installation instructions. Unvented room heaters utilizing fuels other than fuel gas shall be regulated by the *International Mechanical Code*.

**621.2 Prohibited use.** One or more unvented room heaters shall not be used as the sole source of comfort heating in a dwelling unit.

**621.3 Input rating.** Unvented room heaters shall not have an input rating in excess of 40,000 Btu/h (11.7 Kw).

**621.4 Prohibited locations.** Unvented room heaters shall not be installed within occupancies in Groups A, E and I. The location of unvented room heaters shall also comply with Section 303.3.

**621.5 Room or space volume.** The aggregate input rating of all unvented appliances installed in a room or space shall not exceed 20 Btu/h per cubic foot (207 W/m<sup>3</sup>) of volume of such room or space. Where 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 that cannot be closed, the volume of such adjacent room or space shall be permitted to be included in the calculations.

**621.6 Oxygen-depletion safety system.** Unvented room heaters shall be equipped with an oxygen-depletion-sensitive safety shutoff system. The system shall shut off the gas supply to the main and pilot burners when the oxygen in the surrounding atmosphere is depleted to the percent concentration speci-

fied by the manufacturer, but not lower than 18 percent. The system shall not incorporate field adjustment means capable of changing the set point at which the system acts to shut off the gas supply to the room heater.

**621.7 Unvented log heaters.** An unvented log heater shall not be installed in a factory-built fireplace unless the fireplace system has been specifically tested, listed and labeled for such use in accordance with UL 127.

### SECTION 622 (IFGC) VENTED ROOM HEATERS

**622.1 General.** Vented room heaters shall be tested in accordance with ANSI Z21.11.1 or ANSI Z21.86/CSA 2.32, shall be designed and equipped as specified in Section 602.2 and shall be installed in accordance with the manufacturer's installation instructions.

### SECTION 623 (IFGC) COOKING APPLIANCES

**623.1 Cooking appliances.** Cooking appliances that are designed for permanent installation, including ranges, ovens, stoves, broilers, grills, fryers, griddles, hot plates and barbecues, shall be tested in accordance with ANSI Z21.1, ANSI Z21.58 or ANSI Z83.11 and shall be installed in accordance with the manufacturer's installation instructions.

**623.2 Prohibited location.** Cooking appliances designed, tested, listed and labeled for use in commercial occupancies shall not be installed within dwelling units or within any area where domestic cooking operations occur.

**623.3 Domestic appliances.** Cooking appliances installed within dwelling units and within areas where domestic cooking operations occur shall be listed and labeled as household-type appliances for domestic use.

**623.4 Domestic range installation.** Domestic ranges installed on combustible floors shall be set on their own bases or legs and shall be installed with clearances of not less than that shown on the label.

**623.5 Open-top broiler unit hoods.** A ventilating hood shall be provided above a domestic open-top broiler unit, unless otherwise listed for forced down draft ventilation.

**623.5.1 Clearances.** A minimum clearance of 24 inches (610 mm) shall be maintained between the cooking top and combustible material above the hood. The hood shall be at least as wide as the open-top broiler unit and be centered over the unit.

**623.6 Commercial cooking appliance venting.** Commercial cooking appliances, other than those exempted by Section 501.8, shall be vented by connecting the appliance to a vent or chimney in accordance with this code and the appliance manufacturer's instructions or the appliance shall be vented in accordance with Section 505.1.1.

## SECTION 624 (IFGC) WATER HEATERS

**624.1 General.** ~~Water heaters shall be tested in accordance with ANSI Z 21.10.1 and ANSI Z 21.10.3 and shall be installed in accordance with the manufacturer's installation instructions. Water heaters utilizing fuels other than fuel gas shall be regulated by the International Mechanical Code.~~

**624.1.1 Installation requirements.** ~~The requirements for water heaters relative to sizing, relief valves, drain pans and seal protection shall be in accordance with the International Plumbing Code.~~

**624.2 Water heaters utilized for space heating.** ~~Water heaters utilized both to supply potable hot water and provide hot water for space heating applications shall be listed and labeled for such applications by the manufacturer and shall be installed in accordance with the manufacturer's installation instructions and the International shall be installed in accordance with the Uniform Plumbing Code and Seattle Electrical Code.~~

## SECTION 625 (IFGC) REFRIGERATORS

**625.1 General.** Refrigerators shall be tested in accordance with ANSI Z21.19 and shall be installed in accordance with the manufacturer's installation instructions.

Refrigerators shall be provided with adequate clearances for ventilation at the top and back, and shall be installed in accordance with the manufacturer's instructions. If such instructions are not available, at least 2 inches (51mm) shall be provided between the back of the refrigerator and the wall and at least 12 inches (305 mm) above the top.

## SECTION 626 (IFGC) GAS-FIRED TOILETS

**626.1 General.** Gas-fired toilets shall be tested in accordance with ANSI Z21.61 and installed in accordance with the manufacturer's installation instructions.

**626.2 Clearance.** A 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 access for use, cleanout and necessary servicing.

## SECTION 627 (IFGC) AIR CONDITIONING EQUIPMENT

**627.1 General.** Gas-fired air-conditioning equipment shall be tested in accordance with ANSI Z21.40.1 or ANSI Z21.40.2 and shall be installed in accordance with the manufacturer's installation instructions.

**627.2 Independent piping.** Gas piping serving heating equipment shall be permitted to also serve cooling equipment where such heating and cooling equipment cannot be operated simultaneously (see Section 402).

**627.3 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.

**627.4 Clearances for indoor installation.** Air-conditioning equipment installed in rooms other than alcoves and closets shall be installed with clearances not less than those specified in Section 308.3 except that air-conditioning equipment listed for installation at lesser clearances than those specified in Section 308.3 shall be permitted to be installed in accordance with such listing and the manufacturer's instructions and air-conditioning equipment listed

for installation at greater clearances than those specified in Section 308.3 shall be installed in accordance with such listing and the manufacturer's instructions.

Air-conditioning equipment installed in rooms other than alcoves and closets shall be permitted to be installed with reduced clearances to combustible material, provided that the combustible material is protected in accordance with Table 308.2.

**627.5 Alcove and closet installation.** 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 such listing. The installation clearances for air-conditioning equipment in alcoves and closets shall not be reduced by the protection methods described in Table 308.2.

**627.6 Installation.** Air-conditioning equipment shall be installed 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, equipment shall be installed on a surface of noncombustible construction with noncombustible material and surface finish and with no combustible material against the underside thereof.

**627.7 Plenums and air ducts.** A plenum supplied as a part of the air-conditioning equipment shall be installed in accordance with the equipment manufacturer's instructions. Where a plenum is not supplied with the equipment, such plenum shall be installed in accordance with the fabrication and installation instructions provided by the plenum and equipment manufacturer. The method of connecting supply and return ducts shall facilitate proper circulation of air.

Where air-conditioning equipment is installed within a space separated from the spaces served by the equipment, the air circulated by the equipment shall be conveyed by ducts that are sealed to the casing of the equipment and that separate the circulating air from the combustion and ventilation air.

**627.8 Refrigeration coils.** A refrigeration coil shall not be installed in conjunction with a forced-air furnace where 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. 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. 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.

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

**627.9 Cooling units used with heating boilers.** Boilers, where 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. Where hot water heating boilers are connected to heating coils located in air-handling units where they might be exposed to refrigerated air circulation, such boiler piping systems shall be equipped with flow control valves or other

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automatic means to prevent gravity circulation of the boiler water during the cooling cycle.

**627.10 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 (15 240 mm) from the air conditioner and cooling tower.

### SECTION 628 (IFGC) ILLUMINATING APPLIANCES

**628.1 General.** Illuminating appliances shall be tested in accordance with ANSI Z21.42 and shall be installed in accordance with the manufacturer's installation instructions.

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

**628.3 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 (914 mm) in height shall be at least equivalent to that of a 2 1/2-inch-diameter (64 mm) post constructed of 0.064-inch-thick (1.6-mm) steel or a 1-inch (25.4 mm) Schedule 40 steel pipe. Posts 3 feet (914 mm) or less in height shall not be smaller than a 3/4-inch (19.1 mm) Schedule 40 steel pipe. Drain openings shall be provided near the base of posts where there is a possibility of water collecting inside them.

**628.4 Appliance pressure regulators.** Where an 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 shall be permitted to serve more than one illuminating appliance.

### SECTION 629 (IFGC) SMALL CERAMIC KILNS

**629.1 General.** Ceramic kilns with a maximum interior volume of 20 cubic feet (0.566 m<sup>3</sup>) and used for hobby and noncommercial purposes shall be installed in accordance with the manufacturer's installation instructions and the provisions of this code.

### SECTION 630 (IFGC) INFRARED RADIANT HEATERS

**630.1 General.** Infrared radiant heaters shall be tested in accordance with ANSI Z83.6 and shall be installed in accordance with the manufacturer's installation instructions.

**630.2 Support.** Infrared radiant heaters shall be safely and adequately fixed in an approved position independent of gas and electric supply lines. Hanger and brackets shall be of noncombustible material.

### SECTION 631 (IFGC) BOILERS

~~**631.1 Standards.** Boilers shall be listed in accordance with the requirements of ANSI Z21.13 or UL 795. If applicable, the boiler shall be designed and constructed in accordance with the requirements of ASME CSD 1 and as applicable, the ASME *Boiler and Pressure Vessel Code*, Sections I, II, IV, V and IX and NFPA 85.~~

~~**631.2 Installation.** In addition to the requirements of this code, the installation of boilers shall be in accordance with the manufacturer's instructions and the *International Mechanical Code*. Operating instructions of a permanent type shall be attached to the boiler. Boilers shall have all controls set, adjusted and tested by the installer. A complete control diagram together with complete boiler operating instructions shall be furnished by the installer. The manufacturer's rating data and the nameplate shall be attached to the boiler.~~

~~**631.3 Clearance to combustible materials.** Clearances to combustible materials shall be in accordance with Section 308.4.~~

### SECTION 632 (IFGC) EQUIPMENT INSTALLED IN EXISTING UNLISTED BOILERS

~~**632.1 General.** Gas equipment installed in existing unlisted boilers shall comply with Section 631.1 and shall be installed in accordance with the manufacturer's instructions and the *International Mechanical Code*.~~

### SECTION 633 (IFGC) FUEL CELL POWER PLANTS

**633.1 General.** Stationary fuel-cell power plants having a power output not exceeding 1,000 kW shall be tested in accordance with ANSI Z21.83 and shall be installed in accordance with the manufacturer's installation instructions and NFPA 853.

### SECTION 634 (IFGS) CHIMNEY DAMPER OPENING AREA

**634.1 Free opening area of chimney dampers.** Where an unlisted decorative appliance for installation in a vented fireplace is installed, the fireplace damper shall have a permanent free opening equal to or greater than specified in Table 634.1.

**TABLE 634.1  
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) <sup>a</sup>						
	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	8,000
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

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 square inch = 645.16 mm<sup>2</sup>, 1 British thermal unit per hour = 0.2931 W.

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



## CHAPTER 7

# GASEOUS HYDROGEN SYSTEMS

### SECTION 701 (IFGC) GENERAL

**701.1 Scope.** The installation of gaseous hydrogen systems shall comply with this chapter and Chapters 30 and 35 of the *International Fire Code*. Compressed gases shall also comply with Chapter 27 of the *International Fire Code* for general requirements. Containers provided with pyrophoric material shall also comply with Chapter 41 of the *International Fire Code*. Containers having residual gaseous hydrogen shall be considered as full for the purposes of the controls required.

**701.2 Permits.** Permits shall be required as set forth in Section 406 115 and as required by the *International Fire Code*.

### SECTION 702 (IFGC) GENERAL DEFINITIONS

**702.1 Definitions.** The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

**HYDROGEN CUTOFF ROOM.** A room or space which is intended exclusively to house a gaseous hydrogen system.

**HYDROGEN-GENERATING APPLIANCE.** A self-contained package or factory-matched packages of integrated systems for generating gaseous hydrogen. Hydrogen-generating appliances utilize electrolysis, reformation, chemical or other processes to generate hydrogen.

**GASEOUS HYDROGEN SYSTEM.** An assembly of piping, devices and apparatus designed to generate, store, contain, distribute or transport a nontoxic, gaseous hydrogen containing mixture having at least 95-percent hydrogen gas by volume and not more than 1-percent oxygen by volume. Gaseous hydrogen systems consist of items such as compressed gas containers, reactors and appurtenances, including pressure regulators, pressure relief devices, manifolds, pumps, compressors and interconnecting piping and tubing and controls.

### SECTION 703 (IFGC) GENERAL REQUIREMENTS

**703.1 Hydrogen-generating and refueling operations.** Ventilation shall be required in accordance with Section 703.1.1, 703.1.2 or 703.1.3 in public garages, private garages, repair garages, automotive service stations and parking garages which contain hydrogen-generating appliances or refueling systems. Such spaces shall be used for the storage of not more than three hydrogen-fueled passenger motor vehicles and have a floor area not exceeding 850 square feet (79 m<sup>2</sup>). The maximum rated output capacity of hydrogen-generating appliances shall not exceed 4 standard cubic feet per minute (ft<sup>3</sup>/min) of hydrogen for each 250 square feet (23.2 m<sup>2</sup>) of floor area in such spaces. Such equipment and appliances shall not be installed in Group H occupancies except where the occupancy is specifically designed for hydrogen use, or in control areas where open use, handling or dispensing of combustible, flammable or explosive materials occurs. For the purpose of this section, rooms or spaces that are not part of the

living space of a dwelling unit and that communicate directly with a private garage through openings shall be considered to be part of the private garage.

**703.1.1 Natural ventilation.** Indoor locations intended for hydrogen-generating or refueling operations shall communicate with the outdoors in accordance with Sections 703.1.1.1 through 703.1.1.2. The minimum cross-sectional dimension of air openings shall be 3 inches (76 mm). Where ducts are used, they shall be of the same cross-sectional area as the free area of the openings to which they connect. In such locations, equipment and appliances having an ignition source shall be located such that the source of ignition is not less than 12 inches (305 mm) below the ceiling.

**703.1.1.1 Two openings.** Two permanent openings, one located entirely within 12 inches (305 mm) of the ceiling of the garage, and one located entirely within 12 inches (305 mm) of the floor of the garage, shall be provided in the same exterior wall. The openings shall communicate directly with the outdoors. Each opening shall directly communicate with the outdoors horizontally, and have a minimum free area of 1/2 square foot per 1,000 cubic feet (1 m<sup>2</sup>/610 m<sup>3</sup>) of garage volume.

**703.1.1.2 Louvers and grilles.** In calculating the free area required by Section 703.1.1.1, the required size of openings shall be based on the net free area of each opening. If the free area through a design of louver or grille is known, it shall be used in calculating the size opening required to provide the free area specified. If the design and free area are not known, it shall be assumed that wood louvers will have 25-percent free area and metal louvers and grilles will have 75-percent free area. Louvers and grilles shall be fixed in the open position.

**703.1.2 Mechanical ventilation.** Indoor locations intended for hydrogen-generating or refueling operations shall be ventilated in accordance with Section 502.15 of the *International Mechanical Code*.

**703.1.3 Specially engineered installations.** As an alternative to the provisions of Section 703.1.1 and 703.1.2, the necessary supply of air for ventilation and dilution of flammable gases shall be provided by an approved engineered system.

**703.2 Containers, cylinders and tanks.** Compressed gas containers, cylinders and tanks shall comply with Chapters 30 and 35 of the *International Fire Code*.

**703.2.1 Limitations for indoor storage and use.** Flammable gas cylinders in occupancies regulated by the *International Residential Code* shall not exceed 250 cubic feet (7.1 m<sup>3</sup>) at normal temperature and pressure (NTP).

**703.2.2 Design and construction.** Compressed gas containers, cylinders and tanks shall be designed, constructed and tested in accordance with the Chapter 27 of the *International Fire Code*, *ASME Boiler and Pressure Vessel Code* (Section VIII) or DOTn 49 CFR, Parts 100-180.



**703.3 Pressure relief devices.** Pressure relief devices shall be provided in accordance with Sections 703.3.1 through 703.3.8. Pressure relief devices shall be sized and selected in accordance with CGA S-1.1, CGA S-1.2 and CGA S-1.3.

**703.3.1 Valves between pressure relief devices and containers.** Valves including shutoffs, check valves and other mechanical restrictions shall not be installed between the pressure relief device and container being protected by the relief device.

**Exception:** A locked-open shutoff valve on containers equipped with multiple pressure-relief device installations where the arrangement of the valves provides the full required flow through the minimum number of required relief devices at all times.

**703.3.2 Installation.** Valves and other mechanical restrictions shall not be located between the pressure relief device and the point of release to the atmosphere.

**703.3.3 Containers.** Containers shall be provided with pressure relief devices in accordance with the ASME *Boiler and Pressure Vessel Code* (Section VIII), DOTn 49 CFR, Parts 100-180 and Section 703.3.7.

**703.3.4 Vessels other than containers.** Vessels other than containers shall be protected with pressure relief devices in accordance with the ASME *Boiler and Pressure Vessel Code* (Section VIII), or DOTn 49 CFR, Parts 100-180.

**703.3.5 Sizing.** Pressure relief devices shall be sized in accordance with the specifications to which the container was fabricated. The relief device shall be sized to prevent the maximum design pressure of the container or system from being exceeded.

**703.3.6 Protection.** Pressure relief devices and any associated vent piping shall be designed, installed and located so that their operation will not be affected by water or other debris accumulating inside the vent or obstructing the vent.

**703.3.7 Access.** Pressure relief devices shall be located such that they are provided with ready access for inspection and repair.

**703.3.8 Configuration.** Pressure relief devices shall be arranged to discharge unobstructed in accordance with Section 2209 of the *International Fire Code*. Discharge shall be directed to the outdoors in such a manner as to prevent impingement of escaping gas on personnel, containers, equipment and adjacent structures and to prevent introduction of escaping gas into enclosed spaces. The discharge shall not terminate under eaves or canopies.

**Exception:** This section shall not apply to DOTn-specified containers with an internal volume of 2 cubic feet (0.057 m<sup>3</sup>) or less.

**703.4 Venting.** Relief device vents shall be terminated in an approved location in accordance with Section 2209 of the *International Fire Code*.

**703.5 Security.** Compressed gas containers, cylinders, tanks and systems shall be secured against accidental dislodgement in accordance with Chapter 30 of the *International Fire Code*.

**703.6 Electrical wiring and equipment.** Electrical wiring and equipment shall comply with the ~~ICC~~ Seattle *Electrical Code*.

## SECTION 704 (IFGC) PIPING, USE AND HANDLING

**704.1 Applicability.** Use and handling of containers, cylinders, tanks and hydrogen gas systems shall comply with this section. Gaseous hydrogen systems, equipment and machinery shall be listed or approved.

**704.1.1 Controls.** Compressed gas system controls shall be designed to prevent materials from entering or leaving process or reaction systems at other than the intended time, rate or path. Automatic controls shall be designed to be fail safe in accordance with accepted engineering practice.

**704.1.2 Piping systems.** Piping, tubing, valves and fittings conveying gaseous hydrogen shall be designed and installed in accordance with Sections 704.1.2.1 through 704.1.2.5, Chapter 27 of the *International Fire Code*, and ASME B31.3. Cast-iron pipe, valves and fittings shall not be used.

**704.1.2.1 Sizing.** Gaseous hydrogen piping shall be sized in accordance with approved engineering methods.

**704.1.2.2 Identification.** Piping used to convey gaseous hydrogen shall be identified and marked "HYDROGEN," at intervals not exceeding 10 feet (3048 mm). Letters of such marking shall be in a color other than the color of the piping. Piping shall be identified a minimum of one time in each room or space through which it extends.

**704.1.2.3 Piping design and construction.** Piping systems shall be Type 304, Type 304L or Type 316 stainless steel tubing listed or approved for hydrogen service and the use intended through the full range of pressure and temperature to which they will be subjected. Piping systems shall be designed and constructed to provide allowance for expansion, contraction, vibration, settlement and fire exposure.

**704.1.2.3.1 Prohibited locations.** Piping shall not be installed in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumbwaiter or elevator shaft.

**704.1.2.3.2 Piping in solid partitions and walls.** Concealed piping shall not be located in solid partitions and solid walls, except where installed in a ventilated chase or casing.

**704.1.2.3.3 Piping in concealed locations.** Portions of a piping system installed in concealed locations shall not have unions, tubing fittings, right or left couplings, bushings, compression couplings and swing joints made by combinations of fittings.

### Exceptions:

1. Tubing joined by brazing.
2. Fittings listed for use in concealed locations.

**704.1.2.3.4 Piping through foundation wall.** Underground piping shall not penetrate the outer foundation or basement wall of a building.

**704.1.2.3.5 Protection against physical damage.** In concealed locations, where piping other than stainless steel piping, stainless steel tubing or black steel is installed through holes or notches in wood studs, joists, rafters or similar members less than 1 inch (25 mm) from the nearest edge of the member, the pipe shall be protected by shield plates. Shield plates shall be a minimum of  $\frac{1}{16}$ -inch-thick (1.6 mm) steel, shall cover the area of the pipe where the member is notched or bored, and shall extend a minimum of 4 inches (102 mm) above sole plates, below top plates and to each side of a stud, joist or rafter.

**704.1.2.3.6 Piping in solid floors.** Piping in solid floors shall be laid in channels in the floor and covered in a manner that will allow access to the piping with a minimum amount of damage to the building. Where such piping is subject to exposure to excessive moisture or corrosive substances, the piping shall be protected in an approved manner. As an alternative to installation in channels, the piping shall be installed in a casing of Schedule 40 steel, wrought-iron, PVC or ABS pipe with tightly sealed ends and joints and the casing shall be ventilated to the outdoors. Both ends of such casing shall extend not less than 2 inches (51 mm) beyond the point where the pipe emerges from the floor.

**704.1.2.3.7 Piping outdoors.** Piping installed above ground, outdoors, shall be securely supported and located where it will be protected from physical damage. Piping passing through an exterior wall of a building shall be encased in a protective pipe sleeve. The annular space between the piping and the sleeve shall be sealed from the inside such that the sleeve is ventilated to the outdoors. Where passing through an exterior wall of a building, the piping shall also be protected against corrosion by coating or wrapping with an inert material. Below-ground piping shall be protected against corrosion.

**704.1.2.3.8 Settlement.** Piping passing through interior concrete or masonry walls shall be protected against differential settlement.

**704.1.2.4 Joints.** Joints on piping and tubing shall be listed for hydrogen service, inclusive of welded, brazed, flared, socket, slip or compression fittings. Gaskets and sealants shall be listed for hydrogen service. Threaded or flanged connections shall not be used in areas other than hydrogen cutoff rooms or outdoors.

**704.1.2.5 Valves and piping components.** Valves, regulators and piping components shall be listed or approved for hydrogen service, shall be provided with access and shall be designed and constructed to withstand the maximum pressure to which such components will be subjected.

**704.1.2.5.1 Shutoff valves on storage containers and tanks.** Shutoff valves shall be provided on all storage container and tank connections except for pressure relief devices. Shutoff valves shall be provided with ready access.

**704.2 Upright use.** Compressed gas containers, cylinders and tanks, except those with a water volume less than 1.3 gallons (5 L) and those designed for use in a horizontal position, shall be used in an upright position with the valve end up. An upright position shall include conditions where the container, cylinder or tank axis is inclined as much as 45 degrees (0.79 rad) from the vertical.

**704.3 Material-specific regulations.** In addition to the requirements of this section, indoor and outdoor use of hydrogen compressed gas shall comply with the material-specific provisions of Chapters 30 and 35 of the *International Fire Code*.

**704.4 Handling.** The handling of compressed gas containers, cylinders and tanks shall comply with Chapter 27 of the *International Fire Code*.

## SECTION 705 (IFGC) TESTING OF HYDROGEN PIPING SYSTEMS

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

**705.2 Inspections.** Inspection shall consist of a visual examination of the entire piping system installation and a pressure test, prior to system operation. Engineered systems shall be designed using approved engineering methods and the inspection procedures of ASME B31.3, and such inspections shall be verified by the code official.

**705.3 Pressure test.** The test pressure shall be not less than  $1\frac{1}{2}$  times the proposed maximum working pressure, but not less than 5 pounds per square inch gauge (psig) (34.5 kPa gauge), irrespective of the design pressure. Where the test pressure exceeds 125 psig (862 kPa gauge), the test pressure shall not exceed a value that produces hoop stress in the piping greater than 50 percent of the specified minimum yield strength of the pipe. Testing of engineered systems shall utilize the testing procedures of ASME B31.3 provided that test duration and gauge accuracy are included in the procedures as specified in Sections 705.3.1 and 705.3.2.

**705.3.1 Test duration.** The test duration shall not be less than  $\frac{1}{2}$  hour for each 500 cubic feet (14.2 m<sup>3</sup>) of pipe volume. For piping systems having a volume of more than 24,000 cubic feet (680 m<sup>3</sup>), the duration of the test shall not be required to exceed 24 hours.

**705.3.2 Test gauges.** Gauges used for testing shall be as follows:

1. Tests requiring a pressure of 10 pounds per square inch (psi) (68.95 kPa) or less shall utilize a testing gauge having increments of 0.10 psi (.6895 kPa) or less.
2. Tests requiring a pressure of greater than 10 psi (68.95 kPa) but less than or equal to 100 psi (689.5 kPa) shall

utilize a testing gauge having increments of 1 psi (6.895 kPa) or less.

3. Tests requiring a pressure test greater than 100 psi (689.5 kPa) shall utilize a testing gauge having increments of 2 psi (13.79 kPa) or less.

**Exception:** Measuring devices having an equivalent level of accuracy shall be permitted where approved by the design engineer and the code official.

**705.4 Detection of leaks and defects.** The piping system shall withstand the test pressure specified without showing any evidence of leakage or other defects.

**705.4.1 Corrections.** Where leakage or other defects are located, the affected portion of the piping system shall be repaired and retested.

## SECTION 706 (IFGC)

### LOCATION OF GASEOUS HYDROGEN SYSTEMS

**706.1 General.** This section shall govern the location and installation of gaseous hydrogen systems.

#### Exceptions:

1. Dispensing equipment need not be separated from canopies that are constructed in accordance with the *International Building Code* and in a manner that prevents the accumulation of hydrogen gas.
2. Gaseous hydrogen systems located in a separate building designed and constructed in accordance with the *International Building Code* and NFPA 50A.
3. Gaseous hydrogen systems located inside a building in a hydrogen cutoff room designed and constructed in accordance with Section 706.3 and the *International Building Code*.
4. Gaseous hydrogen systems located inside a building not in a hydrogen cutoff room where the gaseous hydrogen system is listed and labeled for indoor installation and installed in accordance with the manufacturer's installation instructions.
5. Stationary fuel-cell power plants in accordance with Section 633.

**706.2 Location on property.** Gaseous hydrogen systems shall be located in accordance with Chapter 22 of the *International Fire Code*.

**706.3 Hydrogen cutoff rooms.** Hydrogen cutoff rooms shall be designed and constructed in accordance with Sections 706.3.1 through 706.3.8 and the *International Building Code*.

**706.3.1 Design and construction.** Interior building openings shall be equipped with self-closing devices. Interior openings shall be electronically interlocked with the gaseous hydrogen system to prevent operation of the system when such openings are ajar or the room shall be provided with a mechanical exhaust ventilation system designed with a capture velocity at the opening of not less than 60 feet per minute (0.3048 m/s). Operable windows are prohibited in interior walls.

**706.3.2 Ventilation.** Cutoff rooms shall be provided with mechanical ventilation in accordance with the applicable

provisions for repair garages in Chapter 5 of the *International Mechanical Code*.

**Exception:** This section shall not apply to rooms provided with ventilation systems meeting the requirements of Section 706.3.1.

**706.3.3 Gas detection system.** Hydrogen cutoff rooms shall be provided with an approved flammable gas-detection system in accordance with Sections 706.3.3.1 through 706.3.3.3.

**706.3.3.1 System design.** The flammable gas-detection system shall be listed for use with hydrogen and any other flammable gases used in the room. The gas detection system shall be designed to activate when the level of flammable gas exceeds 25 percent of the lower flammability limit (LFL) for the gas or mixtures present at anticipated temperature and pressure.

**706.3.3.2 Operation.** Activation of the gas detection system shall result in all of the following:

1. Initiation of distinct audible and visual alarm signals both inside and outside of the cutoff room.
2. Activation of the mechanical ventilation system.

**706.3.3.3 Failure of the gas detection system.** Failure of the gas detection system shall result in activation of the mechanical ventilation system, cessation of hydrogen generation and the sounding of a trouble signal in an approved location.

**706.3.4 Ignition source control.** Open flames, flame-producing devices and other sources of ignition shall be controlled in accordance with Chapter 35 of the *International Fire Code*.

**706.3.5 Explosion control.** Explosion control shall be provided in accordance with Chapter 9 of the *International Fire Code*.

**706.3.6 Standby power.** Mechanical ventilation and gas detection systems shall be connected to a standby power system in accordance with Chapter 27 of the *International Fire Code*.

**706.3.7 Smoking.** Smoking shall be prohibited in hydrogen cutoff rooms. "No Smoking" signs shall be provided at all entrances to hydrogen cutoff rooms.

**706.3.8 Housekeeping.** The hydrogen cutoff room shall be kept free from combustible debris and storage at all times.

## SECTION 707 (IFGC) OPERATION AND MAINTENANCE OF GASEOUS HYDROGEN SYSTEMS

**707.1 Maintenance.** Gaseous hydrogen systems and detection devices shall be maintained in accordance with the *International Fire Code* and the manufacturer's installation instructions.

**707.2 Purging.** Purging of gaseous hydrogen systems shall be in accordance with Section 2211.8 of the *International Fire Code*.

**SECTION 708 (IFGC)  
DESIGN OF LIQUEFIED HYDROGEN SYSTEMS  
ASSOCIATED WITH HYDROGEN  
VAPORIZATION OPERATIONS**

**708.1 General.** The design of liquefied hydrogen systems shall comply with Chapter 32 of the *International Fire Code*.



## IFGC/IFGS CHAPTER 8

# REFERENCED STANDARDS

This chapter lists the standards that are referenced in various sections of this document. The standards are listed herein by the promulgating agency of the standard, the standard identification, the effective date and title, and the section or sections of this document that reference the standard. The application of the referenced standards shall be as specified in Section 102.8.

**ANSI**  
 American National Standards Institute  
 25 West 43rd Street  
 Fourth Floor  
 New York, NY 10036

Standard reference number	Title	Referenced in code section number
LC 1—97	Interior Gas Piping Systems Using Corrugated Stainless Steel Tubing . . . . .	403.5.4
Z21.1—00	Household Cooking Gas Appliances . . . . .	623.1
Z21.5.1—99	Gas Clothes Dryers - Volume I -Type 1 Clothes Dryers . . . . .	613.1
Z21.5.2—99	Gas Clothes Dryers - Volume II- Type 2 Clothes Dryers with Z21.5.2a-99 and Z21.5.2b-99 Addenda . . . . .	613.1, 614.3
Z21.8—94	Installation of Domestic Gas Conversion Burners . . . . .	619.1
Z21.10.1—00	Gas Water Heaters - Volume I - Storage, Water Heaters with Input Ratings of 75,000 Btu per Hour or Less . . . . .	624.1
Z21.10.3—98	Gas Water Heaters - Volume III - Storage, Water Heaters with Input Ratings Above 75,000 Btu per hour, Circulating and Instantaneous Water Heaters—with Z21.10.3a-99 Addendum . . . . .	624.1
Z21.11.1—91	Gas-Fired Room Heaters - Volume I - Vented Room Heaters—with 1993 Addendum (Replaced by Z21.86-98/CSA 2.32 - M98, Vented Gas-Fired Space Heating Appliances) . . . . .	622.1
Z21.11.2—96	Gas-Fired Room Heaters - Volume II - Unvented Room Heaters with Addendum A-97 and Addendum B-98 . . . . .	621.1
Z21.13—99	Gas-Fired Low-Pressure Steam and Hot Water Boilers—with Addenda Z21.13a-1993 and Z21.13b-1994 . . . . .	631.1
Z21.15—97	Manually Operated Gas Valves for Appliances, Appliance Connector Valves, and Hose End Valves . . . . .	409.1.1
Z21.19—90	Refrigerators Using Gas (R 1999) Fuel—with Addenda Z721.19a-1992 (R1999) and Z21.19b-1995 (R1999) . . . . .	625.1
Z21.40.1—96	Gas-Fired Heat Activated Air Conditioning and Heat Pump Appliances—with Z21.40.1a-98 Addendum . . . . .	627.1
Z21.40.2—96	Gas-Fired Work Activated Air Conditioning and Heat Pump Appliances (Internal Combustion)—with Z21.40.2a-97 Addendum . . . . .	627.1
Z21.42—93	Gas-Fired Illuminating Appliances . . . . .	628.1
Z21.47—00	Gas-Fired Central Furnaces—with Addendum Z21.47a-00 . . . . .	618.1
Z21.48—92	Gas-Fired Gravity and Fan Type Floor Furnaces—with 1993 Addendum (Replaced by Z21.86-98/CSA 2.32-M98, Vented Gas-Fired Space Heating Appliances) . . . . .	609.1
Z21.49—92	Gas-Fired Gravity and Fan-Type Vented Wall Furnaces—with 1993 Addendum B-94 (Replaced by Z21.86-98/CSA 2.32-M98, Vented Gas-Fired Space Heating Appliances) . . . . .	608.1
Z21.50—98	Vented Decorative Gas Appliances . . . . .	604.1
Z21.56—98	Gas-Fired Pool Heaters—with Addendum Z21.56a-99 . . . . .	616.1
Z21.58—95	Outdoor Cooking Gas Appliances—with Addendum Z21.58a-1998 . . . . .	623.1
Z21.60—00	Decorative Gas Appliances for Installation in Solid-Fuel Burning Fireplaces . . . . .	602.1
Z21.61—83 (R 1996)	Toilets, Gas-Fired . . . . .	625.1
Z21.69—97	Connectors for Movable Gas Appliances . . . . .	411.1
Z21.83—98	Fuel Cell Power Plants . . . . .	632.1
Z21.84—99	Manually-Lighted, Natural Gas Decorative Gas Appliances for Installation in Solid Fuel Burning Fireplaces . . . . .	602.1, 602.2
Z21.86—98/CSA 2.32 M98	Gas-Fired Vented Space Heating Appliances . . . . .	608.1, 609.1, 622.1
Z21.88—99	Vented Gas Fireplace Heaters . . . . .	605.1
Z83.4—99	Non-Recirculating Direct-Gas-Fired Industrial Air Heaters with Addendum Z83.4a-2001 . . . . .	611.1
Z83.6—90 (R 1998)	Gas-Fired Infrared Heaters . . . . .	630.1
Z83.8—96	Gas -Fired Unit Heaters—with Addendum Z83.8a-1997 . . . . .	620.1
Z83.9—96	Gas-Fired Duct Furnaces . . . . .	610.1
Z83.11—00	Gas Food Service Equipment (Ranges and Unit Broilers), Baking and Roasting Ovens, Fat Fryers, Counter Appliances and Kettles, Steam Cookers, and Steam Generators . . . . .	623.1
Z83.18—90	Recirculating Direct Gas-Fired Industrial Air Heaters with Addenda Z83a 2001 and Z83.18b 1992 . . . . .	612.1

**REFERENCED STANDARDS**

**ASME**

American Society of Mechanical Engineers  
 Three Park Avenue  
 New York, NY 10016-5990

Standard reference number	Title	Referenced in code section number
B1.20.1—R92	Pipe Threads, General Purpose (inch) . . . . .	403.9
B16.1—98	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125 and 250 . . . . .	403.12
B16.20—98	Metallic Gaskets for Pipe Flanges Ring-Joint, Spiral-Wound, and Jacketed — with Addendum B16.20a-2000 . . . . .	403.12
B16.33—90	Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 125 psig (Sizes 1/2 through 2) . . . . .	409.1.1
B31.3—99	Process Piping . . . . .	704.1.2, 705.2, 705.3
B36.10M—00	Welded and Seamless Wrought-Steel Pipe . . . . .	403.4.2
BPVC—01	ASME Boiler & Pressure Vessel Code (2001 Edition) . . . . .	630.1, 703.2.2, 703.3.3, 703.3.4
CSD-1—98	Controls and Safety Devices for Automatically Fired Boilers with the ASME CSD-1a-1999 Addendum . . . . .	631.1

**ASTM**

ASTM International  
 100 Barr Harbor Drive  
 West Conshohocken, PA 19428-2959

Standard reference number	Title	Referenced in code section number
A 53/A 53M—01	Specification for Pipe, Steel, Black and Hot Dipped Zinc-Coated Welded and Seamless . . . . .	403.4.2
A 106—99	Specification for Seamless Carbon Steel Pipe for High-Temperature Service . . . . .	403.4.2
A 254—97	Specification for Copper Braze Steel Tubing . . . . .	403.5.1
A 539—99	Specification for Electric Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines . . . . .	403.5.1
B 88—99	Specification for Seamless Copper Water Tube . . . . .	403.5.2
B 210—00	Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes . . . . .	403.5.3
B 241/B 241M—00	Specification for Aluminum and Aluminum-Alloy, Seamless Pipe and Seamless Extruded Tube . . . . .	403.4.4, 403.5.3
B 280—99	Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service . . . . .	403.5.2
C 64—72 (1977)	Withdrawn No Replacement (Specification for Fireclay Brick Refractories for Heavy Duty Stationary Boiler Service) . . . . .	503.10.2.5
C 315—00	Specification for Clay Flue Linings . . . . .	501.12
D 2513—01A	Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings . . . . .	403.6, 403.6.1, 403.11, 404.14.2

**AWWA**

American Water Works Association  
 6666 West Quincy Avenue  
 Denver, CO 80235

Standard reference number	Title	Referenced in code section number
C111—00	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings . . . . .	403.12

**CGA**

Compressed Gas Association  
 1725 Jefferson Davis Highway, 5th Floor  
 Arlington, VA 22202-4102

Standard reference number	Title	Referenced in code section number
S-1.1—(1994)	Pressure Relief Device Standards—Part 1—Cylinders for Compressed Gases . . . . .	703.3
S-1.2—(1995)	Pressure Relief Device Standards—Part 2—Cargo and Portable Tanks for Compressed Gases . . . . .	703.3
S-1.3—(1995)	Pressure Relief Device Standards—Part 3—Stationary Storage Containers for Compressed Gases . . . . .	703.3

# CSA

CSA America Inc.  
8501 E. Pleasant Valley Rd.  
Cleveland, OH USA 44131-5575

Standard reference Partnumber	Title	Referenced in code section number
CSA 8—93 (Revision 1, 1999)	Requirements for Gas-Fired Log Lighters for Wood Burning Fireplaces . . . . .	603.1

# DOTn

Department of Transportation  
400 Seventh St. SW.  
Washington, DC 20590

Standard reference number	Title	Referenced in code section number
49 CFR, Parts 192.281(e) & 192.283 (b)	Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards . . . . .	403.6.1
Parts 100-180	Hazardous Materials Regulations . . . . .	703.2.2, 703.3.3, 703.3.4

# ICC

International Code Council  
5203 Leesburg Pike, Suite 600  
Falls Church, VA 22041

Standard reference number	Title	Referenced in code section number
IBC—03	International Building Code® . . . . .	102.2.1, 201.3, 301.10, 301.11, 301.12, 301.14, 302.1, 302.2, 305.6, 306.6, 401.1.1, 412.6, 413.3, 413.3.1, 501.1, 501.3, 501.12, 501.15.4, 609.3, 614.2, 706.1, 706.3
ICC EC—03	ICC Electrical Code™—Administrative Provisions . . . . .	201.3, 306.3.1, 306.4.1, 306.5.2, 309.2, 413.8.2.4, 703.6
IEBC—03	International Existing Building Code™ . . . . .	101.2
IECC—03	International Energy Conservation Code® . . . . .	301.2
IFC—03	International Fire Code® . . . . .	201.3, 303.4, 401.2, 412.1, 412.6, 412.7, 412.7.3, 412.8, 413.1, 413.3, 413.3.1, 413.4, 413.8.2.5, 701.1, 701.2, 703.2, 703.2.2, 703.3.8, 703.4, 703.5, 704.1.2, 704.3, 704.4, 706.2, 706.3.4, 706.3.5, 706.3.6, 707.2, 707.1, 708.1
IMC—03	International Mechanical Code® . . . . .	101.2.5, 201.3, 301.1.1, 301.13, 304.11, 501.1, 614.2, 618.5, 621.1, 624.1, 631.2, 632.1, 703.1.2, 706.3.2
IPC—03	International Plumbing Code® . . . . .	201.3, 301.6, 624.1.1, 624.2
IRC—03	International Residential Code® . . . . .	703.2.1

# MSS

Manufacturers Standardization Society of  
the Valve and Fittings Industry  
127 Park Street, Northeast  
Vienna, VA 22180

Standard reference number	Title	Referenced in code section number
SP-6—96	Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings . . . . .	403.12
SP-58—93	Pipe Hangers and Supports—Materials, Design and Manufacture . . . . .	407.2



REFERENCED STANDARDS

**NFPA**

National Fire Protection Association  
 1 Batterymarch Pike  
 P.O. Box 9101  
 Quincy, MA 02269-9101

Standard reference number	Title	Referenced in code section number
37—98	Installation and Use of Stationary Combustion Engines and Gas Turbines . . . . .	616.1
50A—99	Gaseous Hydrogen Systems at Consumer Sites . . . . .	706.1
51—97	Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes . . . . .	414.1
58—01	Liquefied Petroleum Gas Code . . . . .	401.2, 402.6.1, 403.6.2, 403.11
82—99	Incinerators, Waste and Linen Handling Systems and Equipment . . . . .	607.1
85—01	Boiler and Construction Systems Hazards Code . . . . .	631.1
88B—97	Repair Garages . . . . .	305.5
211—00	Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances . . . . .	503.5.2, 503.5.3, 503.5.6.1, 503.5.6.3
853—00	Standard for the Installation of Stationary Fuel Cell Power Plants . . . . .	633.1

**UL**

Underwriters Laboratories Inc.  
 333 Pfingsten Road  
 Northbrook, IL 60062

Standard reference number	Title	Referenced in code section number
103—98	Factory-Built Chimneys, Residential Type and Building Heating Appliances—with Revisions thru March 1999 . . . . .	506.1
127—96	Factory-Built Fireplaces—with Revisions through November 1999 . . . . .	621.7
441—96	Gas Vents—with Revisions through April 1999 . . . . .	502.1
641—95	Type L Low-Temperature Venting Systems—with Revisions through April 1999 . . . . .	502.1
795—99	Commercial-Industrial Gas Heating Equipment . . . . .	610.1, 618.1, 631.1
959—01	Medium Heat Appliance Factory-Built Chimneys . . . . .	506.3
1738—93	Venting Systems for Gas Burning Appliances, Categories II, III and IV with Revisions through December 2000 . . . . .	502.1
1777—98	Chimney Liners—with Revisions through July 1998 . . . . .	501.12, 501.15.4

## APPENDIX A (IFGS)

# SIZING AND CAPACITIES OF GAS PIPING

(This appendix is informative and is not part of the code.)

**A.1 General.** To determine the size of piping used in a gas piping system, the following factors must be considered:

- (1) Allowable loss in pressure from point of delivery to equipment
- (2) Maximum gas demand
- (3) Length of piping and number of fittings
- (4) Specific gravity of the gas
- (5) Diversity factor

For any gas piping system, or special gas utilization equipment, or for conditions other than those covered by the tables provided in this code, 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 code official.

### A.2 Description of tables

**A.2.1 General.** The quantity of gas to be provided at each outlet should be determined, whenever possible, directly from the manufacturer's British thermal unit (Btu) input rating of the equipment that will be installed. In case the ratings of the equipment to be installed are not known, Table 402.2 shows the approximate consumption (in Btu per hour) of certain types of typical household appliances.

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 feet of the gas. The average Btu per cubic feet of the gas in the area of the installation can be obtained from the serving gas supplier.

**A.2.2 Low pressure natural gas tables.** Capacities for gas at low pressure [0.5 psig (3.5 kPa gauge) or less] in cubic feet per hour of 0.60 specific gravity gas for different sizes and lengths are shown in Tables 402.4(1) and 402.4(2) for iron pipe or equivalent rigid pipe, in Tables 402.4(7) through 402.4(9) for smooth wall semi-rigid tubing, and in Tables 402.4(14) through 402.4(16) for corrugated stainless steel tubing. Tables 402.4(1) and 402.4(7) are based upon a pressure drop of 0.3-inch water column (w.c.) (75 Pa), whereas Tables 402.4(2), 402.4(8) and 402.4(14) are based upon a pressure drop of 0.5-inch w.c. (125 Pa). Tables 402.4(9), 402.4(15) and 402.4(16) are special low-pressure applications based upon pressure drops greater than 0.5-inch w.c. (125 Pa). In using these tables, an allowance (in equivalent length of pipe) should be considered for any piping run with four or more fittings [see Table A.2.2].

**A.2.3 Undiluted liquefied petroleum tables.** Capacities in thousands of Btu per hour of undiluted liquefied petroleum gases based on a pressure drop of 0.5-inch w.c. (125 Pa) for different sizes and lengths are shown in Table 402.4(24) for iron pipe or equivalent rigid pipe, in Table 402.4(26) for smooth

wall semi-rigid tubing, in Table 402.4(28) for corrugated stainless steel tubing, and in Tables 402.4(31) and 402.4(33) for polyethylene plastic pipe and tubing. Tables 402.4(29) and 402.4(30) for corrugated stainless steel tubing and Table 402.4(32) for polyethylene plastic pipe are based on operating pressures greater than 0.5 pounds per square inch (psi) (3.5 kPa) and pressure drops greater than 0.5-inch w.c. (125 Pa). In using these tables, an allowance (in equivalent length of pipe) should be considered for any piping run with four or more fittings [see Table A.2.2].

**A.2.4 Natural gas specific gravity.** Gas piping systems that are to be supplied with gas of a specific gravity of 0.70 or less can be sized directly from the tables provided in this code, unless the code official specifies that a gravity factor be applied. Where the specific gravity of the gas is greater than 0.70, the gravity factor should be applied.

Application of the gravity factor converts the figures given in the tables provided in this code to capacities for another gas of different specific gravity. Such application is accomplished by multiplying the capacities given in the tables by the multipliers shown in Table A.2.4. In case the exact specific gravity does not appear in the table, choose the next higher value specific gravity shown.

**TABLE A.2.4**  
**MULTIPLIERS TO BE USED WITH TABLES 402.4(1)**  
**THROUGH 402.4(21) WHERE 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

**A.2.5 Higher pressure natural gas tables.** Capacities for gas at pressures greater than 0.5 psig (3.5 kPa gauge) in cubic feet per hour of 0.60 specific gravity gas for different sizes and lengths are shown in Tables 402.4(3) through 402.4(6) for iron pipe or equivalent rigid pipe, Tables 402.4(10) to 402.4(13) for

**TABLE A.2.2**  
**EQUIVALENT LENGTHS OF PIPE FITTINGS AND VALVES**

		SCREWED FITTINGS <sup>2</sup>				90° WELDING ELBOWS AND SMOOTH BENDS <sup>3</sup>					
		45°/EI	90°/EI	180° close return bends	Tee	R/d = 1	R/d = 1 <sup>1</sup> / <sub>3</sub>	R/d = 2	R/d = 4	R/d = 6	R/d = 8
<b>k factor =</b>		0.42	0.90	2.00	1.80	0.48	0.36	0.27	0.21	0.27	0.36
<b>L/d' ratio<sup>4</sup> n =</b>		14	30	67	60	16	12	9	7	9	12
Nominal pipe size, inches	Inside diameter d, inches, Schedule 40 <sup>6</sup>	<b>L = Equivalent Length In Feet of Schedule 40 (Standard-Weight) Straight Pipe<sup>6</sup></b>									
1/2	0.622	0.73	1.55	3.47	3.10	0.83	0.62	0.47	0.36	0.47	0.62
3/4	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
1 <sup>1</sup> / <sub>4</sub>	1.380	1.61	3.45	7.66	6.90	1.84	1.38	1.03	0.81	1.03	1.38
1 <sup>1</sup> / <sub>2</sub>	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
2 <sup>1</sup> / <sub>2</sub>	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	105.0	94.0	25.1	18.8	14.1	11.0	14.1	18.8
24	22.63	26.4	56.6	126.0	113.0	30.2	22.6	17.0	13.2	17.0	22.6

*continued*

**TABLE A.2.2—continued**  
**EQUIVALENT LENGTHS OF PIPE FITTINGS AND VALVES**

		MITER ELBOWS <sup>3</sup> (No. of miters)					WELDING TEES		VALVES (screwed, flanged, or welded)			
		1-45°	1-60°	1-90°	2-90° <sup>5</sup>	3-90° <sup>5</sup>	Forged	Miter <sup>3</sup>	Gate	Globe	Angle	Swing Check
<i>k</i> factor =		0.45	0.90	1.80	0.60	0.45	1.35	1.80	0.21	10	5.0	2.5
<i>L/d'</i> ratio <sup>4</sup> <i>n</i> =		15	30	60	20	15	45	60	7	333	167	83
Nominal pipe size, inches	Inside diameter <i>d</i> , inches, Schedule 40 <sup>6</sup>	<i>L</i> = Equivalent Length In Feet of Schedule 40 (Standard-Weight) Straight Pipe <sup>6</sup>										
1/2	0.622	0.78	1.55	3.10	1.04	0.78	2.33	3.10	0.36	17.3	8.65	4.32
3/4	0.824	1.03	2.06	4.12	1.37	1.03	3.09	4.12	0.48	22.9	11.4	5.72
1	1.049	1.31	2.62	5.24	1.75	1.31	3.93	5.24	0.61	29.1	14.6	7.27
1 1/4	1.380	1.72	3.45	6.90	2.30	1.72	5.17	6.90	0.81	38.3	19.1	9.58
1 1/2	1.610	2.01	4.02	8.04	2.68	2.01	6.04	8.04	0.94	44.7	22.4	11.2
2	2.067	2.58	5.17	10.3	3.45	2.58	7.75	10.3	1.21	57.4	28.7	14.4
2 1/2	2.469	3.08	6.16	12.3	4.11	3.08	9.25	12.3	1.44	68.5	34.3	17.1
3	3.068	3.84	7.67	15.3	5.11	3.84	11.5	15.3	1.79	85.2	42.6	21.3
4	4.026	5.04	10.1	20.2	6.71	5.04	15.1	20.2	2.35	112.0	56.0	28.0
5	5.047	6.30	12.6	25.2	8.40	6.30	18.9	25.2	2.94	140.0	70.0	35.0
6	6.065	7.58	15.2	30.4	10.1	7.58	22.8	30.4	3.54	168.0	84.1	42.1
8	7.981	9.97	20.0	40.0	13.3	9.97	29.9	40.0	4.65	222.0	111.0	55.5
10	10.02	12.5	25.0	50.0	16.7	12.5	37.6	50.0	5.85	278.0	139.0	69.5
12	11.94	14.9	29.8	59.6	19.9	14.9	44.8	59.6	6.96	332.0	166.0	83.0
14	13.13	16.4	32.8	65.6	21.9	16.4	49.2	65.6	7.65	364.0	182.0	91.0
16	15.00	18.8	37.5	75.0	25.0	18.8	56.2	75.0	8.75	417.0	208.0	104.0
18	16.88	21.1	42.1	84.2	28.1	21.1	63.2	84.2	9.85	469.0	234.0	117.0
20	18.81	23.5	47.0	94.0	31.4	23.5	70.6	94.0	11.0	522.0	261.0	131.0
24	22.63	28.3	56.6	113.0	37.8	28.3	85.0	113.0	13.2	629.0	314.0	157.0

For SI: 1 foot = 305 mm, 1 degree = 0.01745 rad.

Note: 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."

1. Flanged fittings have three-fourths the resistance of screwed elbows and tees.
2. Tabular figures give the extra resistance due to curvature alone to which should be added the full length of travel.
3. Small size socket-welding fittings are equivalent to miter elbows and miter tees.
4. Equivalent resistance in number of diameters of straight pipe computed for a value of (*f* - 0.0075) from the relation (*n* - *k/4f*).
5. For condition of minimum resistance where the centerline length of each miter is between *d* and  $2\frac{1}{2}d$ .
6. For pipe having other inside diameters, the equivalent resistance may be computed from the above *n* values.

Source: Crocker, S. *Piping Handbook*, 4th ed., Table XIV, pp. 100-101. Copyright 1945 by McGraw-Hill, Inc. Used by permission of McGraw-Hill Book Company.

semi-rigid tubing, Tables 402.4(17) and 402.4(18) for corrugated stainless steel tubing, and Tables 402.4(19) through 402.4(21) for polyethylene plastic pipe.

### A.3 Use of capacity tables

**A.3.1 Longest length method.** This sizing method is conservative in its approach by applying the maximum operating conditions in the system as the norm for the system and by setting the length of pipe used to size any given part of the piping system to the maximum value.

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 calculations included in this Appendix).

- (1) Divide the piping system into appropriate segments consistent with the presence of tees, branch lines and main runs. For each segment, determine the gas load (assuming all appliances operate simultaneously) and its overall length. An allowance (in equivalent length of pipe) as determined from Table A.2.2 shall be considered for piping segments that include four or more fittings.
- (2) Determine the gas demand of each appliance to be attached to the piping system. Where Tables 402.4(1) through 402.4(23) 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. Where Tables 402.4(24) through 402.4(33) 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.
- (3) Where 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 specific gravity of the gas to be used in the piping system.
- (4) Determine the length of piping from the point of delivery to the most remote outlet in the building/piping system.
- (5) In the appropriate capacity table, select the row 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 row of the table are multiplied by the appropriate multiplier from Table A.2.4.
- (6) Use this horizontal row to locate ALL gas demand figures for this particular system of piping.
- (7) Starting at the most remote outlet, find the gas demand for that outlet in the horizontal row just selected. If the exact figure of demand is not shown, choose the next larger figure left in the row.
- (8) Opposite this demand figure, in the first row at the top, the correct size of gas piping will be found.
- (9) 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.

When a large number of piping components (such as elbows, tees and valves) are installed in a pipe run, additional pressure loss can be accounted for by the use of equivalent lengths. Pressure loss across any piping component can be equated to the pressure drop through a length of pipe. The equivalent length of a combination of only four elbows/tees can result in a jump to the next larger length row, resulting in a significant reduction in capacity. The equivalent lengths in feet shown in Table A.2.2 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 although the resistance per foot of copper or brass pipe is less than that of steel. 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.

**A.3.2 Branch length method.** This sizing method reduces the amount of conservatism built into the traditional Longest Length Method. The longest length as measured from the meter to the furthest remote appliance is only used to size the initial parts of the overall piping system. The Branch Length Method is applied in the following manner:

- (1) Determine the gas load for each of the connected appliances.
- (2) Starting from the meter, divide the piping system into a number of connected segments, and determine the length and amount of gas that each segment would carry assuming that all appliances were operated simultaneously. An allowance (in equivalent length of pipe) as determined from Table A.2.2 should be considered for piping segments that include four or more fittings.
- (3) Determine the distance from the outlet of the gas meter to the appliance furthest removed from the meter.
- (4) Using the longest distance (found in Step 3), size each piping segment from the meter to the most remote appliance outlet.
- (5) For each of these piping segments, use the longest length and the calculated gas load for all of the connected appliances for the segment and begin the sizing process in Steps 6 through 8.
- (6) Referring to the appropriate sizing table (based on operating conditions and piping material), find the longest length distance in the first column or the next larger distance if the exact distance is not listed. The use of alternative operating pressures and/or pressure drops will require the use of a different sizing table, but will not alter the sizing methodology. In many cases, the use of alternative operating pressures and/or pressure drops will require the approval of both the code official and the local gas serving utility.

- (7) Trace across this row until the gas load is found or the closest larger capacity if the exact capacity is not listed.
- (8) Read up the table column and select the appropriate pipe size in the top row. Repeat Steps 6, 7 and 8 for each pipe segment in the longest run.
- (9) Size each remaining section of branch piping not previously sized by measuring the distance from the gas meter location to the most remote outlet in that branch, using the gas load of attached appliances and following the procedures of Steps 2 through 8.

**A.3.3 Hybrid pressure method.** The sizing of a 2 psi (13.8 kPa) gas piping system is performed using the traditional Longest Length Method but with modifications. The 2 psi (13.8 kPa) system consists of two independent pressure zones, and each zone is sized separately. The Hybrid Pressure Method is applied as follows.

The sizing of the 2 psi (13.8 kPa) section (from the meter to the line regulator) is as follows:

- (1) Calculate the gas load (by adding up the name plate ratings) from all connected appliances. (In certain circumstances the installed gas load may be increased up to 50 percent to accommodate future addition of appliances.) Ensure that the line regulator capacity is adequate for the calculated gas load and that the required pressure drop (across the regulator) for that capacity does not exceed  $\frac{3}{4}$  psi (5.2 kPa) for a 2 psi (13.8 kPa) system. If the pressure drop across the regulator is too high (for the connected gas load), select a larger regulator.
- (2) Measure the distance from the meter to the line regulator located inside the building.
- (3) If there are multiple line regulators, measure the distance from the meter to the regulator furthest removed from the meter.
- (4) The maximum allowable pressure drop for the 2 psi (13.8 kPa) section is 1 psi (6.9 kPa).
- (5) Referring to the appropriate sizing table (based on piping material) for 2 psi (13.8 kPa) systems with a 1 psi (6.9 kPa) pressure drop, find this distance in the first column, or the closest larger distance if the exact distance is not listed.
- (6) Trace across this row until the gas load is found or the closest larger capacity if the exact capacity is not listed.
- (7) Read up the table column to the top row and select the appropriate pipe size.

- (8) If there are multiple regulators in this portion of the piping system, each line segment must be sized for its actual gas load, but using the longest length previously determined above.

The low pressure section (all piping downstream of the line regulator) is sized as follows:

- (1) Determine the gas load for each of the connected appliances.
- (2) Starting from the line regulator, divide the piping system into a number of connected segments and/or independent parallel piping segments, and determine the amount of gas that each segment would carry assuming that all appliances were operated simultaneously. An allowance (in equivalent length of pipe) as determined from Table A.2.2 should be considered for piping segments that include four or more fittings.
- (3) For each piping segment, use the actual length or longest length (if there are sub-branchlines) and the calculated gas load for that segment and begin the sizing process as follows:
  - (a) Referring to the appropriate sizing table (based on operating pressure and piping material), find the longest length distance in the first column or the closest larger distance if the exact distance is not listed. The use of alternative operating pressures and/or pressure drops will require the use of a different sizing table, but will not alter the sizing methodology. In many cases, the use of alternative operating pressures and/or pressure drops may require the approval of the code official.
  - (b) Trace across this row until the appliance gas load is found or the closest larger capacity if the exact capacity is not listed.
  - (c) Read up the table column to the top row and select the appropriate pipe size.
  - (d) Repeat this process for each segment of the piping system.

**A.4 Use of sizing equations.** Capacities of smooth wall pipe or tubing can also be determined by using the following formulae:

- (1) High Pressure [1.5 psi (10.3 kPa) and above]:

$$Q = 181.6 \sqrt{\frac{D^5 \cdot (P_1^2 - P_2^2) \cdot Y}{C_r \cdot fba \cdot L}}$$

$$= 2237 D^{2.623} \left[ \frac{(P_1^2 - P_2^2) \cdot Y}{C_r \cdot L} \right]^{0.541}$$

**SIZING AND CAPACITIES OF GAS PIPING**

(2) Low Pressure [Less than 1.5 psi (10.3 kPa)]:

$$Q = 187.3 \sqrt{\frac{D^5 \cdot \Delta H}{C_r \cdot fba \cdot L}}$$

$$= 2313 D^{2.623} \left( \frac{\Delta H}{C_r \cdot L} \right)^{0.541}$$

where:

$Q$  = Rate, cubic feet per hour at 60°F and 30-inch mercury column

$D$  = Inside diameter of pipe, in.

$P_1$  = Upstream pressure, psia

$P_2$  = Downstream pressure, psia

$Y$  = Superexpansibility factor = 1/supercompressibility factor

$C_r$  = Factor for viscosity, density and temperature\*

$$= 0.00354 ST \left( \frac{Z}{S} \right)^{0.152}$$

Note: See Table 402.4 for  $Y$  and  $C_r$  for natural gas and propane.

$S$  = Specific gravity of gas at 60°F and 30-inch mercury column (0.60 for natural gas, 1.50 for propane), or = 1488 $\mu$

$T$  = 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 $\mu$

$fba$  = Base friction factor for air at 60°F (CF=1)

$L$  = Length of pipe, ft

$\Delta H$  = Pressure drop, in. w.c. (27.7 in. H<sub>2</sub>O = 1 psi)  
(For SI, see Section 402.4)

**A.5 Pipe and tube diameters.** Where the internal diameter is determined by the formulas in Section 402.4, Tables A.5.1 and A.5.2 can be used to select the nominal or standard pipe size based on the calculated internal diameter.

**TABLE A.5.1  
SCHEDULE 40 STEEL PIPE STANDARD SIZES**

NOMINAL SIZE (in.)	INTERNAL DIAMETER (in.)	NOMINAL SIZE (in.)	INTERNAL DIAMETER (in.)
1/4	0.364	1 1/2	1.610
3/8	0.493	2	2.067
1/2	0.622	2 1/2	2.469
3/4	0.824	3	3.068
1	1.049	3 1/2	3.548
1 1/4	1.380	4	4.026

**TABLE A.5.2  
COPPER TUBE STANDARD SIZES**

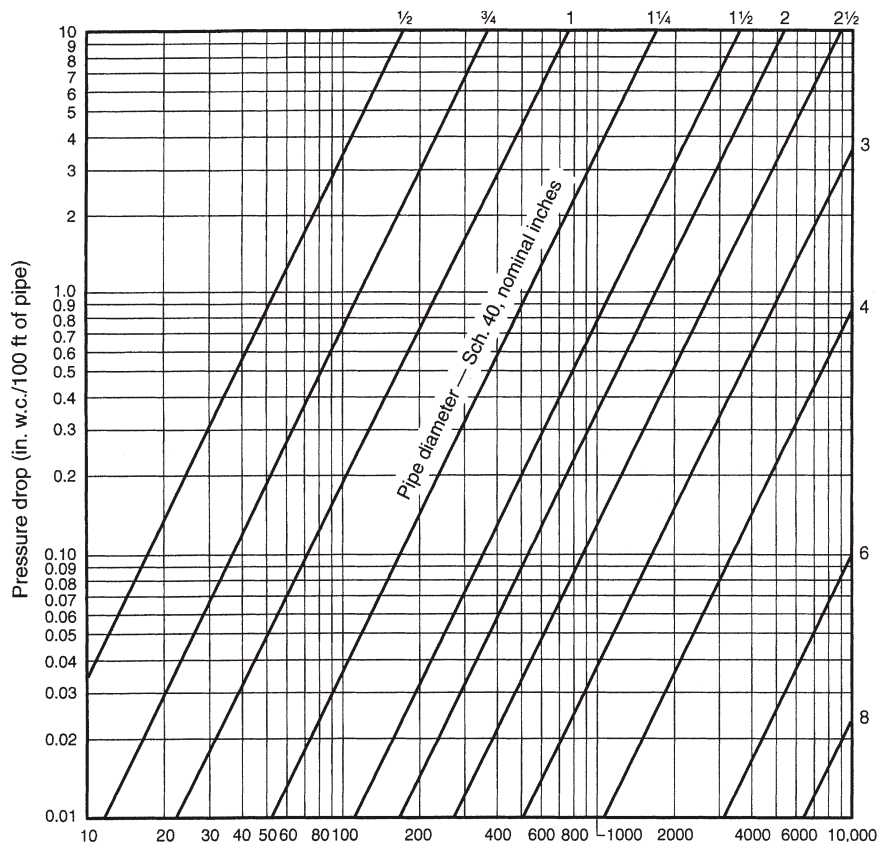
TUBE TYPE	NOMINAL OR STANDARD SIZE inches	INTERNAL DIAMETER inches
K	1/4	0.305
L	1/4	0.315
ACR (D)	3/8	0.315
ACR (A)	3/8	0.311
K	3/8	0.402
L	3/8	0.430
ACR (D)	1/2	0.430
ACR (A)	1/2	0.436
K	1/2	0.527
L	1/2	0.545
ACR (D)	5/8	0.545
ACR (A)	5/8	0.555
K	5/8	0.652
L	5/8	0.666
ACR (D)	3/4	0.666
ACR (A)	3/4	0.680
K	3/4	0.745
L	3/4	0.785
ACR	7/8	0.785
K	1	0.995
L	1	1.025
ACR	1 1/8	1.025
K	1 1/4	1.245
L	1 1/4	1.265
ACR	1 3/8	1.265
K	1 1/2	1.481
L	1 1/2	1.505
ACR	1 5/8	1.505
K	2	1.959
L	2	1.985
ACR	2 1/8	1.985
K	2 1/2	2.435
L	2 1/2	2.465
ACR	2 5/8	2.465
K	3	2.907
L	3	2.945
ACR	3 1/8	2.945

**A.6 Use of sizing charts.** A third method of sizing gas piping is detailed below as an option that is useful when large quantities of piping are involved in a job (e.g., an apartment house) and material costs are of concern. If the user is not completely familiar with this method, the resulting pipe sizing should be checked by a knowledgeable gas engineer. The sizing charts are applied as follows.

- (1) With the layout developed according to Section 106.3.1 of the code, indicate in each section the design gas flow under maximum operation conditions. For many layouts, the maximum design flow will be the sum of all connected loads. However, in some cases, certain combinations of utilization equipment will not occur simultaneously (e.g., gas heating and air conditioning). For these cases, the design flow is the greatest gas flow that can occur at any one time.
- (2) Determine the inlet gas pressure for the system being designed. In most cases, the point of inlet will be the gas meter or service regulator, but in the case of a system addition, it could be the point of connection to the existing system.
- (3) Determine the minimum pressure required at the inlet to the critical utilization equipment. Usually, the critical item will be the piece of equipment with the

highest required pressure for satisfactory operation. If several items have the same required pressure, it will be the one with the greatest length of piping from the system inlet.

- (4) The difference between the inlet pressure and critical item pressure is the allowable system pressure drop. Figures A.6(a) and A.6(b) show the relationship between gas flow, pipe size and pipe length for natural gas with 0.60 specific gravity.
- (5) To use Figure A.6(a) (low pressure applications), calculate the piping length from the inlet to the critical utilization equipment. Increase this length by 50 percent to allow for fittings. Divide the allowable pressure drop by the equivalent length (in hundreds of feet) to determine the allowable pressure drop per hundred feet. Select the pipe size from Figure A.6(a) for the required volume of flow.
- (6) To use Figure A.6(b) (high pressure applications), calculate the equivalent length as above. Calculate the index number for Figure A.6(b) by dividing the difference between the squares of the absolute values of inlet and outlet pressures by the equivalent length (in hundreds of feet). Select the pipe size from Figure A.6(b) for the gas volume required.



**FIGURE A.6 (a)**  
**CAPACITY OF NATURAL GAS PIPING, LOW PRESSURE (0.60 WC)**



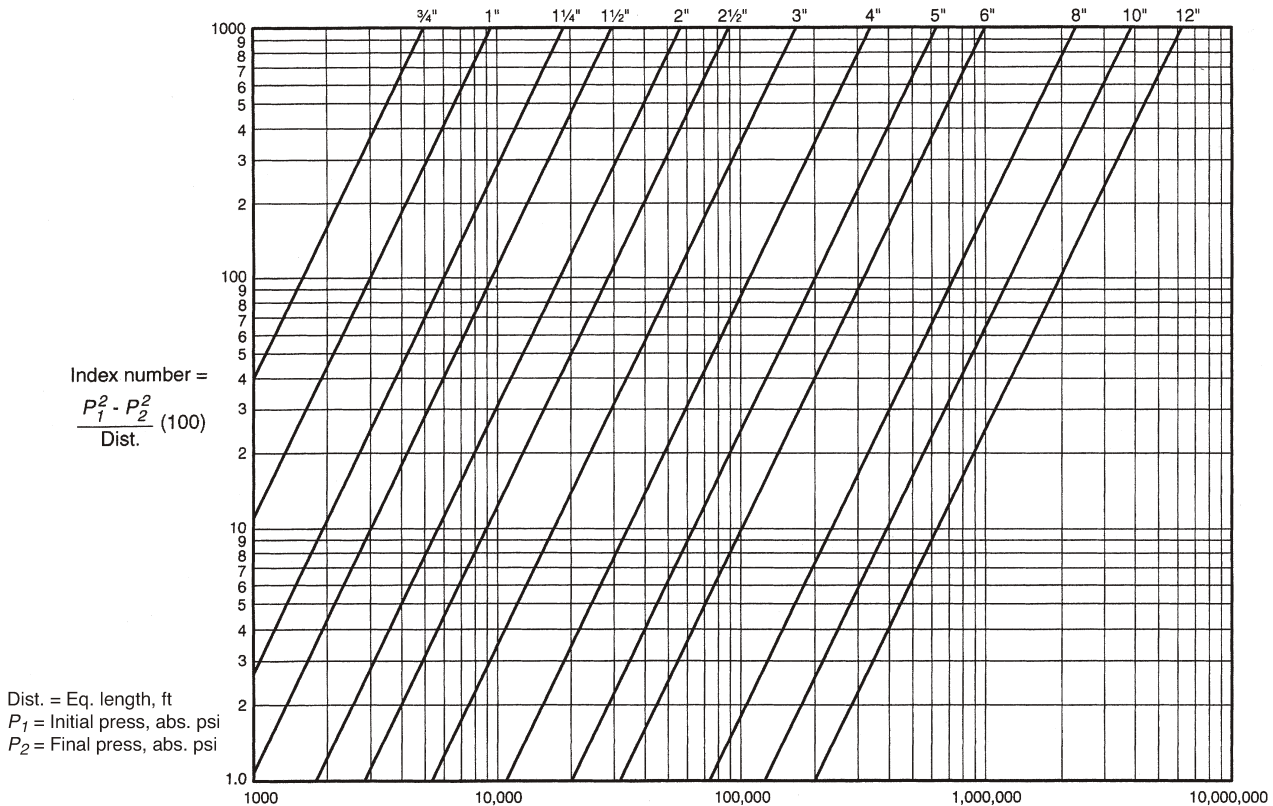


FIGURE A.6 (b)  
CAPACITY OF NATURAL GAS PIPING, HIGH PRESSURE (1.5 psi and above)

**A.7 Examples of piping system design and sizing**

**A.7.1 Example 1: Longest length method.** Determine the required pipe size of each section and outlet of the piping system shown in Figure A.7.1, with a designated pressure drop of 0.5-inch w.c. (125 Pa) using the Longest Length Method. The gas to be used has 0.60 specific gravity and a heating value of 1,000 Btu/ft<sup>3</sup> (37.5 MJ/m<sup>3</sup>).

Solution:

(1) Maximum gas demand for Outlet A:

$$\frac{\text{Consumption (rating plate input, or Table 402.2 if necessary)}}{\text{Btu of gas}} =$$

$$\frac{35,000 \text{ Btu per hour rating}}{1,000 \text{ Btu per cubic foot}} = 35 \text{ cubic feet per hour} = 35 \text{ cfh}$$

Maximum gas demand for Outlet B:

$$\frac{\text{Consumption}}{\text{Btu of gas}} = \frac{75,000}{1,000} = 75 \text{ cfh}$$

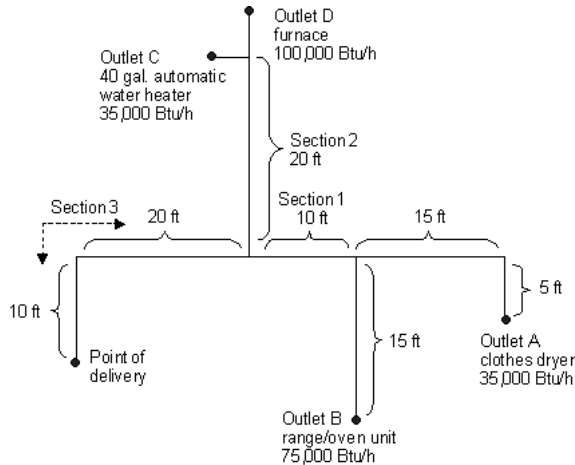
Maximum gas demand for Outlet C:

$$\frac{\text{Consumption}}{\text{Btu of gas}} = \frac{35,000}{1,000} = 35 \text{ cfh}$$

Maximum gas demand for Outlet D:

$$\frac{\text{Consumption}}{\text{Btu of gas}} = \frac{100,000}{1,000} = 100 \text{ cfh}$$

- (2) The length of pipe from the point of delivery to the most remote outlet (A) is 60 feet (18 288 mm). This is the only distance used.
- (3) Using the row marked 60 feet (18 288 mm) in Table 402.4(2):
  - (a) Outlet A, supplying 35 cfh (0.99 m<sup>3</sup>/hr), requires 3/8-inch pipe.
  - (b) Outlet B, supplying 75 cfh (2.12 m<sup>3</sup>/hr), requires 3/4-inch pipe.
  - (c) Section 1, supplying Outlets A and B, or 110 cfh (3.11 m<sup>3</sup>/hr), requires 3/4-inch pipe.
  - (d) Section 2, supplying Outlets C and D, or 135 cfh (3.82 m<sup>3</sup>/hr), requires 3/4-inch pipe.
  - (e) Section 3, supplying Outlets A, B, C and D, or 245 cfh (6.94 m<sup>3</sup>/hr), requires 1-inch pipe.
- (4) If a different gravity factor is applied to this example, the values in the row marked 60 feet (18 288 mm) of Table 402.4(2) would be multiplied by the appropriate multiplier from Table A.2.4 and the resulting cubic feet per hour values would be used to size the piping.



**FIGURE A.7.1**  
PIPING PLAN SHOWING A STEEL PIPING SYSTEM

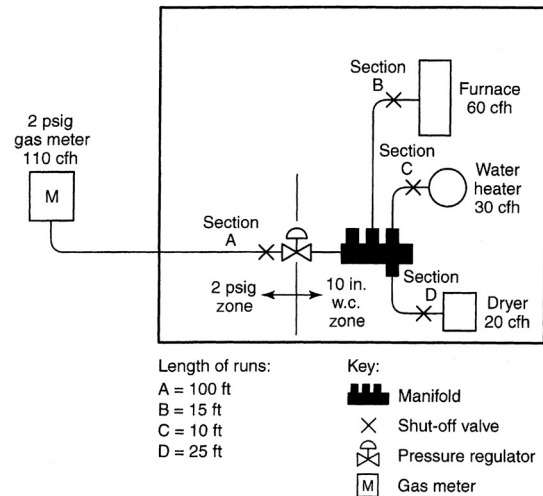
**A.7.2 Example 2: Hybrid or dual pressure systems.** Determine the required CSST size of each section of the piping system shown in Figure A.7.2, with a designated pressure drop of 1 psi (6.9 kPa) for the 2 psi (13.8 kPa) section and 3-inch w.c. (0.75 kPa) pressure drop for the 13-inch w.c. (2.49 kPa) section. The gas to be used has 0.60 specific gravity and a heating value of 1,000 Btu/ft<sup>3</sup> (37.5 MJ/m<sup>3</sup>).

**Solution**

- (1) Size 2 psi (13.8 kPa) line using Table 402.4(17).
- (2) Size 10-inch w.c. (2.5 kPa) lines using Table 402.4(15).
- (3) Using the following, determine if sizing tables can be used.
  - (a) Total gas load shown in Figure A.7.2 equals 110 cfh (3.11 m<sup>3</sup>/hr).
  - (b) Determine pressure drop across regulator [see notes in Table 402.4 (17)].
  - (c) If pressure drop across regulator exceeds  $\frac{3}{4}$  psig (5.2 kPa), Table 402.4 (17) cannot be used. Note: If pressure drop exceeds  $\frac{3}{4}$  psi (5.2 kPa), then a larger regulator must be selected or an alternative sizing method must be used.
  - (d) Pressure drop across the line regulator [for 110 cfh (3.11 m<sup>3</sup>/hr)] is 4-inch w.c. (0.99 kPa) based on manufacturer's performance data.
  - (e) Assume the CSST manufacturer has tubing sizes or EHDs of 13, 18, 23 and 30.
- (4) Section A [2 psi (13.8 kPa) zone]
  - (a) Distance from meter to regulator = 100 feet (30 480 mm).
  - (b) Total load supplied by A = 110 cfh (3.11 m<sup>3</sup>/hr) (furnace + water heater + dryer).
  - (c) Table 402.4 (17) shows that EHD size 18 should be used.

Note: It is not unusual to oversize the supply line by 25 to 50 percent of the as-installed load. EHD size 18 has a capacity of 189 cfh (5.35 m<sup>3</sup>/hr).

- (5) Section B (low pressure zone)
  - (a) Distance from regulator to furnace is 15 feet (4572 mm).
  - (b) Load is 60 cfh (1.70 m<sup>3</sup>/hr).
  - (c) Table 402.4 (15) shows that EHD size 13 should be used.
- (6) Section C (low pressure zone)
  - (a) Distance from regulator to water heater is 10 feet (3048 mm).
  - (b) Load is 30 cfh (0.85 m<sup>3</sup>/hr).
  - (c) Table 402.4 (15) shows that EHD size 13 should be used.
- (7) Section D (low pressure zone)
  - (a) Distance from regulator to dryer is 25 feet (7620 mm).
  - (b) Load is 20 cfh (0.57 m<sup>3</sup>/hr).



**FIGURE A.7.2**  
PIPING PLAN SHOWING A CSST SYSTEM

- (c) Table 402.4(15) shows that EHD size 13 should be used.

**A.7.3 Example 3: Branch length method.** Determine the required semi-rigid copper tubing size of each section of the piping system shown in Figure A.7.3, with a designated pressure drop of 1-inch w.c. (250 Pa) (using the Branch Length Method). The gas to be used has 0.60 specific gravity and a heating value of 1,000 Btu/ft<sup>3</sup> (37.5 MJ/m<sup>3</sup>).

**Solution**

- (1) Section A
  - (a) The length of tubing from the point of delivery to the most remote appliance is 50 feet (15 240 mm), A + C.

- (b) Use this longest length to size Sections A and C.
  - (c) Using the row marked 50 feet (15 240 mm) in Table 402.4(9), Section A, supplying 220 cfh (6.2 m<sup>3</sup>/hr) for four appliances requires 1-inch tubing.
- (2) Section B
- (a) The length of tubing from the point of delivery to the range/oven at the end of Section B is 30 feet (9144 mm), A + B.
  - (b) Use this branch length to size Section B only.
  - (c) Using the row marked 30 feet (9144 mm) in Table 402.4(9), Section B, supplying 75 cfh (2.12 m<sup>3</sup>/hr) for the range/oven requires 1/2-inch tubing.
- (3) Section C
- (a) The length of tubing from the point of delivery to the dryer at the end of Section C is 50 feet (15 240 mm), A + C.
  - (b) Use this branch length (which is also the longest length) to size Section C.
  - (c) Using the row marked 50 feet (15 240 mm) in Table 402.4(9), Section C, supplying 30 cfh (0.85 m<sup>3</sup>/hr) for the dryer requires 3/8-inch tubing.
- (4) Section D
- (a) The length of tubing from the point of delivery to the water heater at the end of Section D is 30 feet (9144 mm), A + D.
  - (b) Use this branch length to size Section D only.
  - (c) Using the row marked 30 feet (9144 mm) in Table 402.4(9), Section D, supplying 35 cfh (0.99 m<sup>3</sup>/hr) for the water heater requires 3/8-inch tubing.
- (5) Section E
- (a) The length of tubing from the point of delivery to the furnace at the end of Section E is 30 feet (9144 mm), A + E.

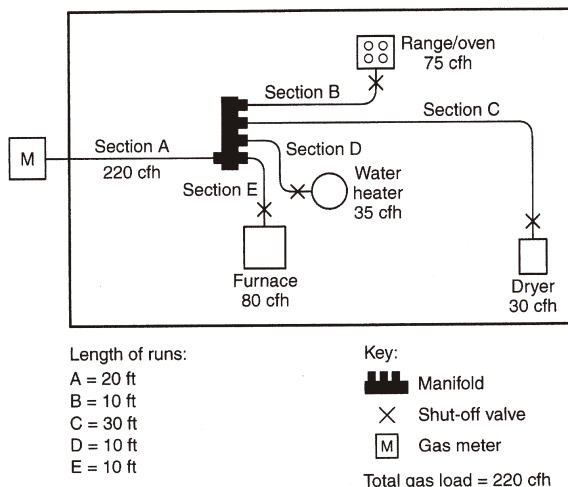


FIGURE A.7.3  
PIPING PLAN SHOWING A COPPER TUBING SYSTEM

- (b) Use this branch length to size Section E only.
- (c) Using the row marked 30 feet (9144 mm) in Table 402.4(9), Section E, supplying 80 cfh (2.26 m<sup>3</sup>/hr) for the furnace requires 1/2-inch tubing.

**A.7.4 Example 4: Modification to existing piping system.** Determine the required CSST size for Section G (retrofit application) of the piping system shown in Figure A.7.4, with a designated pressure drop of 0.5-inch w.c. (125 Pa) using the branch length method. The gas to be used has 0.60 specific gravity and a heating value of 1,000 Btu/ft<sup>3</sup> (37.5 MJ/m<sup>3</sup>).

**Solution**

- (1) The length of pipe and CSST from the point of delivery to the retrofit appliance (barbecue) at the end of Section G is 40 feet (12 192 mm), A + B + G.
- (2) Use this branch length to size Section G.
- (3) Assume the CSST manufacturer has tubing sizes or EHDs of 13, 18, 23 and 30.
- (4) Using the row marked 40 feet (12 192 mm) in Table 402.4(14), Section G, supplying 40 cfh (1.13 m<sup>3</sup>/hr) for the barbecue requires EHD 18 CSST.
- (5) The sizing of Sections A, B, F and E must be checked to ensure adequate gas carrying capacity since an appliance has been added to the piping system (see A.7.1 for details).

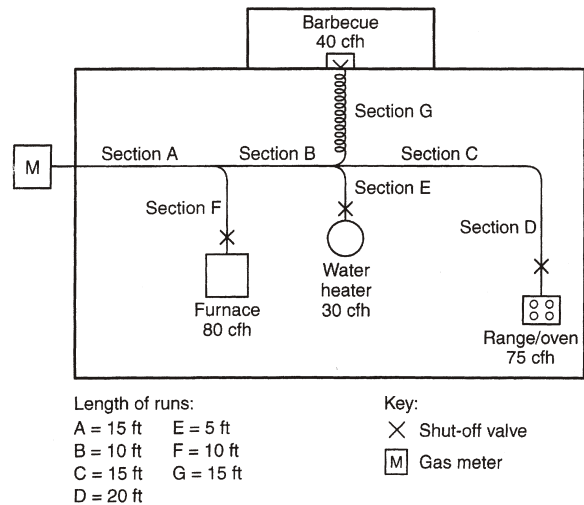


FIGURE A.7.4  
PIPING PLAN SHOWING A MODIFICATION TO EXISTING PIPING SYSTEM

## APPENDIX B (IFGS)

# SIZING OF VENTING SYSTEMS SERVING APPLIANCES EQUIPPED WITH DRAFT HOODS, CATEGORY I APPLIANCES, AND APPLIANCES LISTED FOR USE AND TYPE B VENTS

(This appendix is informative and is not part of the code.)

### EXAMPLES USING SINGLE APPLIANCE VENTING TABLES

#### Example 1: Single draft-hood-equipped appliance

An installer has a 120,000 British thermal unit (Btu) per hour input appliance with a 5-inch-diameter draft hood outlet that needs to be vented into a 10-foot-high Type B vent system. What size vent should be used assuming (a) a 5-foot lateral single-wall metal vent connector is used with two 90-degree elbows, or (b) a 5-foot lateral single-wall metal vent connector is used with three 90-degree elbows in the vent system?

#### Solution:

Table 504.2(2) should be used to solve this problem, because single-wall metal vent connectors are being used with a Type B vent.

- (a) Read down the first column in Table 504.2(2) until the row associated with a 10-foot height and 5-foot lateral is found. Read across this row until a vent capacity greater than 120,000 Btu per hour is located in the shaded columns labeled "NAT Max" for draft-hood-

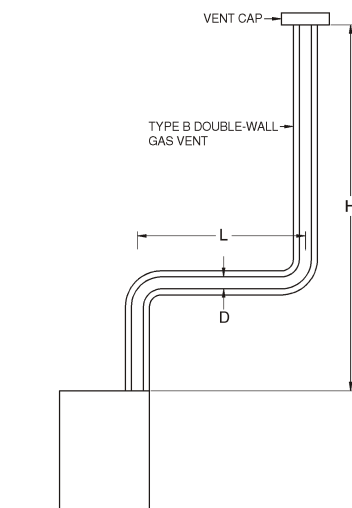
equipped appliances. In this case, a 5-inch-diameter vent has a capacity of 122,000 Btu per hour and may be used for this application.

- (b) If three 90-degree elbows are used in the vent system, then the maximum vent capacity listed in the tables must be reduced by 10 percent (see Section 504.2.3 for single appliance vents). This implies that the 5-inch-diameter vent has an adjusted capacity of only 110,000 Btu per hour. In this case, the vent system must be increased to 6 inches in diameter (see calculations below).

$$122,000 (.90) = 110,000 \text{ for 5-inch vent}$$

From Table 504.2(2), Select 6-inch vent

$186,000 (.90) = 167,000$ ; This is greater than the required 120,000. Therefore, use a 6-inch vent and connector where three elbows are used.

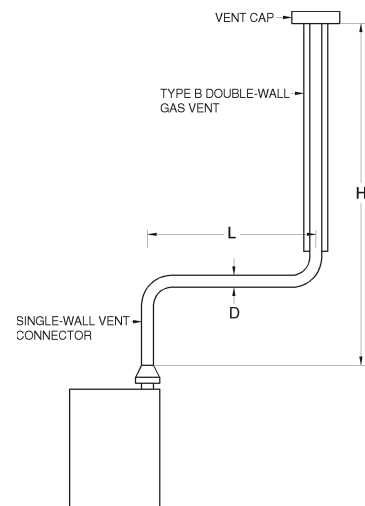


For SI: 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.  
Table 504.2(1) is used when sizing Type B double-wall gas vent connected directly to the appliance.

Note: The appliance may be either Category I draft hood equipped or fan-assisted type.

FIGURE B-1

TYPE B DOUBLE-WALL VENT SYSTEM SERVING A SINGLE APPLIANCE WITH A TYPE B DOUBLE-WALL VENT



For SI: 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.  
Table 504.2(2) is used when sizing a single-wall metal vent connector attached to a Type B double-wall gas vent.

Note: The appliance may be either Category I draft hood equipped or fan-assisted type.

FIGURE B-2

TYPE B DOUBLE-WALL VENT SYSTEM SERVING A SINGLE APPLIANCE WITH A SINGLE-WALL METAL VENT CONNECTOR

**SIZING OF VENTING SYSTEMS**

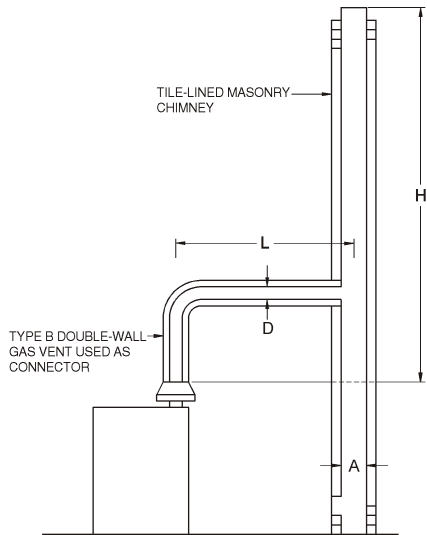
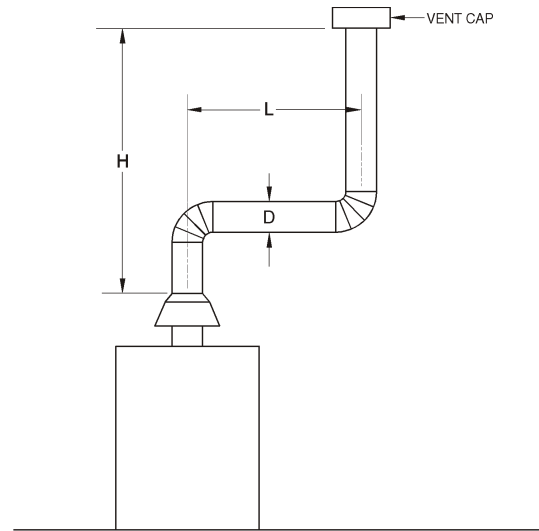


Table 504.2(3) is used when sizing a Type B double-wall gas vent connector attached to a tile-lined masonry chimney.

Note: "A" is the equivalent cross-sectional area of the tile liner.

Note: The appliance may be either Category I draft hood equipped or fan-assisted type.

**FIGURE B-3  
VENT SYSTEM SERVING A SINGLE APPLIANCE  
WITH A MASONRY CHIMNEY OF TYPE B  
DOUBLE-WALL VENT CONNECTOR**



Asbestos cement Type B or single-wall metal vent serving a single draft-hood-equipped appliance [see Table 504.2(5)].

**FIGURE B-5  
ASBESTOS CEMENT TYPE B OR SINGLE-WALL  
METAL VENT SYSTEM SERVING A SINGLE  
DRAFT-HOOD-EQUIPPED APPLIANCE**

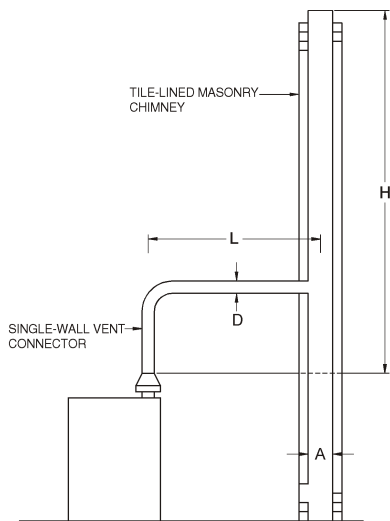


Table 504.2(4) is used when sizing a single-wall vent connector attached to a tile-lined masonry chimney.

Note: "A" is the equivalent cross-sectional area of the tile liner.

Note: The appliance may be either Category I draft hood equipped or fan-assisted type.

**FIGURE B-4  
VENT SYSTEM SERVING A SINGLE APPLIANCE  
USING A MASONRY CHIMNEY AND A  
SINGLE-WALL METAL VENT CONNECTOR**

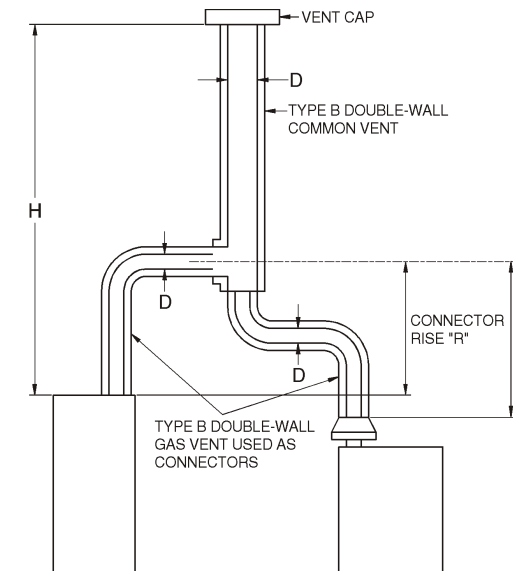


Table 504.3(1) is used when sizing Type B double-wall vent connectors attached to a Type B double-wall common vent.

Note: Each appliance may be either Category I draft hood equipped or fan-assisted type.

**FIGURE B-6  
VENT SYSTEM SERVING TWO OR MORE APPLIANCES  
WITH TYPE B DOUBLE-WALL VENT AND TYPE B  
DOUBLE-WALL VENT CONNECTOR**

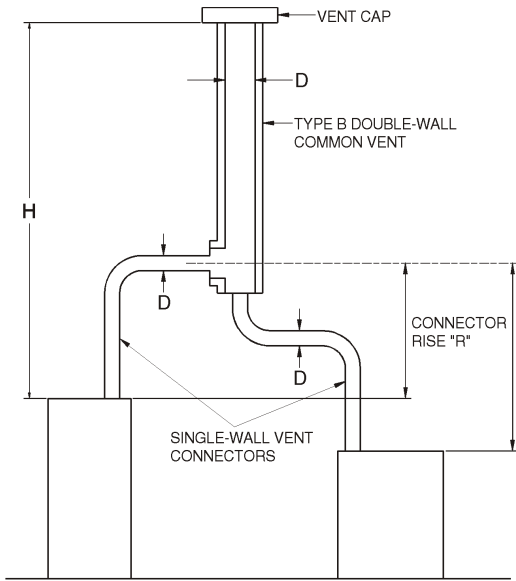


Table 504.3(2) is used when sizing single-wall vent connectors attached to a Type B double-wall common vent.  
 Note: Each appliance may be either Category I draft hood equipped or fan-assisted type.

**FIGURE B-7**  
**VENT SYSTEM SERVING TWO OR MORE APPLIANCES**  
**WITH TYPE B DOUBLE-WALL VENT AND**  
**SINGLE-WALL METAL VENT CONNECTORS**

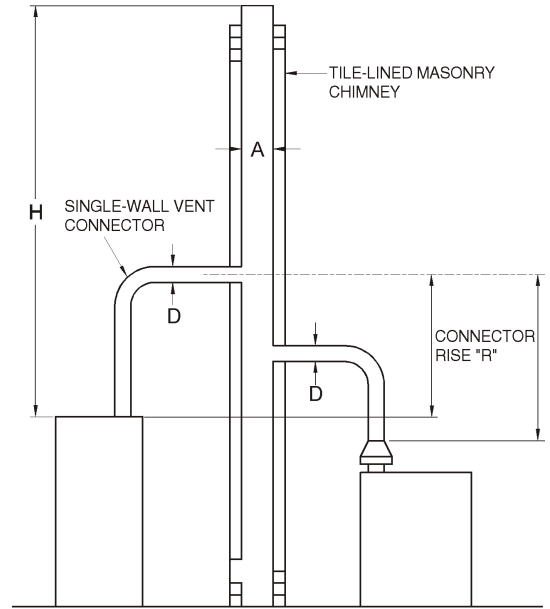


Table 504.3(4) is used when sizing single-wall metal vent connectors attached to a tile-lined masonry chimney.  
 Note: "A" is the equivalent cross-sectional area of the tile liner.  
 Note: Each appliance may be either Category I draft hood equipped or fan-assisted type.

**FIGURE B-9**  
**MASONRY CHIMNEY SERVING TWO OR MORE APPLIANCES**  
**WITH SINGLE-WALL METAL VENT CONNECTORS**

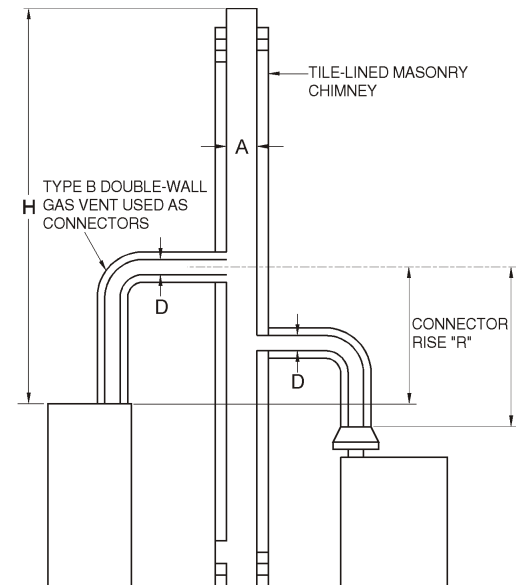
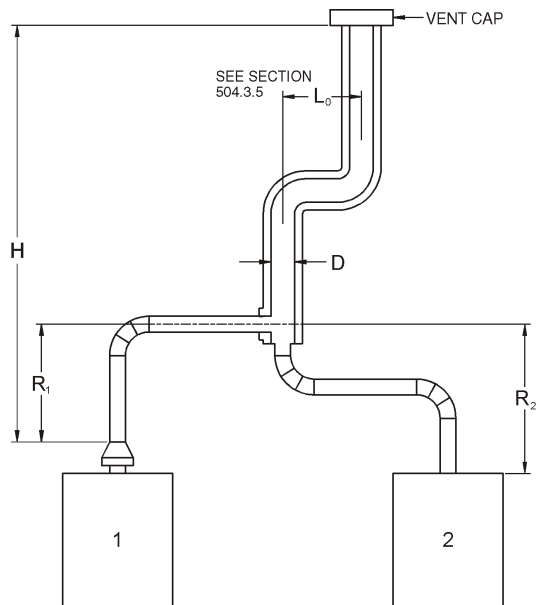


Table 504.3(3) is used when sizing Type B double-wall vent connectors attached to a tile-lined masonry chimney.  
 Note: "A" is the equivalent cross-sectional area of the tile liner.  
 Note: Each appliance may be either Category I draft hood equipped or fan-assisted type.

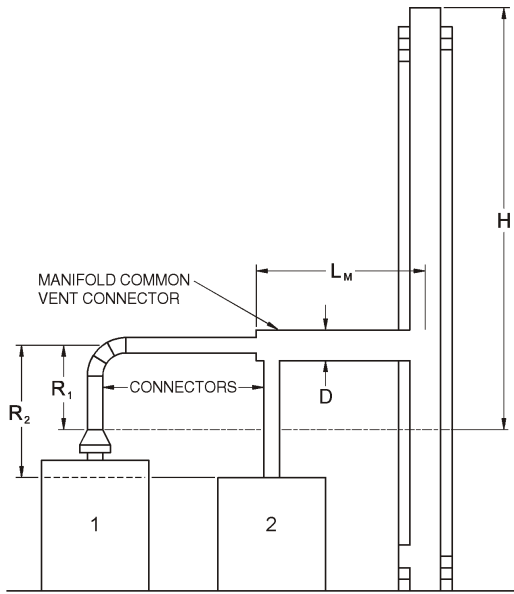
**FIGURE B-8**  
**MASONRY CHIMNEY SERVING TWO OR MORE APPLIANCES**  
**WITH TYPE B DOUBLE-WALL VENT CONNECTOR**



Asbestos cement Type B or single-wall metal pipe vent serving two or more draft-hood-equipped appliances [see Table 504.3(5)].

**FIGURE B-10**  
**ASBESTOS CEMENT TYPE B OR SINGLE-WALL**  
**METAL VENT SYSTEM SERVING TWO OR MORE**  
**DRAFT-HOOD-EQUIPPED APPLIANCES**

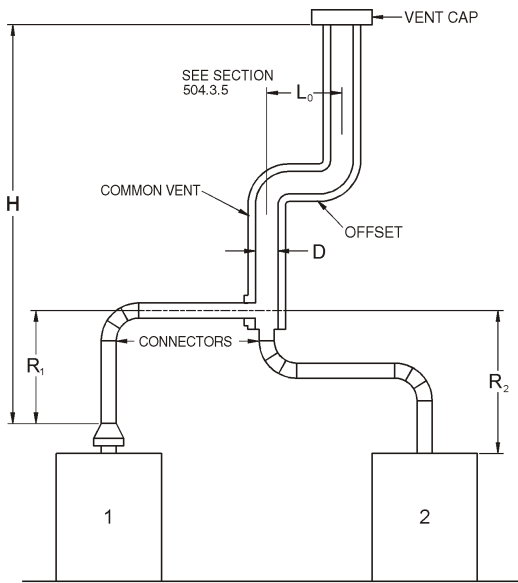
**SIZING OF VENTING SYSTEMS**



Example: Manifolded Common Vent Connector  $L_M$  shall be no greater than 18 times the common vent connector manifold inside diameter; i.e., a 4-inch (102 mm) inside diameter common vent connector manifold shall not exceed 72 inches (1829 mm) in length (see Section 504.3.4).

Note: This is an illustration of a typical manifolded vent connector. Different appliance, vent connector, or common vent types are possible. Consult Section 502.3.

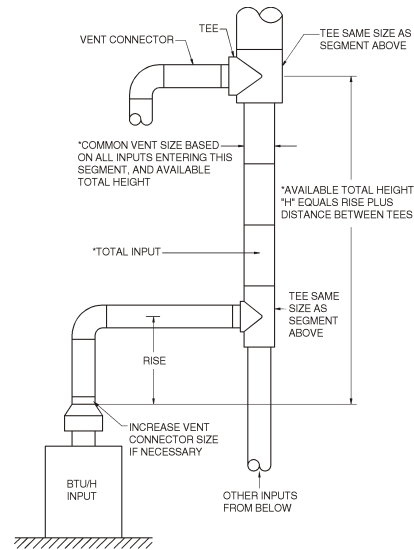
**FIGURE B-11  
USE OF MANIFOLD COMMON VENT CONNECTOR**



Example: Offset Common Vent

Note: This is an illustration of a typical offset vent. Different appliance, vent connector, or vent types are possible. Consult Sections 504.2 and 504.3.

**FIGURE B-12  
USE OF OFFSET COMMON VENT**



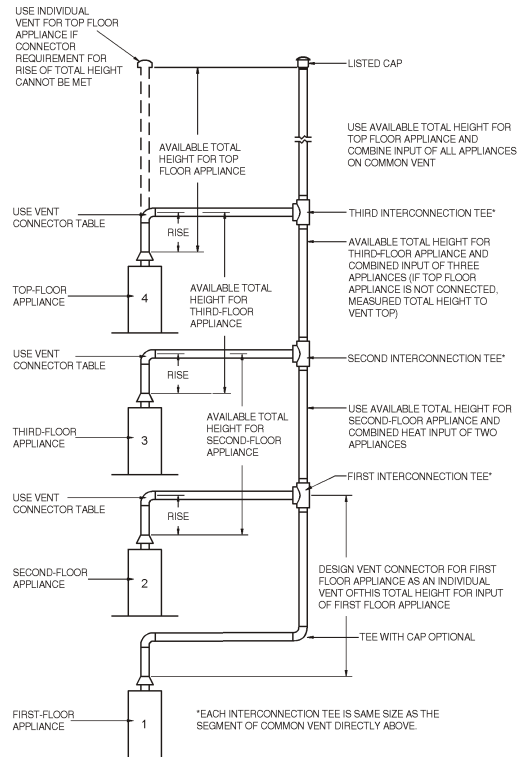
Vent connector size depends on:

- Input
- Rise
- Available total height "H"
- Table 504.3(1) connectors

Common vent size depends on:

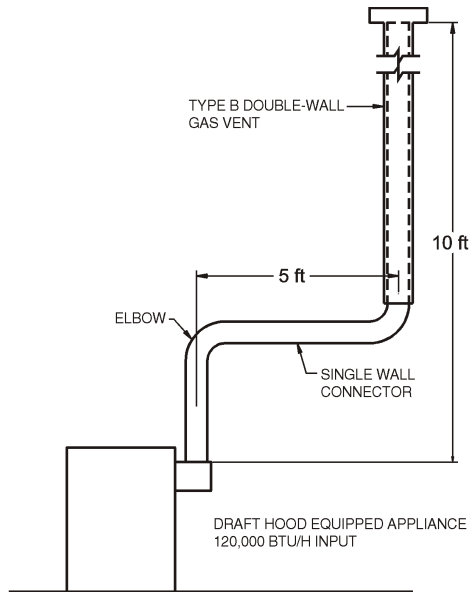
- Combined inputs
- Available total height "H"
- Table 504.3(1) common vent

**FIGURE B-13  
MULTISTORY GAS VENT DESIGN PROCEDURE  
FOR EACH SEGMENT OF SYSTEM**



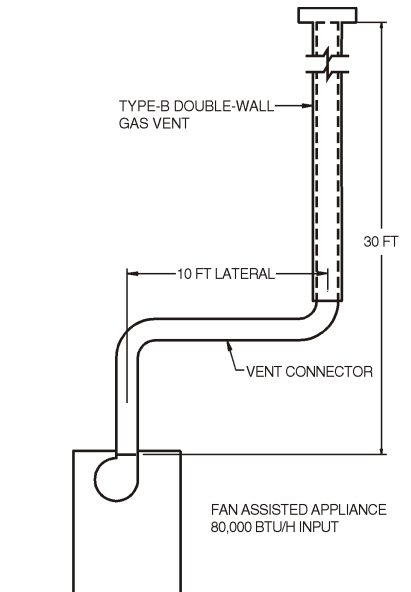
Principles of design of multistory vents using vent connector and common vent design tables (see Sections 504.3.11 through 504.3.17).

**FIGURE B-14  
MULTISTORY VENT SYSTEMS**



For SI: 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.

**FIGURE B-15 (EXAMPLE 1)**  
**SINGLE DRAFT-HOOD-EQUIPPED APPLIANCE**



For SI: 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.

**FIGURE B-16 (EXAMPLE 2)**  
**SINGLE FAN-ASSISTED APPLIANCE**

**Example 2: Single fan-assisted appliance**

An installer has an 80,000 Btu per hour input fan-assisted appliance that must be installed using 10 feet of lateral connector attached to a 30-foot-high Type B vent. Two 90-degree elbows are needed for the installation. Can a single-wall metal vent connector be used for this application?

**Solution:**

Table 504.2(2) refers to the use of single-wall metal vent connectors with Type B vent. In the first column find the row associated with a 30-foot height and a 10-foot lateral. Read across this row, looking at the FAN Min and FAN Max columns, to find that a 3-inch-diameter single-wall metal vent connector is not recommended. Moving to the next larger size single wall connector (4 inches), note that a 4-inch-diameter single-wall metal connector has a recommended minimum vent capacity of 91,000 Btu per hour and a recommended maximum vent capacity of 144,000 Btu per hour. The 80,000 Btu per hour fan-assisted appliance is outside this range, so the conclusion is that a single-wall metal vent connector cannot be used to vent this appliance using 10 feet of lateral for the connector.

However, if the 80,000 Btu per hour input appliance could be moved to within 5 feet of the vertical vent, then a 4-inch single-wall metal connector could be used to vent the appliance. Table 504.2(2) shows the acceptable range of vent capacities for a 4-inch vent with 5 feet of lateral to be between 72,000 Btu per hour and 157,000 Btu per hour.

If the appliance cannot be moved closer to the vertical vent, then Type B vent could be used as the connector material. In this case, Table 504.2(1) shows that for a 30-foot-high vent with 10 feet of lateral, the acceptable range of vent capacities for a 4-inch-diameter vent attached to a fan-assisted appliance is between 37,000 Btu per hour and 150,000 Btu per hour.

**Example 3: Interpolating between table values**

An installer has an 80,000 Btu per hour input appliance with a 4-inch-diameter draft hood outlet that needs to be vented into a 12-foot-high Type B vent. The vent connector has a 5-foot lateral length and is also Type B. Can this appliance be vented using a 4-inch-diameter vent?

**Solution:**

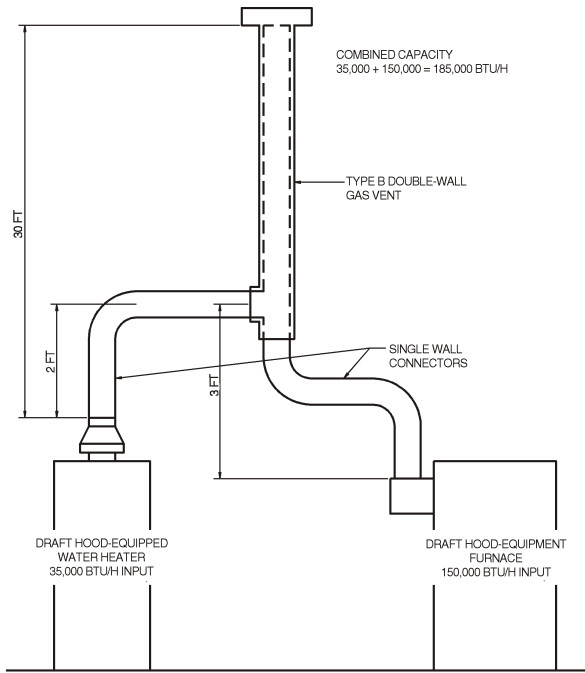
Table 504.2(1) is used in the case of an all Type B vent system. However, since there is no entry in Table 504.2(1) for a height of 12 feet, interpolation must be used. Read down the 4-inch diameter NAT Max column to the row associated with 10-foot height and 5-foot lateral to find the capacity value of 77,000 Btu per hour. Read further down to the 15-foot height, 5-foot lateral row to find the capacity value of 87,000 Btu per hour. The difference between the 15-foot height capacity value and the 10-foot height capacity value is 10,000 Btu per hour. The capacity for a vent system with a 12-foot height is equal to the capacity for a 10-foot height plus  $\frac{2}{5}$  of the difference between the 10-foot and 15-foot height values, or  $77,000 + \frac{2}{5}(10,000) = 81,000$  Btu per hour. Therefore, a 4-inch-diameter vent may be used in the installation.

**EXAMPLES USING COMMON VENTING TABLES**

**Example 4: Common venting two draft-hood-equipped appliances**

A 35,000 Btu per hour water heater is to be common vented with a 150,000 Btu per hour furnace using a common vent with a total height of 30 feet. The connector rise is 2 feet for the water heater with a horizontal length of 4 feet. The connector rise for the furnace is 3 feet with a horizontal length of 8 feet. Assume single-wall metal connectors will be used with Type B vent. What size connectors and combined vent should be used in this installation?





**FIGURE B-17 (EXAMPLE 4)  
COMMON VENTING TWO DRAFT-  
HOOD-EQUIPPED APPLIANCES**

**Solution:**

Table 504.3(2) should be used to size single-wall metal vent connectors attached to Type B vertical vents. In the vent connector capacity portion of Table 504.3(2), find the row associated with a 30-foot vent height. For a 2-foot rise on the vent connector for the water heater, read the shaded columns for draft-hood-equipped appliances to find that a 3-inch-diameter vent connector has a capacity of 37,000 Btu per hour. Therefore, a 3-inch single-wall metal vent connector may be used with the water heater. For a draft-hood-equipped furnace with a 3-foot rise, read across the appropriate row to find that a 5-inch-diameter vent connector has a maximum capacity of 120,000 Btu per hour (which is too small for the furnace) and a 6-inch-diameter vent connector has a maximum vent capacity of 172,000 Btu per hour. Therefore, a 6-inch-diameter vent connector should be used with the 150,000 Btu per hour furnace. Since both vent connector horizontal lengths are less than the maximum lengths listed in Section 504.3.2, the table values may be used without adjustments.

In the common vent capacity portion of Table 504.3(2), find the row associated with a 30-foot vent height and read over to the NAT + NAT portion of the 6-inch-diameter column to find a maximum combined capacity of 257,000 Btu per hour. Since the two appliances total only 185,000 Btu per hour, a 6-inch common vent may be used.

**Example 5a: Common venting a draft-hood-equipped water heater with a fan-assisted furnace into a Type B vent**

In this case, a 35,000 Btu per hour input draft-hood-equipped water heater with a 4-inch-diameter draft hood outlet, 2 feet of connector rise, and 4 feet of horizontal length is to be common vented with a 100,000 Btu per hour fan-assisted furnace with a 4-inch-diameter flue collar, 3 feet of connector rise, and 6 feet of horizontal length. The common vent consists of a 30-foot height of Type B vent. What are the recommended vent diameters for each connector and the common vent? The installer would like to use a single-wall metal vent connector.

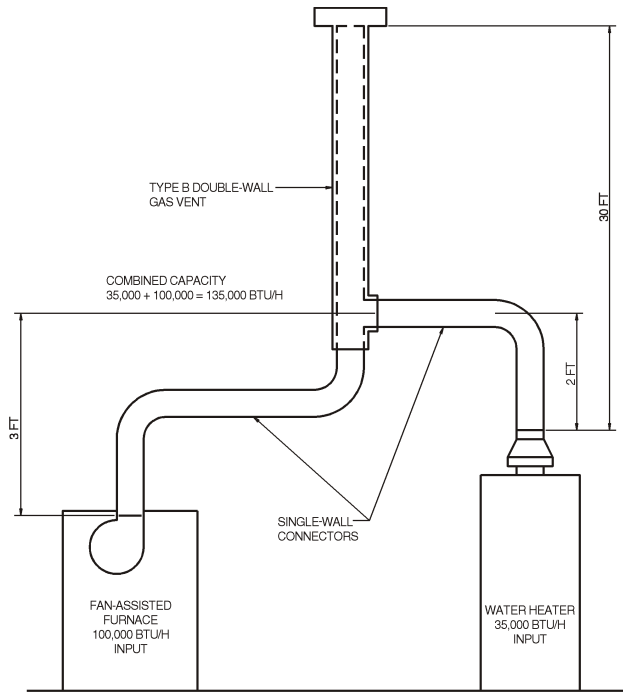
**Solution:** - [Table 504.3(2)]

**Water Heater Vent Connector Diameter.** Since the water heater vent connector horizontal length of 4 feet is less than the maximum value listed in Section 504.3.2, the venting table values may be used without adjustments. Using the Vent Connector Capacity portion of Table 504.3(2), read down the Total Vent Height (*H*) column to 30 feet and read across the 2-foot Connector Rise (*R*) row to the first Btu per hour rating in the NAT Max column that is equal to or greater than the water heater input rating. The table shows that a 3-inch vent connector has a maximum input rating of 37,000 Btu per hour. Although this is greater than the water heater input rating, a 3-inch vent connector is prohibited by Section 504.3.21. A 4-inch vent connector has a maximum input rating of 67,000 Btu per hour and is equal to the draft hood outlet diameter. A 4-inch vent connector is selected. Since the water heater is equipped with a draft hood, there are no minimum input rating restrictions.

**Furnace Vent Connector Diameter.** Using the Vent Connector Capacity portion of Table 504.3(2), read down the Total Vent Height (*H*) column to 30 feet and across the 3-foot Connector Rise (*R*) row. Since the furnace has a fan-assisted combustion system, find the first FAN Max column with a Btu per hour rating greater than the furnace input rating. The 4-inch vent connector has a maximum input rating of 119,000 Btu per hour and a minimum input rating of 85,000 Btu per hour. The 100,000 Btu per hour furnace in this example falls within this range, so a 4-inch connector is adequate. Since the furnace vent connector horizontal length of 6 feet does not exceed the maximum value listed in Section 504.3.2, the venting table values may be used without adjustment. If the furnace had an input rating of 80,000 Btu per hour, then a Type B vent connector [see Table 504.3(1)] would be needed in order to meet the minimum capacity limit.

**Common Vent Diameter.** The total input to the common vent is 135,000 Btu per hour. Using the Common Vent Capacity portion of Table 504.3(2), read down the Total Vent Height (*H*) column to 30 feet and across this row to find the smallest vent diameter in the FAN + NAT column that has a Btu per hour rating equal to or greater than 135,000 Btu per hour. The 4-inch common vent has a capacity of 132,000 Btu per hour and the 5-inch common vent has a capacity of 202,000 Btu per hour. Therefore, the 5-inch common vent should be used in this example.

**Summary.** In this example, the installer may use a 4-inch-diameter, single-wall metal vent connector for the water heater and a 4-inch-diameter, single-wall metal vent connector for the furnace. The common vent should be a 5-inch-diameter Type B vent.



**FIGURE B-18 (EXAMPLE 5A)**  
**COMMON VENTING A DRAFT HOOD WITH A FAN-ASSISTED FURNACE INTO A TYPE B DOUBLE-WALL COMMON VENT**

**Example 5b: Common venting into a masonry chimney**

In this case, the water heater and fan-assisted furnace of Example 5a are to be common vented into a clay tile-lined masonry chimney with a 30-foot height. The chimney is not exposed to the outdoors below the roof line. The internal dimensions of the clay tile liner are nominally 8 inches by 12 inches. Assuming the same vent connector heights, laterals, and materials found in Example 5a, what are the recommended vent connector diameters, and is this an acceptable installation?

**Solution:**

Table 504.3(4) is used to size common venting installations involving single-wall connectors into masonry chimneys.

**Water Heater Vent Connector Diameter.** Using Table 504.3(4), Vent Connector Capacity, read down the Total Vent Height (*H*) column to 30 feet, and read across the 2-foot Connector Rise (*R*) row to the first Btu per hour rating in the NAT Max column that is equal to or greater than the water heater input rating. The table shows that a 3-inch vent connector has a maximum input of only 31,000 Btu per hour while a 4-inch vent connector has a maximum input of 57,000 Btu per hour. A 4-inch vent connector must therefore be used.

**Furnace Vent Connector Diameter.** Using the Vent Connector Capacity portion of Table 504.3(4), read down the Total Vent Height (*H*) column to 30 feet and across the 3-foot Connector Rise (*R*) row. Since the furnace has a fan-assisted combustion system, find the first FAN Max column with a Btu per hour rating greater than the furnace input rating. The 4-inch

vent connector has a maximum input rating of 127,000 Btu per hour and a minimum input rating of 95,000 Btu per hour. The 100,000 Btu per hour furnace in this example falls within this range, so a 4-inch connector is adequate.

**Masonry Chimney.** From Table B-1, the equivalent area for a nominal liner size of 8 inches by 12 inches is 63.6 square inches. Using Table 504.3(4), Common Vent Capacity, read down the FAN + NAT column under the Minimum Internal Area of Chimney value of 63 to the row for 30-foot height to find a capacity value of 739,000 Btu per hour. The combined input rating of the furnace and water heater, 135,000 Btu per hour, is less than the table value, so this is an acceptable installation.

Section 504.3.17 requires the common vent area to be no greater than seven times the smallest listed appliance categorized vent area, flue collar area, or draft hood outlet area. Both appliances in this installation have 4-inch-diameter outlets. From Table B-1, the equivalent area for an inside diameter of 4 inches is 12.2 square inches. Seven times 12.2 equals 85.4, which is greater than 63.6, so this configuration is acceptable.

**Example 5c: Common venting into an exterior masonry chimney**

In this case, the water heater and fan-assisted furnace of Examples 5a and 5b are to be common vented into an exterior masonry chimney. The chimney height, clay tile liner dimensions, and vent connector heights and laterals are the same as in Example 5b. This system is being installed in Charlotte, North Carolina. Does this exterior masonry chimney need to be relined? If so, what corrugated metallic liner size is recommended? What vent connector diameters are recommended?

**Solution:**

According to Section 504.3.20, Type B vent connectors are required to be used with exterior masonry chimneys. Use Table 504.3(8) to size FAN+NAT common venting installations involving Type-B double wall connectors into exterior masonry chimneys.

The local 99-percent winter design temperature needed to use Table 504.3(8) can be found in the ASHRAE *Handbook of Fundamentals*. For Charlotte, North Carolina, this design temperature is 19°F.

**Chimney Liner Requirement.** As in Example 5b, use the 63 square inch Internal Area columns for this size clay tile liner. Read down the 63 square inch column of Table 504.3(8a) to the 30-foot height row to find that the combined appliance maximum input is 747,000 Btu per hour. The combined input rating of the appliances in this installation, 135,000 Btu per hour, is less than the maximum value, so this criterion is satisfied. Table 504.3(8b), at a 19°F design temperature, and at the same vent height and internal area used above, shows that the minimum allowable input rating of a space-heating appliance is 470,000 Btu per hour. The furnace input rating of 100,000 Btu per hour is less than this minimum value. So this criterion is not satisfied, and an alternative venting design needs to be used, such as a Type B vent shown in Example 5a or a listed chimney liner system shown in the remainder of the example.

According to Section 504.3.17, Table 504.3(1) or 504.3(2) is used for sizing corrugated metallic liners in masonry chimneys, with the maximum common vent capacities reduced by 20 percent. This example will be continued assuming Type B vent connectors.

**Water Heater Vent Connector Diameter.** Using Table 504.3(1), Vent Connector Capacity, read down the Total Vent Height (*H*) column to 30 feet, and read across the 2-foot Connector Rise (*R*) row to the first Btu/h rating in the NAT Max column that is equal to or greater than the water heater input rating. The table shows that a 3-inch vent connector has a maximum capacity of 39,000 Btu/h. Although this rating is greater than the water heater input rating, a 3-inch vent connector is prohibited by Table 504.3.21. A 4-inch vent connector has a maximum input rating of 70,000 Btu/h and is equal to the draft hood outlet diameter. A 4-inch vent connector is selected.

**Furnace Vent Connector Diameter.** Using Table 504.3(1), Vent Connector Capacity, read down the Vent Height (*H*) column to 30 feet, and read across the 3-foot Connector Rise (*R*) row to the first Btu per hour rating in the FAN Max column that is equal to or greater than the furnace input rating. The 100,000 Btu per hour furnace in this example falls within this range, so a 4-inch connector is adequate.

**Chimney Liner Diameter.** The total input to the common vent is 135,000 Btu per hour. Using the Common Vent Capacity Portion of Table 504.3(1), read down the Vent Height (*H*) column to 30 feet and across this row to find the smallest vent diameter in the FAN+NAT column that has a Btu per hour rating greater than 135,000 Btu per hour. The 4-inch common vent has a capacity of 138,000 Btu per hour. Reducing the maximum capacity by 20 percent (Section 504.3.17) results in a maximum capacity for a 4-inch corrugated liner of 110,000 Btu per hour, less than the total input of 135,000 Btu per hour. So a larger liner is needed. The 5-inch common vent capacity listed in Table 504.3(1) is 210,000 Btu per hour, and after reducing by 20 percent is 168,000 Btu per hour. Therefore, a 5-inch corrugated metal liner should be used in this example.

**Single-Wall Connectors.** Once it has been established that relining the chimney is necessary, Type B double-wall vent connectors are not specifically required. This example could be redone using Table 504.3(2) for single-wall vent connectors. For this case, the vent connector and liner diameters would be the same as found above with Type B double-wall connectors.

**TABLE B-1  
MASONRY CHIMNEY LINER DIMENSIONS  
WITH CIRCULAR EQUIVALENTS<sup>a</sup>**

NOMINAL LINER SIZE (inches)	INSIDE DIMENSIONS OF LINER (inches)	INSIDE DIAMETER OR EQUIVALENT DIAMETER (inches)	EQUIVALENT AREA (square inches)
4 × 8	2½ × 6½	4	12.2
		5	19.6
		6	28.3
		7	38.3
8 × 8	6¾ × 6¾	7.4	42.7
		8	50.3
8 × 12	6½ × 10½	9	63.6
		10	78.5
12 × 12	9¾ × 9¾	10.4	83.3
		11	95
12 × 16	9½ × 13½	11.8	107.5
		12	113.0
		14	153.9
16 × 16	13¼ × 13¼	14.5	162.9
		15	176.7
16 × 20	13 × 17	16.2	206.1
		18	254.4
20 × 20	16¾ × 16¾	18.2	260.2
		20	314.1
20 × 24	16½ × 20½	20.1	314.2
		22	380.1
24 × 24	20¼ × 20¼	22.1	380.1
		24	452.3
24 × 28	20¼ × 20¼	24.1	456.2
		26.4	543.3
28 × 28	24¼ × 24¼	27	572.5
		27.9	607
30 × 30	25½ × 25½	30	706.8
		30.9	749.9
30 × 36	25½ × 31½	33	855.3
		34.4	929.4
36 × 36	31½ × 31½	36	1017.9

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm<sup>2</sup>.

a. Where liner sizes differ dimensionally from those shown in Table B-1, equivalent diameters may be determined from published tables for square and rectangular ducts of equivalent carrying capacity or by other engineering methods.

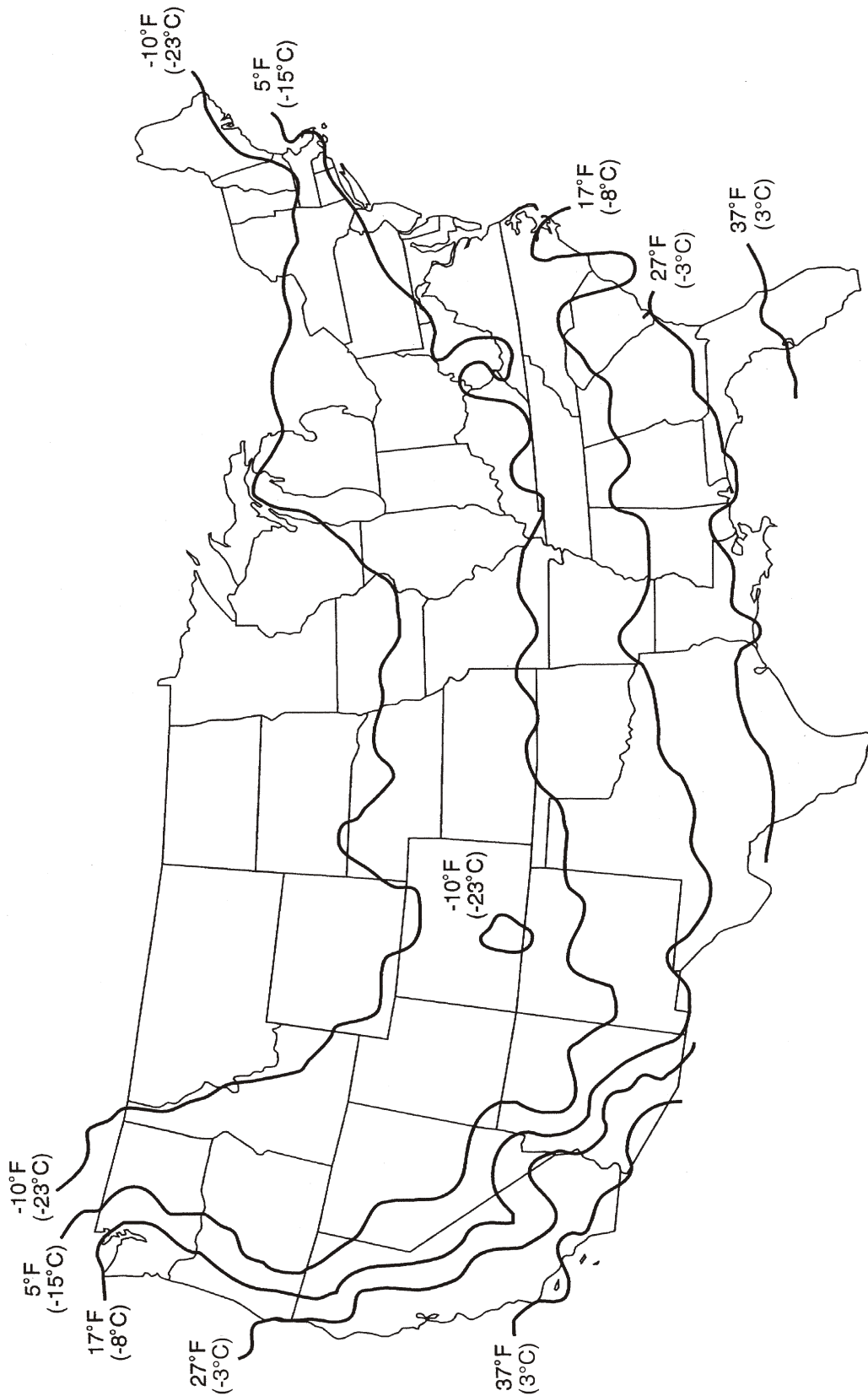


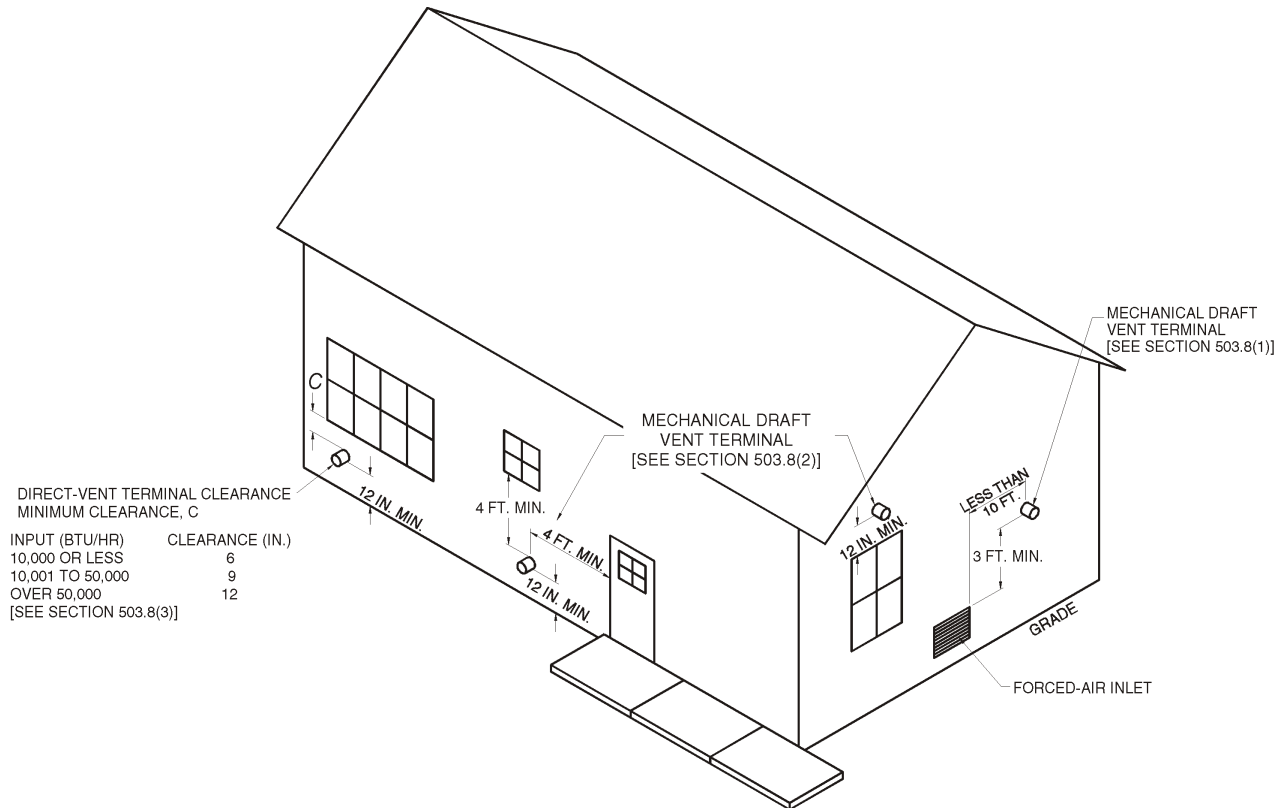
FIGURE B-19



## APPENDIX C (IFGS)

# EXIT TERMINALS OF MECHANICAL DRAFT AND DIRECT-VENT VENTING SYSTEMS

(This appendix is informative and is not part of the code.)



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 British thermal unit per hour = 0.2931 W.

## APPENDIX C EXIT TERMINALS OF MECHANICAL DRAFT AND DIRECT-VENT VENTING SYSTEMS



## APPENDIX D (IFGS)

# RECOMMENDED PROCEDURE FOR SAFETY INSPECTION OF AN EXISTING APPLIANCE INSTALLATION

(This appendix is informative and is not part of the code.)

The following procedure is intended as a guide to aid in determining that an appliance is properly installed and is in a safe condition for continuing use.

This procedure is predicated on central furnace and boiler installations, and it should be recognized that generalized procedures cannot anticipate all situations. Accordingly, in some cases, deviation from this procedure is necessary to determine safe operation of the equipment.

- (a) This procedure should be performed prior to any attempt at modification of the appliance or of the installation.
- (b) If it is determined there is a condition that could result in unsafe operation, the appliance should be shut off and the owner advised of the unsafe condition. The following steps should be followed in making the safety inspection:
  1. Conduct a test for gas leakage. (See Section 406.6)
  2. Visually inspect the venting system for proper size and horizontal pitch and determine there is no blockage or restriction, leakage, corrosion, and other deficiencies that could cause an unsafe condition.
  3. Shut off all gas to the appliance and shut off any other fuel-gas-burning appliance within the same room. **Use the shutoff valve in the supply line to each appliance.**
  4. Inspect burners and crossovers for blockage and corrosion.
  5. **Applicable only to furnaces.** Inspect the heat exchanger for cracks, openings, or excessive corrosion.
  6. **Applicable only to boilers.** Inspect for evidence of water or combustion product leaks.
  7. Insofar as is practical, close all building doors and windows and all doors between the space in which the appliance is located and other spaces of the building. Turn on clothes dryers. Turn on any exhaust fans, such as range hoods and bathroom exhausts, so they will operate at maximum speed. Do not operate a summer exhaust fan. Close fireplace dampers. If, after completing Steps 8 through 13, it is believed sufficient combustion air is not available, refer to Section 304 of this code for guidance.
  8. Place the appliance being inspected in operation. **Follow the lighting instructions.** Adjust the thermostat so appliance will operate continuously.
  9. Determine that the pilot(s), where provided, is burning properly and that the main burner ignition is satisfactory by interrupting and reestablishing the electrical supply to the appliance in any convenient manner. If the appliance is equipped with a continuous pilot(s), test the pilot safety device(s) to determine if it is operating properly by extinguishing the pilot(s) when the main burner(s) is off and determining, after 3 minutes, that the main burner gas does not flow upon a call for heat. If the appliance is not provided with a pilot(s), test for proper operation of the ignition system in accordance with the appliance manufacturer's lighting and operating instructions.
  10. Visually determine that the main burner gas is burning properly (i.e., no floating, lifting, or flashback). Adjust the primary air shutter(s) as required. If the appliance is equipped with high and low flame controlling or flame modulation, check for proper main burner operation at low flame.
  11. Test for spillage at the draft hood relief opening after 5 minutes of main burner operation. Use a flame of a match or candle or smoke.
  12. Turn on all other fuel-gas-burning appliances within the same room so they will operate at their full inputs. **Follow lighting instructions for each appliance.**
  13. Repeat Steps 10 and 11 on the appliance being inspected.
  14. Return doors, windows, exhaust fans, fireplace dampers, and any other fuel-gas-burning appliance to their previous conditions of use.
  15. **Applicable only to furnaces.** Check both the limit control and the fan control for proper operation. Limit control operation can be checked by blocking the circulating air inlet or temporarily disconnecting the electrical supply to the blower motor and determining that the limit control acts to shut off the main burner gas.



16. **Applicable only to boilers.** Determine that the water pumps are in operating condition. Test low water cutoffs, automatic feed controls, pressure and temperature limit controls, and relief valves in accordance with the manufacturer's recommendations to determine that they are in operating condition.

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