City of Sherwood Oregon

Ordinance 2002-1134

AN ORDINANCE ADOPTING RECENT CHANGES TO THE STATE OF OREGON MECHANICAL SPECIALTY CODE

WHEREAS, the City of Sherwood currently regulates the Mechanical Specialty Code as adopted by the State of Oregon, previously adopted by Ordinance 98-1057; and

WHEREAS, the State of Oregon has adopted an update to the Mechanical Specialty Code effective October 1, 2002; and

WHEREAS, this Ordinance shall amend and establish those changes adopted by the State into the local building code for the City of Sherwood;

NOW, THEREFORE, THE CITY RESOLVES AS FOLLOWS:

Section 1: Ordinance 98-1057 is hereby amended to include the State of Oregon 2002 Edition of the Mechanical Specialty Code, effective October 1, 2002, attached hereto as Exhibit A, and hereby APPROVED AND ADOPTED in its entirety, superseding all prior adopted versions of the Mechanical Specialty Code.

Section 2: Because it is necessary to have standardized specifications for construction, whether the construction be pursuant to public contract, or to private development, in place to protect the interest of public health, safety and welfare, an emergency is hereby declared to exist and this Ordinance shall be effective upon its approval and adoption by the City Council and the Mayor.

Duly passed by the City Council this 22nd day of October 2002.

Mark Cottle, Mayor

Attest:

C.L. Wiley, City Recorder

	AYE	NAY
Heironimus	✓	
Durrell	✓	
Claus	absent	
Mays	✓	
Fox	✓	
Cottle	✓	

STATE OF OREGON
2002 EDITION

Mechanical Specialty Code

Effective October 1, 2002
Authorized by ORS 455.010 through 455.897

Based on the

2000 INTERNATIONAL MECHANICAL CODE®

Item No. 10302K

STATE OF OREGON
2002 EDITION

Mechanical Specialty Code

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State of Oregon Mechanical Specialty Code
2002 Edition

Publication Date: July, 2002

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PREFACE

Introduction

Internationally, code officials recognize the need for a modern, up-to-date mechanical code addressing the design and installation of mechanical and fuel gas systems through requirements emphasizing performance. The *International Mechanical Code®*, in this third 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 mechanical code establishes minimum regulations for mechanical and fuel gas systems using prescriptive and performance-related provisions. It is founded on broad-based principles that make possible the use of new materials and new mechanical and fuel gas designs. Additionally, the *International Mechanical Code* is designed to be compatible with the entire family of *International Codes* published by the International Code Council.

The *International Mechanical Code* provides many benefits, among which is the model code development process that offers an international forum for mechanical 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 Mechanical Code* was published in 1996 after an extensive process of selection, coordination and arrangement of numerous considerations and initial preparations by a development committee appointed by and consisting of representatives of BOCA, ICBO and SBCCI. The intent was to draft a comprehensive set of regulations for mechanical systems consistent with and inclusive of the scope and content of the existing model mechanical codes which incorporate the common mechanical code format established by the Council of American Building Officials. This format establishes the title, scope, and sequence of the chapters and does not involve the order or content of the provisions within the chapter.

Technical content of the latest mechanical codes promulgated by BOCA, ICBO and SBCCI was utilized as the basis for the development of this code. While there were a great many similarities among the three codes, careful consideration was given to identified differences. The principles utilized in the original development of this code were based on the intent to establish provisions consistent with the scope of a mechanical 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. This third edition incorporates approved changes to the 1998 edition from the 1998 and 1999 ICC Code Development Cycles.

Marginal Markings

Solid vertical lines in the margins within the body of the code indicate a change from the requirements of the 1998 edition except where a change was minor. Deletion indicators (◆) are provided in the margin where a paragraph or item listing has been deleted if the deletion resulted in a change of requirements. ≻ indicates IMC and IFGC model code language deleted by Oregon. ‖ in the margin indicates an Oregon amendment to model code language. Appendix C is IFGC model code language with some modification by Oregon. Minor changes, such as section renumbering and removal of references to international codes are not indicated with a ‖ in the margin.

Adoption

The *International Mechanical 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 code and in the sample adoption 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 Mechanical Code* is kept up to date through the review of proposed changes submitted by code enforcement 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 contents of this work are subject to change both through the Code Development Cycles and the governmental body that enacts the code into law. For more information regarding the code development process, contact: BOCA, ICBO or SBCCI.

While the development procedure of the *International Mechanical Code* assures the highest degree of care, BOCA, ICBO, SBCCI, 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 BOCA, ICBO and SBCCI 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.

SAMPLE ORDINANCE FOR ADOPTION OF THE *INTERNATIONAL MECHANICAL CODE*

ORDINANCE NO. _____

An ordinance of the [JURISDICTION] adopting the 2000 edition of the *International Mechanical Code,* regulating and controlling the design, construction, quality of materials, erection, installation, alteration, repair, location, relocation, replacement, addition to, use or maintenance of mechanical systems in the [JURISDICTION]; providing for the issuance of permits and collection of fees therefore; 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 certain documents, three (3) copies of which are on file in the office of the [JURISDICTION'S KEEPER OF RECORDS] and the [JURISDICTION], being marked and designated as *International Mechanical Code,* including Appendix Chapters [fill in the applicable Appendix Chapters. (See *International Mechanical Code* Section 101.2.1, 2000 edition)], as published by the International Code Council, be and is hereby adopted as the code of the [JURISDICTION] for regulating the design, construction, quality of materials, erection, installation, alteration, repair, location, relocation, replacement, addition to, use or maintenance of mechanical systems in the [JURISDICTION] and providing for the issuance of permits and collection of fees therefore; and each and all of the regulations, provisions, conditions and terms of such *International Mechanical Code,* 2000 edition, published by the International Code Council, 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.

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: **[OFFENSE, DOLLAR AMOUNT, NUMBER OF DAYS]**

Section 108.5. Insert: **[DOLLAR AMOUNT IN TWO LOCATIONS]**

Chapter 15, Codes. Insert: **[NAMES OF CODES IN TWO LOCATIONS]**

Section 3. That Ordinance No. _____ of [JURISDICTION] entitled *(fill in here the complete title of the present mechanical 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 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 6. 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.

TABLE OF CONTENTS

CHAPTER 1
ADMINISTRATION

SECTION 101
GENERAL

101.1 Title. These regulations shall be known as the *Oregon Mechanical Specialty Code*, hereinafter referred to as "this code."

101.2 Scope. This code shall regulate the design, installation, alteration and inspection of mechanical systems that are permanently installed and utilized to provide control of environmental conditions and related processes within buildings. This code shall also regulate those mechanical systems, system components, equipment and appliances specifically addressed herein. The installation of fuel gas distribution piping and equipment, fuel gas-fired appliances and fuel gas-fired appliance venting systems are found in Appendix C.

Exception: Detached one- and two-family dwellings not more than three stories high and separate means of egress and their accessory structures shall comply with the *One- and Two-family Dwelling Specialty Code.*

ORS 455.020(1) is not part of this code but is reproduced here for the reader's convenience:

455.020 Purpose; scope of application. (1) This chapter is enacted to enable the Director of the Department of Consumer and Business Services to promulgate a state building code to govern the construction, reconstruction, alteration and repair of buildings and other structures and the installation of mechanical devices and equipment therein, and to require the correction of unsafe conditions caused by earthquakes in existing buildings. The state building code shall establish uniform performance standards providing reasonable safeguards for health, safety, welfare, comfort and security of the residents of this state who are occupants and users of buildings, and will provide for the use of modern methods, devices, materials, techniques and practicable maximum energy conservation.

101.2.1 Appendices. The State of Oregon does not adopt Appendices A and B. Appendix C is adopted.

Statutory Reference. This code is adopted pursuant to Oregon Revised Statutes. Where in any specific case this code and the statute specify different requirements, the statute shall govern. Statutes related to this code are ORS 455.010 through 455.897. Statutes referenced may be found on the Web at http://www.oregon.bcd or obtained from the Building Codes Division, PO Box 14470, Salem OR 97309-0404.

101.3 Intent. 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 and location of mechanical systems.

101.4 Severability. If a section, subsection, sentence, clause or phrase of this code is, for any reason, held to be invalid, such decision shall not affect the validity of the remaining portions of this code.

SECTION 102
APPLICABILITY

102.1 General. The provisions of this code shall apply to all matters affecting or relating to structures and premises, as set forth in Section 101. Where, in a specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern. Requirements for equipment and systems in detached one- and two-family dwellings, three stories and less, are found in the *One- and Two-Family Dwelling Specialty Code.*

NOTE: Boilers and pressure vessels are also regulated by the State of Oregon Boiler and Pressure Vessel Law (ORS 480.510 to 480.670).

102.2 Existing installations. Except as otherwise provided for in this chapter, a provision in this code shall not require the removal, alteration or abandonment of, nor prevent the continued utilization and maintenance of, an existing mechanical system lawfully in existence at the time of the adoption of this code.

NOTE: Section 102.3 is not adopted by the State of Oregon.

102.3 Maintenance. Mechanical systems, both existing and new, and parts thereof shall be maintained in proper operating condition in accordance with the original design and in a safe and sanitary condition. Devices or safeguards which are required by this code shall be maintained in compliance with the code edition under which installed. The owner or the owner's designated agent shall be responsible for maintenance of mechanical systems. To determine compliance with this provision, the code official shall have the authority to require a mechanical system to be reinspected.

102.4 Additions, alterations or repairs. Additions, alterations, renovations or repairs to a mechanical system shall conform to that required for a new mechanical system without requiring the existing mechanical system to comply with all of the requirements of this code. Additions, alterations or repairs shall not cause an existing mechanical system to become unsafe, hazardous or overloaded.

Minor additions, alterations, renovations and repairs to existing mechanical systems shall meet the provisions for new construction, unless such work is done in the same manner and arrangement as was in the existing system, is not hazardous and is approved.

102.5 Change in occupancy. No change shall be made in the occupancy of any structure which will subject the structure to any special provision of this code applicable to the new occupancy without approval. The code official shall certify that such structure meets the intent of the provisions of the *Oregon Structural Specialty Code.*

102.6 Historic buildings. The provisions of this code relating to the construction, alteration, repair, enlargement, restoration, relocation or moving of buildings or structures shall not be mandatory for existing buildings or structures identified and

classified by the state or local jurisdiction as historic buildings when such buildings or structures are judged by the code official to be safe and in the public interest of health, safety and welfare regarding any proposed construction, alteration, repair, enlargement, restoration, relocation or moving of buildings.

102.7 Moved buildings. Except as determined by Section 102.2, mechanical systems that are a part of buildings or structures moved into or within the jurisdiction shall comply with the provisions of this code for new installations. See ORS 455.410 for moved buildings.

ORS 455.410 is not a part of this code but is reproduced here for the reader's convenience:

455.410 Relocated buildings, substantial compliance required; permits. (1) Existing buildings or structures which are removed from their foundation and relocated to another site within this state shall be in substantial compliance as defined in subsections (2) and (3) of this section.

(2) "Substantial compliance" means compliance with local construction codes in effect as of the original permit date of the building or structure, or where there was no permitting required at the time of original construction, with basic health and safety standards, as described in the closest dated *Uniform Housing Code*, as published by the International Conference of Building Officials as of the date of construction. Only the insulation, overhead and underneath the structure, shall be upgraded to the current insulation requirements of the state building code, or to the maximum extent possible subject to the design of the structure. Nothing in this statute shall be construed to mean that all heating, plumbing and electrical systems shall be replaced with systems meeting current standards for new construction, except that any life-threatening deficiencies in those systems shall be repaired, notwithstanding that the cost of rehabilitation may exceed 50 percent of the value of the structure before rehabilitation.

(3) All foundation and basement construction on the structure and any remodeling at the new location shall be constructed subject to all applicable local current building and safety codes, or where none exist, with the applicable standards as described in the *Uniform Housing Code* described in subsection (2) of this section.

(4) All moved houses shall be provided with either battery-operated or hard-wired smoke detection devices located in accordance with the provisions of the state building code.

(5) Nothing in this section is intended to permit any person to move a structure unless the person first consults with the appropriate building inspection authority and obtains all required permits.

102.8 Referenced standards. The standards referenced herein shall be those that are listed in Chapter 15 and such standards shall be considered as part of the requirements of this code to the prescribed extent of each such reference. Where differences occur between provisions of this code and the referenced standards, the provisions of this code shall apply.

NOTE: Section 102.9 is not adopted by the State of Oregon.

102.9 Requirements not covered by this code. Requirements necessary for the strength, stability or proper operation of an existing or proposed mechanical system, or for the public safety, health and general welfare, not specifically covered by this code, shall be determined by the code official.

NOTE: Section 103 is not adopted by the State of Oregon.

SECTION 103
DEPARTMENT OF MECHANICAL INSPECTION

103.1 General. The department of mechanical inspection is hereby created and the executive official in charge thereof shall be known as the code official.

103.2 Appointment. The code official shall be appointed by the chief appointing authority of the jurisdiction; and the code official shall not be removed from office except for cause and after full opportunity to be heard on specific and relevant charges by and before the appointing authority.

103.3 Deputies. In accordance with the prescribed procedures of this jurisdiction and with the concurrence of the appointing authority, the code official shall have the authority to appoint a deputy code official, other related technical officers, inspectors and other employees.

103.4 Liability. The code official, officer or employee charged with the enforcement of this code, while acting for the jurisdiction, shall not thereby be rendered liable personally, and is hereby relieved from all personal liability for any damage accruing to persons or property as a result of an act required or permitted in the discharge of official duties.

Any suit instituted against any officer or employee because of an act performed by that officer or employee in the lawful discharge of duties and under the provisions of this code shall be defended by the legal representative of the jurisdiction until the final termination of the proceedings. The code official or any subordinate shall not be liable for costs in an action, suit or proceeding that is instituted in pursuance of the provisions of this code; and any officer of the department of mechanical inspection, acting in good faith and without malice, shall be free from liability for acts performed under any of its provisions or by reason of any act or omission in the performance of official duties in connection therewith.

SECTION 104
DUTIES AND POWERS OF THE CODE OFFICIAL

104.1 General. The code official shall enforce the provisions of this code and shall act on any question relative to the installation, alteration or repair of mechanical systems, except as otherwise specifically provided for by statutory requirements.

NOTE: Section 104.2 is not adopted by the State of Oregon.

104.2 Rule-making authority. The code official shall have authority as necessary in the interest of public health, safety and general welfare, to adopt and promulgate rules and regulations; to interpret and implement the provisions of this code; to secure the intent thereof; and to designate requirements applicable because of local climatic or other conditions. Such rules shall not have the effect of waiving structural or fire performance requirements specifically provided for in this code, or of violating accepted engineering methods involving public safety.

104.3 Applications and permits. The code official shall receive applications and issue permits for the installation and alteration of mechanical systems, inspect the premises for which such permits have been issued and enforce compliance with the provisions of this code.

104.4 Inspections. The code official shall make all of the required inspections. All reports of such inspections shall be in writing and be certified by a responsible officer of such approved agency or by the responsible individual.

104.5 Right of entry. Whenever it is necessary to make an inspection to enforce the provisions of this code, or whenever the

code official has reasonable cause to believe that there exists in a building or upon any premises any conditions or violations of this code which make the building or premises unsafe, insanitary, dangerous or hazardous, the code official shall have the authority to enter the building or premises at all reasonable times to inspect or to perform the duties imposed upon the code official by this code. If such building or premises is occupied, the code official shall present credentials to the occupant and request entry. If such building or premises is unoccupied, the code official shall first make a reasonable effort to locate the owner or other person having charge or control of the building or premises and request entry. If entry is refused, the code official has recourse to every remedy provided by law to secure entry.

When the code official has first obtained a proper inspection warrant or other remedy provided by law to secure entry, an owner or occupant or person having charge, care or control of the building or premises shall not fail or neglect, after proper request is made as herein provided, to promptly permit entry therein by the code official for the purpose of inspection and examination pursuant to this code.

104.6 Identification. The code official shall carry proper identification when inspecting structures or premises in the performance of duties under this code.

104.7 Notices and orders. The code official shall issue all necessary notices or orders to ensure compliance with this code.

104.8 Department records. The code official shall keep official records of applications received, permits and certificates issued, fees collected, reports of inspections, and notices and orders issued. Such records shall be retained in the official records as long as the building or structure to which such records relate remains in existence, unless otherwise provided for by other regulations.

SECTION 105
APPROVAL

NOTE: ORS 455.060 provides for state rulings on acceptable materials, design and methods of construction. When a ruling has been issued, ORS 455.060(4) applies.

ORS 455.060(4) is not part of this code but is reproduced here for the reader's convenience:

455.060 Rulings on acceptability of material, design or method of construction; effect of approval.

(4) A building official or inspector shall approve the use of any material, design or method of construction approved by the director pursuant to this section if the requirement of all other local ordinances are satisfied.

105.1 Modifications. Whenever there are practical difficulties involved in carrying out the provisions of this code, the code official shall have the authority to grant modifications for individual cases, provided the code official shall first find that special individual reason makes the strict letter of this code impractical and the modification is in compliance with the intent and purpose of this code and that such modification does not lessen health, life and fire safety requirements. The details of action granting modifications shall be recorded and entered in the files of the mechanical inspection department.

105.2 Alternative materials, methods, equipment and applicances. The provisions of this code are not intended to prevent the installation of any material or to prohibit any method of construction not specifically prescribed by this code, provided that any such alternative has been approved. An alternative material or method of construction shall be approved where the code official finds that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, at least the equivalent of that prescribed in this code in quality, strength, effectiveness, fire resistance, durability and safety.

105.3 Required testing. Whenever there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the code official shall have the authority to require tests as evidence of compliance to be made at no expense to the jurisdiction.

105.3.1 Test methods. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the code official shall approve the testing procedures.

105.3.2 Testing agency. All tests shall be performed by an approved agency.

105.3.3 Test reports. Reports of tests shall be retained by the code official for the period required for retention of public records.

105.4 Material equipment and appliance reuse. Materials, equipment, appliances and devices shall not be reused unless such elements have been reconditioned, tested and placed in good and proper working condition and approved.

SECTION 106
PERMITS

NOTE: Unless amended by a municipality, under authority of ORS 455.020, the following shall apply.

106.1 When required. An owner, authorized agent or contractor who desires to erect, install, enlarge, alter, repair, remove, convert or replace a mechanical system, the installation of which is regulated by this code, or to cause such work to be done, shall first make application to the code official and obtain the required permit for the work.

Exception: Where equipment and appliance replacements or repairs must be performed in an emergency situation, the permit application shall be submitted within the next working business day of the department of mechanical inspection.

106.2 Permits not required. Permits shall not be required for the following:

1. Portable heating appliances;
2. Portable ventilation appliances and equipment;
3. Portable cooling units;
4. Steam, hot water or chilled water piping within any heating or cooling equipment or appliances regulated by this code;

5. The replacement of any minor part that does not alter the approval of equipment or an appliance or make such equipment or appliance unsafe;
6. Portable evaporative coolers; and
7. Self-contained refrigeration systems that contain 10 pounds (4.5 kg) or less of refrigerant, or that are actuated by motors of 1 horsepower (0.75 kW) or less.

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

NOTE: Unless amended by a municipality, under authority of ORS 455.020, the following shall apply.

106.3 Application for permit. Each application for a permit, with the required fee, shall be filed with the code official on a form furnished for that purpose and shall contain a general description of the proposed work and its location. The application shall be signed by the owner or an authorized agent. The permit application shall indicate the proposed occupancy of all parts of the building and of that portion of the site or lot, if any, not covered by the building or structure and shall contain such other information required by the code official.

Exception: For those inspecting jurisdictions that may have adopted a master permit and/or minor label program under OAR Chapter 918, Division 100, different requirements may also apply.

106.3.1 Construction documents. Construction documents, engineering calculations, diagrams and other data shall be submitted in two or more sets with each application for a permit. The code official shall require construction documents, computations and specifications to be prepared and designed by a registered design professional when required by state law. Construction documents shall be drawn to scale and shall be of sufficient clarity to indicate the location, nature and extent of the work proposed and show in detail that the work conforms to the provisions of this code. Construction documents for buildings more than two stories in height shall indicate where penetrations will be made for mechanical systems.

Exception: The code official shall have the authority to waive the submission of construction documents, calculations or other data if the nature of the work applied for is such that reviewing of construction documents is not necessary to determine compliance with this code.

NOTE: Unless amended by a municipality, under authority of ORS 455.020, the following shall apply.

106.4 Permit issuance. The application, construction documents and other data filed by an applicant for a permit shall be reviewed by the code official. If the code official finds that the proposed work conforms to the requirements of this code and all laws and ordinances applicable thereto, and that the fees specified in Section 106.5 have been paid, a permit shall be issued to the applicant.

NOTE: For those inspecting jurisdictions that may have adopted a master permit and/or minor label program, different requirements may also apply.

106.4.1 Approved construction documents. When the code official issues the permit where construction documents are required, the construction documents shall be endorsed in writing and stamped "APPROVED." Such approved construction documents shall not be changed, modified or altered without authorization from the code official. Work shall be done in accordance with the approved construction documents.

The code official shall have the authority to issue a permit for the construction of a part of a mechanical system before the construction documents for the entire system have been submitted or approved, provided adequate information and detailed statements have been filed complying with all pertinent requirements of this code. The holder of such permit shall proceed at his or her own risk without assurance that the permit for the entire mechanical system will be granted.

106.4.2 Validity. The issuance of a permit or approval of construction documents shall not be construed to be a permit for, or an approval of, any violation of any of the provisions of this code or of other ordinances of the jurisdiction. A permit presuming to give authority to violate or cancel the provisions of this code shall be invalid.

The issuance of a permit based upon construction documents and other data shall not prevent the code official from thereafter requiring the correction of errors in said construction documents and other data or from preventing building operations from being carried on thereunder when in violation of this code or of other ordinances of this jurisdiction.

106.4.3 Expiration. Every permit issued by the code official under the provisions of this code shall expire by limitation and become null and void if the work authorized by such permit is not commenced within 180 days from the date of such permit, or if the work authorized by such permit is suspended or abandoned at any time after the work is commenced for a period of 180 days. Before such work recommences, a new permit shall be first obtained and the fee, therefore, shall be one-half the amount required for a new permit for such work, provided no changes have been made or will be made in the original construction documents for such work, and provided further that such suspension or abandonment has not exceeded one year.

106.4.4 Extensions. A permittee holding an unexpired permit shall have the right to apply for an extension of the time within which the permittee will commence work under that permit when work is unable to be commenced within the time required by this section for good and satisfactory reasons. The code official shall extend the time for action by the permittee for a period not exceeding 180 days if there is reasonable cause. A permit shall not be extended more than once. The fee for an extension shall be one-half the amount required for a new permit for such work.

106.4.5 Suspension or revocation of permit. The code official shall revoke a permit or approval issued under the provisions of this code in case of any false statement or misrepresentation of fact in the application or on the construction documents upon which the permit or approval was based.

106.4.6 Retention of construction documents. One set of construction documents shall be retained by the code official

until final approval of the work covered therein. One set of approved construction documents shall be returned to the applicant, and said set shall be kept on the site of the building or job at all times during which the work authorized thereby is in progress.

NOTE: Unless amended by a municipality, under authority of ORS 455.020 and 455.210, the following shall apply.

106.5 Fees. A permit shall not be issued until the fees prescribed in Section 106.5.2 have been paid, nor shall an amendment to a permit be released until the additional fee, if any, due to an increase of the mechanical system, has been paid.

106.5.1 Work commencing before permit issuance. Any person who commences work on a mechanical system before obtaining the necessary permits shall be subject to 100 percent of the usual permit fee in addition to the required permit fees.

106.5.2 Fee schedule. The fees for mechanical work shall be as indicated in the following schedule.

NOTE: Mechanical permit fees are adopted as fees for the Building Codes Division as required by ORS 455.210. Oregon municipalities may adopt their own fees according to ORS 455.150 and 455.210.

TABLE 1-A
MECHANICAL PERMIT FEES

PERMIT ISSUANCE	
1. For the issuance of each permit	$13.00
2. For issuing each supplemental permit	3.90
UNIT FEE SCHEDULE	
1. For the installation or relocation of each forced-air or gravity-type furnace or burner, including ducts and vents attached to such appliance, up to and including 100,000 btu/h (29.3 kW)	7.80
2. For the installation or relocation of each forced-air or gravity-type furnace or burner, including ducts and vents attached to such appliance over 100,000 Btu/h (29.3 kW)	9.75
3. For the installation or relocation of each floor furnace, including vent	7.80
4. For the installation or relocation of each suspended heater, recessed wall heater or floor-mounted unit heater	7.80
5. For the installation, relocation or replacement of each appliance vent installed and not included in an appliance permit	3.90
6. For the repair of, alteration of, or addition to each heating appliance, refrigeration unit, cooling unit, absorption unit or each heating, cooling, absorption, or evaporative cooling system, including installation of controls regulated by this code	7.80
7. For the installation or relocation of each compressor to and including three horsepower (10.6 kW), or each absorption system to and including 100,000 Btu/h (29.3 kW)	7.80
8. For the installation or relocation of each compressor over three horsepower (10.6 kW), to and including 15 horsepower (52.7 kW), or each absorption system over 100,000 Btu/h (29.3 kW) to and including 500,000 Btu/h (146.6 kW)	14.30
9. For the installation or relocation of each compressor over 15 horsepower (52.7 kW) to and including 30 horsepower (105.5 kW), or each absorption system over 500,000 Btu/h (146.6 kW) to and including 1,000,000 Btu/h (293.1 kW)	19.50
10. For the installation or relocation of each compressor over 30 horsepower (105.5 kW) to and including 50 horsepower (176 kW), or for each absorption system over 1,000,000 Btu/h (293.1 kW) to and including 1,750,000 Btu/h (512.9 kW)	29.25
11. For the installation or relocation of each refrigeration compressor over 50 horsepower (176 kW), or each absorption system over 1,750,000 Btu/h (512.9 kW)	48.75
12. For each air-handling unit to and including 10,000 cubic feet per minute (4720 L/s), including ducts attached thereto	5.85
(**Note:** This fee shall not apply to an air-handling unit which is a portion of a factory-assembled appliance, cooling unit, evaporative cooler or absorption unit for which a permit is required elsewhere in this code.)	
13. For each air-handling unit exceeding 10,000 cfm (4720 L/s)	9.75
14. For each evaporative cooler other than portable type	5.85
15. For each ventilation fan connected to a single duct	3.90
16. For each ventilation system which is not a portion of any heating or air-conditioning system authorized by a permit	5.85
17. For the installation of each hood which is served by mechanical exhaust, including the ducts for such hood	5.85
18. For the installation or relocation of each domestic-type incinerator	9.75
19. For the installation or relocation of each commercial or industrial-type incinerator	39.00
20. For each appliance or piece of equipment regulated by this code, but not classed in other appliance categories, or for which no other fee is listed in this code	5.85
21. Permit fees for fuel-gas piping shall be as follows: For each gas-piping system of one to four outlets For each gas-piping system of five or more outlets, per outlet	 2.60 .65
OTHER INSPECTIONS AND FEES:	
1. Inspections outside normal business hours (minimum charge 2 hours)	$19.50/hour
2. Reinspection fees assessed under provisions of Section 107.2.3	19.50 each
3. Inspections for which no fee is specifically indicated (minimum charge $^1/_2$ hour)	19.50/hour
4. Additional plan review required by changes, additions or revisions to approved plans (minimum charge $^1/_2$ hour)	19.50/hour

NOTE: Section 106.5.3 is not adopted by the State of Oregon.

106.5.3 Fee refunds. The code official shall authorize the refunding of fees as follows.

1. The full amount of any fee paid hereunder which was erroneously paid or collected.
2. Not more than [SPECIFY PERCENTAGE] percent of the permit fee paid when no work has been done under a permit issued in accordance with this code.
3. Not more than [SPECIFY PERCENTAGE] percent of the plan review fee paid when an application for a permit for which a plan review fee has been paid is withdrawn or canceled before any plan review effort has been expended.

The code official shall not authorize the refunding of any fee paid, except upon written application filed by the original permittee not later than 180 days after the date of fee payment.

106.5.4 Plan review fees. When a plan or other data is required to be submitted by Section 106.3.1, a plan review fee shall be paid at the time of submitting plans and specifications for review. The plan review fees for mechanical work shall be equal to 25 percent of the total permit fee as set forth in Table 1-A.

106.5.4.1 Separate fees for plan review. The plan review fees specified in this section are separate fees from the permit fees specified in Section 106.5.2 and are in addition to the permit fees.

106.5.4.2 106.5.4.2 Incomplete or changed plans. When plans are incomplete or changed so as to require additional plan review, an additional plan review fee shall be charged at the rate shown in Table 1-A.

SECTION 107
INSPECTIONS AND TESTING

107.1 Required inspections and testing. The code official, upon notification from the permit holder or the permit holder's agent, shall make the following inspections and other such inspections as necessary, and shall either release that portion of the construction or shall notify the permit holder or the permit holder's agent of violations that must be corrected. The holder of the permit shall be responsible for the scheduling of such inspections.

1. Underground inspection shall be made after trenches or ditches are excavated and bedded, piping installed, and before backfill is put in place. When excavated soil contains rocks, broken concrete, frozen chunks and other rubble that would damage or break the piping or cause corrosive action, clean backfill shall be on the job site.
2. Rough-in inspection shall be made after the roof, framing, fireblocking and bracing are in place and all ducting and other components to be concealed are complete, and prior to the installation of wall or ceiling membranes.
3. Final inspection shall be made upon completion of the mechanical system.

Exception: Ground-source heat pump loop systems tested in accordance with Section 1208.1.1 shall be permitted to be backfilled prior to inspection.

The requirements of this section shall not be considered to prohibit the operation of any heating equipment or appliances installed to replace existing heating equipment or appliances serving an occupied portion of a structure provided that a request for inspection of such heating equipment or appliances has been filed with the department not more than 48 hours after such replacement work is completed, and before any portion of such equipment or appliances is concealed by any permanent portion of the structure.

NOTE: Section 107.1.1 is not adopted by the State of Oregon.

107.1.1 Approved inspection agencies. The code official shall accept reports of approved agencies, provided that such agencies satisfy the requirements as to qualifications and reliability.

NOTE: Section 107.1.2, including subsections are not adopted by the State of Oregon.

107.1.2 Evaluation and follow-up inspection services. Prior to the approval of a prefabricated construction assembly having concealed mechanical work and the issuance of a mechanical permit, the code official shall require the submittal of an evaluation report on each prefabricated construction assembly, indicating the complete details of the mechanical system, including a description of the system and its components, the basis upon which the system is being evaluated, test results and similar information, and other data as necessary for the code official to determine conformance to this code.

107.1.2.1 Evaluation service. The code official shall designate the evaluation service of an approved agency as the evaluation agency, and review such agency's evaluation report for adequacy and conformance to this code.

107.1.2.2 Follow-up inspection. Except where ready access is provided to mechanical systems, service equipment and accessories for complete inspection at the site without disassembly or dismantling, the code official shall conduct the in-plant inspections as frequently as necessary to ensure conformance to the approved evaluation report or shall designate an independent, approved inspection agency to conduct such inspections. The inspection agency shall furnish the code official with the follow-up inspection manual and a report of inspections upon request, and the mechanical system shall have an identifying label permanently affixed to the system indicating that factory inspections have been performed.

107.1.2.3 Test and inspection records. Required test and inspection records shall be available to the code official at all times during the fabrication of the mechanical system and the erection of the building; or such records as the code official designates shall be filed.

107.2 Testing. Mechanical systems shall be tested as required in this code. Tests shall be made by the permit holder and observed by the code official.

107.2.1 New, altered, extended or repaired systems. New mechanical systems and parts of existing systems, which

have been altered, extended, renovated or repaired, shall be tested as prescribed herein to disclose leaks and defects.

107.2.2 Apparatus, material and labor for tests. Apparatus, material and labor required for testing a mechanical system or part thereof shall be furnished by the permit holder.

107.2.3 Reinspection and testing. Where any work or installation does not pass an initial test or inspection, the necessary corrections shall be made so as to achieve compliance with this code. The work or installation shall then be resubmitted to the code official for inspection and testing.

107.3 Contractor responsibilities. It shall be the responsibility of every contractor who enters into contracts for the installation or repair of mechanical systems for which a permit is required to comply with adopted state and local rules and regulations concerning licensing and permits.

107.4 Coordination of inspections. Whenever in the enforcement of this code or another code or ordinance, the responsibility of more than one code official of the jurisdiction is involved, it shall be the duty of the code officials involved to coordinate their inspections and administrative orders as fully as practicable so that the owners and occupants of the structure shall not be subjected to visits by numerous inspectors or multiple or conflicting orders. Whenever an inspector from any agency or department observes an apparent or actual violation of some provision of some law, ordinance or code not within the inspector's authority to enforce, the inspector shall report the findings to the code official having jurisdiction.

107.5 Approval. After the prescribed tests and inspections indicate that the work complies in all respects with this code, a notice of approval shall be issued by the code official.

107.6 Temporary connection. The code official shall have the authority to authorize the temporary connection of a mechanical system to the sources of energy for the purpose of testing mechanical systems or for use under a temporary certificate of occupancy.

NOTE: Section 108 is not adopted by the State of Oregon.

SECTION 108
VIOLATIONS

ORS 455.895 is not part of this code but is reproduced here for the reader's convenience:

455.895 Civil penalties. (1)(a) The State Plumbing Board may impose a civil penalty against a person as provided under ORS 447.992 and 693.992. Amounts recovered under this paragraph are subject to ORS 693.165.

(b) The Electrical and Elevator Board may impose a civil penalty against a person as provided under ORS 479.995, Amounts recovered under this paragraph are subject to ORS 479.850.

(c) The Board of Boiler Rules may impose a civil penalty against a person as provided under ORS 480.670. Amounts recovered under this paragraph shall be deposited to the General Fund.

(2) The Director of the Department of Consumer and Business Services, in consultation with the appropriate board, if any, may impose a civil penalty against any person who violates any provision of ORS 446.003 to 446.200, 446.225 to 446.285, 446.395 to 446.420, 479.510 to 479.945, 479.950, 479.995 and 480.510 to 480.670 and this chapter and ORS chapters 447, 460 and 693 or any rule adopted or order issued for the administration and enforcement of those provisions. Except as provided in subsections (3) and (8) of this section, a civil penalty imposed under this section must be in an amount determined by the appropriate board or the director of not more than $5,000 for each offense or, in the case of a continuing offense, not more than $1,000 for each day of the offense.

(3) Each violation of ORS 446.003 to 446.200 or 446.225 to 446.285, or any rule or order issued thereunder, constitutes a separate violation with respect to each manufactured structure or with respect to each failure or refusal to allow or perform an act required thereby, except that the maximum civil penalty may not exceed $1 million for any related series of violations occurring within one year from the date of the first violation.

(4) The maximum penalty established by this section for a violation may be imposed only upon a finding that the person has engaged in a pattern of violations. The Department of Consumer and Business Services, by rule, shall define what constitutes a pattern of violations. Except as provided in subsection (1) of this section, moneys received from any civil penalty under this section are appropriated continuously for and shall be used by the director for enforcement and administration of provisions and rules described in subsection (2) of this section.

(5) Civil penalties under this section shall be imposed as provided in ORS 183.090.

(6) A civil penalty imposed under this section may be remitted or reduced upon such terms and conditions as the director or the appropriate board considers proper and consistent with the public health and safety. In any judicial review of a civil penalty imposed under this section, the court may, in its discretion, reduce the penalty.

(7) Any officer, director, shareholder or agent of a corporation, or member or agent of a partnership or association, who personally participates in or is an accessory to any violation by the partnership, association or corporation of a provision or rule described in subsection (2) of this section is subject to the penalties prescribed in this section.

(8) In addition to the civil penalty set forth in subsection (1) or (2) of this section, any person who violates a provision or rule described in subsection (2) of this section may be required by the director or the appropriate board to forfeit and pay to the General Fund of the State Treasury a civil penalty in an amount determined by the director or board that shall not exceed five times the amount by which such person profited in any transaction that violates a provision or rule described in subsection (2) of this section.

108.1 Unlawful acts. It shall be unlawful for a person, firm or corporation to erect, construct, alter, repair, remove, demolish or utilize a mechanical system, or cause same to be done, in conflict with or in violation of any of the provisions of this code.

108.2 Notice of violation. The code official shall serve a notice of violation or order to the person responsible for the erection, installation, alteration, extension, repair, removal or demolition of mechanical work in violation of the provisions of this code, or in violation of a detail statement or the approved construction documents thereunder, or in violation of a permit or certificate issued under the provisions of this code. Such order shall direct the discontinuance of the illegal action or condition and the abatement of the violation.

108.3 Prosecution of violation. If the notice of violation is not complied with promptly, the code official shall request the legal counsel of the jurisdiction to institute the appropriate proceeding at law or in equity to restrain, correct or abate such violation, or to require the removal or termination of the unlawful occupancy of the structure in violation of the provisions of this code or of the order or direction made pursuant thereto.

108.4 Violation penalties. Persons who shall violate a provision of this code or shall fail to comply with any of the requirements thereof or who shall erect, install, alter or repair mechanical work in violation of the approved construction documents or directive of the code official, or of a permit or certificate

issued under the provisions of this code, shall be guilty of a [SPECIFY OFFENSE], punishable by a fine of not more than [AMOUNT] dollars or by imprisonment not exceeding [NUMBER OF DAYS], or both such fine and imprisonment. Each day that a violation continues after due notice has been served shall be deemed a separate offense.

108.5 Stop work orders. Upon notice from the code official that mechanical work is being done contrary to the provisions of this code or in a dangerous or unsafe manner, such work shall immediately cease. Such notice shall be in writing and shall be given to the owner of the property, or to the owner's agent, or to the person doing the work. The notice shall state the conditions under which work is authorized to resume. Where an emergency exists, the code official shall not be required to give a written notice prior to stopping the work. Any person who shall continue any work on the system after having been served with a stop work order, except such work as that person is directed to perform to remove a violation or unsafe condition, shall be liable to a fine of not less than [AMOUNT] dollars or more than [AMOUNT] dollars.

108.6 Abatement of violation. The imposition of the penalties herein prescribed shall not preclude the legal officer of the jurisdiction from instituting appropriate action to prevent unlawful construction or to restrain, correct or abate a violation, or to prevent illegal occupancy of a building, structure or premises, or to stop an illegal act, conduct, business or utilization of the mechanical system on or about any premises.

108.7 Unsafe mechanical systems. A mechanical system that is unsafe, constitutes a fire or health hazard, or is otherwise dangerous to human life, as regulated by this code, is hereby declared as an unsafe mechanical system. Use of a mechanical system regulated by this code constituting a hazard to health, safety or welfare by reason of inadequate maintenance, dilapidation, fire hazard, disaster, damage or abandonment is hereby declared an unsafe use. Such unsafe equipment and appliances are hereby declared to be a public nuisance and shall be abated by repair, rehabilitation, demolition or removal.

108.7.1 Authority to condemn mechanical systems. Whenever the code official determines that any mechanical system, or portion thereof, regulated by this code has become hazardous to life, health, property, or has become insanitary, the code official shall order in writing that such system either be removed or restored to a safe condition. A time limit for compliance with such order shall be specified in the written notice. A person shall not use or maintain a defective mechanical system after receiving such notice.

When such mechanical system is to be disconnected, written notice as prescribed in Section 108.2 shall be given. In cases of immediate danger to life or property, such disconnection shall be made immediately without such notice.

108.7.2 Authority to order disconnection of energy sources. The code official shall have the authority to order disconnection of energy sources supplied to a building, structure or mechanical system regulated by this code, when it is determined that the mechanical system or any portion thereof has become hazardous or unsafe. Written notice of such order to disconnect service and the causes therefor shall be given within 24 hours to the owner and occupant of such building, structure or premises, provided, however, that in cases of immediate danger to life or property, such disconnection shall be made immediately without such notice. Where energy sources are provided by a public utility, the code official shall immediately notify the serving utility in writing of the issuance of such order to disconnect.

108.7.3 Connection after order to disconnect. A person shall not make energy source connections to mechanical systems regulated by this code which have 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 mechanical systems.

When a mechanical system 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 appropriate action to prevent, restrain, correct or abate the violation.

NOTE: Section 109 is not adopted by the State of Oregon.

SECTION 109
MEANS OF APPEAL

109.1 Application for appeal. A person shall have the right to appeal a decision of the code official to the board of appeals. An application for appeal shall be based on a claim that the true intent of this code or the rules legally adopted thereunder have been incorrectly interpreted, the provisions of this code do not fully apply, or an equally good or better form of construction is proposed. The application shall be filed on a form obtained from the code official within 20 days after the notice was served.

109.1.1 Limitation of authority. The board of appeals shall have no authority relative to interpretation of the administration of this code nor shall such board be empowered to waive requirements of this code.

ORS 455.690 is not part of this code but is reproduced here for the reader's convenience:

455.690 Appeal to advisory boards. Any person aggrieved by the final decision of a municipal appeals board or a subordinate officer of the Department of Consumer and Business Services as to the application of any provision of a specialty code may, within 30 days after the date of the decision, appeal to the appropriate advisory board. The appellant shall submit a fee of $20, payable to the department, with the request for appeal. The final decision of the involved municipality or state officer shall be subject to review and final determination by the appropriate advisory board as to technical and scientific determinations related to the application of the specialty code involved.

109.2 Membership of board. The board of appeals shall consist of five members appointed by the chief appointing authority as follows: one for five years; one for four years; one for three years; one for two years; and one for one year. Thereafter, each new member shall serve for five years or until a successor has been appointed.

109.2.1 Qualifications. The board of appeals shall consist of five individuals, one from each of the following professions or disciplines.

1. Registered design professional who is a registered architect; or a builder or superintendent of building construction with at least ten years' experience, five of which shall have been in responsible charge of work.
2. Registered design professional with structural engineering or architectural experience.
3. Registered design professional with mechanical and plumbing engineering experience; or a mechanical contractor with at least ten years' experience, five of which shall have been in responsible charge of work.
4. Registered design professional with electrical engineering experience; or an electrical contractor with at least ten years' experience, five of which shall have been in responsible charge of work.
5. Registered design professional with fire protection engineering experience; or a fire protection contractor with at least ten years' experience, five of which shall have been in responsible charge of work.

109.2.2 Alternate members. The chief appointing authority shall appoint two alternate members who shall be called by the board chairman to hear appeals during the absence or disqualification of a member. Alternate members shall possess the qualifications required for board membership and shall be appointed for five years, or until a successor has been appointed.

109.2.3 Chairman. The board shall annually select one of its members to serve as chairman.

109.2.4 Disqualification of member. A member shall not hear an appeal in which that member has a personal, professional or financial interest.

109.2.5 Secretary. The chief administrative officer shall designate a qualified clerk to serve as secretary to the board. The secretary shall file a detailed record of all proceedings in the office of the chief administrative officer.

109.2.6 Compensation of members. Compensation of members shall be determined by law.

109.3 Notice of meeting. The board shall meet upon notice from the chairman, within ten days of the filing of an appeal, or at stated periodic meetings.

109.4 Open hearing. All hearings before the board shall be open to the public. The appellant, the appellant's representative, the code official and any person whose interests are affected shall be given an opportunity to be heard.

109.4.1 Procedure. The board shall adopt and make available to the public through the secretary procedures under which a hearing will be conducted. The procedures shall not require compliance with strict rules of evidence, but shall mandate that only relevant information be received.

109.5 Postponed hearing. When five members are not present to hear an appeal, either the appellant or the appellant's representative shall have the right to request a postponement of the hearing.

109.6 Board decision. The board shall modify or reverse the decision of the code official by a concurring vote of three members.

109.6.1 Resolution. The decision of the board shall be by resolution. Certified copies shall be furnished to the appellant and to the code official.

109.6.2 Administration. The code official shall take immediate action in accordance with the decision of the board.

109.7 Court review. Any person, whether or not a previous party of the appeal, shall have the right to apply to the appropriate court for a writ of certiorari to correct errors of law. Application for review shall be made in the manner and time required by law following the filing of the decision in the office of the chief administrative officer.

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CHAPTER 2
DEFINITIONS

SECTION 201
GENERAL

201.1 Scope. Unless otherwise expressly stated, the following words and terms shall, for the purposes of this code, 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 building, electrical, fire or plumbing code, such terms shall have meanings ascribed to them as in those codes.

201.4 Terms not defined. Except as defined in this chapter or elsewhere in this code, the interpretation of words used in this code shall be in accordance with the meanings defined in the building code and *Webster's Third New International Dictionary of the English Language,* Unabridged, copyright 1986.

SECTION 202
GENERAL DEFINITIONS

ABRASIVE MATERIALS. Moderately abrasive particulate in high concentrations, and highly abrasive particulate in moderate and high concentrations, such as alumina, bauxite, iron silicate, sand and slag.

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 (to)"].

AIR. All air supplied to mechanical equipment and appliances for combustion, ventilation, cooling, etc. Standard air is air at standard temperature and pressure, namely 70°F (21°C) and 29.92 inches of mercury (101.3 kPa).

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-CONDITIONING SYSTEM. A system that consists of heat exchangers, blowers, filters, supply, exhaust and return ducts, and shall include any apparatus installed in connection therewith.

AIR DISTRIBUTION SYSTEM. Any system of ducts, plenums and air-handling equipment that circulates air within a space or spaces and includes systems made up of one or more air-handling units.

AIR, EXHAUST. Air being removed from any space, appliance 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 mechanical system that involves an extension, addition or change to the arrangement, type or purpose of the original installation.

APPLIANCE. A device or apparatus that is manufactured and designed to utilize energy and for which this code provides specific requirements.

APPLIANCE, EXISTING. Any appliance regulated by this code which was legally installed prior to the effective date of this code, or for which a permit to install has been issued.

APPLIANCE TYPE.

High-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 greater than 2,000°F (1093°C).

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, 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.

AUTOMATIC BOILER. Any class of boiler that is equipped with the controls and limit devices specified in Chapter 10.

BASE FLOOD ELEVATION. A reference point, determined in accordance with the building code, based on the depth or peak elevation of flooding, including wave height, which has a 1 percent (100-year flood) or greater chance of occurring in any given year.

BATHROOM. A room containing a bathtub, shower, spa or similar bathing fixture.

BOILER. A closed heating appliance intended to supply hot water or steam for space heating, processing or power purposes. Low-pressure boilers operate at pressures less than or equal to 15 pounds per square inch (psi) (103 kPa) for steam and 160 psi (1103 kPa) for water. High-pressure boilers operate at pressures exceeding those pressures.

BOILER ROOM. A room primarily utilized for the installation of a boiler.

BRAZED JOINT. A gas-tight joint obtained by the joining of metal parts with metallic mixtures or alloys which melt at a temperature above 1,000°F (538°C), but lower than the melting temperature of the parts to be joined.

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 attraction.

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 (0.56°C) (1 Btu = 1055 J).

BUILDING. Any structure occupied or intended for supporting or sheltering any occupancy.

BUILDING CODE. The *Oregon Structural Specialty Code.*

BUILDING OFFICIAL. The officer charged with the administration and enforcement of this code, or a duly authorized representative.

CHIMNEY. A primarily vertical structure containing one or more flues, for the purpose of carrying gaseous products of combustion and air from a fuel-burning 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.

CHIMNEY CONNECTOR. A pipe that connects a fuel-burning appliance to a chimney.

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.

CLOSED COMBUSTION SOLID-FUEL-BURNING APPLIANCE. A heat-producing appliance that employs a combustion chamber that has no openings other than the flue collar, fuel charging door and adjustable openings provided to control the amount of combustion air that enters the combustion chamber.

CLOTHES DRYER. An appliance used to dry wet laundry by means of heat. 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 lawfully adopted.

CODE OFFICIAL. See "Building Official."

COMBUSTIBLE ASSEMBLY. Wall, floor, ceiling or other assembly constructed of one or more component materials that are not defined as noncombustible.

COMBUSTIBLE LIQUIDS. Any liquids having a flash point at or above 100°F (38°C), and that are divided into the following classifications:

Class II. Liquids having flash points at or above 100°F (38°C) and below 140°F (60°C).

Class IIIA. Liquids having flash points at or above 140°F (60°C) and below 200°F (93°C).

Class IIIB. Liquids having flash points at or above 200°F (93°C).

COMBUSTIBLE MATERIAL. Any material not defined as noncombustible.

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 the inert gases, but excluding excess air.

COMMERCIAL FOOD HEAT-PROCESSING APPLIANCES. Appliances used in a food-processing establishment for heat-processing food or utensils, and which produce grease vapors, steam, fumes, smoke or odors that are required to be removed through a local exhaust ventilation system. Such appliances include deep fat fryers; upright broilers; griddles; broilers; fry grills; steam-jacketed kettles; hot-top ranges; char-broilers; ovens; barbecues; rotisseries and similar appliances. For the purpose of this definition, a food-processing establishment shall include any building or a portion thereof used for the processing of food.

COMPENSATING HOODS. Compensating hoods are those having integral (built-in) makeup air supply. The makeup air supply for such hoods is generally supplied from: short-circuit flow from inside the hood, air curtain flow from the bottom of the front face, and front face discharge from the outside front wall of the hood. The compensating makeup airflow can also be supplied from the rear or side of the hood, or the rear, front, or

sides of the cooking equipment. The makeup airflow can be one of a combination of methods.

COMPRESSOR. A specific machine, with or without accessories, for compressing a gas.

COMPRESSOR, POSITIVE DISPLACEMENT. A compressor in which increase in pressure is attained by changing the internal volume of the compression chamber.

COMPRESSOR UNIT. A compressor with its prime mover and accessories.

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.

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

CONDENSER. A heat exchanger designed to liquefy refrigerant vapor by removal of heat.

CONDENSING UNIT. A specific refrigerating machine combination for a given refrigerant, consisting of one or more power-driven compressors, condensers, liquid receivers (when required), and the regularly furnished accessories.

CONDITIONED SPACE. An area, room or space being heated or cooled by any equipment or appliance.

CONFINED SPACES. A space having a volume less than 50 cubic feet per 1,000 British thermal units per hour (Btu/h) (4.8 m^3/kW) of the aggregate input rating of all appliances installed in that space.

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 building permit. The construction drawings shall be drawn to an appropriate scale.

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 burner designed to supply gaseous fuel to an appliance originally designed to utilize another fuel.

COOKING APPLIANCE. See "Commercial food heat-processing appliances."

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

Volume damper. A device that, when installed, will restrict, retard or direct the flow of air in a duct, or the products of combustion in a heat-producing appliance, its vent connector, vent or chimney therefrom.

DESIGN WORKING PRESSURE. The maximum allowable working pressure for which a specific part of a system is designed.

DIRECT REFRIGERATION SYSTEM. A system in which the evaporator or condenser of the refrigerating system is in direct contact with the air or other substances to be cooled or heated.

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

DRAFT. The pressure difference existing between the appliance 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.

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.

DRIP. The container placed at a low point in a system of piping to collect condensate and from which the condensate is removable.

DRY CLEANING SYSTEMS. Dry cleaning plants or systems are classified as follows:

Type I. Those systems using Class I flammable liquid solvents having a flash point below 100°F (38°C).

Type II. Those systems using Class II combustible liquid solvents having a flash point at or above 100°F (38°C) and below 140°F (60°C).

Type III. Those systems using Class III combustible liquid solvents having a flash point at or above 140°F (60°C).

Types IV and V. Those systems using Class IV nonflammable liquid solvents.

DUCT. A tube or conduit utilized for conveying air. The air passages of self-contained systems are not to be construed as air ducts.

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, for air circulation, depends 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 and appliances.

DWELLING. A building or portion thereof that contains not more than two dwelling units.

DWELLING UNIT. A single unit providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking and sanitation.

ELECTRIC HEATING APPLIANCE. An appliance that produces heat energy to create a warm environment by the application of electric power to resistance elements, refrigerant compressors or dissimilar material junctions.

ELECTRICAL CODE. The *Oregon Electrical Specialty Code.*

EQUIPMENT. All piping, ducts, vents, control devices and other components of systems other than appliances which are permanently installed and integrated to provide control of environmental conditions for buildings. This definition shall also include other systems specifically regulated in this code.

EQUIPMENT, EXISTING. Any equipment regulated by this code which was legally installed prior to the effective date of this code, or for which a permit to install has been issued.

EVAPORATIVE COOLER. A device used for reducing the sensible heat of air for cooling by the process of evaporation of water into an airstream.

EVAPORATIVE COOLING SYSTEM. The equipment and appliances intended or installed for the purpose of environmental cooling by an evaporative cooler from which the conditioned air is distributed through ducts or plenums to the conditioned area.

EVAPORATOR. That part of the system in which liquid refrigerant is vaporized to produce refrigeration.

EXCESS AIR. Amount of air provided in addition to theoretical air, to achieve complete combustion of a fuel, thereby preventing the formation of dangerous products of combustion.

EXHAUST AIR. Air removed from a space and not reused.

EXHAUST SYSTEM. An assembly of connected ducts, plenums, fittings, registers, grilles and hoods through which air is conducted from the space or spaces and exhausted to the outside atmosphere.

FIRE CODE. As referenced in this code for construction, alteration and repair of buildings and structures is the *Oregon Uniform Fire Code* as adopted and amended by the State of Oregon Fire Marshal.

FIREPLACE. An assembly consisting of a hearth and fire chamber of noncombustible material and provided with a chimney, for use with solid fuels.

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

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

FIREPLACE STOVE. A chimney-connected, solid-fuel-burning stove (appliance) having part of its fire chamber open to the room.

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 become inoperative, and when flame failure occurs on the burner or group of burners.

FLAME SPREAD INDEX. The numerical value assigned to a material tested in accordance with ASTM E 84.

FLAMMABILITY CLASSIFICATION. Refrigerants shall be assigned to one of the three classes — 1, 2 or 3 in accordance with ASHRAE 34. For Class 2 and 3, the heat of combustion shall be calculated assuming that combustion products are in the gas phase and in their most stable state.

Class 1. Refrigerants that do not show flame propagation when tested in air at 14.7 psia (101 kPa) and 70°F (21°C).

Class 2. Refrigerants having a lower flammability limit (LFL) of more than 0.00625 pound per cubic foot (0.10 kg/m^3) at 70°F (21°C) and 14.7 psia (101 kPa) and a heat of combustion of less than 8,174 Btu/lb. (19 000 kJ/kg).

Class 3. Refrigerants that are highly flammable, having an LFL of less than or equal to 0.00625 pound per cubic foot (0.10 kg/m^3) at 70°F (21°C) and 14.7 psia (101 kPa) or a heat of combustion greater than or equal to 8,174 Btu/lb. (19 000 kJ/kg).

FLAMMABLE LIQUIDS. Any liquid that has a flash point below 100°F (38°C), and has a vapor pressure not exceeding 40 psia (276 kPa) at 100°F (38°C). Flammable liquids shall be known as Class I liquids and shall be divided into the following classifications:

Class IA. Liquids having a flash point below 73°F (23°C) and having a boiling point below 100°F (38°C).

Class IB. Liquids having a flash point below 73°F (23°C) and having a boiling point at or above 100°F (38°C).

Class IC. Liquids having a flash point at or above 73°F (23°C) and below 100°F (38°C).

FLAMMABLE VAPOR OR FUMES. Mixtures of gases in air at concentrations equal to or greater than the lower flammability limit (LFL) and less than or equal to the upper flammability limit (UFL).

FLASH POINT. The minimum temperature corrected to a pressure of 14.7 psia (101 kPa) at which the application of a test flame causes the vapors of a portion of the sample to ignite under the conditions specified by the test procedures and apparatus. The flash point of a liquid shall be determined in accordance with ASTM D 56, ASTM D 93 or ASTM D 3278.

FLOOD ZONES

Flood-hazard zone. Areas that have been determined to be prone to flooding, but not subject to high-velocity waters or wave action.

High-hazard zone. Areas of tidal influence that have been determined to be subject to wave heights in excess of 3 feet (914 mm) or subject to high-velocity wave runup or wave-induced erosion.

FLOOR AREA, NET. The actual occupied area, not including unoccupied accessory areas or thicknesses of walls.

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.

FLUE. A passageway within a chimney or vent through which gaseous combustion products pass.

FLUE CONNECTION (BREECHING). A passage for conducting the products of combustion from a fuel-fired appliance

to the vent or chimney (see also "Chimney connector" and "Vent connector").

FLUE GASES. Products of combustion and excess air.

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 conveying combustion products without leakage to the atmosphere.

FUEL GAS. A natural, manufactured, liquefied petroleum or a mixture of these.

FUEL OIL. Kerosene or any hydrocarbon oil having a flash point not less than 100°F (38°C).

FUEL-OIL PIPING SYSTEM. A closed piping system that connects a combustible liquid from a source of supply to a fuel-oil-burning 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 ROOM. A room primarily utilized for the installation of fuel-burning space heating appliances and water heating appliances other than boilers (see also "Boiler room").

FUSIBLE PLUG. A device arranged to relieve pressure by operation of a fusible member at a predetermined temperature.

GROUND SOURCE HEAT PUMP LOOP SYSTEM. Piping buried in horizontal or vertical excavations or placed in a body of water for the purpose of transporting heat transfer liquid to and from a heat pump. Included in this definition are closed loop systems in which the liquid is recirculated and open loop systems in which the liquid is drawn from a well or other source.

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 use group classification.

HEAT EXCHANGER. A device that transfers heat from one medium to another.

HEAT PUMP. A refrigeration system that extracts heat from one substance and transfers it to another portion of the same substance or to a second substance at a higher temperature for a beneficial purpose.

HEAT TRANSFER LIQUID. The operating or thermal storage liquid in a mechanical system, including water or other liquid base, and additives at the concentration present under operating conditions used to move heat from one location to another. Refrigerants are not included as heat transfer liquids.

HIGH-PROBABILITY SYSTEMS. A refrigeration system in which the basic design or the location of components is such that a leakage of refrigerant from a failed connection, seal or component will enter an occupancy classified area, other than the machinery room.

HIGH-SIDE PRESSURE. The parts of a refrigerating system subject to condenser pressure.

HOOD. An air-intake device used to capture by entrapment, impingement, adhesion or similar means, grease and similar contaminants before they enter a duct system.

Type I. A kitchen hood for collecting and removing grease vapors and smoke.

Type II. A general kitchen hood for collecting and removing steam, vapor, heat or odors.

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.

IMMEDIATELY DANGEROUS TO LIFE OR HEALTH (IDLH). The concentration of airborne contaminants that poses a threat of death, immediate or delayed permanent adverse health effects, or effects that could prevent escape from such an environment. This contaminant concentration level is established by the National Institute of Occupational Safety and Health (NIOSH) based on both toxicity and flammability. It is generally expressed in parts per million by volume (ppm v/v) or milligrams per cubic meter (mg/m^3).

INDIRECT REFRIGERATION SYSTEM. A system in which a secondary coolant cooled or heated by the refrigerating system is circulated to the air or other substance to be cooled or heated. Indirect systems are distinguished by the method of application shown below:

Closed system. A system in which a secondary fluid is either cooled or heated by the refrigerating system and then circulated within a closed circuit in indirect contact with the air or other substance to be cooled or heated.

Double-indirect open-spray system. A system in which the secondary substance for an indirect open spray system is heated or cooled by an intermediate coolant circulated from a second enclosure.

Open-spray system. A system in which a secondary coolant is cooled or heated by the refrigerating system and then circulated in direct contact with the air or other substance to be cooled or heated.

Vented closed system. A system in which a secondary coolant is cooled or heated by the refrigerating system and then passed through a closed circuit in the air or other substance to be cooled or heated, except that the evaporator or condenser is placed in an open or appropriately vented tank.

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, screwed joint or flared 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, PLASTIC SOLVENT CEMENT. A joint made in thermoplastic piping by the use of a solvent or solvent cement which forms a continuous bond between the mating surfaces.

JOINT, SOLDERED. A gas-tight joint obtained by the joining of metal parts with metallic mixtures of alloys which melt at temperatures between 400°F (204°C) and 1,000°F (538°C).

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.

LIMITED CHARGE SYSTEM. A system in which, with the compressor idle, the design pressure will not be exceeded when the refrigerant charge has completely evaporated.

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, appliances or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner. Not all testing laboratories, inspection agencies and other organizations concerned with product evaluation use the same means for identifying listed equipment, appliances or materials. Some 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.

LOWER EXPLOSIVE LIMIT (LEL). See "LFL."

LOWER FLAMMABILITY LIMIT (LFL). The minimum concentration of refrigerant that is capable of propagating a flame through a homogeneous mixture of refrigerant and air.

LOW-PRESSURE HOT-WATER-HEATING BOILER. A boiler furnishing hot water at pressures not exceeding 160 psi (1103 kPa) and at temperatures not exceeding 250°F (121°C).

LOW-PRESSURE STEAM-HEATING BOILER. A boiler furnishing steam at pressures not exceeding 15 psi (103 kPa).

LOW-PROBABILITY SYSTEMS. A refrigeration system in which the basic design or the location of components is such that a leakage of refrigerant from a failed connection, seal or component will not enter an occupancy-classified area, other than the machinery room.

LOW-SIDE PRESSURE. The parts of a refrigerating system subject to evaporator pressure.

MACHINERY ROOM. A room meeting prescribed safety requirements and in which refrigeration systems or components thereof are located (see Sections 1105 and 1106).

MECHANICAL-DRAFT VENTING SYSTEM. A venting system designed to remove flue or vent gases by mechanical means and 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 systems using a fan or other mechanical means to cause the removal of flue or vent gases under positive static 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.

Power 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.

MECHANICAL EQUIPMENT/APPLIANCE ROOM. A room or space in which nonfuel-fired mechanical equipment and appliances are located.

MECHANICAL EXHAUST SYSTEM. A system for removing air from a room or space by mechanical means.

MECHANICAL JOINT. A connection between pipes, fittings, or pipes and fittings, which is neither screwed, caulked, threaded, soldered, solvent cemented, brazed nor welded. Also, a joint in which compression is applied along the centerline of the pieces being joined. Some joints are part of a coupling, fitting or adapter.

MECHANICAL SYSTEM. A system specifically addressed and regulated in this code and composed of components, devices, appliances and equipment.

MODULAR BOILER. A steam or hot water heating assembly consisting of a group of individual boilers called modules intended to be installed as a unit with no intervening stop valves. Modules are under one jacket or are individually jacketed. The individual modules shall be limited to a maximum input rating of 400,000 Btu/h (117 228 W) gas, 3 gallons per hour (gph) (11.4 L/h) oil, or 115 kW (electric).

NATURAL DRAFT SYSTEM. A venting system designed to remove flue or vent gases under nonpositive static vent pressure entirely by natural draft.

NATURAL VENTILATION. The movement of air into and out of a space through intentionally provided openings, such as windows and doors, or through nonpowered ventilators.

NONABRASIVE/ABRASIVE MATERIALS. Nonabrasive particulate in high concentrations, moderately abrasive particulate in low and moderate concentrations, and highly abrasive particulate in low concentrations, such as alfalfa, asphalt, plaster, gypsum and salt.

NONCOMBUSTIBLE MATERIALS. Materials that, when tested in accordance with ASTM E 136, have at least three of four specimens tested meeting all of the following criteria:

1. The recorded temperature of the surface and interior thermocouples shall not at any time during the test rise more than 54°F (12°C) above the furnace temperature at the beginning of the test.
2. There shall not be flaming from the specimen after the first 30 seconds.
3. If the weight loss of the specimen during testing exceeds 50 percent, the recorded temperature of the surface and interior thermocouples shall not at any time during the test rise above the furnace air temperature at the beginning of the test, and there shall not be flaming of the specimen.

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

OCCUPANCY VENTILATION. General ventilation required by the building code to ensure acceptable indoor air quality for the building occupants.

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

OUTDOOR AIR. Air taken from the outdoors, and therefore not previously circulated through the system.

OUTDOOR OPENING. A door, window, louver or skylight openable to the outside atmosphere.

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

PANEL HEATING. A method of radiant space heating in which heat is supplied by large heated areas of room surfaces. The heating element usually consists of warm water piping, warm air ducts, or electrical resistance elements embedded in or located behind ceiling, wall or floor surfaces.

PELLET FUEL-BURNING APPLIANCE. A closed-combustion, vented appliance equipped with a fuel-feed mechanism for burning processed pellets of solid fuel of a specified size and composition.

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.

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

PLASTIC, THERMOSETTING. A plastic that is capable of being changed into a substantially infusible or insoluble product when cured under application of heat or chemical means.

PLUMBING CODE. The *Oregon Plumbing Specialty Code.*

POWER BOILER. See "Boiler."

PREMISES. A lot, plot or parcel of land, including any structure thereon.

PRESSURE, FIELD TEST. A test performed in the field to prove system tightness.

PRESSURE-LIMITING DEVICE. A pressure-responsive mechanism designed to stop automatically the operation of the pressure-imposing element at a predetermined pressure.

PRESSURE-RELIEF DEVICE. A pressure-actuated valve or rupture member designed to relieve excessive pressure automatically.

PRESSURE-RELIEF VALVE. A pressure-actuated valve held closed by a spring or other means and designed to relieve pressure automatically in excess of the device's setting.

PRESSURE VESSELS. Closed containers, tanks or vessels that are designed to contain liquids, gases or both, under pressure.

PRESSURE VESSELS—REFRIGERANT. Any refrigerant-containing receptacle in a refrigerating system. This does not include evaporators where each separate section does not exceed 0.5 cubic foot (0.014 m^3) of refrigerant-containing volume, regardless of the maximum inside dimensions, evaporator coils, controls, headers, pumps and piping.

PROTECTIVE ASSEMBLY (REDUCED CLEARANCE). Any noncombustible assembly that is labeled or constructed in accordance with Table 308.6 and is placed between combustible materials or assemblies and mechanical appliances, devices or equipment, for the purpose of reducing required airspace clearances. Protective assemblies attached directly to a combustible assembly shall not be considered as part of that combustible assembly.

PURGE. To clear of air, water or other foreign substances.

QUICK-OPENING VALVE. A valve that opens completely by fast action, either manually or automatically controlled. A valve requiring one-quarter round turn or less is considered to be quick opening.

RADIANT HEATER. A heater designed to transfer heat primarily by direct radiation.

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 (to)"].

RECEIVER, LIQUID. A vessel permanently connected to a refrigeration system by inlet and outlet pipes for storage of liquid refrigerant.

RECIRCULATED AIR. Air removed from a conditioned space and intended for reuse as supply air.

RECLAIMED REFRIGERANTS. Refrigerants reprocessed to the same specifications as for new refrigerants by means including distillation. Such refrigerants have been chemically analyzed to verify that the specifications have been met. Reclaiming usually implies the use of processes or procedures that are available only at a reprocessing or manufacturing facility.

RECOVERED REFRIGERANTS. Refrigerants removed from a system in any condition without necessarily testing or processing them.

RECYCLED REFRIGERANTS. Refrigerants from which contaminants have been reduced by oil separation, removal of noncondensable gases, and single or multiple passes through devices that reduce moisture, acidity and particulate matter, such as replaceable core filter driers. These procedures usually are performed at the field job site or in a local service shop.

REFRIGERANT. A substance utilized to produce refrigeration by its expansion or vaporization.

REFRIGERANT SAFETY CLASSIFICATIONS. Groupings that indicate the toxicity and flammability classes in accordance with Section 1103.1. The classification group is made up of a letter (A or B) that indicates the toxicity class, followed by a number (1, 2 or 3) that indicates the flammability class. Refrigerant blends are similarly classified, based on the compositions at their worst cases of fractionation, as separately determined for toxicity and flammability. In some cases, the worst case of fractionation is the original formulation.

Flammability. Class 1 indicates refrigerants that do not show flame propagation in air when tested by prescribed methods at specified conditions. Classes 2 and 3 signify refrigerants with "lower flammability" and "higher flammability," respectively; the distinction depends on both the lower flammability limit (LFL) and heat of combustion.

Toxicity. Classes A and B signify refrigerants with "lower toxicity" and "higher toxicity," respectively, based on prescribed measures of chronic (long-term, repeated exposures) toxicity.

REFRIGERATED ROOM OR SPACE. A room or space in which an evaporator or brine coil is located for the purpose of reducing or controlling the temperature within the room or space to below 68°F (20°C).

REFRIGERATING SYSTEM. A combination of interconnected refrigerant-containing parts constituting one closed refrigerant circuit in which a refrigerant is circulated for the purpose of extracting heat.

REFRIGERATION CAPACITY RATING. Expressed as 1 horsepower (0.75 kW), 1 ton or 12,000 Btu/h (3.5 kW), shall all mean the same quantity.

REFRIGERATION MACHINERY ROOM. See "Machinery room."

REFRIGERATION SYSTEM, ABSORPTION. A heat-operated, closed-refrigeration cycle in which a secondary fluid (the absorbent) absorbs a primary fluid (the refrigerant) that has been vaporized in the evaporator.

Direct system. A system in which the evaporator is in direct contact with the material or space refrigerated, or is located in air-circulating passages communicating with such spaces.

Indirect system. A system in which a brine coil cooled by the refrigerant is circulated to the material or space refrigerated, or is utilized to cool the air so circulated. Indirect systems are distinguished by the type or method of application.

REFRIGERATION SYSTEM CLASSIFICATION. Refrigeration systems are classified according to the degree of probability that leaked refrigerant from a failed connection, seal or component will enter an occupied area. The distinction is based on the basic design or location of the components.

REFRIGERATION SYSTEM, MECHANICAL. A combination of interconnected refrigeration-containing parts constituting one closed refrigerant circuit in which a refrigerant is circulated for the purpose of extracting heat and in which a compressor is used for compressing the refrigerant vapor.

REFRIGERATION SYSTEM, SELF-CONTAINED. A complete factory-assembled and tested system that is shipped in one or more sections and has no refrigerant-containing parts that are joined in the field by other than companion or block valves.

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.

RETURN AIR. Air removed from an approved conditioned space or location and recirculated or exhausted.

RETURN AIR SYSTEM. An assembly of connected ducts, plenums, fittings, registers and grilles through which air from the space or spaces to be heated or cooled is conducted back to the supply unit (see also "Supply air system").

ROOM HEATER VENTED. A free-standing heating unit burning solid or liquid fuel for direct heating of the space in and adjacent to that in which the unit is located.

SAFETY VALVE. A valve that relieves pressure in a steam boiler by opening fully at the rated discharge pressure. The valve is of the spring-pop type.

SELF-CONTAINED EQUIPMENT. Complete, factory-assembled and tested, heating, air conditioning or refrigeration equipment installed as a single unit, and having all working parts, complete with motive power, in an enclosed unit of said machinery.

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

SHAFT ENCLOSURE. The walls or construction forming the boundaries of a shaft.

SMOKE DAMPER. A listed device that is designed to resist the passage of air and smoke. The device is arranged to operate automatically, controlled by a smoke detection system, and when required, is capable of being positioned manually from a remote command station.

SMOKE-DEVELOPED INDEX. A numerical value assigned to a material tested in accordance with ASTM E 84.

SOLID FUEL (COOKING APPLICATIONS). Applicable to commercial food service operations only, solid fuel is any bulk material such as hard wood, mesquite, charcoal or briquettes that is combusted to produce heat for cooking operations.

SOURCE CAPTURE SYSTEM. A mechanical exhaust system designed and constructed to capture air contaminants at their source and to exhaust such contaminants to the outdoor atmosphere.

STEAM-HEATING BOILER. A boiler operated at pressures not exceeding 15 psi (103 kPa) for steam.

STOP VALVE. A shutoff valve for controlling the flow of liquid or gases.

STORY. That portion of a building included between the upper surface of a floor and the upper surface of the floor next above, except that the topmost story shall be that portion of a building included between the upper surface of the topmost floor and the ceiling or roof above.

STRENGTH, ULTIMATE. The highest stress level that the component will tolerate without rupture.

SUPPLY AIR. That air delivered to each or any space supplied by the air distribution system or the total air delivered to all spaces supplied by the air distribution system, which is provided for ventilating, heating, cooling, humidification, dehumidification and other similar purposes.

SUPPLY AIR SYSTEM. An assembly of connected ducts, plenums, fittings, registers and grilles through which air, heated or cooled, is conducted from the supply unit to the space or spaces to be heated or cooled (see also "Return air system").

THEORETICAL AIR. The exact amount of air required to supply oxygen for complete combustion of a given quantity of a specific fuel.

THERMAL RESISTANCE (*R*). A measure of the ability to retard the flow of heat. The *R*-value is the reciprocal of thermal conductance.

TLV-TWA (THRESHOLD LIMIT VALUE-TIME-WEIGHTED AVERAGE). The time-weighted average concentration of a refrigerant or other chemical in air for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers are repeatedly exposed, day after day, without adverse effects, as adopted by the American Conference of Government Industrial Hygienists (ACGIH).

TOILET ROOM. A room containing a water closet and, frequently, a lavatory, but not a bathtub, shower, spa or similar bathing fixture.

TOXICITY CLASSIFICATION. Refrigerants shall be classified for toxicity to one of two classes in accordance with ASHRAE 34:

Class A. Refrigerants for which toxicity has not been identified at concentrations less than or equal to 400 parts per million (ppm), based on data used to determine Threshold Limit Value-Time-Weighted Average (TLV-TWA) or consistent indices.

Class B. Refrigerants for which there is evidence of toxicity at concentrations below 400 ppm, based on data used to determine TLV-TWA or consistent indices.

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.

UNCONFINED SPACE. A space having a volume not less than 50 cubic feet per 1,000 Btu/h (4.8 m^3/kW) of the aggregate input rating of all appliances installed in that space. Rooms communicating directly with the space in which the appliances are installed, through openings not furnished with doors, are considered a part of the unconfined space.

UNIT HEATER. A self-contained appliance of the fan type, designed for the delivery of warm air directly into the space in which the appliance is located.

UNUSUALLY TIGHT CONSTRUCTION. Construction meeting the following requirements:

1. Walls and ceilings exposed to the outside atmosphere having a continuous air barrier with openings gasketed or sealed; and
2. Weatherstripping on openable windows and doors; and
3. Caulking or sealants applied to areas, such as joints around window and door frames, between sole plates and floors, between wall-ceiling joints, between wall panels, at penetrations for plumbing, electrical and gas lines, and at other openings.

A building of ordinary tightness is one which does not meet the definition of unusually tight construction.

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.

Pellet vent. A vent listed and labeled for use with listed pellet fuel-burning appliances.

Type L vent. A vent listed and labeled for use with oil-burning appliances that are listed for use with Type L vents.

VENT CONNECTOR. The pipe that connects an approved fuel-fired appliance to a vent.

VENT DAMPER DEVICE, AUTOMATIC. A device intended for installation in the venting system, in the outlet of an individual automatically operated fuel-burning appliance that is designed to open the venting system automatically when the appliance is in operation and to close off the venting system automatically when the appliance is in a standby or shutdown condition.

VENTILATION. The natural or mechanical process of supplying conditioned or unconditioned air to, or removing such air from, any space.

VENTILATION AIR. That portion of supply air that comes from the outside (outdoors), plus any recirculated air that has been treated to maintain the desired quality of air within a designated space.

VENTING SYSTEM. A continuous open passageway from the flue collar 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.

WATER HEATER. Appliances which heat potable water and are equipped with approved safety devices and operate at or below all of the following:

1. Volume of 120 gallons (454 L);
2. Water temperature of 210°F. (98.9°C.);
3. 150 pounds (1031 kPa) per square inch operating pressure; and
4. 200,000 Btu (58 620 W) input.

CHAPTER 3
GENERAL REGULATIONS

SECTION 301
GENERAL

301.1 Code compliance. Heating, ventilating, and cooling equipment and water heaters shall conform to the requirements of this code and applicable sections of Chapter 13 of the *Oregon Structural Specialty Code.* Where differences occur between the provisions of this code and reference standards, the provisions of this code shall apply.

Equipment shall not be installed or altered in violation of this code nor shall the fuel input rate to equipment be increased in excess of the approved Btu/h (W) rating at the altitude where it is being used.

301.2 Energy utilization. Not adopted by the State of Oregon.

301.3 Fuel gas appliances and equipment. The approval and installation of fuel gas distribution piping and equipment, fuel gas-fired appliances and fuel gas-fired appliance venting systems shall be in accordance with Appendix C.

301.4 Listed and labeled. All appliances regulated by this code shall be listed and labeled, unless otherwise approved in accordance with Section 105.

301.5 Labeling. Labeling shall be in accordance with the procedures set forth in Sections 301.5.1 through 301.5.2.3.

301.5.1 Testing. An approved agency shall test a representative sample of the mechanical equipment and 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.

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

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

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

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

301.6 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 the seal or mark of the approved agency. A label shall also include the following:

1. Electrical equipment and appliances: Electrical rating in volts, amperes and motor phase; identification of individual electrical components in volts, amperes or watts, motor phase; Btu/h (W) output; and required clearances.
2. Absorption units: Hourly rating in Btu/h (W); minimum hourly rating for units having step or automatic modulating controls; type of fuel; type of refrigerant; cooling capacity in Btu/h (W); and required clearances.
3. Fuel-burning units: Hourly rating in Btu/h (W); type of fuel approved for use with the appliance; and required clearances.
4. Electric comfort heating appliances: Name and trademark of the manufacturer; the model number or equivalent; the electric rating in volts, ampacity and phase; Btu/h (W) output rating; individual marking for each electrical component in amperes or watts, volts and phase; required clearances from combustibles; and a seal indicating approval of the appliance by an approved agency.

NOTE: For reference only. Not adopted as part of this code.

Wood stoves, as defined by the Oregon Department of Environmental Quality OAR Chapter 340, Division 262, are required by DEQ to bear a certification label.

301.7 Electrical. Electrical wiring, controls and connections to equipment and appliances regulated by this code shall be in accordance with the electrical code.

301.8 Plumbing connections. Potable water supply and building drainage system connections to equipment and appliances regulated by this code shall be in accordance with the plumbing code.

301.9 Fuel types. Fuel-fired appliances shall be designed for use with the type of fuel to which they will be connected and the altitude at which they are installed. Appliances that comprise parts of the building mechanical system 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 input rate shall not be increased or decreased beyond the limit rating for the altitude at which the appliance is installed.

301.10 Vibration isolation. Where vibration isolation of equipment and appliances is employed, an approved means of supplemental restraint shall be used to accomplish the support and restraint.

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

301.12 Wind resistance. Mechanical equipment, appliances and supports that are exposed to wind shall be designed and installed to resist the wind pressures determined in accordance with the building code.

301.13 Flood hazard. For structures located in a special flood-hazard area, mechanical systems shall comply with the flood-resistant construction requirements of the building code.

301.14 Prohibited location. Mechanical systems shall not be located in an elevator shaft.

301.15 Rodent proofing. 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 the entrance of rodents in accordance with the building code.

301.16 Seismic resistance. When earthquake loads are applicable in accordance with the building code, mechanical system supports shall be designed and installed for the seismic forces in accordance with the building code.

SECTION 302
PROTECTION OF STRUCTURE

302.1 Structural safety. The building or structure shall not be weakened by the installation of mechanical systems. Where floors, walls, ceilings or any other portion of the building or structure are required to be altered or replaced in the process of installing or repairing any system, the building or structure shall be left in a safe structural condition in accordance with the building code.

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 building code.

302.3 Cutting, notching and boring in wood framing. The cutting, notching and boring of wood framing members shall comply with Sections 302.3.1 through 302.3.3.

302.3.1 Joist notching. Notches on 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 or bottom of the joist, and the diameter of any such hole shall not exceed one-third of the depth of the joist. Notches in the top or bottom of joists shall not exceed one-sixth the depth and shall not be located in the middle third of the span.

302.3.2 Stud cutting and notching. In exterior walls and bearing partitions, any wood stud is permitted to be cut or notched not to exceed 25 percent of its depth. Cutting or notching of studs not greater than 40 percent of their depth in nonbearing partitions supporting no loads other than the weight of the partition.

302.3.3 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 width of the stud permitted in nonbearing 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 .625 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.

302.4 Cutting, notching and boring in steel framing. The cutting, notching and boring of steel framing members shall comply with Sections 302.4.1 through 302.4.3.

302.4.1 Cutting, notching and boring holes in structural steel framing. The cutting, notching and boring of holes in structural steel framing members shall be as pre-scribed by the registered design professional.

302.4.2 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.

302.4.3 Cutting, notching and boring holes in nonstructural cold-formed steel wall framing. Flanges and lips of nonstructural cold-formed steel wall studs shall not be cut or notched. Holes in webs of nonstructural cold-formed steel wall studs shall be permitted along the center-line of the web of the framing member, shall not exceed 1.5 inches (38 mm) in width or 4 inches (102 mm) in length, and 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
EQUIPMENT AND APPLIANCE LOCATION

303.1 General. Equipment and 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. Fuel-fired 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.

Exception: This section shall not apply to the following appliances:

1. Direct-vent appliances that obtain all combustion air directly from the outdoors.
2. Solid fuel-fired appliances, provided that the room is not a confined space and the building is not of unusually tight construction.
3. Appliances installed in a dedicated enclosure in which all combustion air is taken directly from the outdoors, in accordance with Section 703. Access to such enclo-

sure shall be through a solid door, weather-stripped in accordance with the exterior door air leakage requirements of the building code and equipped with an approved self-closing device.

303.4 Protection from damage. Appliances shall not be installed in a location where subject to mechanical damage unless protected by approved barriers.

303.5 Indoor locations. Fuel-fired furnaces and boilers installed in closets and alcoves shall be listed for such installation. For purposes of this section, a closet or alcove shall be defined as a room or space having a volume less than 12 times the total volume of fuel-fired appliances other than boilers and less than 16 times the total volume of boilers. Room volume shall be computed using the gross floor area and the actual ceiling height up to a maximum computation height of 8 feet (2438 mm).

303.6 Outdoor locations. Appliances installed in other than indoor locations shall be listed and labeled for outdoor installation.

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
INSTALLATION

304.1 General. Equipment and appliances shall be installed as required by the terms of their approval. Equipment and appliances shall be installed in accordance with the conditions of listing and the manufacturer's installation instructions and this code. Manufacturer's installation instructions shall be available on the job site at the time of inspection.

304.2 Conflicts. Where conflicts between this code and the conditions of listing or the manufacturer's installation instructions occur, the provisions of this code shall apply.

Exception: 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.

304.3 Ignition source. Heating and/or cooling equipment and water heaters covered by this code, located in a garage and which generate a glow, spark or flame capable of igniting flammable vapors shall be installed with sources of ignition at least 18 inches (457 mm) above the floor level.

304.4 Public garages. Appliances located in public garages, service stations, 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 304.3 and NFPA 88B.

304.5 Private garages. Appliances located in private garages and carports 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 304.3.

304.6 Construction and protection. Boiler rooms and furnace rooms shall be protected as required by the building code.

304.7 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, shutters, coverings and drapes. Devices such as door stops or limits, closers, drapery ties or guards shall not be used to provide the required clearances.

304.8 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.

304.9 Guards. Guards shall be provided where appliances, equipment, 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 appliance, equipment, fan or component 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 building code.

304.10 Area served. Appliances serving different areas of a building other than where they are installed shall be permanently marked in an approved manner that uniquely identifies the appliance and the area it serves.

SECTION 305
PIPING SUPPORT

305.1 General. All mechanical system piping shall be supported in accordance with this section.

305.2 Materials. Pipe hangers and supports shall have sufficient strength to withstand all anticipated static and specified dynamic loading conditions associated with the intended use.

Pipe hangers and supports that are in direct contact with piping shall be of approved materials that are compatible with the piping and that will not promote galvanic action.

305.3 Structural attachment. Hangers and anchors shall be attached to the building construction in an approved manner.

305.4 Interval of support. Piping shall be supported at distances not exceeding the spacing specified in Table 305.4, or piping shall be supported in accordance with MSS SP-69.

TABLE 305.4
PIPING SUPPORT SPACING[a]

PIPING MATERIAL	MAXIMUM HORIZONTAL SPACING (feet)	MAXIMUM VERTICAL SPACING (feet)
ABS pipe	4	10[c]
Aluminum pipe and tubing	10	15
Brass pipe	10	10
Brass tubing, 1 1/4-inch diameter and smaller	6	10
Brass tubing, 1 1/2-inch diameter and larger	10	10
Cast-iron pipe[b]	5	15
Copper or copper-alloy pipe	12	10
Copper or copper-alloy tubing, 1 1/4-inch diameter and smaller	6	10
Copper or copper-alloy tubing, 1 1/2-inch diameter and larger	10	10
CPVC pipe or tubing, 1 inch and smaller	3	10[c]
CPVC pipe or tubing, 1 1/4 inch and larger	4	10[c]
Steel pipe	12	15
Steel tubing	8	10
Lead pipe	Continuous	4
PB pipe or tubing	2 2/3 (32 inches)	4
PEX Tubing	2 2/3 (32 inches)	10[c]
PVC pipe	4	10[c]

For **SI:** 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. See Section 301.14.

b. The maximum horizontal spacing of cast-iron pipe hangers shall be increased to 10 feet where 10-foot lengths of pipe are installed.

c. Mid-story guide.

SECTION 306
ACCESS AND SERVICE SPACE

306.1 Clearances for maintenance and replacement. Clearances around appliances to elements of permanent construction, including other installed equipment and 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.

306.1.1 Central furnaces. Central furnaces within compartments or alcoves shall have a minimum working space clearance of 3 inches (76 mm) along the sides, back and top with a total width of the enclosing space being at least 12 inches (305 mm) wider than the furnace. Furnaces having a firebox open to the atmosphere shall have at least 6 inches (152 mm) working space along the front combustion chamber side. Combustion air openings at the rear or side of the compartment shall comply with the requirements of Chapter 7.

Exception: This section shall not apply to replacement appliances installed in existing compartments and alcoves where the working space clearances are in accordance with the equipment or appliance manufacturer's installation instructions.

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 accessed by an opening or door and an unobstructed passageway measuring not less than 24 inches (610 mm) 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.

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 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 measured along the centerline of the passageway from the opening to the appliance. 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 appliance. 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 appliance.

Exception: The passageway and level service space are not required where the appliance is capable of being serviced and removed through the required opening.

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 appliance location in accordance with the electrical code.

306.4 Appliances under floors. Underfloor spaces containing appliances requiring access shall be provided with an access opening and unobstructed passageway large enough to remove the largest 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 measured along the centerline of the passageway from the opening to the appliance. 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. Such concrete or masonry shall extend a minimum of 4 inches (102 mm) above the adjoining grade and shall have 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 appliance.

Exception: 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.

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 appliance location in accordance with the electrical code.

306.5 Equipment and appliances on roofs or elevated structures. Where equipment and 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 equipment and appliances' level service space. Such access shall not require climbing over obstructions greater than 30 inches (762 mm) high or walking on roofs having a slope greater than 4 units vertical in 12 units horizontal (33 percent slope).

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

306.6 Sloped roofs. Where appliances are installed on a roof having a slope of 3 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 304.9.

SECTION 307
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 horizontal slope in the direction of discharge of not less than one-eighth unit vertical in 12 units horizontal (1-percent slope).

307.2 Evaporators and cooling coils. Condensate drain systems shall be provided for equipment and appliances containing evaporators or cooling coils. Condensate drain systems shall be designed, constructed and installed in accordance with Sections 307.2.1 through 307.2.4.

307.2.1 Condensate disposal. Condensate from all cooling coils or evaporators shall be conveyed from the drain pan outlet to an approved place of disposal as follows:

1. Units larger than 6 tons (21.1 kW) nominal capacity shall discharge to a sanitary sewer drain or storm sewer drain. Where discharging to a sanitary sewer, such drains shall be indirectly connected in accordance with the plumbing code.
2. Units 6 tons (21.1 kW) and smaller nominal capacity shall discharge in accordance with Item 1, or shall discharge to a gutter, roof drain or other approved location.
3. Condensate drains from rooftop units shall discharge in accordance with Item 1 or 2, or shall discharge onto rooftops where the condensate does not discharge into a street, alley or other areas so as to cause a nuisance.

307.2.2 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 (19 mm) internal diameter and shall not decrease in size from the drain pan 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.

307.2.3 Auxiliary and secondary drain systems. In addition to the requirements of Section 307.2.1, a secondary drain or auxiliary drain pan shall be required for each cooling or evaporator coil where damage to any building components will occur as a result of overflow from the equipment drain pan or stoppage in the condensate drain piping. One of the following methods shall be used:

1. An auxiliary drain pan with a separate drain shall be provided under the coils on which condensation will occur. The auxiliary pan drain shall discharge to a conspicuous point of disposal to alert occupants in the event of a stoppage of the primary drain. The pan shall have a minimum depth of 1.5 inches (38 mm), shall not be less than 3 inches (76 mm) larger than the unit or the coil dimensions in width and length and shall be constructed of corrosion-resistant material. Metallic pans shall have a minimum thickness of not less than 0.0276-inch (0.7 mm) galvanized sheet metal. Nonmetallic pans shall have a minimum thickness of not less than 0.0625 inch (1.6 mm).
2. A separate overflow drain line shall be connected to the drain pan provided with the equipment. Such overflow drain shall discharge to a conspicuous point of disposal to alert occupants in the event of a stoppage of the primary drain. The overflow drain line shall connect to the drain pan at a higher level than the primary drain connection.
3. An auxiliary drain pan without a separate drain line shall be provided under the coils on which condensate will occur. Such pan shall be equipped with a water-level detection device that will shut off the equipment

served prior to overflow of the pan. The auxiliary drain pan shall be constructed in accordance with Item 1 of this section.

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

SECTION 308
CLEARANCE REDUCTION

308.1 Scope. This section shall govern the reduction in required clearances to combustible materials and combustible assemblies for chimneys, vents, kitchen exhaust equipment, mechanical appliances, and mechanical devices and equipment.

308.2 Listed appliances and equipment. 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.

Exception: Unlisted appliances and equipment, when approved by the building official, shall be in accordance with an approved nationally recognized standard.

308.3 Protective assembly construction and installation. Reduced clearance protective assemblies, including structural and support elements, shall be constructed of noncombustible materials. Spacers utilized to maintain an airspace between the protective assembly and the protected material or assembly shall be noncombustible. Where a space between the protective assembly and protected combustible material or assembly is specified, the same space shall be provided around the edges of the protective assembly and the spacers shall be placed so as to allow air circulation by convection in such space. Protective assemblies shall not be placed less than 1 inch (25 mm) from the mechanical appliances, devices or equipment, regardless of the allowable reduced clearance.

308.4 Allowable reduction. The reduction of required clearances to combustible assemblies or combustible materials shall be based on the utilization of a reduced clearance protective assembly in accordance with Section 308.5 or 308.6.

308.5 Labeled assemblies. The allowable clearance reduction shall be based on an approved reduced clearance protective assembly that has been tested and bears the label of an approved agency.

308.6 Reduction table. The allowable clearance reduction shall be based on one of the methods specified in Table 308.6. Where required clearances are not listed in Table 308.6, 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.

308.7 Solid fuel-burning appliances. The clearance reduction methods specified in Table 308.6 shall not be utilized to reduce the clearance required for solid fuel-burning appliances that are labeled for installation with clearances of 12 inches (305 mm) or less. Where appliances are labeled for installation with clearances greater than 12 inches (305 mm), the clearance reduction methods of Table 308.6 shall not reduce the clearance to less than 12 inches (305 mm).

308.8 Masonry chimneys. The clearance reduction methods specified in Table 308.6 shall not be utilized to reduce the clearances required for masonry chimneys as specified in Chapter 8 and the building code.

308.9 Chimney connector pass-throughs. The clearance reduction methods specified in Table 308.6 shall not be utilized to reduce the clearances required for chimney connector pass-throughs as specified in Section 803.10.4.

308.10 Masonry fireplaces. The clearance reduction methods specified in Table 308.6 shall not be utilized to reduce the clearances required for masonry fireplaces as specified in Chapter 8 and the building code.

308.11 Kitchen exhaust ducts. The clearance reduction methods specified in Table 308.6 shall not be utilized to reduce the minimum clearances required by Section 506.3.12 for kitchen exhaust ducts enclosed in a shaft.

TABLE 308.6
CLEARANCE REDUCTION METHODS

TYPE OF PROTECTIVE ASSEMBLY[a]	REDUCED CLEARANCE WITH PROTECTION (inches)[a]							
	Horizontal combustible assemblies located above the heat source				Horizontal combustible assemblies located beneath the heat source and all vertical combustible assemblies			
	Required clearance to combustibles without protection (inches)[a]				Required clearance to combustibles without protection (inches)[a]			
	36	18	9	6	36	18	9	6
Galvanized sheet metal, minimum nominal thickness of 0.024 inch (No. 24 Gage), mounted on 1-inch glass fiber or mineral wool batt reinforced with wire on the back, 1 inch off the combustible assembly	18	9	5	3	12	6	3	3
Galvanized sheet metal, minimum nominal thickness of 0.024 inch (No. 24 Gage), spaced 1 inch off the combustible assembly	18	9	5	3	12	6	3	2
Two layers of galvanized sheet metal, minimum nominal thickness of 0.024 inch (No. 24 Gage), having a 1-inch airspace between layers, spaced 1 inch off the combustible assembly	18	9	5	3	12	6	3	3
Two layers of galvanized sheet metal, minimum nominal thickness of 0.024 inch (No. 24 Gage), having 1 inch of fiberglass insulation between layers, spaced 1 inch off the combustible assembly	18	9	5	3	12	6	3	3
1/2-inch inorganic insulating board, over 1 inch of fiberglass or mineral wool batt, against the combustible assembly	24	12	6	4	18	9	5	3
3 1/2-inch brick wall, spaced 1 inch off the combustible wall	—	—	—	—	12	6	6	6
3 1/2-inch brick wall, against the combustible wall	—	—	—	—	24	12	6	5
Prefabricated brick 1 1/8 inch thick spaced out 1 inch and ventilated	30	15	9	3	18	9	6	3

For **SI:** 1 inch = 25.4 mm, °C = [(°F) - 32]/1.8, 1 pound per cubic foot = 16.02 kg/m^3, 1.0 (Btu · in.)/(sq. ft. · hr. · °F) = 0.144 W/m^2 · K.

[a] Mineral wool batts (blanket or board) shall have a minimum density of 8 pounds per cubic foot and a minimum melting point of 1,500°F. Insulation material utilized as part of a clearance reduction system shall have a thermal conductivity of 1.0 (Btu · in.)/(sq. ft. · hr. · °F) or less. Insulation board shall be of noncombustible material.

CHAPTER 4
VENTILATION

SECTION 401
GENERAL

401.1 Scope. This chapter, in conjunction with the building code, shall govern the ventilation of spaces within a building intended to be occupied. This chapter does not govern the requirements for smoke control systems.

401.2 Ventilation required. Every occupied space shall be ventilated in accordance with Chapter 12 of the building code.

NOTE: Heating, ventilating and air conditioning controls shall conform to Chapter 13 of the *Oregon Structural Specialty Code*.

401.3 Vestibule ventilation. Vestibule ventilation for smokeproof enclosures shall be in accordance with the building code.

401.4 Outdoor air inlets. Outdoor air for a ventilation system shall not be taken from the following locations:

1. Closer than 10 feet (3048 mm) from an appliance vent outlet, unless such vent outlet is at least 3 feet (914 mm) above the outdoor air inlet.
2. Where it will pick up hazardous fumes, or flammable vapors.
3. A hazardous or unsanitary location.
4. Closer than 10 feet (3048 mm) from a vent opening of a plumbing drainage system unless such vent outlet is at least 3 feet (914 mm) above the outdoor air inlet.
5. Attics, crawl spaces or garages.

401.5 Opening location. Not adopted by the State of Oregon.

401.5.1 Intake openings. Mechanical and gravity outside air intake openings shall be located a minimum of 10 feet (3048 mm) from any hazardous or noxious contaminant, such as vents, chimneys, plumbing vents, streets, alleys, parking lots and loading docks, except as otherwise specified in this code. Where a source of contaminant is located within 10 feet (3048 mm) of an intake opening, such opening shall be located a minimum of 2 feet (610 mm) below the contaminant source.

401.5.2 Exhaust openings. Outside exhaust openings shall be located so as not to create a nuisance. Exhaust air shall not be directed onto walkways.

401.6 Outdoor opening protection. Air exhaust and intake openings that terminate outdoors shall be protected with corrosion-resistant screens, louvers or grilles. Openings in louvers, grilles and screens shall be sized in accordance with Table 401.6. Openings shall be protected against local weather conditions. Outdoor air exhaust and intake openings located in exterior walls shall meet the provisions for exterior wall opening protectives in accordance with the building code.

TABLE 401.6
OPENING SIZES IN LOUVERS, GRILLES AND SCREENS PROTECTING OUTDOOR EXHAUST AND AIR INTAKE OPENINGS

OUTDOOR OPENING TYPE	MINIMUM AND MAXIMUM OPENING SIZES IN LOUVERS, GRILLES AND SCREENS MEASURED IN ANY DIRECTION
Exhaust openings	Not < $^1/_4$ inch and not > $^1/_2$ inch
Intake openings in residential occupancies	Not < $^1/_4$ inch and not > $^1/_2$ inch
Intake openings in other than residential occupancies	> $^1/_4$ inch and not > 1 inch

For **SI:** 1 inch = 25.4 mm.

401.7 Contaminant sources. Stationary local sources producing air-borne particulates, heat, odors, fumes, spray, vapors, smoke or gases in such quantities as to be irritating or injurious to health shall be provided with an exhaust system in accordance with Chapter 5 or a means of collection and removal of the contaminants. Such exhaust shall discharge directly to an approved location at the exterior of the building.

SECTION 402
NATURAL VENTILATION

Not adopted by the State of Oregon.

SECTION 403
MECHANICAL VENTILATION

Not adopted by the State of Oregon.

SECTION 404
ENCLOSED PARKING GARAGES

Not adopted by the State of Oregon.

SECTION 405
SYSTEMS CONTROL

Not adopted by the State of Oregon.

SECTION 406
VENTILATION OF UNINHABITED SPACES

406.1 General. Uninhabited spaces, such as crawl spaces and attics, shall be provided with natural ventilation openings as required by the building code or shall be provided with a mechanical exhaust and supply air system. The mechanical exhaust rate shall be not less than 0.02 cfm per square foot (0.00001 $m^3/s \cdot m^2$) of horizontal area and shall be automatically controlled to operate when the relative humidity in the space served exceeds 60 percent.

(Pages 29 and 30 have been deleted. Text continues on page 31.)

CHAPTER 5
EXHAUST SYSTEMS

SECTION 501
GENERAL

501.1 Scope. This chapter shall govern the design, construction and installation of mechanical exhaust systems, including dust, stock and refuse conveyor systems and exhaust systems serving commercial food heat-processing appliances.

501.2 Independent system required. Single or combined mechanical exhaust systems from bath, toilet, urinal, locker, service sink closets and similar rooms shall be independent of other exhaust systems. Type I exhaust systems shall be independent of all other exhaust systems except as provided in Section 506.3.7. Single or combined Type II exhaust systems for food-processing operations shall be independent of all other exhaust systems. Kitchen exhaust systems shall be constructed in accordance with Section 505 for domestic equipment and Sections 506 through 509 for commercial equipment.

501.3 Outdoor discharge. The air removed by every mechanical exhaust system shall be discharged outdoors at a point where it will not cause a nuisance and from which it cannot again be readily drawn in by a ventilating system. Air shall not be exhausted into an attic or crawl space.

Exception: Whole-house ventilation-type attic fans that discharge into the attic space of dwelling units having private attics shall not be prohibited.

501.4 Pressure equalization. Mechanical exhaust systems shall be sized to remove the quantity of the air required by this chapter to be exhausted. The system shall operate when air is required to be exhausted. Where mechanical exhaust is required in a room or space in other than occupancies in Use Group R-3, such space shall be maintained with a neutral or negative pressure. If a greater quantity of air is supplied by a mechanical ventilating supply system than is removed by a mechanical exhaust system for a room, adequate means shall be provided for the natural exit of the excess air supplied. If only a mechanical exhaust system is installed for a room or if a greater quantity of air is removed by a mechanical exhaust system than is supplied by a mechanical ventilating supply system for a room, adequate means shall be provided for the natural supply of the deficiency in the air supplied.

501.5 Ducts. Where exhaust duct construction is not specified in this chapter, such construction shall comply with Chapter 6.

SECTION 502
REQUIRED SYSTEMS

502.1 General. An exhaust system shall be provided, maintained and operated for all occupied areas where machines, vats, tanks, furnaces, forges, salamanders and other appliances, equipment and processes in such areas produce or throw off dust or particles sufficiently light to float in the air, or which emit heat, odors, fumes, spray, gas or smoke, in such quantities so as to be irritating or injurious to health or safety and as specifically required by this section.

502.1.1 Exhaust location. The inlet to the exhaust system shall be located in the area of heaviest concentration of contaminants.

502.1.2 Fuel dispensing areas. The bottom of the air inlet or exhaust opening in fuel dispensing areas shall be located not more than 18 inches (457 mm) above the floor.

502.1.3 Equipment, appliances and service rooms. All equipment, appliances and system service rooms that house sources of odors, fumes, noxious gases, smoke, steam, dust, spray or other contaminants, shall be designed and constructed so as to prevent spreading of such contaminants to other occupied parts of the building.

502.1.4 Hazardous exhaust. The mechanical exhaust of high concentrations of dust or hazardous vapors shall conform to the requirements of Section 510.

502.2 Spray-painting and dipping rooms. Rooms or booths utilized for spray painting or dipping shall have a mechanical exhaust system that complies with the fire code and NFPA 33 for spray painting or NFPA 34 for dipping. The exhaust system shall have automatic controls to ensure its operation while spray painting or dipping is being conducted.

502.3 Dry-cleaning appliances. The exhaust system for Type I and Type II systems shall provide a complete and continuous air change not less than once every 3 minutes in dry-cleaning and dry-dyeing rooms. The system shall be provided with means for remote control and shall operate automatically when any dry-cleaning or dry-dyeing appliance is in use. Dry-cleaning appliances shall be provided with an exhaust system capable of maintaining a minimum air velocity of 100 feet per minute (0.5 m/s) across the face of the loading door.

502.4 Hazardous materials. All structures in which hazardous materials are stored shall be provided with a mechanical exhaust system where required by the fire code. The mechanical exhaust ventilation rate shall not be less than 1 cfm (0.00047 m^3/s) per square foot of floor area utilized for storage, and not less than 150 cfm (0.071 m^3/s) total.

502.4.1 Design. The mechanical exhaust system shall be designed with consideration for the potential fumes or vapors released. Where fumes and vapors are heavier than air, the inlet to the exhaust shall be taken from a point within 12 inches (305 mm) above the floor. The exhaust and supply air openings shall be located to provide uniform air movement across all portions of the floor, room or space. The mechanical exhaust system shall be designed with controls to ensure continuous operation.

502.4.2 Controls. A manual shutoff control shall be provided outside the hazardous material storage room adjacent to the access door into the room or in an approved remote

location. The shutoff control shall be of the break-glass type and shall be identified by the words "Ventilation System Emergency Shutoff."

502.5 Dry cleaning plants. Not adopted by the State of Oregon.

502.6 Application of flammable finishes. Not adopted by the State of Oregon.

502.7 Hazardous materials—general requirements. Not adopted by the State of Oregon.

502.8 Hazardous materials—requirements for specific materials. Not adopted by the State of Oregon.

502.9 Hazardous production materials (HPM). Not adopted by the State of Oregon.

502.10 Motion picture projectors. Motion picture projectors shall be exhausted in accordance with Section 502.10.1 or 502.10.2.

502.10.1 Projectors with an exhaust discharge. Projectors equipped with an exhaust discharge shall be directly connected to a mechanical exhaust system. The exhaust system shall operate at an exhaust rate as indicated by the manufacturer's installation instructions.

502.10.2 Projectors without exhaust connection. Projectors without an exhaust connection shall have contaminants exhausted through a mechanical exhaust system. The exhaust rate for electric arc projectors shall be a minimum of 200 cubic feet per minute (cfm) (0.09 m^3/s) per lamp. The exhaust rate for xenon projectors shall be a minimum of 300 cfm (0.14 m^3/s) per lamp. The xenon projector exhaust shall be at a rate such that the exterior temperature of the lamp housing shall not exceed 130°F (54°C). The lamp and projection room exhaust systems, if combined or independent, shall not be interconnected with any other exhaust or return system within the building.

502.11 Organic coating processes. Not adopted by the State of Oregon.

502.12 Public garages. Mechanical exhaust systems for public garages, as required in accordance with the building code, Section 1203.2.11.

502.13 Motor vehicle operation. In areas where motor vehicles operate, mechanical ventilation shall be provided in accordance with the building code, Section 1203.2.8.

502.14 Repair garages. Not adopted by the State of Oregon.

502.15 Repair garages for natural gas- and hydrogen-fueled vehicles. Not adopted by the State of Oregon.

502.16 Tire rebuilding or recapping. Each room where rubber cement is used or mixed, or where flammable or combustible solvents are applied, shall be ventilated in accordance with the applicable provisions of NFPA 91.

502.16.1 Buffing machines. Each buffing machine shall be connected to a dust-collecting system that prevents the accumulation of the dust produced by the buffing process.

502.17 Specific rooms. Specific rooms, including bathrooms, locker rooms, smoking lounges and toilet rooms, shall be exhausted in accordance with the ventilation requirements of the building code.

SECTION 503
MOTORS AND FANS

503.1 General. Motors and fans shall be sized to provide the required air movement. Motors in areas that contain flammable vapors or dusts shall be of a type approved for such environments. A manually operated remote control installed at an approved location shall be provided to shut off fans or blowers in flammable vapor or dust systems. Electrical equipment and appliances used in operations that generate explosive or flammable vapors, fumes or dusts shall be interlocked with the ventilation system so that the equipment and appliances cannot be operated unless the ventilation fans are in operation. Motors for fans used to convey flammable vapors or dusts shall be located outside the duct or shall be protected with approved shields and dustproofing. Motors and fans shall be provided with a means of access for servicing and maintenance.

503.2 Fans. Parts of fans in contact with explosive or flammable vapors, fumes or dusts shall be of nonferrous or nonsparking materials, or their casing shall be lined or constructed of such material. When the size and hardness of materials passing through a fan is capable of producing a spark, both the fan and the casing shall be of nonsparking materials. When fans are required to be spark resistant, their bearings shall not be within the airstream, and all parts of the fan shall be grounded. Fans in systems-handling materials that are capable of clogging the blades, and fans in buffing or woodworking exhaust systems, shall be of the radial-blade or tube-axial type.

503.3 Equipment and appliances identification plate. Equipment and appliances used to exhaust explosive or flammable vapors, fumes or dusts shall bear an identification plate stating the ventilation rate for which the system was designed.

503.4 Corrosion-resistant fans. Fans located in systems conveying corrosives shall be of materials that are resistant to the corrosive or shall be coated with corrosion-resistant materials.

SECTION 504
CLOTHES DRYER EXHAUST

504.1 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.

504.2 Exhaust 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 building code to be fire-resistance rated, unless such duct is constructed of galvanized steel or aluminum of the thickness specified in Section 603.3 and the fire-resistance rating is maintained in accordance with the building code.

504.3 Cleanout. Each vertical riser shall be provided with a means for cleanout.

504.4 Exhaust installation. Dryer 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 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.

504.5 Makeup air. Installations exhausting more than 200 cfm (0.09 m^3/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 (0.0645 m^2) shall be provided in the closet enclosure.

504.6 Domestic clothes dryer ducts. Exhaust ducts for domestic clothes dryers shall be constructed of metal and 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 limited to single lengths not to exceed 8 feet (2438 mm) in length. Transition ducts shall not be concealed within construction.

504.6.1 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 $2^1/_2$ feet (762 mm) for each 45-degree (0.79 rad) bend and 5 feet (1524 mm) for each 90-degree (1.6 rad) bend.

504.6.2 Rough-in required. When a compartment or space for a domestic clothes dryer is provided, an exhaust duct system shall be installed in accordance with Section 504.6.

504.7 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. Clothes dryer transition ducts used to connect the appliance to the exhaust duct system shall be limited to single lengths not to exceed 8 feet (2438 mm) in length and shall be listed and labeled for the application. Transition ducts shall not be concealed within construction.

SECTION 505
DOMESTIC KITCHEN EXHAUST EQUIPMENT

505.1 Domestic systems. Where domestic range hoods and domestic appliances equipped with down draft exhaust are located within dwelling units, such hoods and appliances shall discharge to the outdoors through ducts constructed of galvanized steel, stainless steel, aluminum or copper. Such ducts shall have smooth inner walls and shall be air tight and equipped with a backdraft damper.

Exceptions:

1. Where installed in accordance with the manufacturer's installation instructions, listed and labeled ductless range hoods shall not be required to discharge to the outdoors.
2. Ducts for domestic kitchen cooking appliances equipped with downdraft exhaust systems shall be permitted to be constructed of Schedule 40 PVC pipe provided that the installation complies with all of the following:
   - 2.1 The duct shall be installed under a concrete slab floor poured on grade.
   - 2.2 The underfloor trench in which the duct is installed shall be completely backfilled with sand or gravel.
   - 2.3 The PVC duct shall extend not greater than 1 inch (25.4 mm) above the indoor concrete floor surface.
   - 2.4 The PVC duct shall extend not greater than 1 inch (25.4 mm) above grade outside of the building.
   - 2.5 The PVC duct joints shall be solvent cemented.

SECTION 506
COMMERCIAL KITCHEN GREASE DUCTS AND EXHAUST EQUIPMENT

506.1 General. Commercial kitchen grease ducts and exhaust equipment shall comply with the requirements of this section. Commercial kitchen grease ducts shall be designed for the type of cooking appliance and hood served.

506.2 Corrosion protection. Ducts exposed to the outside atmosphere or subject to a corrosive environment shall be protected against corrosion in an approved manner.

506.3 Ducts serving Type I hoods. Commercial kitchen exhaust systems serving Type I hoods shall be designed, constructed and installed in accordance with Sections 506.3.1 through 506.3.14.3.

506.3.1 Exhaust fans. Exhaust fan housings serving a Type I hood shall be constructed of steel.

Exception: Fans listed and labeled as power roof ventilators for restaurant cooking appliances.

506.3.1.1 Fan motor. Exhaust fan motors shall be located outside of the exhaust airstream.

506.3.2 Grease diverter. Where a centrifugal fan with horizontal discharge is located outside the building, such fan shall be provided with a duct or duct fitting connected to the fan outlet that diverts the discharge from the grease exhaust duct system in an upward direction. Such diverter duct or fitting shall comply with the following:

1. The duct or duct fitting shall be constructed of metal as set forth in Chapter 6.
2. The maximum total developed length of the duct or duct fitting measured along the centerline shall not exceed three times the vertical dimension of the fan outlet.
3. The duct or duct fitting shall be provided with openings at the lowest point to permit drainage of grease to an approved collection device.

506.3.3 Grease duct materials. Grease ducts serving a Type I hood shall be constructed of steel not less than 0.055 inch (1.4 mm) (No. 16 Gage) in thickness or stainless steel not less than 0.044 inch (1.1 mm) (No. 18 gage) in thickness.

Exception: Listed and labeled factory-built commercial kitchen grease ducts installed in accordance with Section 304.1.

506.3.4 Joints, seams and penetrations of grease ducts. Joints, seams and penetrations of grease ducts shall be made with a continuous liquid-tight weld or braze made on the external surface of the duct system.

Exceptions:

1. Penetrations shall not be required to be welded or brazed where sealed by devices that are listed for the application.
2. Internal welding or brazing shall not be prohibited provided that the joint is formed or ground smooth and is provided with ready access for inspection.
3. Listed and labeled factory-built commercial kitchen grease ducts installed in accordance with Section 304.1.

506.3.4.1 Duct joint types. Duct joints shall be butt joints or overlapping duct joints of either the telescoping or bell type. Overlapping joints shall be installed to prevent ledges and obstructions from collecting grease or interfering with gravity drainage to the intended collection point. The difference between the inside cross-sectional dimensions of overlapping sections of duct shall not exceed $^1/_4$ inch (6 mm). The length of overlap for overlapping duct joints shall not exceed 2 inches (51 mm).

506.3.4.2 Duct-to-hood joints. Duct to hood joints shall be made with continuous internal or external liquid-tight welded or brazed joints. Such joints shall be smooth, accessible for inspection, and without grease traps.

Exceptions: This section shall not apply to:

1. A vertical duct to hood collar connection made in the top plane of the hood in accordance with all of the following:
   1.1 The hood duct opening shall have a 1-inch (25.4 mm) deep, full perimeter, welded flange turned down into the hood interior at an angle of 90 degrees from the plane of the opening.
   1.2 The duct shall have a 1-inch (25.4 mm) deep flange made by a 1-inch by 1-inch (25.4 mm by 25.4 mm) angle iron welded to the full perimeter of the duct not less than 1 inch (25.4 mm) above the bottom end of the duct.
   1.3 A gasket rated for use at not less than 1,500°F (815°C) is installed between the duct flange and the top of the hood.
   1.4 The duct to hood joint shall be secured by stud bolts not less than $^1/_4$ inch (6.4 mm) in diameter welded to the hood with a spacing not greater than 4 inches (102 mm) on center for the full perimeter of the opening. All bolts and nuts are to be secured with lockwashers.
2. Listed and labeled duct to hood collar connections installed in accordance with Section 304.1.

506.3.4.3 Duct to exhaust fan connections. Duct to exhaust fan connections shall be flanged and gasketed at the base of the fan for listed and labeled vertical discharge fans; shall be flanged, gasketed, and bolted to the inlet of the fan for side inlet utility fans; and shall be flanged, gasketed, and bolted to the inlet and outlet of the fan for in-line fans.

506.3.4.4 Vibration isolation. A vibration isolation connector for connecting a duct to a fan shall consist of noncombustible packing in a metal sleeve joint of approved design or shall be a coated fabric flexible duct connector listed and labeled for the application. Vibration isolation connectors shall be installed only at the connection of a duct to a fan inlet or outlet.

506.3.5 Grease duct supports. Grease duct bracing and supports shall be of noncombustible material securely attached to the structure and designed to carry gravity and seismic loads within the stress limitations of the building code. Bolts, screws, rivets and other mechanical fasteners shall not penetrate duct walls.

506.3.6 Air velocity. Grease duct systems serving a Type I hood shall be designed and installed so as to provide an air velocity within the duct system of not less than 1,500 feet per minute (7.6 m/s).

Exception: The velocity limitations shall not apply within duct transitions utilized to connect ducts to differently sized or shaped openings in hoods and fans, provided that such transitions do not exceed 3 feet (914 mm) in length and are designed to prevent the trapping of grease.

506.3.7 Separation of grease duct system. A separate grease duct system shall be provided for each Type I hood. A separate grease duct system is not required where all of the following conditions are met:

1. All interconnected hoods are located within the same story.
2. All interconnected hoods are located within the same room or in adjoining rooms.
3. Interconnecting ducts do not penetrate assemblies required to be fire-resistance rated.
4. The grease duct system does not serve solid fuel-fired appliances.

506.3.8 Clearances. Grease duct systems serving a Type I hood shall have a clearance to combustible construction of not less than 18 inches (457 mm).

Exceptions:

1. Listed and labeled factory-built commercial kitchen grease ducts installed in accordance with Section 304.1.
2. Grease ducts installed in accordance with Section 506.3.12.

506.3.9 Prevention of grease accumulation. Duct systems serving a Type I hood shall be constructed and installed so

that grease cannot collect in any portion thereof, and the system shall slope not less than one-fourth unit vertical in 12 units horizontal (2-percent slope) toward the hood or toward an approved grease reservoir. Where horizontal ducts exceed 75 feet (22 860 mm) in length, the slope shall be not less than one unit vertical in 12 units horizontal (8.3-percent slope). Exhaust fans shall be positioned so that the discharge will not impinge on the roof, other equipment or appliances or parts of the structure. A vertical discharge fan shall be manufactured with an approved drain outlet at the bottom of the housing to permit drainage of grease to an approved grease reservoir.

506.3.10 Cleanouts and other openings. Grease duct systems shall not have openings therein other than those required for proper operation and maintenance of the system. Any portion of such system having sections not provided with access from the duct entry or discharge shall be provided with cleanout openings. Cleanout openings shall be equipped with tight-fitting doors constructed of steel having a thickness not less than that required for the duct. Doors shall be equipped with a substantial method of latching, sufficient to hold the door tightly closed. Doors shall be designed so that they are operable without the use of a tool. Door assemblies, including any frames and gasketing, shall be approved for the purpose, and shall not have fasteners that penetrate the duct. Listed and labeled access door assemblies shall be installed in accordance with the terms of the listing.

506.3.10.1 Personnel entry. Where ductwork is large enough to allow entry of personnel, not less than one approved or listed opening having dimensions not less than 20 inches by 20 inches (508 mm by 508 mm) shall be provided in the horizontal sections, and in the top of vertical risers. Where such entry is provided, the duct and its supports shall be capable of supporting the additional load and the cleanouts specified in Section 506.3.11 are not required.

506.3.11 Horizontal cleanouts. Cleanouts located on horizontal sections of ducts shall be spaced not more than 20 feet (6096 mm) apart. The cleanouts shall be located on the side of the duct with the opening not less than $1^1/_2$ inches (38 mm) above the bottom of the duct, and not less than 1 inch (25.4 mm) below the top of the duct. The opening minimum dimensions shall be 12 inches (305 mm) on each side. Where the dimensions of the side of the duct prohibit the cleanout installation prescribed herein, the openings shall be on the top of the duct or the bottom of the duct. Where located on the top of the duct, the opening edges shall be a minimum of 1 inch (25.4 mm) from the edges of the duct. Where located in the bottom of the duct, cleanout openings shall be designed to provide internal damming around the opening, shall be provided with gasketing to preclude grease leakage, shall provide for drainage of grease down the duct around the dam, and shall be approved for the application. Where the dimensions of the sides, top or the bottom of the duct preclude the installation of the prescribed minimum size cleanout opening, the cleanout shall be located on the duct face that affords the largest opening dimension and shall be installed with the opening edges at the prescribed distances from the duct edges as previously set forth in this section.

506.3.12 Duct enclosure. A grease duct serving a Type I hood that penetrates a ceiling, wall or floor shall be enclosed from the point of penetration to the outlet terminal. A duct shall only penetrate exterior walls at locations where unprotected openings are permitted by the building code. Ducts shall be enclosed in accordance with the building code requirements for shaft construction. The duct enclosure shall be sealed around the duct at the point of penetration and vented to the outside of the building through the use of weather-protected openings. The enclosure shall be separated from the duct by a minimum of 6 inches (152 mm) and a maximum of 12 inches (305 mm) and shall serve a single grease exhaust duct system (see Section 506.3.8).

Exceptions:

1. The shaft enclosure provisions of Section 506.3.12 shall not be required where a duct penetration is protected with a through-penetration firestop system classified in accordance with ASTM E 814 and having an "F" and "T" rating equal to the fire-resistance rating of the assembly being penetrated and where the surface of the duct is continuously covered on all sides from the point at which the duct penetrates a ceiling wall or floor to the outlet terminal with a classified and labeled material, system, method of construction or product specifically evaluated for such purpose, in accordance with a nationally recognized standard for such enclosure materials.
2. A duct enclosure shall not be required for a grease duct that penetrates only a non-fire-resistance-rated roof/ceiling assembly.

506.3.13 Fire-resistive access opening. Where cleanout openings are located in ducts within a fire-resistance-rated enclosure, access openings shall be provided in the enclosure at each cleanout point. Access openings shall be equipped with tight-fitting sliding or hinged doors that are equal in fire-resistive protection to that of the shaft or enclosure. An approved sign shall be placed on access opening panels with wording as follows: "ACCESS PANEL. DO NOT OBSTRUCT."

506.3.14 Type I exhaust outlets. Exhaust outlets for grease ducts serving commercial food heat-processing appliances shall conform to the requirements of Sections 506.3.14.1 through 506.3.14.3.

506.3.14.1 Termination above the roof. Exhaust outlets that terminate above the roof shall have the discharge located not less than 40 inches (1016 mm) above the roof surface.

506.3.14.2 Termination through an exterior wall. Exhaust outlets shall be permitted to terminate through exterior walls where the smoke, grease, gases, vapors and odors in the discharge from such terminiations do not create a public nuisance or a fire hazard. Such terminations shall not be located where protected openings are required by the building code. Other exterior openings shall

not be located within 3 feet (914 mm) of such terminations.

506.3.14.3 Termination location. Exhaust outlets shall be located not less than 10 feet (3048 mm) horizontally from parts of the same or contiguous buildings, adjacent property lines and air intake openings into any building and shall be located not less than 10 feet (3048 mm) above the adjoining grade level.

Exceptions:

1. Exhaust outlets shall terminate not less than 5 feet (1524 mm) from an adjacent building, adjacent property line and air intake openings into a building where air from the exhaust outlet discharges away from such locations.
2. The minimum horizontal distance between vertical discharge fans and parapet-type building structures shall be 2 feet (610 mm) provided that such structures are not higher than the top of the fan discharge opening.

506.4 Ducts serving Type II hoods. Commercial kitchen exhaust systems serving Type II hoods shall comply with Sections 506.4.1 and 506.4.2.

506.4.1 Type II exhaust outlets. Exhaust outlets for ducts serving Type II hoods shall comply with Sections 401.5 and 401.5.2. Such outlets shall be protected against local weather conditions and shall meet the provisions for exterior wall opening protectives in accordance with the building code.

506.4.2 Ducts. Ducts and plenums serving Type II hoods shall be constructed of rigid metallic materials. Duct construction, installation, bracing and supports shall comply with Chapter 6. Ducts subject to positive pressure and ducts conveying mositure-laden or waster-heat-laden air shall be constructed, joined and sealed in an appoved manner.

SECTION 507
COMMERCIAL KITCHEN HOODS

507.1 General. Commercial kitchen exhaust hoods shall comply with the requirements of this section. Hoods shall be Type I or Type II and shall be designed to capture and confine cooking vapors and residues.

Exception: Factory-built commercial exhaust hoods which are tested in accordance with UL 710, listed, labeled and installed in accordance with Section 304.1 shall not be required to comply with Sections 507.4, 507.5, 507.7, 507.12, 507.13, 507.15 and 507.16.

507.2 Where required. A Type I or Type II hood shall be installed at or above all commercial food heat-processing appliances. A Type II hood shall be installed above commercial dishwashing machines.

Exceptions:

1. Food heat-processing appliances installed within a dwelling unit.
2. Under-counter type commerical diswashing machines.

507.2.1 Type I and Type II hoods. A Type I hood shall be installed at or above all commercial food heat-processing appliances that produce grease vapors or smoke. A Type I or Type II hood shall be installed at or above all commercial food heat-processing appliances that produces fumes, steam, odor or heat.

507.2.2 Domestic cooking appliances used for commercial purposes. Domestic cooking appliances utilized for commercial purposes shall be provided with Type I or II hoods as required for the type of appliances and processes in accordance with Sections 507.2 and 507.2.1.

507.2.3 Solid fuel. Type I hoods for use over solid fuel-burning cooking appliances shall discharge to an exhaust system that is independent of other exhaust systems.

507.3 Fuel-burning appliances. Where vented fuel-burning appliances are located in the same room or space as the hood, provisions shall be made to prevent the hood system from interfering with normal operation of the appliance vents.

507.4 Type I materials. Type I hoods shall be constructed of steel not less than 0.043 inch (1.09 mm) (No. 18 MSG) in thickness, or stainless steel not less than 0.037 inch (0.94 mm) (No. 20 MSG) in thickness.

507.5 Type II hood materials. Type II hoods shall be constructed of steel not less than 0.030 inch (0.76 mm) (No. 22 gage) in thickness, stainless steel not less than 0.024 inch (0.61 mm) (No. 24 gage) in thickness, copper sheets weighing not less than 24 ounces per square foot (7.3 kg/m^2), or of other approved material and gage.

507.6 Supports. Hoods shall be secured in place by noncombustible supports. All Type I and II hood supports shall be adequate for the applied load of the hood, the unsupported ductwork, the effluent loading, and the possible weight of personnel working in or on the hood.

507.7 Hood joints, seams and penetrations. Hood joints, seams and penetrations shallcomply with Sections 507.7.1 and 507.7.2.

507.7.1 Type I hoods. External hood joints, seams and penetrations for Type I hoods shall be made with a continuous external liquid-tight weld or braze to the lowest outermost perimeter of the hood. Internal hood joints, seams, penetrations, filter support frames and other appendages attached insid the hood shall not be required to be welded or brazed, but shall be otherwise sealed to be grease tight.

Exceptions:

1. Penetrations shall not be required to be welded or brazed where sealed by devices that are listed for the application.
2. Internal welding or brazing of seams, joints, and penetrations of the hood shall not be prohibited provided that the joint is formed smooth or ground so as to not trap grease, and is readily cleanable.
3. External hood joints and seams tested and listed in accordance with the requirements of UL 710 shall not be required to be welded or brazed.

507.7.2 Type II hoods. Joints, seams and penetrations for Type II hoods shall be constructed as set forth in Chapter 6,

shall be sealed on the interior of the hood and shall provide a smooth surface that is readily cleanable and water tight.

507.8 Cleaning and grease gutters. A hood shall be designed to provide for thorough cleaning of the entire hood. Grease gutters shall drain to an approved collection receptacle that is fabricated, designed and installed to allow access for cleaning.

507.9 Clearances for Type I hood. A Type I hood shall be installed with a clearance to combustibles of not less than 18 inches (457 mm). This clearance may be reduced to 3 inches (76 mm), provided the combustible material is protected with materials as specified for one-hour fire-resistive construction on the hood side. Hoods less than 12 inches (305 mm) from the ceiling or wall shall be flashed solidly with materials of the thickness specified in Section 508.2 or materials conforming to one-hour fire-resistive construction.

507.10 Hoods penetrating a ceiling. Type I hoods or portions thereof penetrating a ceiling, wall or furred space shall comply with all the requirements of Section 506.3.12.

507.11 Grease filters. Type I hoods shall be equipped with listed grease filters designed for the specific purpose. Grease-collecting equipment shall be provided with access for cleaning. The lowest edge of a grease filter located above the cooking surface shall be not less than the height specified in Table 507.11.

TABLE 507.11
MINIMUM DISTANCE BETWEEN THE LOWEST EDGE OF A GREASE FILTER AND THE COOKING SURFACE OR THE HEATING SURFACE

TYPE OF COOKING APPLIANCE	HEIGHT ABOVE COOKING SURFACE (feet)
Without exposed flame	1/2
Exposed flame and burners	2
Exposed charcoal and charbroil type	3 1/2

For **SI:** 1 foot = 304.8 mm.

507.11.1 Criteria. Filters shall be of such size, type and arrangement as will permit the required quantity of air to pass through such units at rates not exceeding those for which the filter or unit was designed or approved. Filter units shall be installed in frames or holders so as to be readily removable without the use of separate tools, unless designed and installed to be cleaned in place and the system is equipped for such cleaning in place. Removable filter units shall be of a size that will allow them to be cleaned in a dishwashing machine or pot sink. Filter units shall be arranged in place or provided with drip-intercepting devices to prevent grease or other condensate from dripping into food or on food preparation surfaces.

507.11.2 Mounting position. Filters shall be installed at an angle of not less than 45 degrees (0.79 rad) from the horizontal and shall be equipped with a drip tray beneath the lower edge of the filters.

507.12 Canopy size and location. The inside edge of canopy-type commercial cooking hoods shall overhang or extend a horizontal distance of not less than 6 inches (152 mm) beyond the edge of the cooking surface, on all open sides. The vertical distance between the front lower lip of the hood and the cooking surface shall not exceed 4 feet (1219 mm).

Exception: The hood shall be permitted to be flush with the outer edge of the cooking surface where the hood is closed to the appliance side by a non-combustible wall or panel.

507.13 Capacity of hoods. Canopy-type commercial cooking hoods shall exhaust a minimum quantity of air (Q) determined in accordance with this section and Sections 507.13.1 through 507.13.4.

where:

A = The horizontal surface area of the hood, in square feet (m^2).

D = Distance in feet (mm) between the lower lip of the hood and the cooking surface.

P = That part of the perimeter of the hood that is open, in feet (mm).

Q = Quantity of air, in cubic feet per minute (L/s).

507.13.1 Solid fuel-burning cooking appliances. The minimum airflow for Type I hoods used for solid fuel-burning cooking appliances, grease-burning charbroilers and similar appliances shall be:

Number of exposed sides	Formula	For **SI:**
4 (island or central hood)	$Q = 300A$	$Q = 1.52A$
3 or less	$Q = 200A$	$Q = 1.02A$
Alternate formula	$Q = 100PD$	$Q = 0.51PD$

507.13.2 High temperature. The minimum airflow for Type I hoods used for high-temperature appliances such as deep-fat fryers shall be determined as follows:

Number of exposed sides	Formula	For **SI:**
4 (island or central hood)	$Q = 150A$	$Q = 0.76A$
3 or less	$Q = 100A$	$Q = 0.51A$
Alternate formula	$Q = 100PD$	$Q = 0.51PD$

507.13.3 Medium temperature. The minimum airflow for Type I hoods used for medium-temperature appliances such as rotisseries, grills and ranges shall be determined as follows:

Number of exposed sides	Formula	For **SI:**
4 (island or central hood)	$Q = 100A$	$Q = 0.51A$
3 or less	$Q = 75A$	$Q = 0.38A$
Alternate formula	$Q = 50PD$	$Q = 0.25PD$

507.13.4 Low temperature. The minimum airflow for Type I hoods used for low-temperature appliances such as medium-to-low-temperature ranges, roasters, roasting ovens, pastry ovens and appliances approved for use under a Type II hood, such as pizza ovens, shall be determined as follows:

Number of exposed sides	Formula	For SI:
4 (island or central hood)	$Q = 75A$	$Q = 0.38A$
3 or less	$Q = 50A$	$Q = 0.25A$
Alternate formula	$Q = 50PD$	$Q = 0.25PD$

507.14 Noncanopy size and location. Noncanopy-type hoods shall be located a maximum of 3 feet (914 mm) above the cooking surface. The edge of the hood shall be set back a maximum of 1 foot (305 mm) from the edge of the cooking surface.

507.15 Capacity for noncanopy hoods. In addition to all other requirements for hoods specified in this section, the volume of air exhausting through a noncanopy-type hood to the duct system shall be not less than 300 cfm per lineal foot [0.46 $m^3/(s \cdot m)$] of cooking appliances.

507.16 Exhaust outlets. Exhaust outlets located within the hood shall be located so as to optimize the capture of particulate matter. Each outlet shall serve not more than a 12-foot (3658 mm) section of hood.

507.17 Performance test. A performance test shall be conducted upon completion and before final approval of the installation of a ventilation system serving commercial food heat-processing appliances. The test shall verify the rate of airflow and proper operation as specified in this chapter. The permit holder shall furnish the necessary test equipment and devices required to perform the tests.

SECTION 508
COMMERCIAL KITCHEN MAKEUP AIR

508.1 Makeup air. Makeup air shall be supplied during the operation of commercial kitchen exhaust systems that are provided for commercial food heat-processing appliances. The amount of makeup air supplied shall be approximately equal to the amount of exhaust air. The makeup air shall not reduce the effectiveness of the exhaust system. Makeup air shall be provided by gravity or mechanical means or both. For mechanical makeup air systems, the exhaust and makeup air systems shall be electronically interlocked to ensure that makeup air is provided whenever the exhaust system is in operation.

508.2 Compensating hoods. Manufacturers of compensating hoods shall provide a label indicating minimum exhaust flow and maximum makeup airflow that provides capture and containment of the exhaust effluent.

SECTION 509
FIRE EXTINGUISHING SYSTEM

509.1 Where required. Commercial food heat-processing appliances required by Section 507.2.1 to have a Type I hood shall be provided with an approved automatic fire suppression system complying with Sections 509.2 through 509.7.

509.2 Design. The automatic fire suppression system shall be designed to protect the surface of the commercial food heat-processing appliances and the exhaust system serving such appliances. The automatic fire suppression system shall be designed to protect the commercial exhaust hoods, commercial kitchen ducts and the enclosed plenum space within the hood above the filters.

509.3 Type of system. The automatic fire suppression system shall be of a type recognized for protection of commercial cooking appliance and exhaust systems of the type and arrangement protected. Preengineered automatic dry- and wet-chemical fire suppression system shall be tested in accordance with UL 300. Automatic fire suppression systems, including preengineered and engineered dry- and wet-chemical fire-suppression systems, shall be listed and labeled for specific use as protection for commercial cooking operations and shall be installed in accordance with Section 304.1. Automatic fire suppression systems of the following types shall be installed in accordance with the referenced standard indicated:

1. Carbon-dioxide extinguishing system, NFPA 12.
2. Automatic sprinkler system, NFPA 13.
3. Foam-water sprinkler system or foam-water spray systems, NFPA 16.
4. Dry-chemical extinguishing systems, NFPA 17.
5. Wet-chemical extinguishing systems, NFPA 17A.

509.4 System actuation. Each automatic fire suppression system shall have both automatic and manual actuation means. A manual actuation device shall be located at or near a means of egress from the cooking area, a minimum of 10 feet (3048 mm) and a maximum of 20 feet (6096 mm) from the kitchen exhaust system. The manual actuation device shall be located a minimum of 4 feet 6 inches (1372 mm) and a maximum of 5 feet (1524 mm) above the floor. The manual actuation shall require a maximum force of 40 pounds (178 N) and a maximum movement of 14 inches (356 mm) to actuate the fire suppression system.

Exception: Automatic sprinkler systems shall not be required to be equipped with manual actuation means.

509.5 System interconnection. The actuation of the automatic fire suppression system shall automatically shut down the fuel or electrical power supply to the cooking appliances. The fuel and electrical power supply reset shall be manual.

509.6 Nozzles. Access shall be provided to all nozzles or sprinklers in the automatic fire suppression system for the purposes of inspection and maintenance.

509.7 System test and inspection. The automatic fire suppression system shall be acceptance-tested in accordance with the fire code and installation standard listed in Section 509.3, and with the manufacturer's instructions.

SECTION 510
HAZARDOUS EXHAUST SYSTEMS

510.1 General. This section shall govern the design and construction of duct systems for hazardous exhaust and shall determine where such systems are required. Hazardous exhaust systems are systems designed to capture and control hazardous emissions generated from product handling or processes, and convey those emissions to the outdoors. Hazardous emissions include flammable vapors, gases, fumes, mists or dusts, and volatile or airborne materials posing a health hazard, such as

toxic or corrosive materials. For the purposes of this section, the health-hazard rating of materials shall be as specified in NFPA 704.

510.2 Where required. A hazardous exhaust system shall be required wherever operations involving the handling or processing of hazardous materials, in the absence of such exhaust systems and under normal operating conditions, have the potential to create one of the following conditions:

1. A flammable vapor, gas, fume, mist or dust is present in concentrations exceeding 25 percent of the lower flammability limit of the substance for the expected room temperature.
2. A vapor, gas, fume, mist or dust with a health-hazard rating of 4 is present in any concentration.
3. A vapor, gas, fume, mist or dust with a health-hazard rating of 1, 2 or 3 is present in concentrations exceeding 1 percent of the median lethal concentration of the substance for acute inhalation toxicity.

510.3 Design and operation. The design and operation of the exhaust system shall be such that flammable contaminants are diluted in noncontaminated air to maintain concentrations in the exhaust flow below 25 percent of the contaminant's lower flammability limit.

510.4 Independent system. Hazardous exhaust systems shall be independent of other types of exhaust systems. Incompatible materials, as defined in the fire code, shall not be exhausted through the same hazardous exhaust system. Hazardous exhaust systems shall not share common shafts with other duct systems, except where such systems are hazardous exhaust systems originating in the same fire area.

Contaminated air shall not be recirculated to occupied areas unless the contaminants have been removed. Air contaminated with explosive or flammable vapors, fumes or dusts; flammable or toxic gases; or radioactive material shall not be recirculated.

510.5 Design. Systems for removal of vapors, gases and smoke shall be designed by the constant velocity or equal friction methods. Systems conveying particulate matter shall be designed employing the constant velocity method.

510.5.1 Balancing. Systems conveying explosive or radioactive materials shall be prebalanced by duct sizing. Other systems shall be balanced by duct sizing with balancing devices, such as dampers. Dampers provided to balance airflow shall be provided with securely fixed minimum-position blocking devices to prevent restricting flow below the required volume or velocity.

510.5.2 Emission control. The design of the system shall be such that the emissions are confined to the area in which they are generated by air currents, hoods or enclosures and shall be exhausted by a duct system to a safe location or treated by removing contaminants.

510.5.3 Hoods required. Hoods or enclosures shall be used where contaminants originate in a limited area of a space. The design of the hood or enclosure shall be such that air currents created by the exhaust systems will capture the contaminants and transport them directly to the exhaust duct.

510.5.4 Contaminant capture and dilution. The velocity and circulation of air in work areas shall be such that contaminants are captured by an airstream at the area where the emissions are generated and conveyed into a product-conveying duct system. Contaminated air from work areas where hazardous contaminants are generated shall be diluted below the thresholds specified in Section 510.2 with air that does not contain other hazardous contaminants.

510.5.5 Makeup air. Makeup air shall be provided at a rate approximately equal to the rate that air is exhausted by the hazardous exhaust system. Makeup-air intakes shall be located so as to avoid recirculation of contaminated air.

510.5.6 Clearances. The minimum clearance between hoods and combustible construction shall be the clearance required by the duct system.

510.5.7 Ducts. Hazardous exhaust duct systems shall extend directly to the exterior of the building and shall not extend into or through ducts and plenums.

510.6 Penetrations. Penetrations of structural elements by a hazardous exhaust system shall conform to the building code.

510.7 Suppression required. Ducts shall be protected with an approved automatic fire suppression system installed in accordance with the building code.

Exception: An approved automatic fire suppression system shall not be required in ducts conveying materials, fumes, mists and vapors that are nonflammable and noncombustible.

510.8 Duct construction. Ducts utilized to convey hazardous exhaust shall be constructed of approved G90 galvanized sheet steel, with a minimum nominal thickness as specified in Table 510.8.

Nonmetallic ducts utilized in systems exhausting nonflammable corrosive fumes or vapors shall be listed and labeled. Nonmetallic duct shall have a flame spread index of 25 or less and a smoke-developed index of 50 or less, when tested in accordance with ASTM E 84. Ducts shall be approved for installation in such an exhaust system.

Where the products being exhausted are detrimental to the duct material, the ducts shall be constructed of alternative materials that are compatible with the exhaust.

TABLE 510.8
MINIMUM DUCT THICKNESS

DIAMETER OF DUCT OR MAXIMUM SIDE DIMENSION	MINIMUM NOMINAL THICKNESS		
	Nonabrasive materials	Nonabrasive/ abrasive materials	Abrasive materials
0 - 8 inches	0.028 inch (No. 24 Gage)	0.034 inch (No. 22 Gage)	0.040 inch (No. 20 Gage)
9 - 18 inches	0.034 inch (No. 22 Gage)	0.040 inch (No. 20 Gage)	0.052 inch (No. 18 Gage)
19 - 30 inches	0.040 inch (No. 20 Gage)	0.052 inch (No. 18 Gage)	0.064 inch (No. 16 Gage)
Over 30 inches	0.052 inch (No. 18 Gage)	0.064 inch (No. 16 Gage)	0.079 inch (No. 14 Gage)

For **SI:** 1 inch = 25.4 mm.

510.8.1 Duct joints. Ducts shall be made tight with lap joints having a minimum lap of 1 inch (25 mm).

510.8.2 Clearance to combustibles. Ducts shall have a clearance to combustibles in accordance with Table 510.8.2. Exhaust gases having temperatures in excess of 600°F (316°C) shall be exhausted to a chimney in accordance with Section 511.2.

TABLE 510.8.2
CLEARANCE TO COMBUSTIBLES

TYPE OF EXHAUST OR TEMPERATURE OF EXHAUST (°F)	CLEARANCE TO COMBUSTIBLES (Inches)
Less than 100	1
100-600	12
Flammable vapors	6

For SI: 1 inch = 25.4 mm, °C = [(°F)- 32]/1.8.

510.8.3 Explosion relief. Systems exhausting potentially explosive mixtures shall be protected with an approved explosion relief system or by an approved explosion prevention system designed and installed in accordance with NFPA 69. An explosion relief system shall be designed to minimize the structural and mechanical damage resulting from an explosion or deflagration within the exhaust system. An explosion prevention system shall be designed to prevent an explosion or deflagration from occurring.

510.9 Supports. Ducts shall be supported at intervals not exceeding 10 feet (3048 mm). Supports shall be constructed of noncombustible material.

SECTION 511
DUST, STOCK AND REFUSE CONVEYOR SYSTEMS

511.1 Dust, stock and refuse conveying systems. Dust, stock and refuse conveying systems shall comply with the provisions of Section 510 and Sections 511.1.1 through 511.1.2.

511.1.1 Collectors and separators. Cyclone collectors and separators and associated supports shall be constructed of noncombustible materials and shall be located on the exterior of the building or structure. A collector or separator shall not be located nearer than 10 feet (3048 mm) to combustible construction or to an unprotected wall or floor opening, unless the collector is provided with a metal vent pipe that extends above the highest part of any roof within a distance of 30 feet (9144 mm).

511.1.2 Discharge pipe. Discharge piping shall conform to the requirements for ducts, including clearances required for high-heat appliances, as contained in this code. A delivery pipe from a cyclone collector shall not convey refuse directly into the firebox of a boiler, furnace, dutch oven, refuse burner, incinerator or other appliance.

511.1.3 Conveying system exhaust discharge. An exhaust system shall discharge to the outside of the building either directly by flue, or indirectly through the separator, bin or vault into which the system discharges.

511.1.4 Spark protection. The outlet of an open-air exhaust terminal shall be protected with an approved metal or other noncombustible screen to prevent the entry of sparks.

511.1.5 Explosion relief vents. A safety or explosion relief vent shall be provided on all systems that convey combustible refuse or stock of an explosive nature, in accordance with the requirements of the building code.

511.1.5.1 Screens. Where a screen is installed in a safety relief vent, the screen shall be so attached so as to permit ready release under the explosion pressure.

511.1.5.2 Hoods. The relief vent shall be provided with an approved noncombustible cowl or hood, or with a counterbalanced relief valve or cover arranged to prevent the escape of hazardous materials, gases or liquids.

511.2 Exhaust outlets. Outlets for exhaust that exceed 600°F (315°C) shall be designed as a chimney in accordance with Table 511.2.

The termination point for exhaust ducts discharging to the atmosphere shall not be less than the following:

1. Ducts conveying explosive or flammable vapors, fumes or dusts: 30 feet (9144 mm) from property line; 10 feet (3048 mm) from openings into the building; 6 feet (1829 mm) from exterior walls or roofs; 30 feet (9144 mm) from combustible walls or openings into the building which are in the direction of the exhaust discharge; and 10 feet (3048 mm) above adjoining grade.
2. Other product-conveying outlets: 10 feet (3048 mm) from property line; 3 feet (914 mm) from exterior wall or roof; 10 feet (3048 mm) from openings into the building; and 10 feet (3048 mm) above adjoining grade.
3. Environmental air duct exhaust: 3 feet (914 mm) from property line; and 3 feet (914 mm) from openings into the building.

SECTION 512
SUBSLAB SOIL EXHAUST SYSTEMS

512.1 General. When a subslab soil exhaust system is provided, the duct shall conform to the requirements of this section.

512.2 Materials. Subslab soil exhaust system duct material shall be air duct material listed and labeled to the requirements of UL 181 for Class 0 air ducts, or any of the following piping materials that comply with the plumbing code as building sanitary drainage and vent pipe: cast iron; galvanized steel; brass or copper pipe; copper tube of a weight not less than that of copper drainage tube, Type DWV; plastic piping.

512.3 Grade. Exhaust system ducts shall not be trapped and shall have a minimum slope of one-eighth unit vertical in 12 units horizontal (1-percent slope).

512.4 Termination. Subslab soil exhaust system ducts shall extend through the roof and terminate at least 6 inches (152 mm) above the roof and at least 10 feet (3048 mm) from any operable openings or air intake.

512.5 Identification. Subslab soil exhaust ducts shall be permanently identified within each floor level by means of a tag, stencil or other approved marking.

TABLE 511.2
CONSTRUCTION, CLEARANCE AND TERMINATION REQUIREMENTS FOR SINGLE-WALL METAL CHIMNEYS

CHIMNEYS SERVING	MINIMUM THICKNESS		TERMINATION				CLEARANCE			
			Above roof opening (feet)	Above any part of building within (feet)			Combustible construction (inches)		Noncombustible construction	
	Wall	Lining		10	25	50	Interior inst.	Exterior inst.	Interior inst.	Exterior inst.
Low-heat appliances (1,000°F normal operating temp.)	0.127″ (No. 10 MSG)	None	3	2	—	—	18	6	Up to 18 ″ diameter, 2″ Over 18″ diameter, 4″	
Medium-heat appliances (2,000°F maximum)[b]	0.127″ (No. 10 MSG)	Up to 18″ dia.— $2^1/_2$″ Over 18″ $4^1/_2$″ on $4^1/_2$″ bed	10	—	10	—	36	24		
High-heat appliances (Over 2,000°F)[a]	0.127″ (No. 10 MSG)	$4^1/_2$″ laid on $4^1/_2$″ bed	20	—	—	20	See Footnote c			

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, °C = [(°F)- 32]/1.8.

[a] Lining shall extend from bottom to top of outlet.

[b] Lining shall extend from 24 inches below connector to 24 feet above.

[c] Clearance shall be as specified by the design engineer and shall have sufficient clearance from buildings and structures to avoid overheating combustible materials (maximum 160°F).

SECTION 513
SMOKE CONTROL SYSTEMS

Not adopted by the State of Oregon. Refer to the building code for these requirements.

(Pages 42 through 50 have been deleted. Text continues on page 51.)

CHAPTER 6
DUCT SYSTEMS

SECTION 601
GENERAL

601.1 Scope. Duct systems used for the movement of air in air-conditioning, heating, ventilating and exhaust systems shall conform to the provisions of this chapter except as otherwise specified in Chapters 5 and 7.

Exception: Ducts discharging combustible material directly into any combustion chamber shall conform to the requirements of NFPA 82.

601.2 Air movement in egress elements. Exits and exit access corridors shall not serve as supply, return, exhaust, relief or ventilation air ducts or plenums.

Exceptions:

1. Utilization of an exit access corridor as a source of makeup air for exhaust systems in rooms that open directly onto such corridors, such as toilet rooms, bathrooms, dressing rooms, smoking lounges and janitor closets, shall not be prohibited, provided that each such corridor is directly supplied with outdoor air at a rate not less than the rate of makeup air taken from the corridor.
2. The utilization of the space between the corridor ceiling and the floor or roof structure above as a return air plenum shall not be prohibited where the corridor is not required to be of fire-resistance-rated construction or is separated from the plenum by fire-resistance-rated construction.
3. Where located within a dwelling unit, the utilization of egress corridors as return air plenums shall not be prohibited.
4. Where located within tenant spaces of 1,000 square feet (93 m^2) or less in area, utilization of exit access corridors as return air plenums shall not be prohibited.

601.3 Contamination prevention. Exhaust ducts under positive pressure, chimneys and vents shall not extend into or pass through ducts or plenums.

SECTION 602
PLENUMS

602.1 General. A plenum is an enclosed portion of the building structure that is designed to allow air movement, and thereby serve as part of an air distribution system. Supply, return, exhaust, relief and ventilation air plenums shall be limited to uninhabited crawl spaces, areas above a ceiling or below the floor, attic spaces and mechanical equipment rooms. Plenums shall be limited to one fire area. Fuel-fired appliances shall not be installed within a plenum.

602.2 Construction. Plenum enclosures shall be constructed of materials permitted for the type of construction classification of the building.

The use of gypsum boards to form plenums shall be limited to systems where the air temperatures do not exceed 125°F (52°C) and the building and mechanical system design conditions are such that the gypsum board surface temperature will be maintained above the airstream dew-point temperature. Air plenums formed by gypsum boards shall not be incorporated in air-handling systems utilizing evaporative coolers.

602.2.1 Materials exposed within plenums. Except as required by Sections 602.2.1.1 through 602.2.1.3, materials exposed within plenums shall be noncombustible or shall have a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with ASTM E 84.

Exceptions:

1. Rigid and flexible ducts and connectors shall conform to Section 603.
2. Duct coverings, linings, tape and connectors shall conform to Sections 603 and 604.
3. This section shall not apply to materials exposed within plenums in one- and two-family dwellings.
4. This section shall not apply to smoke detectors.

602.2.1.1 Wiring. Combustible electrical or electronic wiring methods and materials, optical fiber cable, and optical fiber raceway exposed within a plenum shall have a peak optical density not greater than 0.50, an average optical density not greater than 0.15, and a flame spread not greater than 5 feet (1524 mm) when tested in accordance with UL 910. Only type OFNP (plenum-rated nonconductive optical fiber cable) shall be installed in plenum-rated optical fiber raceways. Wiring, cable, and raceways addressed in this section shall be listed and labeled as plenum-rated and shall be installed in accordance with the electrical code.

602.2.1.2 Fire sprinkler piping. Plastic fire sprinkler piping exposed within a plenum shall be used only in wet pipe systems and shall have a peak optical density not greater than 0.50, an average optical density not greater than 0.15, and a flame spread of not greater than 5 feet (1524 mm) when tested in accordance with UL 1887. Piping shall be listed and labeled.

602.2.1.3 Pneumatic tubing. Combustible pneumatic tubing exposed within a plenum shall have a peak optical density not greater than 0.50, an average optical density not greater than 0.15, and a flame spread of not greater than 5 feet (1524 mm) when tested in accordance with UL 1820. Combustible pneumatic tubing shall be listed and labeled.

602.2.1.4 Combustible electrical equipment. Combustible electrical equipment exposed within a plenum shall

have a peak rate of heat release not greater than 100 kilowatts, a peak optical density not greater than 0.50, and an average optical density not greater than 0.15 when tested in accordance with UL 2043. Combustible electrical equipment shall be listed and labeled.

602.3 Stud cavity and joist space plenums. Stud wall cavities and the spaces between solid floor joists to be utilized as air plenums shall comply with the following conditions:

1. Such cavities or spaces shall not be utilized as a plenum for supply air.
2. Such cavities or spaces shall not be part of a required fire-resistance-rated assembly.
3. Stud wall cavities shall not convey air from more than one floor level.
4. Stud wall cavities and joist space plenums shall comply with the floor penetration protection requirements of the building code.
5. Stud wall cavities and joist space plenums shall be isolated from adjacent concealed spaces by approved fireblocking as required in the building code.

602.4 Flood hazard. For structures located in a flood-hazard zone or a high-hazard zone, plenum spaces shall be located above the base flood elevation or shall be protected so as to prevent water from entering or accumulating within the plenum space during floods up to the base flood elevation. If the plenum spaces are located below the base flood elevation, they shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the base flood elevation.

SECTION 603
DUCT CONSTRUCTION AND INSTALLATION

603.1 General. An air distribution system shall be designed and installed to supply the required distribution of air. The installation of an air distribution system shall not affect the fire protection requirements specified in the building code. Ducts shall be constructed, braced, reinforced and installed to provide structural strength and durability.

603.2 Duct classification. Ducts shall be classified based on the maximum operating pressure of the duct at pressures of positive or negative 0.5, 1.0, 2.0, 3.0, 4.0, 6.0, or 10.0 inches of water column. The pressure classification of ducts shall equal or exceed the design pressure of the air distribution in which the ducts are utilized.

603.3 Metallic ducts. All metallic ducts shall be constructed as specified in SMACNA *HVAC Duct Construction Standards—Metal and Flexible.*

Exception: Ducts installed within single dwelling units shall have a minimum thickness as specified in Table 603.3.

TABLE 603.3
DUCT CONSTRUCTION MINIMUM SHEET METAL THICKNESSES FOR SINGLE DWELLING UNITS

DUCT SIZE	GALVANIZED STEEL		APPROXIMATE ALUMINUM B.&S. GAGE
	Minimum thickness (inches)	Equivalent galvanized Gage No.	
Round ducts and enclosed rectangular ducts			
14" or less	0.013	30	26
Over 14"	0.016	28	24
Exposed rectangular ducts			
14" or less	0.016	28	24
Over 14"	0.019	26	22

For **SI:** 1 inch = 25.4 mm.

603.4 Nonmetallic ducts. Nonmetallic ducts shall be constructed with Class 0 or Class 1 duct material in accordance with UL 181. Fibrous duct construction shall conform to the SMACNA *Fibruous Glass Duct Construction Standards* or NAIMA *Fibrous Glass Duct Construction Standards*. The maximum air temperature within nonmetallic ducts shall not exceed 250°F (121°C).

603.4.1 Gypsum ducts. The use of gypsum boards to form air shafts (ducts) shall be limited to return air systems where the air temperatures do not exceed 125°F (52°C) and the gypsum board surface temperature is maintained above the airstream dew-point temperature. Air ducts formed by gypsum boards shall not be incorporated in air-handling systems utilizing evaporative coolers.

603.5 Flexible air ducts and flexible air connectors. Flexible air ducts, both metallic and nonmetallic, shall comply with Sections 603.5.1, 603.5.1.1 and 603.5.3 through 603.5.5. Flexible air connectors, both metallic and nonmetallic, shall comply with Sections 603.5.2 through 603.5.5.

603.5.1 Flexible air ducts. Flexible air ducts, both metallic and nonmetallic, shall be tested in accordance with UL 181. Such ducts shall be listed and labeled as Class 0 or Class 1 flexible air ducts and shall be installed in accordance with Section 304.1.

603.5.1.1 Duct length. Flexible air ducts shall not be limited in length.

603.5.2 Flexible air connectors. Flexible air connectors, both metallic and nonmetallic, shall be tested in accordance with UL 181. Such connectors shall be listed and labeled as Class 0 or Class 1 flexible air connectors and shall be installed in accordance with Section 304.1.

603.5.2.1 Connector length. Flexible air connectors shall be limited in length to 14 feet (4267 mm).

603.5.3 Air temperature. The design temperature of air to be conveyed in flexible air ducts and flexible air connectors shall be less than 250°F (121°C).

603.5.4 Flexible air duct and air connector clearance. Flexible air ducts and air connectors shall be installed with a minimum clearance to an appliance as specified in the appliance manufacturer's installation instructions.

603.5.5 Penetrations prohibited. Flexible air ducts and flexible air connectors shall not pass through any fire-resistance-rated assembly. Flexible air connectors shall not pass through any wall, floor or ceiling.

603.6 Rigid duct penetrations. Duct system penetrations of walls, floors, ceilings and roofs and air transfer openings in such building components shall be protected as required by the building code.

603.7 Underground ducts. Ducts shall be approved for underground installation. Metallic ducts not having an approved protective coating shall be completely encased in a minimum of 2 inches (51 mm) of concrete.

603.7.1 Slope. Ducts shall slope to allow drainage to a point provided with access.

603.7.2 Sealing. Ducts shall be sealed and secured prior to pouring the concrete encasement.

603.7.3 Flood hazard. All underground ducts located in a flood-hazard zone or a high-hazard zone shall be located above the base flood elevation or shall be protected so as to prevent water from entering or accumulating within the ducts during floods up to the base flood elevation. If the ducts are located below the base flood elevation, the ducts shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the base flood elevation.

603.7.4 Plastic ducts and fittings. Plastic ducts shall be constructed of PVC having a minimum pipe stiffness of 8 psi (55 kPa) at 5 percent-deflection when tested in accordance with ASTM D 2412. Plastic duct fittings shall be constructed of either PVC or high-density polyethylene. Plastic duct and fittings shall be utilized in underground installations only. The maximum design temperature for the systems utilizing plastic duct and fittings shal be 150°F (66°C).

603.8 Joints, seams and connections. All longitudinal and transverse joints, seams and connections shall be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems or tapes. Tapes and mastics used with rigid fibrous glass ducts shall be listed and labeled in accordance with UL 181A. Tapes and mastics used with flexible air ducts and air connectors shall be listed and labeled in accordance with UL 181B. Duct connections to sheet metal fittings or flanges of air distribution system equipment and appliances shall be mechanically fastened.

603.9 Supports. Ducts shall be supported with approved hangers at intervals not exceeding 10 feet (3048 mm) or by other approved duct support systems designed in accordance with the building code. Flexible and other factory-made ducts shall be supported in accordance with the manufacturer's installation instructions.

603.10 Furnace connections. Ducts connecting to a furnace shall have a clearance to combustibles in accordance with the furnace manufacturer's installation instructions.

603.11 Condensation. Provisions shall be made to prevent the formation of condensation on the exterior of any duct.

603.12 Location. Ducts shall not be installed in or within 4 inches (102 mm) of the earth, except where such ducts comply with Section 603.7.

603.13 Mechanical protection. Ducts installed in locations where they are exposed to mechanical damage by vehicles or from other causes shall be protected by approved barriers.

603.14 Weather protection. All ducts including linings, coverings and vibration isolation connectors installed on the exterior of the building shall be adequately protected against the elements.

603.15 Registers, grilles and diffusers. Duct registers, grilles and diffusers shall be installed in accordance with the manufacturer's installation instructions. Balancing dampers or other means of supply air adjustment shall be provided in the branch ducts or at each individual duct register, grille or diffuser.

603.15.1 Floor registers. Floor registers shall resist, without structural failure, a 200-pound (890 N) concentrated load on a 2-inch diameter (51 mm) disc applied to the most critical area of the exposed face.

SECTION 604
INSULATION

604.1 General. Duct insulation shall conform to the requirements of Sections 604.2 through 604.11 Chapter 13 of the *Oregon Structural Specialty Code.*

604.2 Surface temperature. Ducts that operate at temperatures exceeding 120°F (49°C) shall have sufficient thermal insulation to limit the exposed surface temperature to 120°F (49°C).

604.3 Coverings and linings. Coverings and linings, including adhesives when used, shall have a flame spread index not more than 25 and a smoke-developed index not more than 50, when tested in accordance with ASTM E 84. Duct coverings and linings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C 411 at the temperature to which they are exposed in service. The test temperature shall not fall below 250°F (121°C).

604.4 Foam plastic insulation. Foam plastic shall conform to the requirements of Section 604 and the building code.

604.5 Appliance insulation. Listed and labeled appliances that are internally insulated shall be considered as conforming to the requirements of Section 604.

604.6 Penetration of assemblies. Duct coverings shall not penetrate a wall or floor required to have a fire-resistance rating or required to be fireblocked.

604.7 Identification. External duct insulation and factory-insulated flexible duct shall be legibly printed or identified at intervals not greater than 36 inches (914 mm) with the name of the manufacturer; the thermal resistance *R*-value at the specified installed thickness; and the flame spread and smoke-developed indexes of the composite materials. All duct insulation product *R*-values shall be based on insulation only, excluding air films, vapor retarders, or other duct components, and shall be based on tested *C*-values at 75°F (24°C) mean temperature

at the installed thickness, in accordance with recognized industry procedures. The installed thickness of duct insulation used to determine its *R*-values shall be determined as follows:

1. For duct board, duct liner and factory-made rigid ducts not normally subjected to compression, the nominal insulation thickness shall be used.
2. For duct wrap, the installed thickness shall be assumed to be 75 percent (25-percent compression) of nominal thickness.
3. For factory-made flexible air ducts, the installed thickness shall be determined by dividing the difference between the actual outside diameter and nominal inside diameter by two.

604.8 Lining installation. Linings shall be interrupted at the area of operation of a fire damper and at a minimum of 6 inches (152 mm) upstream of and 6 inches (152 mm) downstream of electric-resistance and fuel-burning heaters in a duct system. Metal nosings or sleeves shall be installed over exposed duct liner edges that face opposite the direction of airflow.

604.9 Thermal continuity. Where a duct liner has been interrupted, a duct covering of equal thermal performance shall be installed.

604.10 Service openings. Service openings shall not be concealed by duct coverings unless the exact location of the opening is properly identified.

> **604.11 Vapor retarders.** Not adopted by the State of Oregon.

604.12 Weatherproof barriers. Insulated exterior ducts shall be protected with an approved weatherproof barrier.

604.13 Internal insulation. Materials used as internal insulation and exposed to the airstream in ducts shall be shown to be durable when tested in accordance with UL 181. Exposed internal insulation that is not impermeable to water shall not be used to line ducts or plenums from the exit of a cooling coil to the downstream end of the drain pan.

SECTION 605
AIR FILTERS

605.1 General. Heating and air-conditioning systems of the central type shall be provided with approved air filters. Filters shall be installed in the return air system, upstream from any heat exchanger or coil, in an approved convenient location. Liquid adhesive coatings used on filters shall have a flashpoint not lower than 325°F (163°C).

605.2 Approval. Media-type and electrostatic-type air filters shall be listed and labeled. Air filters utilized within dwelling units shall be designed for the intended application and shall not be required to be listed and labeled.

605.3 Airflow over the filter. Ducts shall be constructed to allow an even distribution of air over the entire filter.

SECTION 606
SMOKE DETECTION SYSTEMS CONTROL

606.1 Controls required. Air distribution systems shall be equipped with smoke detectors listed and labeled for installation in air distribution systems, as required by this section.

606.2 Where required. Smoke detectors shall be installed where indicated in Sections 606.2.1 through 606.2.3.

Exception: Smoke detectors shall not be required where air distribution systems are incapable of spreading smoke beyond the enclosing walls, floors and ceilings of the room or space in which the smoke is generated.

606.2.1 Return air systems. Smoke detectors shall be installed in return air systems with a design capacity greater than 2,000 cfm (0.9 m^3/s), in the return air duct or plenum upstream of any filters, exhaust air connections, outdoor air connections, or decontamination equipment and appliances.

Exception: Smoke detectors are not required in the return air system where the space served by the air distribution system is protected by a system of area smoke detectors in accordance with the building code. The area smoke detector system shall comply with Section 606.4.

606.2.2 Common supply and return air systems. Where multiple air-handling systems share common supply or return air ducts or plenums with a combined design capacity greater than 2,000 cfm (0.9 m^3/s), the return air system shall be provided with smoke detectors in accordance with Section 606.2.1.

Exception: Individual smoke detectors shall not be required for each VAV zone unit or VAV-type fan-powered terminal unit, provided that such units do not have an individual design capacity greater than 2,000 cfm and such units will be shut down by activation of:

1. Smoke detectors required by Section 606.2.1 and 606.2.3.
2. An approved area smoke detector system located in the return air pelnum serving such untis.
3. An area smoke detector system as prescribed in the exception to Section 606.2.1.

In all cases, the smoke detectors shall comply with Sections 606.4 and 606.4.1.

606.2.3 Return risers. Where return air risers serve two or more stories and are part of a return air system having a design capacity greater than 15,000 cfm (7.1 m^3/s), smoke detectors shall be installed at each story. Such smoke detectors shall be located upstream of the connection between the return air riser and any air ducts or plenums.

606.3 Installation. Smoke detectors required by this section shall be installed in accordance with NFPA 72. The required smoke detectors shall be installed to monitor the entire airflow conveyed by the system including return air and exhaust or relief air. Access shall be provided to smoke detectors for inspection and maintenance.

606.4 Controls operation. Upon activation, the smoke detectors shall shut down the air distribution system. Air distribution

systems that are part of a smoke control system shall switch to the smoke-control mode upon activation of a detector.

606.4.1 Supervision. The smoke detectors shall be connected to a fire alarm system. The actuation of a smoke detector shall activate a visible and audible supervisory signal at a constantly attended location.

Exceptions:

1. The supervisory signal at a constantly attended location is not required where the smoke detector activates the building's alarm-indicating appliances.
2. In occupancies not required to be equipped with a fire-alarm system, actuation of a smoke detector shall activate a visible and an audible signal in an approved location. Smoke detector trouble conditions shall activate a visible or audible signal in an approved location and shall be identified as air duct detector trouble.

SECTION 607
FIRE AND SMOKE DAMPERS

607.1 Fire dampers. Fire dampers shall be installed where required by the building code, shall be listed and labeled, shall comply with UL 555 and shall be installed in accordance with the manufacturer's installation instructions. Fire dampers that have been tested for closure under airflow conditions shall be labeled for maximum airflow and direction of flow. Fire dampers installed in systems that continue to operate when smoke or heat from a fire is detected shall be labeled for installation in dynamic systems as required by UL 555. Ductwork shall be connected to damper sleeves or assemblies in such a way that collapse of the ductwork will not dislodge the damper or impair its proper operation.

607.2 Smoke dampers. Smoke dampers shall be installed where required by the building code, shall be listed and labeled, shall comply with UL 555S and shall be installed in accordance with the manufacturer's installation instructions. Smoke dampers shall be closed by the activation of an approved smoke detection system, an approved smoke control system controller or a spot-type detector installed at the point of penetration and listed for releasing service. Smoke detection shall be in accordance with NFPA 72. Smoke dampers shall also close whenever the fan serving the duct system is shut off.

607.3 Ceiling dampers. Ceiling dampers shall be installed where required by the building code, shall be listed and labeled, shall comply with UL 555C and shall be installed in accordance with the manufacturer's installation instructions. Fire dampers not meeting the temperature performance capabilities of ceiling dampers shall not be used as substitutes.

607.4 Multiple arrangements. Where multiple dampers are required, the installation shall be framed in an approved manner to ensure that the dampers remain in place.

607.5 Access and identification. Dampers shall be provided with an approved means of access, large enough to permit inspection and maintenance of the damper and its operating parts. The access shall not affect the integrity of fire-resistance-rated assemblies. Access points shall be permanently identified on the exterior by a label having letters not less than ½ inch (12.7 mm) in height reading: SMOKE DAMPER or FIRE DAMPER. Access doors in ducts shall be tight fitting and suitable for the required duct construction.

607.6 Freedom from interference. Dampers shall be installed in a manner to ensure positive closing or opening as required by function. Interior liners and insulation shall be interrupted at damper locations to prevent interference with damper operation. Exterior materials shall be installed so as to prevent interference with the operation or maintenance of external operating devices for dampers.

607.7 Temperature classification or operating elements. Fusible links, thermal sensors, and pneumatic or electric operators shall have a temperature rating or classification as required by the building code and not less than 50°F. (10°C.).

(Pages 57 and 58 have been deleted. Text continues on page 59.)

CHAPTER 7
COMBUSTION AIR

SECTION 701
GENERAL

701.1 Scope. The provisions of this chapter shall govern the requirements for combustion and dilution air for fuel-burning appliances. The requirements for combusion and filution air for gas-fired appliances shall be in accordance with Appendix C.

701.2 Combustion and dilution air required. Every room or space containing fuel-burning appliances shall be provided with combustion and dilution air as required by this code. Combustion and dilution air shall be provided in accordance with Section 702, 703, 705, 706 or 707 or shall be provided by an approved engineered system. Direct vent appliances or equipment that do not draw combustion air from inside of the building are not required to be considered in the determination of the combustion and dilution air requirements. Combustion air requirements shall be determined based on the simultaneous operation of all fuel-burning appliances drawing combustion and dilution air from the room or space.

701.3 Circulation of air. The equipment and appliances within every room containing fuel-burning appliances shall be installed so as to allow free circulation of air. Provisions shall be made to allow for the simultaneous operation of mechanical exhaust systems, fireplaces or other equipment and appliances operating in the same room or space from which combustion and dilution air is being drawn. Such provisions shall prevent the operation of such appliances, equipment and systems from affecting the supply of combustion and dilution air.

Exception: Rooms provided with exhaust air systems such as kitchens, baths, toilet rooms and smoking lounges may use air supplied through adjacent habitable or occupiable spaces to compensate for the air exhausted.

701.3.1 Special conditions. In buildings containing combustion appliances, equipment or fireplaces not equipped with forced or induced draft or separated from the habitable area, where an individual exhaust appliance exceeds 350 cfm (165.2 L/s), make-up air of sufficient quantity to equal that being exhausted shall be supplied to the area being ventilated. In such cases, the minimum size make-up air duct shall be 6 inches (152 mm) in diameter or equivalent area.

701.4 Crawl space and attic space. For the purposes of this chapter, an opening to a naturally ventilated crawl space or attic space shall be considered equivalent to an opening to the outdoors.

701.4.1 Crawl space. Where lower-combustion air openings connect with crawl spaces, such spaces shall have unobstructed openings to the outdoors at least twice that required for the combustion air openings. The height of the crawl space shall comply with the requirements of the building code and shall be without obstruction to the free flow of air.

701.4.2 Attic space. Where combustion air is obtained from an attic area, the attic ventilating openings shall not be subject to ice or snow blockage, and the attic shall have not less than 30 inches (762 mm) vertical clear height at its maximum point. Attic ventilation openings shall be sized to provide the combined area of the combustion air opening or openings to the attic and the attic ventilation openings required by the building code. The combustion air openings shall be provided with a sleeve of not less than 0.019-inch (0.5 mm) (No. 26 Gage) galvanized steel or other approved material extending from the appliance enclosure to at least 6 inches (152 mm) above the top of the ceiling joists and insulation.

701.5 Prohibited sources. Openings and ducts shall not connect appliance enclosures with a space in which the operation of a fan will adversely affect the flow of combustion air. Combustion air shall not be obtained from a hazardous location, except where the fuel-fired appliances are located within the hazardous location and are installed in accordance with this code. Combustion air shall not be taken from a refrigeration machinery room.

SECTION 702
INSIDE AIR

702.1 All air from indoors. Combustion and dilution air shall be permitted to be obtained entirely from the indoors in buildings that are not of unusually tight construction. In buildings of unusually tight construction, combustion air shall be obtained from the outdoors in accordance with Section 703, 704, 706 or 707.

702.2 Air from the same room or space. The room or space containing fuel-burning appliances shall be an unconfined space as defined in Section 202.

702.3 Air from adjacent spaces. Where the volume of the room in which the fuel-burning appliances are located does not comply with Section 702.2, additional inside combustion and dilution air shall be obtained by opening the room to adjacent spaces so that the combined volume of all communicating spaces meets the volumetric requirement of Section 702.2. Openings connecting the spaces shall comply with Sections 702.3.1 and 702.3.2.

702.3.1 Number and location of openings. Two openings shall be provided, one within 1 foot (305 mm) of the ceiling of the room and one within 1 foot (305 mm) of the floor.

702.3.2 Size of openings. The net free area of each opening, calculated in accordance with Section 709, shall be a minimum of 1 square inch per 1,000 Btu/h (2201 mm^2/kW) of input rating of the fuel-burning appliances drawing combustion and dilution air from the communicating spaces and shall be not less than 100 square inches (64 516 mm^2).

SECTION 703
OUTDOOR AIR

703.1 All air from the outdoors. Where all combustion and dilution air is to be provided by outdoor air, the required combustion and dilution air shall be obtained by opening the room to the outdoors. Openings connecting the room to the outdoor air shall comply with Sections 703.1.1 through 703.1.4.

703.1.1 Number and location of openings. Two openings shall be provided, one within 1 foot (305 mm) of the ceiling of the room and one within 1 foot (305 mm) of the floor.

703.1.2 Size of direct openings. The net free area of each direct opening to the outdoors, calculated in accordance with Section 709, shall be a minimum of 1 square inch per 4,000 Btu/h (550 mm^2/kW) of combined input rating of the fuel-burning appliances drawing combustion and dilution air from the room.

703.1.3 Size of horizontal openings. The net free area of each opening, calculated in accordance with Section 709 and connected to the outdoors through a horizontal duct, shall be a minimum of 1 square inch per 2,000 Btu/h (1100 mm^2/kW) of combined input rating of the fuel-burning appliances drawing combustion and dilution air from the room. The cross-sectional area of the duct shall be equal to or greater than the required size of the opening.

703.1.4 Size of vertical openings. The net free area of each opening, calculated in accordance with Section 709 and connected to the outdoors through a vertical duct, shall be a minimum of 1 square inch per 4,000 Btu/h (550 mm^2/kW) of combined input rating of the fuel-burning appliances drawing combustion and dilution air from the room. The cross-sectional area of the duct shall be equal to or greater than the required size of the opening.

SECTION 704
COMBINED USE OF INSIDE AND OUTDOOR AIR (CONDITION 1)

704.1 Combination of air from inside and outdoors. This section shall apply only to applianced located in confined spaces in buildings not of unusually tight construction. Where the volumes of rooms and spaces are combined for the purpose of providing indoor combustion air, such rooms and spaces shall communicate through permanent openings in compliance with Sections 702.2.1 and 702.2.2. The required combustion and dilution air shall be obtained by opening the room to the outdoors utilizing a combination of inside and outdoor air, prorated in accordance with Section 704.1.6. The ratio of interior spaces shall comply with Section 704.1.5. The number, location and ratios of openings connecting the space with the outdoor air shall comply with Sections 704.1.1 through 704.1.4.

704.1.1 Number and location of openings. At least two openings shall be provided, one within 1 foot (305 mm) of the ceiling of the room and one within 1 foot (305 mm) of the floor.

704.1.2 Ratio of direct openings. Where direct openings to the outdoors are provided in accordance with Section 703.1, the ratio of direct openings shall be the sum of the net free areas of both direct openings to the outdoors, divided by the sum of the required areas for both such openings as determined in accordance with Section 703.1.2.

704.1.3 Ratio of horizontal openings. Where openings connected to the outdoors through horizontal ducts are provided in accordance with Section 703.1, the ratio of horizontal openings shall be the sum of the net free areas of both such openings, divided by the sum of the required areas for both such openings as determined in accordance with Section 703.1.3.

704.1.4 Ratio of vertical openings. Where openings connected to the outdoors through vertical ducts are provided in accordance with Section 703.1, the ratio of vertical openings shall be the sum of the net free areas of both such openings, divided by the sum of the required areas for both such openings as determined in accordance with Section 703.1.4.

704.1.5 Ratio of interior spaces. The ratio of interior spaces shall be the available volume of all communicating spaces, divided by the required volume as determined in accordance with Section 702.2.

704.1.6 Prorating of inside and outdoor air. In spaces that utilize a combination of inside and outdoor air, the sum of the ratios of all direct openings, horizontal openings, vertical openings and interior spaces shall equal or exceed 1.

SECTION 705
COMBINED USE OF INSIDE AND OUTDOOR AIR (CONDITION 2)

705.1 General. This section shall apply only to appliances located in unconfined spaces in buildings of unusually tight construction. Combustion air supplied by a combined use of indoor and outdoor air shall be supplied through openings and ducts extending to the appliance room or to the vicinity of the appliance.

705.1.1 Openings and supply ducts. Openings shall be provided, located and sized in accordance with Section 702.3; additionally, there shall be one opening to the outdoors having a free area of at least 1 square inch per 5,000 Btu/h (440 mm^2/kW) of total input of all appliances in the space.

SECTION 706
FORCED COMBUSTION AIR SUPPLY

706.1 General. Where all combustion air and dilution air is provided by a mechanical forced-air system, the combustion air and dilution air shall be supplied at the minimum rate of 1 cfm per 2,400 Btu/h [0.00067 $m^3/(s \cdot kW)$] of combined input rating of all the fuel-burning appliances served. Each of the appliances served shall be electrically interlocked to the mechanical forced-air system so as to prevent operation of the appliances when the mechanical system is not in operation. Where combustion air and dilution air is provided by the building's mechanical ventilation system, the system shall provide

the specified combustion/dilution air rate in addition to the required ventilation air.

SECTION 707
DIRECT CONNECTION

707.1 General. Fuel-burning appliances that are listed and labeled for direct combustion air connection to the outdoors shall be installed in accordance with the manufacturer's installation instructions.

SECTION 708
COMBUSTION AIR DUCTS

708.1 General. Combustion air ducts shall:

1. Be of galvanized steel complying with Chapter 6 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. Have a minimum cross-sectional dimension of 3 inches (76 mm).
3. Terminate in an unobstructed space allowing free movement of combustion air to the appliances.
4. Have the same cross-sectional areas as the free area of the openings to which they connect.
5. Serve a single appliance enclosure.
6. 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.
7. Not be screened where terminating in an attic space.
8. Not slope downward toward the source of combustion air, where serving the upper required combustion air opening.

SECTION 709
OPENING OBSTRUCTIONS

709.1 General. The required size of openings for combustion and dilution air shall be based on the net free area of each opening. The net free area of an opening shall be that specified by the manufacturer of the opening covering. In the absence of such information, openings covered with metal louvers shall be deemed to have a net free area of 75 percent of the area of the opening, and openings covered with wood louvers shall be deemed to have a net free area of 25 percent of the area of the opening.

709.2 Dampered openings. Where the combustion air openings are provided with volume, smoke or fire dampers, the dampers shall be electrically interlocked with the firing cycle of the appliances served, so as to prevent operation of any appliance that draws combustion and dilution air from the room when any of the dampers are closed. Manually operated dampers shall not be installed in combustion air openings.

SECTION 710
OPENING LOCATION AND PROTECTION

710.1 General. Combustion air openings to the outdoors shall comply with the location and protection provisions of Sections 401.5 and 401.6 applicable to outside air intake openings. ||

CHAPTER 8
CHIMNEYS AND VENTS

SECTION 801
GENERAL

801.1 Scope. This chapter shall govern the installation, maintenance, repair and approval of factory-built chimneys, chimney liners, vents and connectors. This chapter shall also govern the utilization of masonry chimneys. Gas-fired appliances shall be vented in accordance with Appendix C.

801.2 General. Every fuel-burning appliance shall discharge the products of combustion to a vent, factory-built chimney or masonry chimney except for appliances vented in accordance with Section 804. The chimney or vent shall be designed for the type of appliance being vented.

801.2.1 Oil-fired appliances. Oil-fired appliances shall be vented in accordance with this code and NFPA 31.

801.3 Masonry chimneys. Masonry chimneys shall be constructed in accordance with the building code.

801.4 Positive flow. Venting systems shall be designed and constructed so as to develop a positive flow adequate to convey all combustion products to the outside atmosphere.

801.5 Design. Venting systems shall be designed in accordance with this chapter or shall be approved engineered systems.

801.6 Minimum size of chimney or vent. Except as otherwise provided for in this chapter, the size of the chimney or vent, serving a single appliance, except engineered systems, shall have a minimum area equal to the area of the appliance connection.

801.7 Solid fuel appliance flues. The cross-sectional area of a flue serving a solid fuel-burning appliance shall be not greater than three times the cross-sectional area of the appliance flue collar or flue outlet.

801.8 Abandoned inlet openings. Abandoned inlet openings in chimneys and vents shall be closed by an approved method.

801.9 Positive pressure. Where an appliance equipped with a forced or induced draft system creates a positive pressure in the venting system, the venting system shall be designed for positive pressure applications.

801.10 Connection to fireplace. Connection of appliances to chimney flues serving fireplaces shall be in accordance with Sections 801.10.1 through 801.10.3.

801.10.1 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.

801.10.2 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.

801.10.3 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 provided with access or shall be removable for inspection and cleaning of both the connector and the flue. Listed direct connection devices shall be installed in accordance with their listing.

801.11 Multiple solid fuel prohibited. A solid fuel-burning appliance or fireplace shall not connect to a chimney passageway venting another appliance.

801.12 Chimney entrance. Connectors shall connect to a chimney flue at a point not less than 12 inches (305 mm) above the lowest portion of the interior of the chimney flue.

801.13 Cleanouts. 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.

Exception: Cleanouts shall not be required for chimney flues serving masonry fireplaces, if such flues are provided with access through the fireplace opening.

801.14 Connections to exhauster. All appliance connections to a chimney or vent equipped with a power exhauster shall be made on the inlet side of the exhauster. All 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.

801.15 Fuel-fired appliances. Masonry chimneys utilized to vent fuel-fired appliances shall be located, constructed and sized as specified in the manufacturer's installation instructions for the appliances being vented.

801.16 Flue lining. Masonry chimneys shall be lined. The lining material shall be compatible with the type of appliance connected, in accordance with the appliance listing and manufacturer's installation instructions. Listed materials used as flue linings shall be installed in accordance with their listings and the manufacturer's installation instructions.

801.16.1 Residential and low-heat appliances (general). 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 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).

801.17 Space around lining. The space surrounding a flue lining system or other vent installed within a masonry chimney shall not be used to vent any other appliance. This shall not prevent the installation of a separate flue lining in accordance with the manufacturer's installation instructions and this code.

801.18 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 801.18.1 through 801.18.4.

801.18.1 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 the venting of oil-fired appliances to masonry chimneys, the resizing shall be in accordance with NFPA 31.

801.18.2 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. Where an oil-fired appliance is connected to an existing masonry chimney, such chimney flue shall be repaired or relined in accordance with NFPA 31.

801.18.3 Cleanout. Masonry chimneys shall be provided with a cleanout opening complying with Section 801.13.

801.18.4 Clearances. Chimneys and vents shall have airspace clearance to combustibles in accordance with the building code and the chimney or vent manufacturer's installation instructions.

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. Noncombustible fireblocking shall be provided in accordance with the building code.

801.19 Multistory prohibited. Common venting systems for appliances located on more than one floor level shall be prohibited, except where all of the appliances served by the common vent are located in rooms or spaces that are accessed only from the outdoors. The appliance enclosures shall not communicate with the occupiable areas of the building.

SECTION 802
VENTS

802.1 General. All vent systems shall be listed and labeled. Type L vents and pellet vents shall be tested in accordance with UL 641.

802.2 Vent application. The application of vents shall be in accordance with Table 802.2.

TABLE 802.2
VENT APPLICATIONS

VENT TYPES	APPLIANCE TYPES
Type L oil vents	Oil-burning appliances listed and labeled for venting with Type L vents; gas appliances listed and labeled for venting with Type B vents.
Pellet vents	Pellet fuel-burning appliances listed and labeled for venting with pellet vents.

802.3 Installation. Vent systems shall be sized, installed and terminated in accordance with the vent and appliance manufacturer's installation instructions.

802.4 Vent termination caps required. Type L vents shall terminate with a listed and labeled cap in accordance with the vent manufacturer's installation instructions.

802.5 Type L vent terminations. Type L vents shall terminate not less than 2 feet (610 mm) above the highest point of the roof penetration and not less than 2 feet (610 mm) higher than any portion of a building within 10 feet (3048 mm).

802.6 Minimum vent heights. Vents shall terminate not less than 5 feet (1524 mm) in vertical height above the highest connected appliance or flue collar.

Exceptions:

1. Venting systems of direct vent appliances shall be installed in accordance with the appliance and the vent manufacturer's instructions.
2. Appliances listed for outdoor installations incorporating integral venting means shall be installed in accordance with their listings and the manufacturer's installation instructions.
3. Pellet vents shall be installed in accordance with the appliance and the vent manufacturer's installation instructions.

802.7 Support of vents. All portions of vents shall be adequately supported for the design and weight of the materials employed.

802.8 Insulation shield. Where vents pass through insulated assemblies, an insulation shield constructed of not less than No. 26 Gage sheet metal shall be installed to provide clearance between the vent and the insulation material. The clearance shall be not 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 se-

cured 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.

SECTION 803
CONNECTORS

803.1 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.

803.2 Location. Connectors shall be located entirely within the room in which the connecting appliance is located, except as provided for in Section 803.10.4. Where passing through an unheated space, a connector shall not be constructed of single-wall pipe.

803.3 Size. The connector shall not be smaller than the size of the flue collar or the size of the outlet of the draft hood supplied by the appliance manufacturer. Where the appliance has more than one flue outlet, and in the absence of the manufacturer's specific instructions, the connector area shall be not less than the combined area of the flue outlets for which it acts as a common connector.

803.4 Branch connections. All branch connections to the vent connector shall be made in accordance with the vent manufacturer's instructions.

803.5 Manual dampers. Manual dampers shall not be installed in connectors except in chimney connectors serving solid fuel-burning appliances.

803.6 Automatic dampers. Automatic dampers shall be listed and labeled in accordance with UL 17 for oil-fired heating appliances. The dampers shall be installed in accordance with the manufacturer's installation instructions. An automatic vent damper device shall not be installed on an existing appliance unless the appliance is listed and labeled and the device is installed in accordance with the terms of its listing. The name of the installer and date of installation shall be marked on a label affixed to the damper device.

803.7 Connectors serving two or more appliances. Where two or more connectors enter a common gas vent or chimney, the smaller connector shall enter at the highest level consistent with available headroom or clearance to combustible material.

803.8 Vent connector construction. Vent connectors shall be constructed of metal. The minimum nominal thickness of the connector shall be 0.019 inch (0.5 mm) (No. 28 Gage) for galvanized steel, 0.022 inch (0.6 mm) (No. 26 B & S Gage) for copper, and 0.020 inch (0.5 mm) (No. 24 B & S Gage) for aluminum.

803.9 Chimney connector construction. Chimney connectors for low-heat appliances shall be of sheet steel pipe having resistance to corrosion and heat not less than that of galvanized steel specified in Table 803.9(1). Connectors for medium-heat appliances and high-heat appliances shall be of sheet steel not less than the thickness specified in Table 803.9(2).

TABLE 803.9(1)
MINIMUM CHIMNEY CONNECTOR THICKNESS FOR LOW-HEAT APPLIANCES

DIAMETER OF CONNECTOR (inches)	MINIMUM NOMINAL THICKNESS (galvanized) (inches)
5 and smaller	0.022 (No. 26 Gage)
Larger than 5 and up to 10	0.028 (No. 24 Gage)
Larger than 10 and up to 16	0.034 (No. 22 Gage)
Larger than 16	0.064 (No. 16 Gage)

For SI: 1 inch = 25.4 mm.

TABLE 803.9(2)
MINIMUM CHIMNEY CONNECTOR THICKNESS FOR MEDIUM- AND HIGH-HEAT APPLIANCES

AREA (square inches)	EQUIVALENT ROUND DIAMETER (inches)	MINIMUM NOMINAL THICKNESS (inches)
0 - 154	0 - 14	0.060 (No. 16 Gage)
155 - 201	15 - 16	0.075 (No. 14 Gage)
202 - 254	17 - 18	0.105 (No. 12 Gage)
Greater than 254	Greater than 18	0.135 (No. 10 Gage)

For SI: 1 inch = 25.4 mm, 1 square inch = 645.16 mm^2.

803.10 Installation. Connectors shall be installed in accordance with Sections 803.10.1 through 803.10.6.

803.10.1 Supports and joints. Connectors shall be supported in an approved manner, and joints shall be fastened with sheet metal screws, rivets or other approved means.

803.10.2 Length. The maximum horizontal length of a single-wall connector shall be 75 percent of the height of the chimney or vent.

803.10.3 Connection. The connector shall extend to the inner face of the chimney or vent liner, but not beyond. A connector entering a masonry chimney shall be cemented to masonry in an approved manner. Where thimbles are installed to facilitate removal of the connector from the masonry chimney, the thimble shall be permanently cemented in place with high-temperature cement.

803.10.4 Connector pass-through. Chimney connectors shall not pass through any floor or ceiling, nor through a fire-resistance-rated wall assembly. Chimney connectors for domestic-type appliances shall not pass through walls or partitions constructed of combustible material to reach a masonry chimney unless:

1. The connector is labeled for wall pass-through and is installed in accordance with the manufacturer's instructions; or
2. The connector is put through a device labeled for wall pass-through; or
3. The connector has a diameter not larger than 10 inches (254 mm) and is installed in accordance with one of the methods in Table 803.10.4. Concealed metal parts of the pass-through system in contact with flue gases shall be of stainless steel or equivalent material that resists corrosion, softening or cracking up to 1,800°F (980°C).

TABLE 803.10.4
CHIMNEY CONNECTOR SYSTEMS AND CLEARANCES TO COMBUSTIBLE WALL MATERIALS FOR DOMESTIC HEATING APPLIANCES[a, b, c, d]

System A (12-inch clearance)	A $3\frac{1}{2}$-inch-thick brick wall shall be framed into the combustible wall. A $\frac{5}{8}$-inch-thick fire-clay liner (ASTM C 315 or equivalent)[e] shall be firmly cemented in the center of the brick wall maintaining a 12-inch clearance to combustibles. The clay liner shall run from the outer surface of the bricks to the inner surface of the chimney liner.
System B (9-inch clearance)	A labeled solid-insulated factory-built chimney section (1-inch insulation) the same inside diameter as the connector shall be utilized. Sheet metal supports cut to maintain a 9-inch clearance to combustibles shall be fastened to the wall surface and to the chimney section. Fasteners shall not penetrate the chimney flue liner. The chimney length shall be flush with the masonry chimney liner and sealed to the masonry with water-insoluble refractory cement. Chimney manufacturers' parts shall be utilized to fasten securely the chimney connector to the chimney section.
System C (6-inch clearance)	A sheet metal (minimum No. 24 Gage) ventilated thimble having two 1-inch air channels shall be installed with a sheet steel chimney connector (minimum No. 24 Gage). Sheet steel supports (minimum No. 24 Gage) shall be cut to maintain a 6-inch clearance between the thimble and combustibles. One side of the support shall be fastened to the wall on all sides. Glass-fiber insulation shall fill the 6-inch space between the thimble and the supports.
System D (2-inch clearance)	A labeled solid-insulated factory-built chimney section (1-inch insulation) with a diameter 2 inches larger than the chimney connector shall be installed with a sheet steel chimney connector (minimum No. 24 Gage). Sheet metal supports shall be positioned to maintain a 2-inch clearance to combustibles and to hold the chimney connector to ensure that a 1-inch airspace surrounds the chimney connector through the chimney section. The steel support shall be fastened to the wall on all sides and the chimney section shall be fastened to the supports. Fasteners shall not penetrate the liner of the chimney section.

For **SI:** 1 inch = 25.4 mm, 1.0 Btu × in/ft^2 · h · °F = 0.144 W/m^2 · °K.

a. Insulation material that is part of the wall pass-through system shall be noncombustible and shall have a thermal conductivity of 1.0 Btu × in/ft^2 · h · °F or less.

b. All clearances and thicknesses are minimums.

c. Materials utilized to seal penetrations for the connector shall be noncombustible.

d. Connectors for all systems except System B shall extend through the wall pass-through system to the inner face of the flue liner.

e. ASTM C 315.

803.10.5 Pitch. Connectors shall rise vertically to the chimney or vent with a minimum pitch equal to one-fourth unit vertical in 12 units horizontal (2-percent slope).

803.10.6 Clearances. Connectors shall have a minimum clearance to combustibles in accordance with Table 803.10.6. The clearances specified in Table 803.10.6 apply, except where the listing and labeling of an appliance specifies a different clearance, in which case the labeled clearance shall apply. The clearance to combustibles for connectors shall be reduced only in accordance with Section 308.

TABLE 803.10.6
CONNECTORS CLEARANCES TO COMBUSTIBLES

TYPE OF APPLIANCE	MINIMUM CLEARANCE (inches)
Domestic-type appliances	
Chimney and vent connectors	
Electric and oil incinerators	18
Oil and solid fuel appliances	18
Oil appliances labeled for venting with Type L vents	9
Commercial, industrial-type appliances	
Low-heat appliances	
Chimney connectors	
Oil and solid fuel boilers, furnaces and water heaters	18
Oil unit heaters	18
Other low-heat industrial appliances	18
Medium-heat appliances	
Chimney connectors	
All gas, oil and solid fuel appliances	36
High-heat appliances	
Masonry or metal connectors	(As determined by
All gas, oil and solid fuel appliances	the code official)

For **SI:** 1 inch = 25.4 mm.

SECTION 804
DIRECT-VENT, INTEGRAL VENT AND MECHANICAL DRAFT SYSTEMS

804.1 Direct-vent terminations. Vent terminals for direct-vent appliances shall be installed in accordance with the manufacturer's installation instructions.

804.2 Appliances with integral vents. Appliances incorporating integral venting means shall be installed in accordance with their listings and the manufacturer's installation instructions.

804.2.1 Terminal clearances. Appliances designed for natural draft venting and incorporating integral venting means shall be located so that a minimum clearance of 9 inches (229 mm) is maintained between vent terminals and from any openings through which combustion products enter the building. Appliances using forced draft venting shall be located so that a minimum clearance of 12 inches (305 mm) is maintained between vent terminals and from any openings through which combustion products enter the building.

804.3 Mechanical draft systems. Mechanical draft systems of either forced or induced draft design shall comply with Sections 804.3.1 through 804.3.7.

804.3.1 Forced draft systems. Forced draft systems and all portions of induced draft systems under positive pressure during operation shall be designed and installed so as to be gas tight to prevent leakage of combustion products into a building.

804.3.2 Automatic shutoff. Power exhausters shall be electrically connected to each appliance to prevent operation of the appliance when the power exhauster is not in operation.

Exception: An interlock between the cooking appliance and the exhaust hood system shall not be required for manually operated appliances that are factory equipped with a standing pilot burner ignition system.

804.3.3 Termination. The termination of chimneys or vents equipped with power exhausters shall be located a minimum of 10 feet (3048 mm) from the lot line or from adjacent buildings. The exhaust shall be directed away from the building.

804.3.4 Horizontal terminations. Horizontal terminations shall comply with the following requirements:

1. Where located adjacent to walkways, the termination of mechanical draft systems shall be not less than 7 feet (2134 mm) above the level of the walkway.
2. Vents shall terminate at least 3 feet (914 mm) above any forced air inlet located within 10 feet (3048 mm).
3. The vent system shall terminate at least 4 feet (1219 mm) below, 4 feet (1219 mm) horizontally from or 1 foot (305 mm) above any door, window or gravity air inlet into the building.
4. The vent termination point shall not be located closer than 3 feet (914 mm) to an interior corner formed by two walls perpendicular to each other.
5. The vent termination shall not be mounted directly above or within 3 feet (914 mm) horizontally from an oil tank vent or gas meter.
6. The bottom of the vent termination shall be located at least 12 inches (305 mm) above finished grade.

804.3.5 Vertical terminations. Vertical terminations shall comply with the following requirements:

1. Where located adjacent to walkways, the termination of mechanical draft systems shall be not less than 7 feet (2134 mm) above the level of the walkway.
2. Vents shall terminate at least 3 feet (914 mm) above any forced air inlet located within 10 feet (3048 mm).
3. Where the vent termination is located below an adjacent roof structure, the termination point shall be located at least 3 feet (914 mm) from such structure.
4. The vent shall terminate at least 4 feet (1219 mm) below, 4 feet (1219 mm) horizontally from, or 1 foot (305 mm) above any door, window or gravity air inlet for the building.
5. A vent cap shall be installed to prevent rain from entering the vent system.
6. The vent termination shall be located at least 3 feet (914 mm) horizontally from any portion of the roof structure.

804.3.6 Exhauster connections. An appliance vented by natural draft shall not be connected into a vent, chimney or vent connector on the discharge side of a mechanical flue exhauster.

804.3.7 Exhauster sizing. Mechanical flue exhausters and the vent system served shall be sized and installed in accordance with the manufacturer's installation instructions.

SECTION 805
FACTORY-BUILT CHIMNEYS

805.1 Listing. Factory-built chimneys shall be listed and labeled and shall be installed and terminated in accordance with the manufacturer's installation instructions.

805.2 Solid fuel appliances. Factory-built chimneys for use with solid fuel-burning appliances shall comply with the Type HT requirements of UL 103.

Exception: Chimneys for use with fireplace stoves listed only to UL 737 shall comply with the requirements of UL 103.

805.3 Factory-built fireplaces. Chimneys for use with factory-built fireplaces shall comply with the requirements of UL 127.

805.4 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.

805.5 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 comply with UL 959.

805.6 Decorative shrouds. Decorartive shrouds shall not be installed at the termination of facotry-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 Section 304.1

SECTION 806
METAL CHIMNEYS

806.1 General. Metal chimneys shall be constructed and installed in accordance with NFPA 211.

CHAPTER 9
SPECIFIC APPLIANCES, FIREPLACES AND SOLID FUEL-BURNING EQUIPMENT

SECTION 901
GENERAL

901.1 Scope. This chapter shall govern the approval, design, installation, construction, maintenance, alteration and repair of the appliances and equipment specifically identified herein and factory-built fireplaces. The approval, design, installation, construction, maintenance, alteration and repair of gas-fired appliances shall be regulated by Appendix C.

901.2 General. The requirements of this chapter shall apply to the mechanical equipment and appliances regulated by this chapter, in addition to the other requirements of this code.

901.3 Hazardous locations. Fireplaces and solid fuel-burning appliances shall not be installed in hazardous locations.

901.4 Fireplace accessories. Listed fireplace accessories shall be installed in accordance with the conditions of the listing and the manufacturer's installation instructions.

SECTION 902
MASONRY FIREPLACES

902.1 General. Masonry fireplaces shall be constructed in accordance with the building code.

SECTION 903
FACTORY-BUILT FIREPLACES

903.1 General. Factory-built fireplaces shall be listed and labeled and shall be installed in accordance with the conditions of the listing. Factory-built fireplaces shall be tested in accordance with UL 127.

903.2 Hearth extensions. Hearth extensions of approved factory-built fireplaces and fireplace stoves shall be installed in accordance with the listing of the fireplace. The hearth extension shall be readily distinguishable from the surrounding floor area.

903.3 Unvented gas log heaters. An unvented gas 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 904
PELLET FUEL-BURNING APPLIANCES

904.1 General. Pellet fuel-burning appliances shall be listed and labeled and shall be installed in accordance with the terms of the listing.

SECTION 905
FIREPLACE STOVES AND ROOM HEATERS

905.1 General. Fireplace stoves and solid-fuel-type room heaters shall be listed and labeled and shall be installed in accordance with the conditions of the listing. Fireplace stoves shall be tested in accordance with UL 737. Solid-fuel-type room heaters shall be tested in accordance with UL 1482. Fireplace inserts intended for installation in fireplaces shall be listed and labeled in accordance with the requirements of UL 1482 and shall be installed in accordance with the manufacturer's installation instructions.

905.2 Connection to fireplace. The connection of solid fuel appliances to chimney flues serving fireplaces shall comply with Sections 801.7 and 801.10.

SECTION 906
FACTORY-BUILT BARBECUE APPLIANCES

906.1 General. Factory-built barbecue appliances shall be of an approved type and shall be installed in accordance with the manufacturer's installation instructions, this chapter and Chapters 3, 5, 7, 8 and Appendix C.

SECTION 907
INCINERATORS AND CREMATORIES

907.1 General. Incinerators and crematories shall be listed and labeled and shall be installed in accordance with the manufacturer's installation instructions.

SECTION 908
COOLING TOWERS, EVAPORATIVE CONDENSERS AND FLUID COOLERS

908.1 General. A cooling tower used in conjunction with an air-conditioning appliance shall be installed in accordance with the manufacturer's installation instructions.

908.2 Access. Cooling towers, evaporative condensers and fluid coolers shall be provided with ready access.

908.3 Location. Cooling towers, evaporative condensers and fluid coolers shall be located to prevent the discharge vapor plumes from entering occupied spaces. Plume discharges shall be not less than 5 feet (1524 mm) above or 20 feet (6096 mm) away from any ventilation inlet to a building. Location on the property shall be as required for buildings by the building code.

908.4 Support and anchorage. Supports for cooling towers, evaporative condensers and fluid coolers shall be designed in accordance with the building code. Seismic restraints shall be as required by the building code.

908.5 Water supply. Water supplies and backflow protection shall be as required by the plumbing code.

908.6 Drainage. Drains, overflows and blow-down provisions shall be indirectly connected to an approved disposal location. Discharge of chemical waste shall be approved by the appropriate regulatory authority.

SECTION 909
VENTED WALL FURNACES

909.1 General. Vented wall furnaces shall be installed in accordance with their listing and the manufacturer's installation instructions. Oil-fired furnaces shall be tested in accordance with UL 730.

909.2 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.

909.3 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.

909.4 Ducts prohibited. Ducts shall not be attached to wall furnaces. Casing extension boots shall not be installed unless listed as part of the appliance.

909.5 Manual shutoff valve. A manual shutoff valve shall be installed ahead of all controls.

909.6 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 must be removed for normal servicing operations shall not be attached to the building construction.

SECTION 910
FLOOR FURNACES

910.1 General. Floor furnaces shall be installed in accordance with their listing and the manufacturer's installation instructions. Oil-fired furnaces shall be tested in accordance with UL 729.

910.2 Placement. Floor furnaces shall not be installed in the floor of any aisle or passageway of any auditorium, public hall, place of assembly, or in any egress element from any such room or space.

With the exception of wall register models, a floor furnace shall not be placed closer than 6 inches (152 mm) to the nearest wall, and wall register models shall not be placed closer than 6 inches (152 mm) to a corner.

The furnace shall be placed such that a drapery or similar combustible object will not be nearer than 12 inches (305 mm) to any portion of the register of the furnace. Floor furnaces shall not be installed in concrete floor construction built on grade. 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.

910.3 Bracing. The floor around the furnace shall be braced and headed with a support framework design in accordance with the building code.

910.4 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 reduced to not less than 2 inches (51 mm). Where these clearances are not present, 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.

SECTION 911
DUCT FURNACES

911.1 General. Duct furnaces shall be installed in accordance with the manufacturer's installation instructions. Electric furnaces shall be tested in accordance with UL 1995.

SECTION 912
INFRARED RADIANT HEATERS

912.1 Support. Infrared radiant heaters shall be safely and adequately fixed in an approved position independent of fuel and electric supply lines. Hangers and brackets shall be noncombustible material.

912.2 Clearances. Heaters shall be installed with clearances from combustible material in accordance with the manufacturer's installation instructions.

SECTION 913
CLOTHES DRYERS

913.1 General. Clothes dryers shall be installed in accordance with the manufacturer's installation instructions. Electric residential clothes dryers shall be tested in accordance with an approved test standard. Electric commercial clothes dryers shall be tested in accordance with UL 1240. Electric coin-operated clothes dryers shall be tested in accordance with UL 2158.

913.2 Exhaust required. Clothes dryers shall be exhausted in accordance with Section 504.

913.3 Clearances. Clothes dryers shall be installed with clearance to combustibles in accordance with the manufacturer's installation instructions.

SECTION 914
SAUNA HEATERS

914.1 Location and protection. Sauna heaters shall be located so as to minimize the possibility of accidental contact by a person in the room.

914.1.1 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.

914.2 Installation. Sauna heaters shall be listed and labeled and shall be installed in accordance with its listing and the manufacturer's installation instructions.

914.3 Access. Panels, grilles and access doors that are required to be removed for normal servicing operations, shall not be attached to the building.

914.4 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.

914.4.1 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.

914.5 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.

914.5.1 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 915
ENGINE AND GAS TURBINE-POWERED EQUIPMENT AND APPLIANCES

915.1 General. The installation of liquid-fueled stationary internal combustion engines and gas turbines, including fuel storage and piping, shall meet the requirements of NFPA 37.

915.2 Powered equipment and appliances. Permanently installed equipment and appliances powered by internal combustion engines and turbines shall be installed in accordance with the manufacturer's installation instructions and NFPA 37.

SECTION 916
POOL AND SPA HEATERS

916.1 General. Pool and spa heaters shall be installed in accordance with the manufacturer's installation instructions. Oil-fired pool heaters shall be tested in accordance with UL 726.

SECTION 917
COOKING APPLIANCES

917.1 Cooking appliances. Cooking appliances that are designed for permanent installation, including ranges, ovens, stoves, broilers, grills, fryers, griddles and barbecues, shall be listed, labeled and installed in accordance with the manufacturer's installation instructions. Oil-burning stoves shall be tested in accordance with UL 896. Solid-fuel-fired ovens shall be tested in accordance with UL 2162.

917.2 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.

917.3 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.

917.4 Installation of a listed cooking appliance or microwave over a listed cooking top appliance. The installation of a listed cooking appliance or microwave oven over a listed cooking top appliance shall conform to the conditions of the upper appliance's listing and the manufacturer's installation instructions.

SECTION 918
FORCED-AIR WARM-AIR FURNACES

918.1 Forced-air furnaces. Forced-air furnaces shall be installed in accordance with the listings and the manufacturer's installation instructions. Oil-fired furnaces shall be tested in accordance with UL 727. Electric furnaces shall be tested in accordance with UL 1096 or UL 1995. Solid fuel furnaces shall be tested in accordance with UL 391.

918.2 Minimum duct sizes. 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 per 1,000 Btu/h (4402 mm^2/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 not be less than 2 square inches for each 1,000 Btu/h (4402 mm^2/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.

918.3 Heat pumps. The minimum unobstructed total area of the outside and return air ducts or openings to a heat pump shall be not less than 6 square inches per 1,000 Btu/h (13 208 mm^2/kW) output rating or as indicated by the conditions of listing of the heat pump. Electric heat pumps shall be tested in accordance with UL 559 or UL 1995.

918.4 Dampers. Volume dampers shall not be placed in the air inlet to a furnace in a manner which will reduce the required air to the furnace.

918.5 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.

918.6 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.

   Exception: Listed outdoor appliances which provide both circulating air inlet and vent discharge.

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 this 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 Sections 918.2 and 918.3, 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 closet, bathroom, toilet room, kitchen, garage, mechanical room, boiler room or furnace room.
6. A room or space containing a fuel-burning appliance where such room or space serves as the sole source of return air.

   Exceptions:

   1. This shall not apply where the fuel-burning appliance is a direct-vent appliance.
   2. This shall not apply where 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. This shall not apply where rooms or spaces containing solid fuel-burning appliances, provided that return-air inlets are located not less than 10 feet (3048 mm) from the fire box of such appliances.

918.7 Outside opening protection. Outdoor air intake openings shall be protected in accordance with Section 401.6.

918.8 Return-air limitation. Return air from one dwelling unit shall not be discharged into another dwelling unit.

SECTION 919
CONVERSION BURNERS

919.1 Conversion burners. The installation of conversion burners shall conform to ANSI Z21.8.

SECTION 920
UNIT HEATERS

920.1 General. Unit heaters shall be installed in accordance with the listing and the manufacturer's installation instructions. Oil-fired unit heaters shall be tested in accordance with UL 731.

920.2 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. Suspended-type oil-fired unit heaters shall be installed in accordance with NFPA 31.

920.3 Ductwork. A unit heater shall not be attached to a warm-air duct system unless listed for such installation.

SECTION 921
VENTED ROOM HEATERS

921.1 General. Vented room heaters shall be listed and labeled and shall be installed in accordance with the conditions of the listing and the manufacturer's instructions.

SECTION 922
KEROSENE AND OIL-FIRED STOVES

922.1 General. Kerosene and oil-fired stoves shall be listed and labeled and shall be installed in accordance with the conditions of the listing and the manufacturer's installation instructions. Kerosene and oil-fired stoves shall comply with NFPA 31. Oil-fired stoves shall be tested in accordance with UL 896.

SECTION 923
SMALL CERAMIC KILNS

923.1 General. The provisions of this section shall apply to listed and unlisted kilns that are used for ceramics, have a maximum interior volume of 20 cubic feet (0.566 m^3) and are used for hobby and noncommercial purposes.

923.1.1 Installation. Lised kilns shall be installed in accordance with the manufacturer's installation instructions and the provisions of this code.

923.2 Unlisted kiln installation. Unlisted kilns shall be installed in accordance with the manufacturer's installation instructions and the provisions of this code.

923.2.1 Installations inside buildings. In addition to other requirements specified in this section, interior installation shall meet the following requirements:

923.2.2 Clearances for interior installation. The sides and tops of kilns shall be located a minimum of 18 inches (457 mm) from any noncombustible wall surface and 3 feet (914 mm) from any combustible wall surface. Kilns shall be installed on noncombustible flooring, consisting of at least 2 inches (51 mm) of solid masonry or concrete extending at least 12 inches (305 mm) beyond the base or supporting members of the kiln.

Exception: These clearances may be reduced, provided independent testing is provided to and approved by the building official.

923.2.3 Control side clearance. The clearance on the gas or electrical control side of a kiln shall not be reduced to less than 30 inches (762 mm).

923.2.4 Hoods. A canopy type hood shall be installed directly above each kiln. The face opening area of the hood shall be equal to or greater than the top horizontal surface area of the kiln. The hood shall be constructed of not less than 0.024-inch (0.61 mm) (No. 24 U.S. gage) galvanized steel or equivalent and be supported at a height of between 12 inches and 30 inches (305 mm and 762 mm) above the kiln by noncombustible supports.

Exception: Electric kilns installed with listed exhaust blowers may be used when marked as being suitable for the kiln and installed in accordance with manufacturer's instructions.

923.2.5 Gravity ventilation ducts. Each kiln hood shall be connected to a gravity ventilation duct extending in a vertical direction to outside the building. This duct shall be of the same construction as the hood and shall have a cross-sectional area of not less than one fifteenth of the face opening of the hood. The duct shall terminate a minimum of 12 inches (305 mm) above any portion of a building within 4 feet (1219 mm) and terminate no less 4 feet (1219 mm) from any openable windows or other opening into the building or adjacent property line. The duct to the outside shall be shielded, without reduction of duct area, to prevent entrance of rain into the duct. The duct shall be supported at each section by noncombustible supports.

923.2.6 Hood and duct clearances. Every hood and duct serving a fuel-burning kiln shall have a clearance from combustible construction of at least 18 inches (457 mm). This clearance may be reduced in accordance with Table 308.2.

923.2.6.1 Makeup air. Provisions shall be made for air to enter the room in which a kiln is installed at a rate at least equal to the air being removed through the kiln hood.

923.3 Exterior Installations. Kilns shall be installed with minimum clearances as specified in Section 923.2.2. Kilns located under a roof and enclosed by two or more vertical wall surfaces, shall have a hood and gravity ventilation duct installed to comply with Sections 923.2.4 and 923.2.5.

SECTION 924
STATIONARY FUEL CELL POWER PLANTS

924.1 General. Stationary fuel cell ppower 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.

SECTION 925
WOOD STOVES

925.1 Used wood stoves.

NOTE: For reference only. Not adopted as part of this code.

The installation of used wood stoves defined and regulated by the Oregon Department of Envoronmental Quality's OAR Chapter 340, Division 262 (wood-burning room heaters as used in this code) is prohibited.

Exceptions:

1. Wood stoves certified as new on or after July 1, 1986, under rules adopted pursuant or OAR Chapter 340, Division 262.
2. Antique wood stoves pursuant to OAR Chapter 340, Division 262.
3. Pellet stoves under rules adopted pursuant to OAR Chapter 340, Division 262.

925.2 Labeling for identification.

NOTE: For reference only. Not adopted as part of this code.

Wood stoves, as defined by the Oregon Department of Environmental Quality, OAR Chapter 340, Division 262, are required by DEQ to bear a certification label.

CHAPTER 10
BOILERS, WATER HEATERS AND PRESSURE VESSELS

SECTION 1001
GENERAL

1001.1 Scope. The purpose of this chapter is to establish and provide minimum standards for the protection of the public welfare, health and safety, and property by regulating and controlling the location of steam and hot-water boilers, water heaters and pressure vessels. Boilers and pressure vessels and their related piping are regulated by the Oregon Boiler and Pressure Vessel Law.

SECTION 1002
WATER HEATERS

1002.1 General. Potable water heaters and hot water storage tanks shall be listed and labeled and installed in accordance with the manufacturer's installation instructions, the plumbing code and this code. All water heaters shall be capable of being removed without first removing a permanent portion of the building structure. The potable water connections and relief valves for all water heaters shall conform to the requirements of the plumbing code.

1002.2 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 plumbing code.

1002.2.1 Sizing. Water heaters utilized for both potable water heating and space-heating applications shall be sized to prevent the space-heating load from diminishing the required potable water-heating capacity.

1002.2.2 Scald protection. Where a combination potable water-heating and space-heating system requires water for space heating at temperatures higher than 140°F (60°C), a tempering valve shall be provided to temper the water supplied to the potable hot water distribution system to a temperature of 140°F (60°C) or less.

1002.3 Supplemental water-heating devices. Potable water-heating devices that utilize refrigerant-to-water heat exchangers shall be approved and installed in accordance with the plumbing code and the manufacturer's installation instructions.

SECTION 1003
BOILERS AND PRESSURE VESSELS

1003.1 Scope. The requirements of this section shall apply to the boiler rooms, combustion air, chimneys and vents, and fuel piping related to the construction, installation, repair and alteration of rooms for the installation of boilers and pressure vessels.

1003.2 Workmanship. All equipment, appurtenances, devices and piping shall be installed in a workmanlike manner conforming to provisions and intent of this chapter.

SECTION 1004
DEFINITIONS

1004.1 Definitions. Certain words and terms used in this chapter, unless clearly inconsistent with their context, shall mean as follows:

BOILER is as defined in ORS 480.515(2).

ORS 480.515(2) is not a part of this code but is reproduced here for the reader's convenience:

480.515 Definitions for ORS 480.510 to 480.670.

(2) "Boiler" or "boilers" means:

(a) A closed vessel or vessels intended for the heating or vaporizing of liquids to be used externally to such vessel or vessels by the application of heat from combustible fuels, electricity or nuclear energy;

(b) Related appurtenances including but not limited to pressure piping directly connected and related to the safe operation of a boiler; and

(c) Pressure piping consisting of boiler or nonboiler external piping connected to a boiler, but not potable water nonboiler external piping.

DOMESTIC WATER HEATER is as defined in ORS 480.525(1)(b).

ORS 480.525(1)(b) is not a part of this code but is reproduced here for the reader's convenience:

480.525 Exempt vessels.

(1)(b) Domestic water heaters designed for heating potable water, equipped with an approved pressure-relieving device, containing only water and that do not exceed:

(A) Capacity of 120 gallons;

(B) Water temperature of 210 degrees Fahrenheit;

(C) Pressure of 150 pounds per square inch gauge pressure; or

(D) Heat input of 200,000 BTU per hour.

SECTION 1005
PERMITS REQUIRED

1005.1 Permits. It shall be unlawful to install any boiler or pressure vessel regulated by this code without first obtaining a permit to do so from the building official and an installation permit from the Oregon Building Codes Division, Boiler and Pressure Vessel Program.

SECTION 1006
DETAILED REQUIREMENTS

1006.1 Safety requirements. The installation of all boilers and pressure vessels shall conform to the minimum requirements for safety established by this code.

1006.2 Stack dampers. Stack dampers on boilers fired with oil or solid fuel shall not close more than 80 percent of the stack area when closed, except on automatic boilers with prepurge, automatic draft control and interlock. Operative dampers shall not be placed within any stack, flue or vent of a gas-fired boiler, except on an automatic boiler with prepurge, automatic draft control and interlock.

SECTION 1007
EXPANSION TANKS

1007.1 Expansion tanks. All water heating systems provided with an air expansion tank shall be securely fastened to the structure; supports shall be adequate to carry twice the weight of the tank filled with water without placing any strain on connecting piping.

All water heating systems incorporating hot-water tanks or fluid relief columns shall be installed to prevent freezing under normal operating conditions.

SECTION 1008
SAFETY OR RELIEF VALVE DISCHARGE

1008.1 General. The discharge from relief valves shall be piped to within 18 inches (457 mm) of the floor or to an open receptacle, and when the operating temperature is in excess of 212°F (100°C), shall be equipped with a splash shield or centrifugal separator. When the discharge from safety valves would result in a hazardous discharge of steam inside the boiler room, such discharge shall be extended outside the boiler room. No valve of any description shall be placed between the safety valve and the atmosphere.

SECTION 1009
GAS-PRESSURE REGULATORS

1009.1 General. An approved gas-pressure regulator shall be installed on gas-fired boilers where the gas supply pressure is higher than that at which the main burner is designed to operate. A separate approved gas-pressure regulator shall be installed to regulate the gas pressure to the pilot or pilots. A separate regulator shall not be required for the pilot or pilots on manufacturer-assembled boiler-burner units which have been approved by the building official and on gas-fired boilers in Group R Occupancies of less than six units and in Group M Occupancies.

SECTION 1010
CLEARANCE FOR ACCESS

1010.1 Access. When boilers are installed or replaced, clearance shall be provided to allow access for inspection, maintenance and repair, and passageways shall have an unobstructed width of not less than 18 inches (457 mm). Clearance for repair and cleaning may be provided through a door or access panel into another area, provided the opening is of sufficient size.

Package boilers, miniature boilers, low-pressure boilers and hot-water supply boilers with no manhole on top of shell shall have a minimum clearance of 2 feet (610 mm) from the ceiling.

SECTION 1011
BOILER ROOM ENCLOSURES

1011.1 Boiler rooms. Boiler rooms and enclosures and access thereto shall comply with Chapter 3 of this code and the building code.

SECTION 1012
FLOORS

1012.1 General. Boilers shall be mounted on floors of noncombustible construction unless listed for mounting on combustible floors. The floor and related structural supports shall be designed as required in the building code to carry the loads imposed by the boiler and appurtenances.

SECTION 1013
CHIMNEYS OR VENTS

1013.1 General. When required, boilers shall be connected to a chimney or vent as provided for other fuel-burning equipment in Chapter 8 or Appendix C of this code.

SECTION 1014
DRAINAGE

1014.1 Drains. The boiler room shall have an approved floor drain or equivalent means for disposing of accumulation of liquid wastes incidental to cleaning or recharging.

SECTION 1015
FUEL SUPPLY PIPING

1015.1 Piping. Fuel supply piping shall conform to Chapter 13, Appendix C or the standards cited in Chapter 15, Referenced Standards, Tanks, Piping, Valves, etc.

SECTION 1016
AIR FOR COMBUSTION AND VENTILATION

1016.1 General. Air for combustion and ventilation shall be according to Chapter 7 or Appendix C of this code.

SECTION 1017
STEAM AND WATER PIPING

NOTE: Boilers and pressure vessels and related piping are regulated by the state of Oregon Boiler and Pressure Vessel Law (ORS 480.510 to 480.670).

1017.1 General. Steam piping is regulated according to and under the jurisdiction of the Oregon Boiler and Pressure Vessel Law and related administrative rules and the jurisdiction of Oregon Building Codes Division, Boiler and Pressure Vessel Program. Water piping for hot-water heating systems and hydronics shall be installed according to Chapter 12.

CHAPTER 11
REFRIGERATION

SECTION 1101
GENERAL

1101.1 Scope. This chapter shall govern the design, installation, construction and repair of refrigeration systems that vaporize and liquefy a fluid during the refrigerating cycle. Refrigerant piping design and installation, including pressure vessels and pressure relief devices, shall conform to this code. Permanently installed refrigerant storage systems and other components shall be considered as part of the refrigeration system to which they are attached.

NOTE: Brazing certifications required. A person qualified for inspection of brazing or welding of refrigeration piping shall have a valid certification meeting the requirements in OAR 918-098-0900. A person engaged in the brazing or welding of refrigeration piping shall have a valid certification meeting the requirements in OAR 918-440-0015. For refrigeration piping regulated by the State of Oregon Boiler and Pressure Vessel Program, see requirements listed in OAR 918-225-0310. All three of these administrative rules were effective July 1, 2001.

918-098-0900

Refrigeration Inspector Certification

(1) All persons engaged in the inspection of brazing or welding related to the installation, alteration or repair of refrigeration piping systems, except as regulated by the Oregon Boiler and Pressure Vessel Program under OAR Chapter 918, Division 225, shall:

(a) Possess a current and valid A- or B-level Mechanical Inspector Certification issued under OAR 918-098-0120 or 918-098-0130; and

(b) Successfully complete a training program in accordance with either Section IX, "Welding and Brazing Qualification" of the **ASME Boiler and Pressure Vessel Code,** or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification" issued by a division-approved organization.

(2) Inspector certification for refrigeration piping in one- and two-family dwellings is not required.

918-440-0015

Refrigeration Installer Certification

All persons engaged in brazing or welding related to the installation, alteration or repair of refrigeration piping systems not regulated by the Oregon Boiler and Pressure Vessel Program under OAR Chapter 918, Division 225, shall be certified in accordance with the requirements of this rule.

(1) The minimum requirement for persons engaged in brazing or welding of refrigeration piping systems is a current and valid certification issued upon completion of a class by a division-approved certifying organization in brazing or welding in accordance with either:

(a) Section IX, Welding and Brazing Qualifications of the ASME Boiler and Pressure Vessel Code; or

(b) AWS B2.2, Standard for Brazing Procedure and Performance Qualification.

(2) Refrigeration systems installed in dwelling units regulated under the **One and Two Family Dwelling Specialty Code** are exempt from this rule.

(3) All refrigeration piping system requirements not regulated by OAR 918-225-0310 are subject to the **Oregon Mechanical Specialty Code.**

(Continued)

918-225-0310

Refrigerant Piping Systems; Components

(1) The requirements of OAR 918-225-0430(5) shall be enforced under this rule for all refrigerant piping systems consisting of welded, brazed or mechanically assembled piping and piping fittings exceeding 2 inches NPS, and containing any refrigerant chemical rated as other than A-1 or B-1 by the American Society of Heating, Refrigeration and Air Conditioning Engineers (**ASHRAE 34**) as adopted by the **Oregon Mechanical Specialty Code.**

(2) One- and two-family dwelling units and air conditioning refrigeration systems used solely for human comfort are exempt from this rule.

(3) All refrigeration piping system requirements other than those regulated by this rule are subject to the **Oregon Mechanical Specialty Code.**

1101.2 Factory-built equipment and appliances. Listed and labeled self-contained, factory-built equipment and appliances shall be tested in accordance with UL 207, 303, 412, 465, 471 or 1995. Such equipment and appliances are deemed to meet the design, manufacture, and factory test requirements of this code if installed in accordance with their listing and the manufacturer's installation instructions.

1101.3 Protection. Any portion of a refrigeration system that is subject to physical damage shall be protected in an approved manner.

1101.4 Water connection. Water supply and discharge connections associated with refrigeration systems shall be made in accordance with this code and the plumbing code.

1101.5 Fuel gas connection. Fuel gas devices, equipment and appliances used with refrigeration systems shall be installed in accordance with Appendix C.

1101.6 General. Refrigeration systems shall comply with the requirements of this code and, except as modified by this code, ASHRAE 15. Ammonia-refrigerating systems shall comply with this code and, except as modified by this code, ASHRAE 15 and IIAR 2.

SECTION 1102
SYSTEM REQUIREMENTS

1102.1 General. The system classification, allowable refrigerants, the maximum quantity, enclosure requirements, location limitations, and field pressure test requirements shall be determined as follows:

1. Determine the refrigeration system's classification, in accordance with Section 1103.3.
2. Determine the refrigerant classification in accordance with Section 1103.1.
3. Determine the maximum allowable quantity of refrigerant in accordance with Section 1104, based on type of refrigerant, system classification, and occupancy.
4. Determine the system enclosure requirements in accordance with Section 1104.

5. Refrigeration equipment and appliance location and installation shall be subject to the limitations of Chapter 3.
6. Nonfactory-tested, field-erected equipment and appliances shall be pressure tested in accordance with Section 1108.

1102.2 Refrigerants. The refrigerant shall be that for which the equipment or appliance was designed to utilize or converted to utilize. Refrigerants not identified in Table 1103.1 shall be approved before use.

1102.2.1 Mixing. Refrigerants, including refrigerant blends, with different designations in ASHRAE 34 shall not be mixed in a system.

Exception: Addition of a second refrigerant is allowed where permitted by the equipment or appliance manufacturer to improve oil return at low temperatures. The refrigerant and amount added shall be in accordance with the manufacturer's instructions.

1102.2.2 Purity. Refrigerants used in refrigeration systems shall be new, recovered or reclaimed refrigerants in accordance with Section 1102.2.2.1, 1102.2.2.2 or 1102.2.2.3. Where required by the equipment or appliance owner or the code official, the installer shall furnish a signed declaration that the refrigerant used meets the requirements of Section 1102.2.2.1, 1102.2.2.2 or 1102.2.2.3.

Exception: The refrigerant used shall meet the purity specifications set by the manufacturer of the equipment or appliance in which such refrigerant is used where such specifications are different from that specified in Sections 1102.2.2.1, 1102.2.2.2 or 1102.2.2.3.

1102.2.2.1 New refrigerants. Refrigerants shall be of a purity level specified by the equipment or appliance manufacturer.

1102.2.2.2 Recovered refrigerants. Refrigerants that are recovered from refrigeration and air-conditioning systems shall not be reused in other than the system from which they were recovered and in other systems of the same owner. Recovered refrigerants shall be filtered and dried before reuse. Recovered refrigerants that show clear signs of contamination shall not be reused unless reclaimed in accordance with Section 1102.2.2.3.

1102.2.2.3 Reclaimed refrigerants. Used refrigerants shall not be reused in a different owner's equipment or appliances unless tested and found to meet the purity requirements of ARI 700. Contaminated refrigerants shall not be used unless reclaimed and found to meet the purity requirements of ARI 700.

SECTION 1103
REFRIGERATION SYSTEM CLASSIFICATION

1103.1 Refrigerant classification. Refrigerants shall be classified in accordance with ASHRAE 34 as listed in Table 1103.1.

1103.2 Occupancy classification. Locations of refrigerating systems are described by occupancy classifications that consider the ability of people to respond to potential exposure to refrigerants. Where equipment or appliances, other than piping, are located outside a building and within 20 feet (6096 mm) of any building opening, such equipment or appliances shall be governed by the occupancy classification of the building. Occupancy classifications shall be defined as follows:

1. Institutional occupancy is that portion of premises from which, because they are disabled, debilitated or confined, occupants cannot readily leave without the assistance of others. Institutional occupancies include, among others, hospitals, nursing homes, asylums and spaces containing locked cells.
2. Public assembly occupancy is that portion of premises where large numbers of people congregate and from which occupants cannot quickly vacate the space. Public assembly occupancies include, among others, auditoriums, ballrooms, classrooms, passenger depots, restaurants and theaters.
3. Residential occupancy is that portion of premises that provides the occupants with complete independent living facilities, including permanent provisions for living, sleeping, eating, cooking and sanitation. Residential occupancies include, among others, dormitories, hotels, multi-unit apartments and private residences.
4. Commercial occupancy is that portion of premises where people transact business, receive personal service or purchase food and other goods. Commercial occupancies include, among others, office and professional buildings, markets (but not large mercantile occupancies) and work or storage areas that do not qualify as industrial occupancies.
5. Large mercantile occupancy is that portion of premises where more than 100 persons congregate on levels above or below street level to purchase personal merchandise.
6. Industrial occupancy is that portion of premises that is not open to the public, where access by authorized persons is controlled, and that is used to manufacture, process or store goods such as chemicals, food, ice, meat or petroleum.
7. Mixed occupancy occurs when two or more occupancies are located within the same building. When each occupancy is isolated from the rest of the building by tight walls, floors and ceilings and by self-closing doors, the requirements for each occupancy shall apply to its portion of the building. When the various occupancies are not so isolated, the occupancy having the most stringent requirements shall be the governing occupancy.

1103.3 System classification. Refrigeration systems shall be classified according to the degree of probability that refrigerant leaked from a failed connection, seal, or component could enter an occupied area. The distinction is based on the basic design or location of the components.

1103.3.1 Low-probability systems. Double-indirect open-spray systems, indirect closed systems and indirect-vented closed systems shall be classified as low-probability systems, provided that all refrigerant-containing piping and fittings are isolated when the quantities in Table 1103.1 are exceeded.

TABLE 1103.1
REFRIGERANT CLASIFICATION, AMOUNT AND TLV-TWA

REFRIG-ERANT	CHEMICAL FORMULA	CHEMICAL NAME OR BLEND	HAZARD CATE-GORIES[a]	REFRIGER-ANT CLAS-SIFICATION	DEGREES OF HAZARD[b]	[M] AMOUNT OF REFRIGER-ANT PER OCCUPIED SPACE			TVL-TWA PPM
						Pounds per 1,000 cubic feet	ppm	g/m	
R-11	CCl_3F	Trichlorofluoromethane	OHH	A1	2-0-0[c]	1.6	4,000	25	C1,000
R-12	CCl_2F_2	Dichlorodifluoromethane	CG, OHH	A1	2-0-0[c]	12	40,000	200	1,000
R-13	$CClF_3$	Chlorotrifluoromethane	CG, OHH	A1	2-0-0[c]	18	67,000	290	1,000
R-13B1	$CBrF_3$	Bromotrifluoromethane	CG, OHH	A1	2-0-0[c]	22	57,000	350	1,000
R-14	CF_4	Tetrafluoromethane (carbon tetrafluoride)	CG, OHH	A1	2-0-0[c]	15	67,000	240	1,000
R-22	$CHClF_2$	Chlorodifluoromethane	CG, OHH	A1	2-0-0[c]	9.4	42,000	150	1,000
R-23	CHF_3	Trifluoromethane (fluoroform)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-113	CCl_2FCClF_2	1,1,2-trichloro-1,2,2-trifluoroethane	OHH	A1	2-0-0[c]	1.9	4,000	31	1,000
R-114	$CClF_2CClF_2$	1,2-dichloro-1,1,2,2-tetrafluoroethane	CG, OHH	A1	2-0-0[c]	9.4	21,000	150	1,000
R-123	$CHCl_2CF_3$	2,2-dichloro-1,1,1-trifluoroethane	OHH	B1	2-0-0[c]	0.4	1,000	6.3	30
R-124	$CHClFCF_3$	2-chloro-1,1,1,2-tetrafluoroethane	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-134a	CH_2FCF_3	1,1,1,2-tetrafluoroethane	CG, OHH	A1	2-0-0[c]	16	60,000	250	1,000
R-170	CH_3CH_3	Ethane	CG, F, OHH	A3	2-4-0	0.50	6,400	8.0	1,000
R-236fa	$CF_3CH_2CF_3$	1,1,1,3,3,3-hexafluoropropane	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-245fa	$CHF_2CH_2CF_3$	1,1,1,3,3-pentafluoropropane	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-290	$CH_3CH_2CH_3$	Propane	CG, F, OHH	A3	2-4-0	0.50	4,400	8.0	1,000
R-400	zeotrope	R-12/114	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-401A	zeotrope	R-22/152a/124 (53/13/34)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-401B	zeotrope	R-22/152a/124 (61/11/28)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-401C	zeotrope	R-22/152a/124 (33/15/52)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-402A	zeotrope	R-125/290/22 (60/2/38)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-402B	zeotrope	R-125/290/22 (38/2/60)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-404A	zeotrope	R-125/143a/134a (44/52/4)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-407A	zeotrope	R-32/125/134a (20/40/40)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-407B	zeotrope	R-32/125/134a (10/70/20)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-407C	zeotrope	R-32/125/134a (23/25/52)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-407D	zeotrope	R-32/125/134a (15/15/70)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-407E	zeotrope	R-32/125/134a (25/15/60)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-408A	zeotrope	R-125/143a/22 (7/46/47)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-409A	zeotrope	R-22/124/142b (60/25/15)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-409B	zeotrope	R-22/124/142b (65/25/10)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-410A	zeotrope	R-32/125 (50/50)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-416A	zeotrope	R-134a/124/600 (59/39.5/1.5)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-500	azeotrope	R-12/152a (73.8/26.2)	CG, OHH	A1	2-0-0[c]	12	47,000	200	1,000
R-502	azeotrope	R-22/115 (48.8/51.2)	CG, OHH	A1	2-0-0[c]	19	65,000	300	1,000
R-503	azeotrope	R-23/13 (40.1/59.9)	CG, OHH	A1	2-0-0[c]	15	67,000	240	1,000
R-507A	azeotrope	R-125/143a (50/50)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-508A	azeotrope	R-23/116 (39/61)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-508B	azeotrope	R-23/116 (46/54)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-509A	azeotrope	R-22/218 (44/56)	CG, OHH	A1	2-0-0[c]	—	—	—	—
R-600	$CH_3CH_2CH_2CH_3$	Butane	CG, F, OHH	A3	1-4-0	0.51	3,400	8.2	800
R-600a	$CH(CH_3)2\text{-}CH_3$	Isobutane (2-methyl propane)	CG, F, OHH	A3	2-4-0	0.51	3,400	8.2	800
R-717	NH_3	Ammonia	CG, C, F,OHH	B2	3-3-0[d]	0.022	500	0.35	25
R-718	H2O	Water	—	A1	0-0-0	—	—	—	—
R-744	CO_2	Carbon dioxide	CG, OHH	A1	2-0-0[c]	5.7	50,000	91	5,000
R-1150	$CH_2=CH_2$	Ethene (ethylene)	CG, F, OHH	A3	1-4-2	0.38	5,200	6.0	1,000
R-1270	$CH_3CH=CH_2$	Propene (propylene)	CG, F, OHH	B3	1-4-1	0.37	3,400	5.0	1,000

For **SI:** 1 pound = 0.454 kg, 1 cubic foot = 0.0283 m^3.

a. CG = Compressed gas; C = Corrosive; F = Flammable; OHH = Other Health Hazard.

b. Degrees of hazard are for health, fire, and reactivity, respectively, in accordance with NFPA 704.

c. Reduction to 1-0-0 is allowed if analysis satisfactory to the code official shows that the maximum concentration for a rupture or full loss of refrigerant charge would not exceed the IDLH, considering both the refrigerant quantity and room volume.

d. For installations that are entirely outdoors, use 3-1-0.

1103.3.2 High-probability systems. Direct systems and indirect open-spray systems shall be classified as high-probability systems.

Exception: An indirect open-spray system shall not be required to be classified as a high-probability system if the pressure of the secondary coolant is at all times (operating and standby) greater than the pressure of the refrigerant.

SECTION 1104
SYSTEM APPLICATION REQUIREMENTS

1104.1 General. The refrigerant, occupancy and system classification cited in this section shall be determined in accordance with Sections 1103.1, 1103.2 and 1103.3, respectively. For refrigerant blends assigned dual classifications, as formulated and for the worst case of fractionation, the classifications for the worst case of fractionation shall be used.

1104.2 Machinery room. Except as provided in Sections 1104.2.1 and 1104.2.2, all components containing the refrigerant shall be located either outdoors or in a machinery room where the quantity of refrigerant in an independent circuit of a system exceeds the amounts shown in Table 1103.1. For refrigerant blends not listed in Table 1103.1, the same requirement shall apply when the amount for any blend component exceeds that indicated in Table 1103.1 for that component. This requirement shall also apply when the combined amount of the blend components exceeds a limit of 69,100 parts per million (ppm) by volume. Machinery rooms required by this section shall be constructed and maintained in accordance with Section 1105 for Group A1 and B1 refrigerants and in accordance with Sections 1105 and 1106 for Group A2, B2, A3 and B3 refrigerants.

Exceptions:

1. Machinery rooms are not required for listed equipment and appliances containing not more than 6.6 pounds (3 kg) of refrigerant, regardless of the refrigerant's safety classification, where installed in accordance with the equipment's or appliance's listing and the equipment or appliance manufacturer's installation instructions.
2. Piping in conformance with Section 1107 is allowed in other locations to connect components installed in a machinery room with those installed outdoors.

1104.2.1 Institutional occupancies. The amounts shown in Table 1103.1 shall be reduced by 50 percent for all areas of institutional occupancies except kitchens, laboratories, and mortuaries. The total of all Groups A2, B2, A3 and B3 refrigerants shall not exceed 550 pounds (250 kg) in occupied areas or machinery rooms.

1104.2.2 Industrial occupancies and refrigerated rooms. This section applies only to industrial occupancies and refrigerated rooms for manufacturing, food and beverage preparation, meat cutting, other processes, and storage. Machinery rooms are not required where all of the following conditions are met:

1. The space containing the machinery is separated from other occupancies by tight construction with tight-fitting doors.
2. Access is restricted to authorized personnel.
3. The floor area per occupant is not less than 100 square feet (9.3 m^2) where machinery is located on floor levels with exits more than 6.6 feet (2012 mm) above the ground. Where provided with egress directly to the outdoors or into approved building exits, the minimum floor area shall not apply.
4. Refrigerant detectors are installed as required for machinery rooms in accordance with Section 1105.3.
5. Surfaces having temperatures exceeding 800°F (427°C) and open flames are not present where any Groups A2, B2, A3 or B3 refrigerant is used. (See Section 1104.3.4.)
6. All electrical equipment and appliances conform to Class 1, Division 2, of NFPA 70 where the quantity of any Groups A2, B2, A3, or B3 refrigerant in a single independent circuit would exceed 25 percent of the lower flammability limit (LFL) upon release to the space.
7. All refrigerant-containing parts in systems exceeding 100 HP (74.6 kW) drive power, except evaporators used for refrigeration or dehumidification; condensers used for heating; control and pressure-relief valves for either; and connecting piping, shall be located either outdoors or in a machinery room.

1104.3 Refrigerant restrictions. Refrigerant applications, maximum quantities and use shall be restricted in accordance with Sections 1104.3.1 through 1104.3.4.

1104.3.1 Air-conditioning for human comfort. In other than industrial occupancies where the quantity in a single independent circuit does not exceed the amount in Table 1103.1, Groups B1, B2 and B3 refrigerants shall not be used in high-probability systems for air-conditioning for human comfort.

1104.3.2 Nonindustrial occupancies. Groups A2 and B2 refrigerants shall not be used in high-probability systems where the quantity of refrigerant in any independent refrigerant circuit exceeds the amount shown in Table 1104.3.2. Group A3 and B3 refrigerants shall not be used except where approved.

Exception: This section does not apply to laboratories where the floor area per occupant is not less than 100 square feet (9.3 m^2).

1104.3.3 All occupancies. The total of all Groups A2, B2, A3, and B3 refrigerants other than R-717, ammonia, shall not exceed 1,100 pounds (500 kg) except where approved.

TABLE 1104.3.2
MAXIMUM PERMISSIBLE QUANTITIES OF REFRIGERANTS

TYPE OF REFRIGERATION SYSTEM	MAXIMUM POUNDS (kg) FOR VARIOUS OCCUPANCIES			
	Institutional	Assembly	Residential	All other occupanices
Sealed absorption system				
In exit access	0(0)	0(0)	3.3(1.5)	3.3(1.5)
In adjacent outdoor locations	0(0)	0(0)	22(10)	22(10)
In other than exit access	0(0)	6.6(3)	6.6(3)	6.6(3)
Unit systems				
In other than exit access	0(0)	0(0)	6.6(3)	6.6(3)

For **SI:** 1 pound = 0.454 kg.

1104.3.4 Protection from refrigerant decomposition. Where any device having an open flame or surface temperature greater than 800°F (427°C) is used in a room containing more than 6.6 pounds (3 kg) of refrigerant in a single independent circuit, a hood and exhaust system shall be provided in accordance with Section 510. Such exhaust system shall exhaust combustion products to the outdoors.

Exception: A hood and exhaust system shall not be required:

1. Where the refrigerant is R-717, R-718, or R-744;
2. Where the combustion air is ducted from the outdoors in a manner that prevents leaked refrigerant from being combusted; or
3. Where a refrigerant detector is used to stop the combustion in the event of a refrigerant leak. (See Sections 1105.3 and 1105.6.)

1104.4 Volume calculations. Volume calculations shall be in accordance with Sections 1104.4.1 through 1104.4.3.

1104.4.1 Noncommunicating spaces. Where the refrigerant-containing parts of a system are located in one or more spaces that do not communicate through permanent openings or HVAC ducts, the volume of the smallest, enclosed occupied space shall be used to determine the permissible quantity of refrigerant in the system.

1104.4.2 Communicating spaces. Where an evaporator or condenser is located in an air duct system, the volume of the smallest enclosed occupied space served by the duct system shall be used to determine the maximum allowable quantity of refrigerant in the system.

Exception: If airflow to any enclosed space cannot be reduced below one-quarter of its maximum, the entire space served by the air duct system shall be used to determine the maximum allowable quantity of refrigerant in the system.

1104.4.3 Plenums. Where the space above a suspended ceiling is continuous and part of the supply or return air plenum system, this space shall be included in calculating the volume of the enclosed space.

SECTION 1105
MACHINERY ROOM, GENERAL REQUIREMENTS

Note: Refer also to Oregon Structural Specialty Code Chapter 28 for these requirements.

1105.1 Access. Access to machinery rooms shall be restricted to authorized personnel. A sign shall be posted on the machinery room door prohibiting access by others.

1105.2 Dimensions. A machinery room shall be dimensioned so as to provide clearances required by Chapter 3. There shall be clear head room of not less than 7-1/4 feet (2210 mm) below equipment and appliances located over passageways.

1105.3 Doors. Each machinery room shall have self-closing, weather-stripped doors opening in the direction of egress travel. Doors and door openings shall comply with the requirements of the building code.

1105.4 Openings. Openings to other parts of the building that permit passage of escaping refrigerant to other parts of the building are prohibited. Ducts and air handlers in the machinery room that operate at a lower pressure than the room shall be sealed to prevent any refrigerant leakage from entering the airstream.

Exceptions:

1. Egress doors serving the machinery room.
2. Access doors and panels in air ducts and air-handling units, provided that such openings are gasketed and tight fitting.

1105.5 Tests. Periodic tests of the mechanical ventilating system shall be performed in accordance with manufacturer's specifications and as required by the code official.

1105.6 Fuel-burning appliances. Open flames that use combustion air from the machinery room shall not be installed in a machinery room.

Exceptions:

1. Matches, lighters, halide leak detectors and similar devices.
2. Where the refrigerant is carbon dioxide or water.
3. Fuel-burning appliances shall not be prohibited in the same machinery room with refrigerant-containing equipment or appliances where combustion air is ducted from outside the machinery room and sealed in such a manner as to prevent any refrigerant leakage from entering the combustion chamber, or where a refrigerant vapor detector is employed to automatically shut off the combustion process in the event of refrigerant leakage.

1105.7 Ventilation. Machinery rooms shall be mechanically ventilated to the outdoors. Mechanical ventilation shall be capable of exhausting the minimum quantity of air both at the normal operating and emergency conditions. Multiple fans or multispeed fans shall be allowed in order to produce the emergency ventilation rate and to obtain a reduced airflow for normal ventilation.

Exception: Where a refrigerating system is located outdoors more than 20 feet (6096 mm) from any building opening and is enclosed by a penthouse, lean-to or other open structure, natural or mechanical ventilation shall be provided. Location of the openings shall be based on the relative density of the refrigerant to air. The free-aperture cross section for the ventilation of the machinery room shall be not less than:

$$F = \sqrt{G} \qquad \textbf{(Equation 11-1)}$$

For SI: $F = 0.138\sqrt{G}$

where:

F = The free opening area in square feet (m^2).

G = The mass of refrigerant in pounds (kg) in the largest system, any part of which is located in the machinery room.

1105.7.1 Discharge location. The discharge of the air shall be to the outdoors in accordance with Chapter 5. Exhaust from mechanical ventilation systems shall be discharged not less than 20 feet (6096 mm) from a property line or openings into buildings.

1105.7.2 Make-up air. Provisions shall be made for make-up air to replace that being exhausted. Openings for make-up air shall be located to avoid intake of exhaust air. Supply and exhaust ducts to the machinery room shall serve no other area, shall be constructed in accordance with Chapter 5 and shall be covered with corrosion-resistant screen of not less than $^1/_4$-inch (6.4 mm) mesh.

1105.7.3 Quantity—normal ventilation. During occupied conditions, the mechanical ventilation system shall exhaust the larger of the following:

1. Not less than 0.5 cfm per square foot (0.0025 $m^3/s\ m^2$) of machinery room area or 20 cfm (0.009 m^3/s) per person.
2. A volume required to limit the room temperature rise to 18°F (10°C) taking into account the ambient heating effect of all machinery in the room.

1105.7.4 Quantity—emergency conditions. Upon actuation of the refrigerant detector required in Section 1105.3, the mechanical ventilation system shall exhaust air from the machinery room in the following quantity:

$$Q = 100 \times \sqrt{G} \qquad \textbf{(Equation 11-2)}$$

For SI: $Q = 0.07 \times \sqrt{G}$

where:

Q = The airflow in cubic feet per minute (m^3/s).

G = The design mass of refrigerant in pounds (kg) in the largest system, any part of which is located in the machinery room.

1105.8 Termination of relief devices. Pressure-relief devices, fusible plugs and purge systems located within the machinery room shall terminate outside of the structure at a location not less than 15 feet (4572 mm) above the adjoining grade level and not less than 20 feet (6096 mm) from any window, ventilation opening or exit.

1105.9 Ammonia discharge. Pressure-relief valves for ammonia systems shall discharge in accordance with ASHRAE 15.

SECTION 1106
MACHINERY ROOM, SPECIAL REQUIREMENTS

1106.1 General. Where required by Section 1104.2, the machinery room shall meet the requirements of this section in addition to the requirements of Section 1105.

1106.2 Elevated temperature. There shall not be an open flame-producing device or continuously operating hot surface over 800°F (427°C) permanently installed in the room.

1106.3 Construction requirements. The machinery room shall be separated from other occupied space with smoke-tight, 1-hour fire-resistance-rated construction.

1106.4 Opening protections. Opening protection between the machinery room and other occupied spaces shall be approved, self-closing, tight-fitting fire doors with a minimum fire-resistance rating of ¾ hour.

1106.5 Pipe penetrations. All pipe penetrations of the interior walls, ceiling or floor of machinery rooms shall be sealed vapor tight and protected in accordance with the building code.

1106.6 Exterior openings. Openings in exterior walls of machinery rooms shall not be located under any exit, stairway or exit discharge.

1106.7 Egress. Each machinery room shall be provided with a minimum of one exit door that opens directly to the outside.

Exception: Self-closing, tight-fitting doors opening into a vestibule leading directly outside.

1106.8 Ammonia room ventilation. Ventilation systems in ammonia machinery rooms shall be operated continuously.

Exceptions:

1. Machinery rooms equipped with a vapor detector that will automatically start the ventilation system and actuate an alarm at a detection level not to exceed 1,000 ppm; or
2. Machinery rooms conforming to the Class 1, Division 2, hazardous location classification requirements of NFPA 70.

1106.9 Flammable refrigerants. Where refrigerants of Groups A2, A3, B2 and B3 are used, the machinery room shall conform to the Class 1, Division 2, hazardous location classification requirements of NFPA 70.

Exception: Ammonia machinery rooms.

1106.10 Remote controls. Remote control of the mechanical equipment and appliances located in the machinery room shall be provided at an approved location immediately outside the machinery room and adjacent to its principal entrance.

1106.10.1 Refrigeration system. A clearly identified switch of the break-glass type shall provide off-only control of all electrically energized equipment and appliances in the machinery room, other than refrigerant leak detectors and machinery room ventilation.

1106.10.2 Ventilation system. A clearly identified switch of the break-glass type shall provide on-only control of the machinery room ventilation fans.

1106.11 Emergency signs and lables. Refrigeration units or systems shall be provided with approved emergency signs, charts, and lables in accordance with the fire code.

SECTION 1107
REFRIGERANT PIPING

1107.1 General. All refrigerant piping shall be installed, tested and placed in operation in accordance with this chapter.

1107.2 Pipe enclosures. Rigid or flexible metal enclosures or pipe ducts shall be provided for soft, annealed copper tubing and used for refrigerant piping erected on the premises and containing other than Group A1 or B1 refrigerants. Enclosures shall not be required for connections between condensing units and the nearest riser box(es), provided such connections do not exceed 6 feet (1829 mm) in length.

1107.3 Condensation. All refrigerating piping and fittings, brine piping and fittings that, during normal operation, will reach a surface temperature below the dew point of the surrounding air, and are located in spaces or areas where condensation will cause a safety hazard to the building occupants, structure, electrical equipment or any other equipment or appliances, shall be protected in an approved manner to prevent such damage.

1107.4 Materials for refrigerant pipe and tubing. Piping materials shall be as set forth in Sections 1107.4.1 through 1107.4.5.

1107.4.1 Steel pipe. Carbon steel pipe with a wall thickness not less than Schedule 80 shall be used for Group A2, A3, B2 or B3 refrigerant liquid lines for sizes $1^1/_2$ inches (38 mm) and smaller. Carbon steel pipe with a wall thickness not less than Schedule 40 shall be used for Group A1 or B1 refrigerant liquid lines 6 inches (152 mm) and smaller, Group A2, A3, B2 or B3 refrigerant liquid lines sizes 2 inches (51 mm) through 6 inches (152 mm), and all refrigerant suction and discharge lines 6 inches (152 mm) and smaller. Type F steel pipe shall not be used for refrigerant lines having an operating temperature less than -20°F (-29°C).

1107.4.2 Copper and brass pipe. Standard iron-pipe size, copper and red brass (not less than 80-percent copper) pipe shall conform to ASTM B 42 and ASTM B 43.

1107.4.3 Copper tube. Copper tube used for refrigerant piping erected on the premises shall be seamless copper tube of Type ACR (hard or annealed) complying with ASTM B 280. Where approved, copper tube for refrigerant piping erected on the premises shall be seamless copper tube of Type K, L or M (drawn or annealed) in accordance with ASTM B 88. Annealed temper copper tube shall not be used in sizes larger than a 2-inch (51 mm) nominal size. Mechanical joints shall not be used on annealed temper copper tube in sizes larger than $^7/_8$-inch (22 mm) OD size.

1107.4.4 Copper tube joints. Copper tubing joints used in refrigerating systems containing Group A2, A3, B2 or B3 refrigerants shall be brazed. Soldered joints shall not be used in such refrigerating systems.

1107.4.5 Aluminum tube. Type 3003-0 aluminum tubing with high-pressure fittings shall not be used with methyl chloride and other refrigerants known to attack aluminum.

1107.5 Joints and refrigerant-containing parts in air ducts. Joints and all refrigerant-containing parts of a refrigerating system located in an air duct of an air-conditioning system carrying conditioned air to and from humanly occupied space shall be constructed to withstand, without leakage, a pressure of 150 percent of the higher of the design pressure or pressure-relief device setting.

1107.6 Exposure of refrigerant pipe joints. Refrigerant pipe joints erected on the premises shall be exposed for visual inspection prior to being covered or enclosed.

1107.7 Stop valves. All systems containing more than 6.6 pounds (3 kg) of a refrigerant in systems using positive-displacement compressors, shall have stop valves installed as follows:

1. At the inlet of each compressor, compressor unit or condensing unit.
2. At the discharge outlet of each compressor, compressor unit or condensing unit and of each liquid receiver.

Exceptions:

1. Systems that have a refrigerant pumpout function capable of storing the entire refrigerant charge in a receiver or heat exchanger.
2. Systems that are equipped with provisions for pumpout of the refrigerant using either portable or permanently installed recovery equipment.
3. Self-contained systems.

1107.7.1 Liquid receivers. All systems containing 100 pounds (45 kg) or more of a refrigerant, other than systems utilizing nonpositive displacement compressors, shall have stop valves, in addition to those required by Section 1107.7, on each inlet of each liquid receiver. Stop valves shall not be required on the inlet of a receiver in a condensing unit, nor on the inlet of a receiver which is an integral part of the condenser.

1107.7.2 Copper tubing. Stop valves used with soft annealed copper tubing or hard-drawn copper tubing $^7/_8$-inch (22.2 mm) OD standard size or smaller shall be securely mounted, independent of tubing fastenings or supports.

1107.7.3 Identification. Stop valves shall be identified where their intended purpose is not obvious. Numbers shall not be used to label the valves, unless a key to the numbers is located near the valves.

SECTION 1108
FIELD TEST

1108.1 General. Every refrigerant-containing part of every system that is erected on the premises, except compressors, condensers, vessels, evaporators, safety devices, pressure gauges and control mechanisms that are listed and factory tested, shall be tested and proved tight after complete installation, and before operation. Tests shall include both the high- and low-pressure sides of each system at not less than the lower

of the design pressures or the setting of the pressure-relief device(s). The design pressures for testing shall be those listed on the condensing unit, compressor or compressor unit nameplate, as required by ASHRAE 15.

Exceptions:

1. Gas bulk storage tanks that are not permanently connected to a refrigeration system.
2. Systems erected on the premises with copper tubing not exceeding $^5/_8$-inch (15.8 mm) OD, with wall thickness as required by ASHRAE 15, shall be tested in accordance with Section 1108.1, or by means of refrigerant charged into the system at the saturated vapor pressure of the refrigerant at 70°F (21°C) or higher.
3. Limited-charge systems equipped with a pressure relief device, erected on the premises, shall be tested at a pressure not less than one and one-half times the pressure setting of the relief device. If the equipment or appliance has been tested by the manufacturer at one and one-half times the design pressure, the test after erection on the premises shall be conducted at the design pressure.
4. Where a compressor is used as a booster to obtain an intermediate pressure and discharges into the suction side of another compressor, the booster compressor shall be considered a part of the low side, provided that it is protected by a pressure relief device.
5. In field-testing systems using centrifugal or other nonpositive displacement compressors, the entire system shall be considered as the low-side pressure for field test purposes.

1108.2 Test gases. Tests shall be performed with an inert dried gas including, but not limited to, nitrogen and carbon dioxide. Oxygen, air, combustible gases and mixtures containing such gases shall not be used.

Exception: The use of air is allowed to test R-717, ammonia, systems provided that they are subsequently evacuated before charging with refrigerant.

1108.3 Test apparatus. The means used to build up the test pressure shall have either a pressure-limiting device or a pressure-reducing device and a gauge on the outlet side.

1108.4 Declaration. A certificate of test shall be provided for all systems containing 55 pounds (25 kg) or more of refrigerant. The certificate shall give the name of the refrigerant and the field test pressure applied to the high side and the low side of the system. The certification of test shall be signed by the installer and shall be made part of the public record.

CHAPTER 12
HYDRONIC PIPING

SECTION 1201
GENERAL

1201.1 Scope. The provisions of this chapter shall govern the construction, installation, alteration and repair of hydronic piping systems. This chapter shall apply to hydronic piping systems that are parts of heating, ventilation and air-conditioning systems. Such piping systems shall include steam, hot water, chilled water, steam condensate and ground source heat pump loop systems. Potable cold and hot water distribution systems shall be installed in accordance with the plumbing code.

1201.2 Pipe sizing. Piping for hydronic systems shall be sized for the demand of the system.

SECTION 1202
MATERIAL

1202.1 Piping. Piping material shall conform to the standards cited in this section.

Exception: Embedded piping regulated by Section 1209.

1202.2 Used materials. Reused pipe, fittings, valves or other materials shall be clean and free of foreign materials and shall be approved by the code official for reuse.

1202.3 Material rating. Materials shall be rated for the operating temperature and pressure of the hydronic system. Materials shall be suitable for the type of fluid in the hydronic system.

1202.4 Piping materials standards. Hydronic pipe shall conform to the standards listed in Table 1202.4. The exterior of the pipe shall be protected from corrosion and degradation.

TABLE 1202.4
HYDRONIC PIPE

MATERIAL	STANDARD (see Chapter 15)
Acrylonitrile butadiene styrene (ABS) plastic pipe	ASTM D 1527; ASTM D 2282
Brass pipe	ASTM B 43
Brass tubing	ASTM B 135
Copper or copper-alloy pipe	ASTM B 42; ASTM B 302
Copper or copper-alloy tube (Type K, L or M)	ASTM B 75; ASTM B 88; ASTM B 251
Chlorinated polyvinyl chloride (CPVC) plastic pipe	ASTM D 2846; ASTM F 441; ASTM F 442

(continued)

TABLE 1202.4—continued
HYDRONIC PIPE

MATERIAL	STANDARD (see Chapter 15)
Cross-linked polyethylene/aluminum/ cross-linked polyethylene (PEX-AL-PEX) pressure pipe	ASTM F1281; CSA CAN/CSA-B-137.10
Cross-linked polyethylene (PEX) tubing	ASTM F 876; ASTM F 877
Lead pipe	FS WW-P-325B
Polybutylene (PB) plastic pipe and tubing	ASTM D 3309
Polyethylene (PE) pipe, tubing and fittings (for ground source heat pump loop systems)	ASTM D 2513; ASTM D 3035; ASTM D 2447; ASTM D 2683; ASTM F 1055; ASTM D 2837; ASTM D 3350; ASTM D 1693
Polyvinyl chloride (PVC) plastic pipe	ASTM D 1785; ASTM D 2241
Steel pipe	ASTM A 53; ASTM A 106
Steel tubing	ASTM A 254

1202.5 Pipe fittings. Hydronic pipe fittings shall be approved for installation with the piping materials to be installed, and shall conform to the respective pipe standards or to the standards listed in Table 1202.5.

TABLE 1202.5
HYDRONIC PIPE FITTINGS

MATERIAL	STANDARD (see Chapter 15)
Bronze	ASME B16.24
Copper and copper alloys	ASME B16.15; ASME B16.18; ASME B16.22; ASME B16.23; ASME B16.26; ASME B16.29
Gray iron	ASTM A 126
Malleable iron	ASME B16.3
Plastic	ASTM D 2466; ASTM D 2467; ASTM D 2468; ASTM F 438; ASTM F 439; ASTM F 877
Steel	ASME B16.5; ASME B16.9; ASME B16.11; ASME B16.28; ASTM A 420

1202.6 Valves. Valves shall be constructed of materials that are compatible with the type of piping material and fluids in the system. Valves shall be rated for the temperatures and pressures of the systems in which the valves are installed.

1202.7 Flexible connectors, expansion and vibration compensators. Flexible connectors, expansion and vibration control devices and fittings shall be of an approved type.

SECTION 1203
JOINTS AND CONNECTIONS

1203.1 Approval. Joints and connections shall be of an approved type. Joints and connections shall be tight for the pressure of the hydronic system.

1203.1.1 Joints between different piping materials. Joints between different piping materials shall be made with approved adapter fittings. Joints between different metallic piping materials shall be made with approved dielectric fittings or brass converter fittings.

1203.2 Preparation of pipe ends. Pipe shall be cut square, reamed and chamfered, and shall be free of burrs and obstructions. Pipe ends shall have full-bore openings and shall not be undercut.

1203.3 Joint preparation and installation. When required by Sections 1203.4 through 1203.14, the preparation and installation of brazed, mechanical, soldered, solvent-cemented, threaded and welded joints shall comply with Sections 1203.3.1 through 1203.3.7.

1203.3.1 Brazed joints. Joint surfaces shall be cleaned. An approved flux shall be applied where required. The joint shall be brazed with a filler metal conforming to AWS A5.8.

1203.3.2 Mechanical joints. Mechanical joints shall be installed in accordance with the manufacturer's instructions.

1203.3.3 Soldered joints. Joint surfaces shall be cleaned. A flux conforming to ASTM B 813 shall be applied. The joint shall be soldered with a solder conforming to ASTM B 32.

1203.3.4 Solvent-cemented joints. Joint surfaces shall be clean and free of moisture. An approved primer shall be applied to CPVC and to PVC pipe-joint surfaces. Joints shall be made while the cement is wet. Solvent cement conforming to the following standards shall be applied to all joint surfaces:

1. ASTM D 2235 for ABS joints.
2. ASTM F 493 for CPVC joints.
3. ASTM D 2564 for PVC joints.

CPVC joints shall be made in accordance with ASTM D 2846.

1203.3.5 Threaded joints. Threads shall conform to ASME B1.20.1. Schedule 80 or heavier plastic pipe shall be threaded with dies specifically designed for plastic pipe. Thread lubricant, pipe-joint compound or tape shall be applied on the male threads only and shall be approved for application on the piping material.

1203.3.6 Welded joints. Joint surfaces shall be cleaned by an approved procedure. Joints shall be welded with an approved filler metal.

1203.3.7 Grooved and shouldered joints. Grooved and shouldered joints shall be approved and installed in accordance with the manufacturer's installation instructions.

1203.4 ABS plastic pipe. Joints between ABS plastic pipe or fittings shall be solvent-cemented or threaded joints conforming to Section 1203.3.

1203.5 Brass pipe. Joints between brass pipe or fittings shall be brazed, mechanical, threaded or welded joints conforming to Section 1203.3.

1203.6 Brass tubing. Joints between brass tubing or fittings shall be brazed, mechanical or soldered joints conforming to Section 1203.3.

1203.7 Copper or copper-alloy pipe. Joints between copper or copper-alloy pipe or fittings shall be brazed, mechanical, soldered, threaded or welded joints conforming to Section 1203.3.

1203.8 Copper or copper-alloy tubing. Joints between copper or copper-alloy tubing or fittings shall be brazed, mechanical or soldered joints conforming to Section 1203.3 or flared joints conforming to Section 1203.8.1.

1203.8.1 Flared joints. Flared joints shall be made by a tool designed for that operation.

1203.9 CPVC plastic pipe. Joints between CPVC plastic pipe or fittings shall be solvent-cemented or threaded joints conforming to Section 1203.3.

1203.10 Polybutylene plastic pipe and tubing. Joints between polybutylene plastic pipe and tubing or fittings shall be mechanical joints conforming to Section 1203.3 or heat-fusion joints conforming to Section 1203.10.1.

1203.10.1 Heat-fusion joints. Joints shall be of the socket-fusion or butt-fusion type. Joint surfaces shall be clean and free of moisture. Joint surfaces shall be heated to melt temperatures and joined. The joint shall be undisturbed until cool. Joints shall be made in accordance with ASTM D 3309.

1203.11 Cross-linked polyethylene (PEX) plastic tubing. Joints between cross-linked polyethylene plastic tubing and fittings shall conform to Sections 1203.11.1 and 1203.11.2. Mechanical joints shall conform to Section 1203.3.

1203.11.1 Compression-type fittings. When compression-type fittings include inserts and ferrules or O-rings, the fittings shall be installed without omitting the inserts and ferrules or O-rings.

1203.11.2 Plastic-to-metal connections. Soldering on the metal portion of the system shall be performed at least 18 inches (457 mm) from a plastic-to-metal adapter in the same water line.

1203.12 PVC plastic pipe. Joints between PVC plastic pipe and fittings shall be solvent-cemented or threaded joints conforming to Section 1203.3.

1203.13 Steel pipe. Joints between steel pipe or fittings shall be mechanical joints that are made with an approved elastomeric seal, or shall be threaded or welded joints conforming to Section 1203.3.

1203.14 Steel tubing. Joints between steel tubing or fittings shall be mechanical or welded joints conforming to Section 1203.3.

1203.15 Polyethylene plastic pipe and tubing for ground source heat pump loop systems. Joints between polyethylene plastic pipe and tubing or fittings for ground source heat pump loop systems shall be heat fusion joints conforming to Section

1203.15.1, electrofusion joints conforming to Section 1203.15.2, or stab type insertion joints conforming to Section 1203.15.3.

1203.15.1 Heat-fusion joints. Joints shall be of the socket-fusion, saddle-fusion or butt-fusion type, fabricated in accordance with the piping manufacturer's instructions. Joint surfaces shall be clean and free of moisture. Joint surfaces shall be heated to melt temperatures and joined. The joint shall be undisturbed until cool. Fittings shall be manufactured in accordance with ASTM D 2683.

1203.15.2 Electrofusion joints. Joints shall be of the electrofusion type. Joint surfaces shall be clean and free of moisture, and scoured to expose virgin resin. Joint surfaces shall be heated to melt temperatures for the period of time specified by the manufacturer. The joint shall be undisturbed until cool. Fittings shall be manufactured in accordance with ASTM F 1055.

1203.15.3 Stab type insert fittings. Joint surfaces shall be clean and free of moisture. Pipe ends shall be chamfered and inserted into the fitting to full depth. Fittings shall be manufactured in accordance with ASTM D 2513.

SECTION 1204
PIPE INSULATION

1204.1 Insulation characteristics. Pipe insulation installed in buildings shall conform to the requirements of the building code, shall be tested in accordance with ASTM E 84 and shall have a maximum flame spread index of 25 and a smoke-developed index not exceeding 450. Insulation installed in an air plenum shall comply with Section 602.2.1.

Exception: The maximum flame spread index and smoke-developed index shall not apply to one- and two-family dwellings.

1204.2 Required thickness. Hydronic piping shall be insulated to the thickness required by the building code.

SECTION 1205
VALVES

1205.1 Where required. Shutoff valves shall be installed in hydronic piping systems in the locations indicated in Sections 1205.1.1 through 1205.1.6.

1205.1.1 Heat exchangers. Shutoff valves shall be installed on the supply and return side of a heat exchanger.

Exception: Shutoff valves shall not be required when heat exchangers are integral with a boiler; or are a component of a manufacturer's boiler and heat exchanger packaged unit and are capable of being isolated from the hydronic system by the supply and return valves required by Section 1005.1.

1205.1.2 Central systems. Shutoff valves shall be installed on the building supply and return of a central utility system.

1205.1.3 Pressure vessels. Shutoff valves shall be installed on the connection to any pressure vessel.

1205.1.4 Pressure-reducing valves. Shutoff valves shall be installed on both sides of a pressure-reducing valve.

1205.1.5 Equipment and appliances. Shutoff valves shall be installed on connections to mechanical equipment and appliances. This requirement does not apply to components of a hydronic system such as pumps, air separators, metering devices and similar equipment.

1205.1.6 Expansion tanks. Shutoff valves shall be installed at connections to nondiaphragm-type expansion tanks.

1205.2 Reduced pressure. A pressure relief valve shall be installed on the low-pressure side of a hydronic piping system that has been reduced in pressure. The relief valve shall be set at the maximum pressure of the system design. The valve shall be installed in accordance with Section 1008.

SECTION 1206
PIPING INSTALLATION

1206.1 General. Piping, valves, fittings and connections shall be installed in accordance with the conditions of approval.

1206.1.1 Prohibited tee applications. Fluid in the supply side of a hydronic system shall not enter a tee fitting through the branch opening.

1206.2 System drain down. Hydronic piping systems shall be designed and installed to permit the system to be drained. Where the system drains to the plumbing drainage system, the installation shall conform to the requirements of the plumbing code.

1206.3 Protection of potable water. The potable water system shall be protected from backflow in accordance with the plumbing code.

1206.4 Pipe penetrations. Openings for pipe penetrations in walls, floors or ceilings shall be larger than the penetrating pipe. Openings through concrete or masonry building elements shall be sleeved. The annular space surrounding pipe penetrations shall be protected in accordance with the building code.

1206.5 Clearance to combustibles. A pipe in a hydronic piping system in which the exterior temperature exceeds 250°F (121°C) shall have a minimum clearance of 1 inch (25.4 mm) to combustible materials.

1206.6 Contact with building material. A hydronic piping system shall not be in direct contact with building materials that cause the piping material to degrade or corrode, or that interfere with the operation of the system.

1206.7 Water hammer. The flow velocity of the hydronic piping system shall be controlled to reduce the possibility of water hammer. Where a quick-closing valve creates water hammer, an approved water-hammer arrestor shall be installed. The arrestor shall be located within a range as specified by the manufacturer of the quick-closing valve.

1206.8 Steam piping pitch. Steam piping shall be installed to drain to the boiler or the steam trap. Steam systems shall not have drip pockets that reduce the capacity of the steam piping.

1206.9 Strains and stresses. Piping shall be installed so as to prevent detrimental strains and stresses in the pipe. Provisions shall be made to protect piping from damage resulting from expansion, contraction and structural settlement. Piping shall be installed so as to avoid structural stresses or strains within building components.

1206.9.1 Flood hazard. Piping located in a flood-hazard zone or high-hazard zone shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the base flood elevation.

1206.10 Pipe support. Pipe shall be supported in accordance with Section 305.

1206.11 Condensation. Provisions shall be made to prevent the formation of condensation on the exterior of piping.

SECTION 1207
TRANSFER FLUID

1207.1 Flash point. The flash point of transfer fluid in a hydronic piping system shall be a minimum of 50°F (28°C) above the maximum system operating temperature.

1207.2 Makeup water. The transfer fluid shall be compatible with the makeup water supplied to the system.

SECTION 1208
TESTS

1208.1 General. Hydronic piping systems, other than ground-source heat pump loop systems, shall be tested hydrostatically at one and one-half times the maximum system design pressure, but not less than 100 psi (689 kPa). Ground-source heat pump loop systems shall be tested in accordance with Section 1208.1.1

1208.1.1 Ground-source heat pump loop systems. Before connection (header) trenches are backfilled, the assembled loop system shall be pressure tested with water at 100 psi (689 kPa) for 30 minutes with no observed leaks. Flow and pressure loss testing shall be performed and the acutal flow rates and pressure drops shall be compared to the calculated design values. If actual flow rate or pressure drop values differ from calculated design values by more than 10 percent the problem shall be identified and corrected.

SECTION 1209
EMBEDDED PIPING

1209.1 Materials. Piping for heating panels shall be standard-weight steel pipe, Type L copper tubing, polybutylene or other approved plastic pipe or tubing rated at 100 psi (689 kPa) at 180°F (82°C).

1209.2 Pressurizing during installation. Piping to be embedded in concrete shall be pressure tested prior to pouring concrete. During pouring, the pipe shall be maintained at the proposed operating pressure.

1209.3 Embedded joints. Joints of pipe or tubing that are embedded in a portion of the building, such as concrete or plaster, shall be in accordance with the requirements of Sections 1209.3.1 through 1209.3.3.

1209.3.1 Steel pipe joints. Steel pipe shall be welded by electrical arc or oxygen/acetylene method.

1209.3.2 Copper tubing joints. Copper tubing shall be joined by brazing with filler metals having a melting point of not less than 1,000°F (538°C).

1209.3.3 Polybutylene joints. Polybutylene pipe and tubing shall be installed in continuous lengths or shall be joined by heat fusion in accordance with Section 1203.10.1.

1209.4 Not embedded related piping. Joints of other piping in cavities or running exposed shall be joined by approved methods in accordance with manufacturer's installation instructions and related sections of this code.

CHAPTER 13
FUEL OIL PIPING AND STORAGE

SECTION 1301
GENERAL

1301.1 Scope. This chapter shall govern the design, installation, construction and repair of fuel oil storage and piping systems.

1301.2 Storage and piping systems. Fuel oil storage systems shall comply with the fire code. Fuel oil piping systems shall comply with teh requirements of this code and the Oregon Department of Environmental Quality.

1301.3 Fuel type. An appliance shall be designed for use with the type of fuel to which it will be connected. Such appliance shall not be converted from the fuel specified on the rating plate for use with a different fuel without securing reapproval from the code official.

1301.4 Fuel tanks, piping and valves. The tank, piping and valves for appliances burning oil shall be installed in accordance with the requirements of this chapter. When an oil burner is served by a tank, any part of which is above the level of the burner inlet connection and where the fuel supply line is taken from the top of the tank, an approved antisiphon valve or other siphon-breaking device shall be installed in lieu of the shutoff valve.

SECTION 1302
MATERIAL

1302.1 General. Piping materials shall conform to the standards cited in this section.

1302.2 Rated for system. All materials shall be rated for the operating temperatures and pressures of the system, and shall be compatible with the type of liquid.

1302.3 Pipe standards. Fuel oil pipe shall comply with one of the standards listed in Table 1302.3.

1302.4 Nonmetallic pipe. All nonmetallic pipe shall be listed and labeled as being acceptable for the intended application for flammable and combustible liquids. Nonmetallic pipe shall only be installed outside, underground.

1302.5 Fittings and valves. Fittings and valves shall be approved for the piping systems, and shall be compatible with, or shall be of the same material as, the pipe or tubing.

1302.6 Bending of pipe. Pipe shall be approved for bending. Pipe bends shall be made with approved equipment. The bend shall not exceed the structural limitations of the pipe.

1302.7 Pumps. Pumps that are not part of an appliance shall be of a positive-displacement type. The pump shall automatically shut off the supply when not in operation. Pumps shall be listed and labeled.

1302.8 Flexible connectors and hoses. Flexible connectors and hoses shall be listed and labeled.

TABLE 1302.3
FUEL OIL PIPING

MATERIAL	STANDARD (see Chapter 15)
Brass pipe	ASTM B 43
Brass tubing	ASTM B 135
Copper or copper-alloy pipe	ASTM B 42; ASTM B 302
Copper or copper-alloy tubing (Type K, L or M)	ASTM B 75; ASTM B 88; ASTM B 280
Labeled pipe	(see Section 1302.4)
Nonmetallic pipe	ASTM D 2996
Steel pipe	ASTM A 53; ASTM A 106
Steel tubing	ASTM A 254; ASTM A 539

SECTION 1303
JOINTS AND CONNECTIONS

1303.1 Approval. Joints and connections shall be approved and of a type approved for fuel-oil piping systems. All threaded joints and connections shall be made tight with suitable lubricant or pipe compound. Unions requiring gaskets or packings, right or left couplings, and sweat fittings employing solder having a melting point of less than 1,000°F (538°C) shall not be used in oil lines. Cast-iron fittings shall not be used. Joints and connections shall be tight for the pressure required by test.

1303.1.1 Joints between different piping materials. Joints between different piping materials shall be made with approved adapter fittings. Joints between different metallic piping materials shall be made with approved dielectric fittings or brass converter fittings.

1303.2 Preparation of pipe ends. All pipe shall be cut square, reamed and chamfered and be free of all burrs and obstructions. Pipe ends shall have full-bore openings and shall not be undercut.

1303.3 Joint preparation and installation. Where required by Sections 1303.4 through 1303.10, the preparation and installation of brazed, mechanical, threaded and welded joints shall comply with Sections 1303.3.1 through 1303.3.4.

1303.3.1 Brazed joints. All joint surfaces shall be cleaned. An approved flux shall be applied where required. The joints shall be brazed with a filler metal conforming to AWS A5.8.

1303.3.2 Mechanical joints. Mechanical joints shall be installed in accordance with the manufacturer's instructions.

1303.3.3 Threaded joints. Threads shall conform to ASME B1.20.1. Pipe-joint compound or tape shall be applied on the male threads only.

1303.3.4 Welded joints. All joint surfaces shall be cleaned by approved procedure. The joint shall be welded with an approved filler metal.

1303.4 Brass pipe. Joints between brass pipe or fittings shall be brazed, mechanical, threaded or welded joints complying with Section 1303.3.

1303.5 Brass tubing. Joints between brass tubing or fittings shall be brazed or mechanical joints complying with Section 1303.3.

1303.6 Copper or copper-alloy pipe. Joints between copper or copper-alloy pipe or fittings shall be brazed, mechanical, threaded or welded joints complying with Section 1303.3.

1303.7 Copper or copper-alloy tubing. Joints between copper or copper-alloy tubing or fittings shall be brazed or mechanical joints complying with Section 1303.3 or flared joints. Flared joints shall be made by a tool designed for that operation.

1303.8 Nonmetallic pipe. Joints between nonmetallic pipe or fittings shall be installed in accordance with the manufacturer's instructions for the labeled pipe and fittings.

1303.9 Steel pipe. Joints between steel pipe or fittings shall be threaded or welded joints complying with Section 1303.3 or mechanical joints complying with Section 1303.9.1.

1303.9.1 Mechanical joints. Joints shall be made with an approved elastomeric seal. Mechanical joints shall be installed in accordance with the manufacturer's instructions. Mechanical joints shall be installed outside, underground, unless otherwise approved.

1303.10 Steel tubing. Joints between steel tubing or fittings shall be mechanical or welded joints complying with Section 1303.3.

1303.11 Piping protection. Proper allowance shall be made for expansion, contraction, jarring and vibration. Piping other than tubing, connected to underground tanks, except straight fill lines and test wells, shall be provided with flexible connectors, or otherwise arranged to permit the tanks to settle without impairing the tightness of the piping connections.

SECTION 1304
PIPING SUPPORT

1304.1 General. Pipe supports shall be in accordance with Section 305.

SECTION 1305
FUEL OIL SYSTEM INSTALLATION

1305.1 Size. The fuel oil system shall be sized for the maximum capacity of fuel oil required. The minimum size of a supply line shall be $^3/_8$-inch (9.5 mm) inside diameter nominal pipe or $^3/_8$-inch (9.5 mm) OD tubing. The minimum size of a return line shall be $^1/_4$-inch (6.4 mm) inside diameter nominal pipe or $^5/_{16}$-inch (7.9 mm) outside diameter tubing. Copper tubing shall have 0.035-inch (0.9 mm) nominal and 0.032-inch (0.8 mm) minimum wall thickness.

1305.2 Protection of pipe, equipment and appliances. All fuel oil pipe, equipment and appliances shall be protected from physical damage.

1305.2.1 Flood hazard. All fuel oil pipe located in a flood-hazard zone or a high-hazard zone shall be capable of resisting hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to the base flood elevation.

1305.3 Supply piping. Supply piping shall connect to the top of the fuel oil tank. Fuel oil shall be supplied by a transfer pump or automatic pump or by other approved means.

Exception: This section shall not apply to inside or aboveground fuel oil tanks.

1305.4 Return piping. Return piping shall connect to the top of the fuel oil tank. Valves shall not be installed on return piping.

1305.5 System pressure. The system shall be designed for the maximum pressure required by the fuel-oil-burning appliance. Air or other gases shall not be used to pressurize tanks.

1305.6 Fill piping. A fill pipe shall terminate outside of a building at a point at least 2 feet (610 mm) from any building opening at the same or lower level. A fill pipe shall terminate in a manner designed to minimize spilling when the filling hose is disconnected. Fill opening shall be equipped with a tight metal cover designed to discourage tampering.

1305.7 Vent piping. Liquid fuel vent pipes shall terminate outside of buildings at a point not less than 2 feet (610 mm) measured vertically or horizontally from any building opening. Outer ends of vent pipes shall terminate in a weather-proof vent cap or fitting or be provided with a weather-proof hood. All vent caps shall have a minimum free open area equal to the cross-sectional area of the vent pipe and shall not employ screens finer than No. 4 mesh. Vent pipes shall terminate sufficiently above the ground to avoid being obstructed with snow or ice. Vent pipes from tanks containing heaters shall be extended to a location where oil vapors discharging from the vent will be readily diffused. If the static head with a vent pipe filled with oil exceeds 10 psi (69 kPa), the tank shall be designed for the maximum static head which will be imposed.

Liquid fuel vent pipes shall not be cross connected with fill pipes, lines from burners or overflow lines from auxiliary tanks.

SECTION 1306
OIL GAUGING

1306.1 Level indication. All tanks in which a constant oil level is not maintained by an automatic pump shall be equipped with a method of determining the oil level.

1306.2 Test wells. Test wells shall not be installed inside buildings. For outside service, test wells shall be equipped with a tight metal cover designed to discourage tampering.

1306.3 Inside tanks. The gauging of inside tanks by means of measuring sticks shall not be permitted. An inside tank provided with fill and vent pipes shall be provided with a device to

indicate either visually or audibly at the fill point when the oil in the tank has reached a predetermined safe level.

1306.4 Gauging devices. Gauging devices such as liquid level indicators or signals shall be designed and installed so that oil vapor will not be discharged into a building from the liquid fuel supply system.

1306.5 Gauge glass. A tank used in connection with any oil burner shall not be equipped with a glass gauge or any gauge which, when broken, will permit the escape of oil from the tank.

SECTION 1307
FUEL OIL VALVES

1307.1 Building shutoff. A shutoff valve shall be installed on the fuel-oil supply line at the entrance to the building. Inside or above-ground tanks are permitted to have valves installed at the tank. The valve shall be capable of stopping the flow of fuel oil to the building or to the appliance served where the valve is installed at a tank inside the building.

1307.2 Appliance shutoff. A shutoff valve shall be installed at the connection to each appliance where more than one fuel-oil-burning appliance is installed.

1307.3 Pump relief valve. A relief valve shall be installed on the pump discharge line where a valve is located downstream of the pump and the pump is capable of exceeding the pressure limitations of the fuel oil system.

1307.4 Fuel-oil heater relief valve. A relief valve shall be installed on the discharge line of fuel-oil-heating appliances.

1307.5 Relief valve operation. The relief valve shall discharge fuel oil when the pressure exceeds the limitations of the system. The discharge line shall connect to the fuel oil tank.

SECTION 1308
TESTING

1308.1 Testing required. Fuel oil piping shall be tested in accordance with NFPA 31.

CHAPTER 14
SOLAR SYSTEMS

SECTION 1401
GENERAL

1401.1 Scope. This chapter shall govern the construction, installation, alteration and repair of systems, equipment and appliances intended to utilize solar energy for nonpotable space heating or cooling, swimming pool heating or process heating.

1401.2 Potable water supply. Potable water systems shall be protected against contamination in accordance with the plumbing code.

1401.3 Heat exchangers. Heat exchangers used in domestic water-heating systems shall be approved for the intended use. The system shall have adequate protection to ensure that the potability of the water supply and distribution system is properly safeguarded.

1401.4 Solar energy equipment and appliances. Solar energy equipment and appliances shall conform to the requirements of this chapter and shall be installed in accordance with the manufacturer's installation instructions.

1401.5 Ducts. Ducts utilized in solar heating and cooling systems shall be constructed and installed in accordance with Chapter 6 of this code.

SECTION 1402
INSTALLATION

1402.1 Access. Access shall be provided to solar energy equipment and appliances for maintenance.

1402.2 Controlling condensation. Where attics or structural spaces are part of a passive solar system, ventilation of such spaces, as required by Section 406, is not required where other approved means of controlling condensation are provided.

1402.3 Roof-mounted collectors. Roof-mounted solar collectors that also serve as a roof covering shall conform to the requirements for roof coverings in accordance with the building code.

Exception: The use of plastic solar collector covers shall be limited to those approved plastics meeting the requirements for plastic roof panel in the building code.

1402.3.1 Collectors mounted above the roof. When mounted on or above the roof covering, the collector array and supporting construction shall be constructed of noncombustible materials or fire-retardant-treated wood conforming to the building code to the extent required for the type of roof construction of the building to which the collectors are accessory.

Exception: The use of plastic solar collector covers shall be limited to those approved plastics meeting the requirements for plastic roof panel in the building code.

1402.4 Equipment. The solar energy system shall be equipped in accordance with the requirements of Sections 1402.4.1 through 1402.4.4.

1402.4.1 Pressure and temperature. Solar energy system components containing pressurized fluids shall be protected against pressures and temperatures exceeding design limitations with a pressure and temperature relief valve. Each section of the system in which excessive pressures are capable of developing shall have a relief device located so that a section cannot be valved off or otherwise isolated from a relief device. Relief valves shall comply with the requirements of Section 1008.

1402.4.2 Vacuum. The solar energy system components that are subjected to a vacuum while in operation or during shutdown shall be designed to withstand such vacuum or shall be protected with vacuum relief valves.

1402.4.3 Protection from freezing. System components shall be protected from damage by freezing of heat transfer liquids at the lowest ambient temperatures that will be encountered during the operation of the system.

1402.4.4 Expansion tanks. Liquid single-phase solar energy systems shall be equipped with expansion tanks sized in accordance with Section 1007.

1402.5 Roof penetrations. Roof penetrations shall be flashed to prevent entry of water.

1402.6 Filtering. Air transported to occupied spaces through rock or dust-producing materials by means other than natural convection shall be filtered at the outlet from the heat storage system.

SECTION 1403
HEAT TRANSFER FLUIDS

1403.1 Flash point. The flash point of heat transfer liquids utilized in solar system equipment and appliances shall not be less than the highest temperature determined from the following:

1. Fifty °F (28°C) above the design maximum operating (flow) temperature of the fluid in the solar system.
2. Two hundred °F (111°C) below the design maximum nonoperating (no-flow) temperature of the fluid attained in the collector, provided that the collector manifold assembly is located outside of the building and is exposed to the weather, and provided that relief valves located adjacent to the collector or collector manifold do not discharge directly into the building.

3. The design maximum no-flow temperature in other collector manifold and relief valve configurations.

1403.2 Flammable gases and liquids. A flammable liquid or gas shall not be utilized as a heat transfer fluid. The flash point of liquids used in occupancies classified in Use Group H or F shall not be lower unless approved.

SECTION 1404
MATERIALS

1404.1 Collectors. Factory-built collectors shall be listed and labeled, and bear a label showing the manufacturer's name and address, model number, collector dry weight, collector maximum allowable operating and nonoperating temperatures and pressures, minimum allowable temperatures and the types of heat transfer fluids that are compatible with the collector. The label shall clarify that these specifications apply only to the collector.

1404.2 Thermal storage units. Pressurized thermal storage units shall be listed and labeled, and bear a label showing the manufacturer's name and address, model number, serial number, storage unit maximum and minimum allowable operating temperatures, storage unit maximum and minimum allowable operating pressures and the types of heat transfer fluids compatible with the storage unit. The label shall clarify that these specifications apply only to the thermal storage unit.

CHAPTER 15
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
11 West 42nd Street
New York, NY 10036

Standard reference number	Title	Referenced in code section number
Z21.8—94	Installation of Domestic Gas Conversion Burners	919.1
Z21.83—98	Fuel Cell Power Plants	924.1

ARI

Air-Conditioning and Refrigeration Institute
Suite 425
4301 North Fairfax Drive
Arlington, VA 22203

Standard reference number	Title	Referenced in code section number
700—95	Specifications for Fluorocarbon and Other Refrigerants	1102.2.2.3

ASHRAE

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
1791 Tullie Circle, NE
Atlanta, GA 30329-2305

Standard reference number	Title	Referenced in code section number
15—94	Safety Code for Mechanical Refrigeration	1101.6, 1105.9, 1108.1
34—97	Number Designation and Safety Classification of Refrigerants—with Addenda through 1997	202, 1102.2.1, 1103.1

ASME

American Society of Mechanical Engineers
345 East 47th Street
New York, NY 10017

Standard reference number	Title	Referenced in code section number
B1.20.1—83	Pipe Threads, General Purpose (Inch)	1203.3.5, 1303.3.3
B16.3—92	Malleable Iron Threaded Fittings	Table 1202.5
B16.5—96	Pipe Flanges and Flanged Fittings—with B16.5a-98 Addendum	Table 1202.5
B16.9—93	Factory Made Wrought Steel Buttwelding Fittings	Table 1202.5
B16.11—96	Forged Fittings, Socket-Welding and Threaded	Table 1202.5
B16.15—85	Cast Bronze Threaded Fittings, Classes 125 and 250	Table 1202.5
B16.18—84	Cast Copper Alloy Solder Joint Pressure Fittings	513.13.1, Table 1202.5

ASME—continued

B16.22—95	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings — with B16.22a-98 Addendum	Table 1202.5
B16.23—92	Cast Copper Alloy Solder Joint Drainage Fittings (DWV)	Table 1202.5
B16.24—92	Cast Copper Alloy Pipe Flanges and Flanged Fittings: Class 150, 300,400, 600, 900, 1500 and 2500 — with 1991 Errata	Table 1202.5
B16.26—88	Cast Copper Alloy Fittings for Flared Copper Tubes	Table 1202.5
B16.28—94	Wrought Steel Buttwelding Short Radius Elbows and Returns	Table 1202.5
B16.29—94	Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings-DWV	Table 1202.5

ASTM

American Society for Testing and Materials
100 Barr Harbor Dive
West Conshohocken, PA 19428-2956

Standard reference number	Title	Referenced in code section number
A 53—97b	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless	Table 1202.4, Table 1302.3
A 106—97a	Specification for Seamless Carbon Steel Pipe for High-Temperature Service	Table 1202.4, Table 1302.3
A 126—95e^{01}	Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings	Table 1202.5
A 254—97	Specification for Copper Brazed Steel Tubing	Table 1202.4, Table 1302.3
A 420/A 420M—96a	Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service	Table 1202.5
A 539—96	Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines	Table 1302.3
B 32—96	Specification for Solder Metal	1203.3.3
B 42—98	Specification for Seamless Copper Pipe, Standard Sizes	1107.4.2, Table 1202.4, Table 1302.3
B 43—98	Specification for Seamless Red Brass Pipe, Standard Sizes	1107.4.2, Table 1202.4, Table 1302.3
B 75—97	Specification for Seamless Copper Tube	Table 1202.4, Table 1302.3
B 88—96	Specification for Seamless Copper Water Tube	1107.4.3, Table 1202.4, Table 1302.3
B 135—96	Specification for Seamless Brass Tube	Table 1202.4, Table 1302.3
B 251—97	Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube	Table 1202.4
B 280—98	Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service	1107.4.3, Table 1302.3
B 302—98	Specification for Threadless Copper Pipe	Table 1202.4, Table 1302.3
B 813—93	Standard Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube	1203.3.3
C 315—98b	Specification for Clay Flue Linings	801.16.1, Table 803.10.4
C 411—97	Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation	604.3
D 56—98a	Test Method for Flash Point by Tag Closed Tester	202
D 93—99	Test Method for Flash Point by Pensky-Martens Closed Cup Tester	202
D 1527—96a	Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80	Table 1202.4
D 1693—97a	Test Method for Environment Stress-Cracking of Ethylene Plastics	Table 1202.2
D 1785—96b	Specification for Poly (Vinyl Chloride)(PVC) Plastic Pipe, Schedules 40, 80 and 120	Table 1202.4
D 2235—96a	Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings	1203.3.4
D 2241—96b	Specification for Poly (Vinyl Chloride)(PVC) Pressure-Rated Pipe (SDR-Series)	Table 1202.4
D 2282—96a	Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe (SDR-PR)	Table 1202.4
D 2412—96	Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading	603.7.4
D 2447—95	Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter	Table 1202.4
D 2466—97	Specification for Poly (Vinyl Chloride)(PVC) Plastic Pipe Fittings, Schedule 40	Table 1202.5
D 2467—98a	Specification for Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80	Table 1202.5
D 2468—96a	Specification for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40	Table 1202.5
D 2513—97	Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings	Table 1202.4, 1203.15.3
D 2564—96a	Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings	1203.3.4
D 2683—98	Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Poilyethylene Pipe and Tubing	Table 1202.4, 1203.15.1
D 2837—98	Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials	Table 1202.4
D 2846/D 2846M—97	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot and Cold Water Distribution Systems	Table 1202.4, 1203.3.4
D 2996—95	Specification for Filament-Wound Fiberglass (Glass Fiber Reinforced Thermosetting Resin) Pipe	Table 1302.3
D 3035—95	Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter	Table 1202.4
D 3278—96e^{01}	Test Methods for Flash Point of Liquids by Setaflash Small Scale-Closed-Cup Apparatus	202

ASTM—continued

D 3309—96a	Specification for Polybutylene (PB) Plastic Hot- and Cold-Water Distribution Systems	Table 1202.4, 1203.10.1
D 3350—93	Specification for Polyethylene Plastics Pipe and Fittings Materials	Table 1202.4
E 84—98e^{01}	Test Method for Surface Burning Characteristics of Building Materials	202, 510.8, 602.2.1, 604.3, 1204.1
E 136—98e^{01}	Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C	202
E 814—97	Test Method for Fire Tests of Through-Penetration Fire Stops	506.3.12
F 438—97	Specification for Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40	Table 1202.5
F 439—97	Specification for Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80	Table 1202.5
F 441/F 441M—97	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80	Table 1202.4
F 442/F 442M—97	Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)	Table 1202.4
F 493—97	Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings	1203.3.4
F 876—97	Specification for Crosslinked Polyethylene (PEX) Tubing	Table 1202.4
F 877—99	Specification for Crosslinked Polyethylene (PEX) Plastic Hot and Cold-Water Distribution Systems	Table 1202.4, Table 1202.5
F 1055—95a	Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing	Table 1202.4, 1203.15.2
F 1281—98	Specification for Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylen (PEX-AL-PEX) Pressure Pipe	Table 1202.4

AWS

American Welding Society
550 N.W. LeJeune Road
P. O. Box 351040
Miami, FL 33135

Standard reference number	Title	Referenced in code section number
A5.8—92	Specifications for Filler Metals for Brazing	1203.3.1, 1403.3.1

CSA

Canadian Standards Association
178 Rexdale Blvd.
Rexdale (Toronto), Ontario, Canada M9W 1R3

Standard reference number	Title	Referenced in code section number
CAN/CSA-B137.10—91	Crosslinked Polyethylene/Aluminum/Polyethylene Composite Pressure Pipe Systems	Table 1202.4

FS

Federal Specifications*
General Service Administration
7th & D Streets
Specification Section, Room 6039
Washington, DC 20407

Standard reference number	Title	Referenced in code section number
WW-P-325B—76	Federal Specifications for Pipe, Bends, Traps, Caps and Plugs; Lead (for Industrial Pressure and Soil and Waste Applications)	Table 1202.4

* Standards are available from the Supt. of Documents, U.S. Government Printing Office, Washington, DC 20402-9325

IIAR

International Institute of Ammonia Refrigeration
Suite 700
1101 Connecticut Ave., NW
Washington, DC 20036

Standard reference number	Title	Referenced in code section number
2—92	Equipment, Design, and Installation of Ammonia Mechanical Refrigeration Systems	1101.6

MSS

Manufacturers Standardization Society of the Valve & Fittings Industry, Inc.
127 Park Street, N.E.
Vienna, VA 22180

Standard reference number	Title	Referenced in code section number
SP-69—96	Pipe Hangers and Supports	305.4

NAIMA

North American Insulation Manufacturers Association
Suite 310
44 Canal Center Plaza
Alexandria, VA 22314

Standard reference number	Title	Referenced in code section number
AF116—97	Fibrous Glass Duct Construction Standards	603.4

NFPA

National Fire Protection Association
Batterymarch Park
Quincy, MA 02269

Standard reference number	Title	Referenced in code section number
12—93	Carbon Dioxide Extinguishing Systems	509.3
13—96	Installation of Sprinkler Systems	509.3
16—95	Installation of Deluge Foam-Water Sprinkler Systems and Foam-Water Spray Systems	509.3
31—97	Installation of Oil-Burning Equipment	801.2.1, 801.18.1, 801.18.2, 920.2, 922.1, 1308.1
37—98	Stationary Combustion Engines and Gas Turbines	915.1, 915.2
58—98	Liquefied Petroleum Gas Code	502.8.10
69—97	Explosion Prevention Systems	510.8.3
72—96	National Fire Alarm Code	606.3, 607.2
82—99	Incinerators, Waste and Linen Handling Systems and Equipment	601.1
88B—97	Repair Garages	304.4
91—99	Exhaust Systems for Air Conveying of Materials	502.8
211—96	Chimneys, Fireplaces, Vents and Solid Fuel-Burning Appliances	806.1
704—96	Identification of the Hazards of Materials for Emergency Response	502.7.4, Table 1103.1, 510.1

SMACNA

Sheet Metal & Air Conditioning Contractors National Assoc., Inc.
4021 Lafayette Center Road
Chantilly, VA 22021

Standard reference number	Title	Referenced in code section number
SMACNA—95	HVAC Duct Construction Standards—Metal and Flexible; Addendum Number 1 November 1997	603.3
SMACNA—92	Fibrous Glass Duct Construction Standards	603.4

UL

Underwriters Laboratories Inc.
333 Pfingsten Road
Northbrook, IL 60062-2096

Standard reference number	Title	Referenced in code section number
17—94	Vent or Chimney Connector Dampers for Oil-Fired Appliances—with Revisions thru September 1998	803.6
103—95	Chimneys, Factory-Built, Residential Type and Building Heating Appliance—with Revisions thru March 1999	805.2
127—96	Factory-Built Fireplaces—with Revisions thru January 1998	805.3, 903.1, 903.3
181—96	Factory-made Air Ducts and Air Connectors—with Revisiosn thru December 1998	512.2, 603.4, 603.5.1, 603.5.2, 604.12
207—93	Refrigerant-Containing Components and Accessories, Nonelectrical—with Revisions thru October 1997	1101.2
300—96	Fire Testing of Fire Extinguishing Systems for Protection of Restaurant Cooking Areas	509.3
391—95	Solid-Fuel and Combination-Fuel Central and Supplementary Furnaces—with Revisions thru June 1997	918.1
412—93	Refrigeration Unit Coolers—with Revisions thru November 1998	1101.2
471—95	Commercial Refrigerators and Freezers—with Revisions thru April 1998	1101.2
555—95	Fire Dampers	607.1
555C—96	Ceiling Dampers	607.3
555S—96	Leakage Rated Dampers for Use in Smoke Control Systems	607.2
641—95	Low-Temperature Venting Systems, Type L	802.1
710—95	Exhaust Hoods for Commercial Cooking Equipment	507.7.1
726—95	Oil-Fired Boiler Assemblies—with Revisions thru January 1999	916.1
727—94	Oil-Fired Central Furnaces—with Revisions thru January 1999	918.1
729—94	Oil-Fired Floor Furnaces—with Revisions thru August 1995	910.1
730—94	Oil-Fired Wall Furnaces—with Revisions thru January 1999	909.1
731—95	Oil-Fired Unit Heaters—with Revisions thru January 1999	920.1
737—96	Fireplace Stoves—with Revisions thru June 1998	805.2, 905.1
896—93	Oil-Burning Stoves—with Revisions thru April 1997	916.1, 917.1, 922.1
910—98	Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Use in Space Transporting Environmental Air	602.2.1.1
959—95	Medium Heat Appliance Factory Built Chimneys—with Revisions thru April 1998	805.5
1240—94	Electric Commercial Clothes Drying Equipment—with Revisions thru October 1998	913.1
1482—96	Room Heaters, Solid-Fuel Type—with Revisions thru September 1998	905.1
1777—96	Chimney Liners—with Revisions through August 1998	801.16.1, 801.19
1820—95	Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics	602.2.1.3
1887—96	Fire Tests of Plastic Sprinkler Pipe for Flame and Smoke Characteristics—with Revisions thru April 1998	602.2.1.2
1995—95	Heating and Cooling Equipment—with Revisions thru June 1998	911.1, 918.1, 918.3, 1101.2
2043—96	Fire Test for Heat and Visible Smoke Release for Discrete Products and their Accessories Installed in Air-Handling Spaces	602.2.1.4
2158—97	Electronic Clothes Dryers—with Revisions June 1997	913.1
2162—94	Outline of Investigation for Commercial Wood-Fired Baking Ovens—Refractory Type	917.1

(Note: UL 303-97, UL 465-82, UL 559-85 & UL 1096-86 are replaced by UL 1995-95 and UL 1556-90 is replaced by 2158-97.)

APPENDIX A

COMBUSTION AIR OPENINGS AND CHIMNEY CONNECTOR PASS-THROUGHS

Not adopted by the State of Oregon.

Figures A-1 through A-4 are illustrations of appliances located in confined spaces.

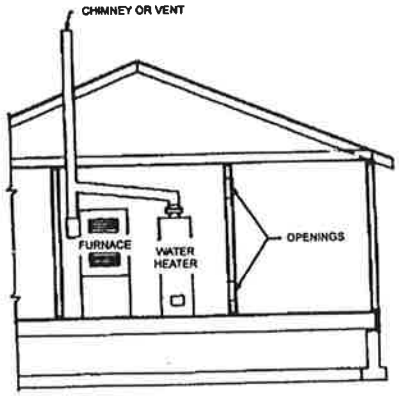


FIGURE A-1
ALL AIR FROM INSIDE THE BUILDING

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

For SI: 1 square inch = 645 mm^2, 1 British thermal unit per hour = 0.2931 W.

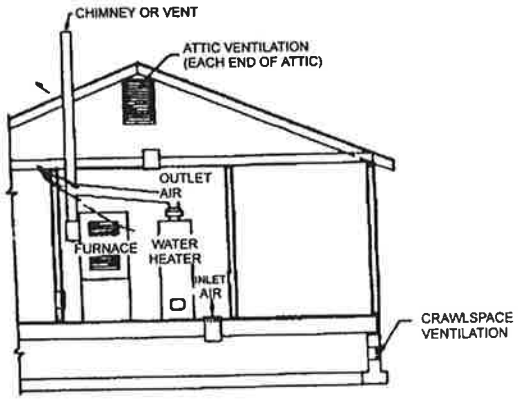


FIGURE A-2
ALL AIR FROM OUTDOORS—INLET AIR FROM VENTILATED CRAWL SPACE AND OUTLET AIR TO VENTILATED ATTIC

NOTE: The inlet and outlet air openings shall each have a free area of not less than 1 square inch per 4,000 Btu per hour or the total input rating of all appliances in the enclosure.

For SI: 1 square inch = 645 mm^2, 1 British thermal unit per hour = 0.2931 W.

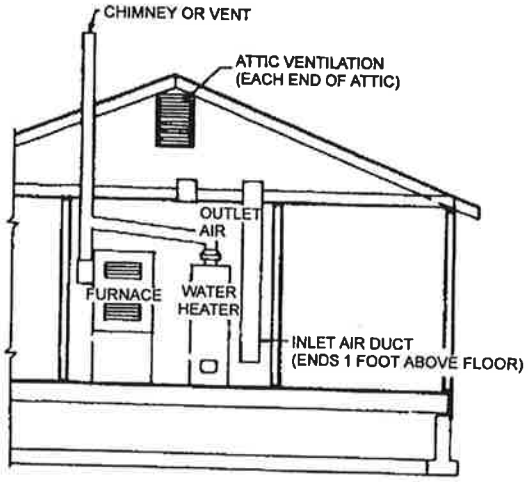


FIGURE A-3
ALL AIR FROM OUTDOORS THROUGH VENTILATED ATTIC

NOTE: The inlet and outlet air openings shall each have a free area of not less than 1 square inch per 4,000 Btu per hour of the total input rating of all appliances in the enclosure.

For **SI:** 1 foot = 304.8 mm, 1 square inch = 645 mm^2, 1 British thermal unit per hour = 0.2931 W.

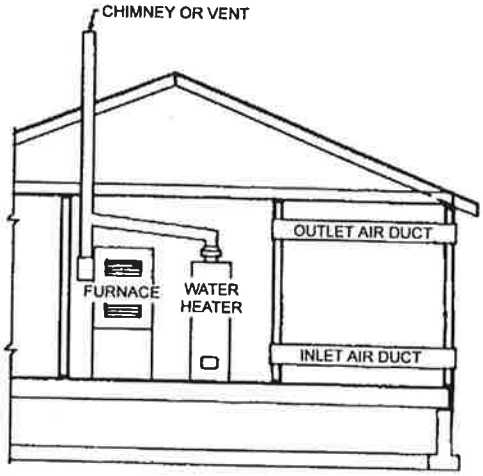


FIGURE A-4
ALL AIR FROM OUTDOORS THROUGH HORIZONTAL DUCTS OR DIRECT OPENINGS

NOTE: Each air duct opening shall have a free area of not less than 1 square inch per 2,000 Btu per hour of the total input rating of all appliances in the enclosure. If the appliance room is located against an outside wall and the air openings communicate directly with the outdoors, each opening shall have a free area of not less than 1 square inch per 4,000 Btu per hour or the total input rating of all appliances in the enclosure.

For **SI:** 1 foot = 304.8 mm, 1 square inch = 645 mm^2, 1 British thermal unit per hour = 0.2931 W.

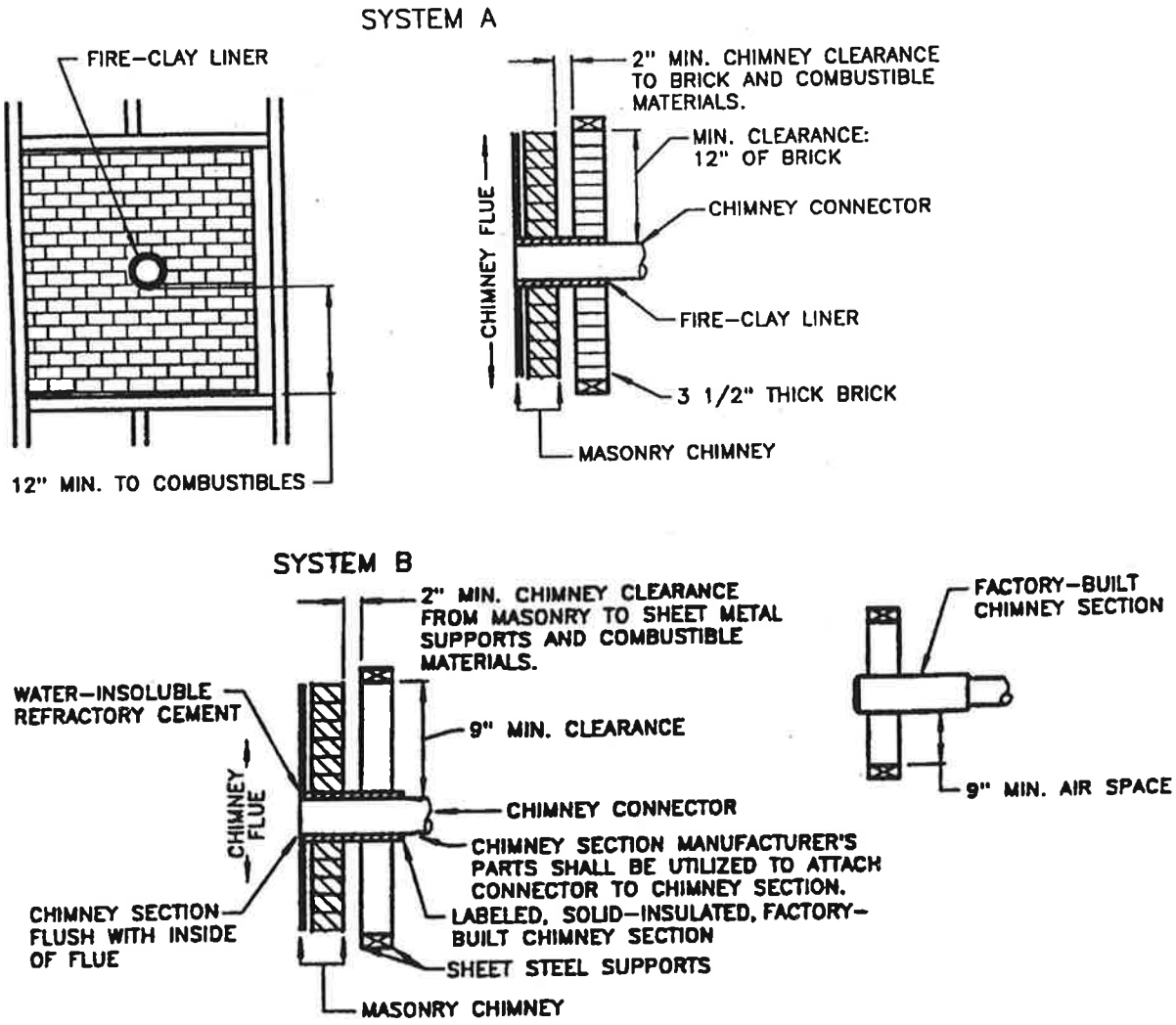


FIGURE A-5
CHIMNEY CONNECTOR SYSTEMS

For SI: 1 inch = 25.4 mm.

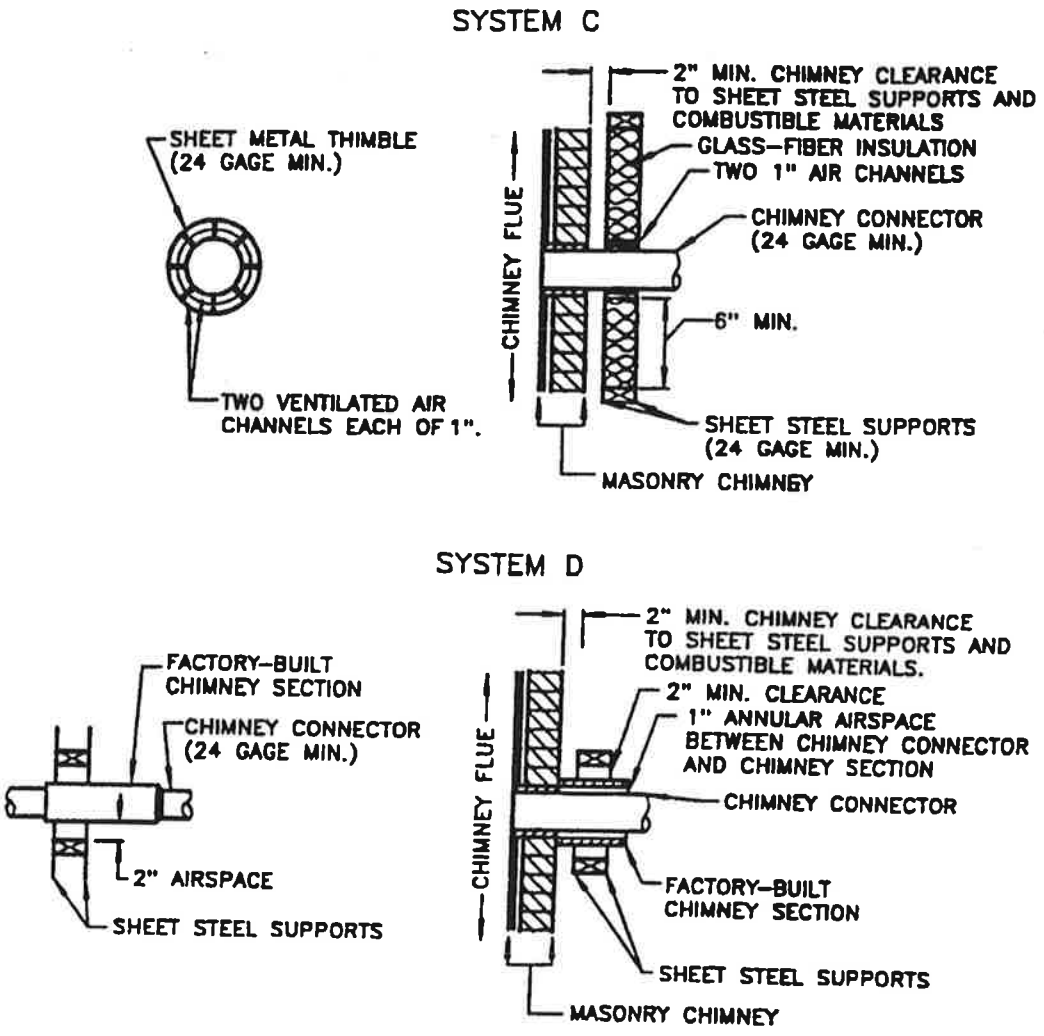


FIGURE A-5—continued
CHIMNEY CONNECTOR SYSTEMS

For SI: 1 inch = 25.4 mm.

APPENDIX B
RECOMMENDED PERMIT FEE SCHEDULE

Not adopted by the State of Oregon.

B101
MECHANICAL WORK, OTHER THAN GAS PIPING SYSTEMS

B101.1 Initial Fee

For issuing each permit $___

B101.2 Additional Fees

B101.2.1 Fee for inspecting heating, ventilating, ductwork, air-conditioning, exhaust, venting, combustion air, pressure vessel, solar, fuel oil and refrigeration systems and appliance installation shall be $___ for the first $1,000.00, or fraction thereof, of valuation of the installation plus $___ for each additional $1,000.00 or fraction thereof.

B101.2.2 Fee for inspecting repairs, alterations and additions to an existing system shall be $___ plus $___ for each $1,000.00 or fraction thereof.

B101.2.3 Fee for inspecting boilers (based upon Btu input):

33,000 Btu (1 BHp) to 165,000 (5 BHp)	$ ___
165,001 Btu (5 BHp) to 330,000 (10 BHp)	$ ___
330,001 Btu (10 BHp) to 1,165,000 (52 BHp)	$ ___
1,165,001 Btu (52 BHp) to 3,300,000 (98 BHp)	$ ___
over 3,300,000 Btu (98 BHp)	$ ___

For **SI:** 1 British thermal unit = 0.2931 W, 1 BHp = 33,475 Btu/hr.

B102
FEE FOR REINSPECTION

If it becomes necessary to make a reinspection of a heating, ventilation, air-conditioning or refrigeration system, or boiler installation, the installer of such equipment shall pay a reinspection fee of $___.

B103
TEMPORARY OPERATION INSPECTION FEE

When preliminary inspection is requested for purposes of permitting temporary operation of a heating, ventilating, refrigeration, or air-conditioning system, or portion thereof, a fee of $___ shall be paid by the contractor requesting such preliminary inspection. If the system is not approved for temporary operation on the first preliminary inspection, the usual reinspection fee shall be charged for each subsequent preliminary inspection for such purpose.

B104
SELF-CONTAINED UNITS LESS THAN 2 TONS

In all buildings, except one- and two-family dwellings, where self-contained air-conditioning units of less than 2 tons are to be installed, the fee charged shall be that for the total cost of all units combined (see B101.2.1 for rate).

APPENDIX C
FUEL GAS

Note: Appendix C is IFGC model code language with some modification by Oregon. Minor changes such as section renumbering and removal of references to "international" codes are not indicated with a || in the margin.

SECTION C101
GENERAL

C101.1 Scope. This appendix shall apply to the installation of fuel gas piping systems, fuel gas utilization equipment, and related accessories as follows:

1. Coverage of piping systems shall extend from the point of delivery to the connections with gas utilization equipment (see "Point of delivery").
2. Systems with an operating pressure of 125 psig (862 kPa gauge) or less. Systems that exceed the limit of this item shall be designed.

   Exceptions:

   1. Piping systems for gas-air mixtures within the flammable range with an operating pressure of 10 psig (69 kPa gauge).
   2. LP-Gas piping systems with an operating pressure of 20 psig (140 kPa gauge) or less.
3. Piping systems requirements shall include design, materials, components, fabrication, assembly, installation, testing, and inspection.
4. Requirements for gas utilization equipment and related accessories shall include installation, combustion and ventilation air and venting.

C101.2 Exemptions. This appendix shall not apply to the following:

1. Portable LP-Gas equipment of all types that are not connected to a fixed fuel piping system.
2. Raw material (feedstock) applications except for piping to special atmosphere generators.
3. Oxygen-fuel gas cutting and welding systems.
4. Industrial gas applications using gases such as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen, and nitrogen.
5. Petroleum refineries, pipeline compressor or pumping stations, loading terminals, compounding plants, refinery tank farms, and natural gas processing plants.
6. Integrated chemical plants or portions of such plants where flammable or combustible liquids or gases are produced by chemical reactions or used in chemical reactions.
7. LP-Gas installations at utility gas plants.
8. Liquefied natural gas (LNG) installations.
9. Proprietary items of equipment, apparatus, or instruments such as gas generating sets, compressors, and calorimeters.
10. LP-Gas equipment for vaporization, gas mixing, and gas manufacturing.
11. Temporary LP-Gas piping for buildings under construction or renovation that is not to become part of the permanent piping system.
12. Installation of LP-Gas systems for railroad switch heating.
13. Installation of LP-Gas and compressed natural gas (CNG) systems on vehicles.
14. Except as provided in Section C401.1.1, gas piping, meters, gas pressure regulators, and other appurtenances used by the serving gas supplier in the distribution of gas, other than undiluted LP-Gas.
15. Building design and construction, except as specified herein.

C101.3 Intent. 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 and location of fuel gas systems.

C101.4 Severability. If a section, subsection, sentence, clause or phrase of this code or appendix is, for any reason, held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this code or appendix.

SECTION C102
INSPECTIONS AND TESTING

C102.1 Required inspections and testing. The code official, upon notification from the permit holder or the permit holder's agent, shall make the following inspections and other such inspections as necessary, and shall either release that portion of the construction or shall notify the permit holder or the permit holder's agent of violations that are required to be corrected. The holder of the permit shall be responsible for the scheduling of such inspections.

1. Underground inspection shall be made after trenches or ditches are excavated and bedded, piping installed, and before backfill is put in place. When excavated soil contains rocks, broken concrete, frozen chunks and other rubble that would damage or break the piping or cause corrosive action, clean backfill shall be on the job site.
2. Rough-in inspection shall be made after the roof, framing, fireblocking and bracing are in place and components to be concealed are complete, and prior to the installation of wall or ceiling membranes.
3. Final inspection shall be made upon completion of the installation.

The requirements of this section shall not be considered to prohibit the operation of any heating equipment installed to replace existing heating equipment serving an occupied portion of a structure in the event a request for inspection of such heating equipment has been filed with the department not more than 48 hours after replacement work is completed, and before any portion of such equipment is concealed by any permanent portion of the structure.

C102.2 Testing. Installations shall be tested as required in this code and in accordance with this section. Tests shall be made by the permit holder and observed by the code official.

C102.2.1 New, altered, extended or repaired installations. New installations and parts of existing installations, which have been altered, extended, renovated, or repaired, shall be tested as prescribed herein to disclose leaks and defects.

C102.2.2 Apparatus, instruments, material and labor for tests. Apparatus, instruments, material and labor required for testing an installation or part thereof shall be furnished by the permit holder.

C102.2.3 Reinspection and testing. Where any work or installation does not pass an initial test or inspection, the necessary corrections shall be made so as to achieve compliance with this code. The work or installation shall then be resubmitted to the code official for inspection and testing.

C102.3 Approval. After the prescribed tests and inspections indicate that the work complies in all respects with this appendix, a notice of approval shall be issued by the code official.

C102.4 Temporary connection. The code official shall have the authority to authorize the temporary connection of an installation to the sources of energy for the purpose of testing the installation or for use under a temporary certificate of occupancy.

SECTION C201
GENERAL

C201.1 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.

C201.2 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.

C201.3 Terms defined in other codes. Where terms are not defined in this code and are defined in the electrical code, building code, fire code, mechanical code, or plumbing code, such terms shall have meanings ascribed to them as in those codes.

C201.4 Terms not defined. Except as defined in this appendix or elsewhere in this code, the interpretation of words used in this code shall be in accordance with the meanings defined in the Webster's Third New International Dictionary of the English Language, Unabridged, copyright 1986.

SECTION C202
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 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 CONDITIONER, GAS FIRED. A gas-burning, automatically-operated appliance for supplying cooled and/or dehumidified air or chilled liquid.

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.

ANODELESS RISER. A transition assembly in which plastic piping is installed and terminated aboveground 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. Appli-ances equipped with an automatic burner ignition and safety shut-off device and other automatic devices which accomplish complete turn-on and shut-off of the gas to the main burner or burners, and graduate the gas supply to the burner or burners, but do not affect complete shut-off of the gas.

APPLIANCE FUEL CONNECTOR. An assembly of listed semirigid or flexible tubing and fittings to carry fuel between a fuel piping outlet and a fuel-burning appliance.

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.

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 re-ignition 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.

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.

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 the inert gases, but excluding excess air.

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

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.

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

CONFINED SPACES. A space having a volume less than 50 cubic feet per 1,000 British thermal units per hour (Btu/h) (4.8 m^3/kW) of the aggregate input rating of all appliances installed in that space.

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

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 which occupies I cubic foot (0.02832 m^3) 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/b = 0.2931 W).

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

DIRECT-FIRED MAKEUP AIR HEATER. A heater in which all of the products of combustion generated by the burners are released into the outdoor air stream being heated.

DIRECT-FIRED INDUSTRIAL AIR HEATER. A heater in which all of the products of combustion generated by the

burners are released into the air stream being heated; whose purpose is to offset the building heat loss by heating incoming outside air, inside air or a combination of both.

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.

EQUIPMENT. See "Appliance."

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 become inoperative, and when flame failure occurs on the burner or group of burners.

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. A natural, manufactured, liquefied petroleum or a mixture of these.

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.

Gravity Type: A central furnace depending primarily on circulation of air by gravity.

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.

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.

Horizontal Forced Air Type: A furnace with air flow through the appliance essentially in a horizontal path.

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

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.

Multiple Position Furnace: A furnace designed so that it can be installed with the airflow discharge in the upflow, horizontal or downflow direction.

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

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.

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 use group classification.

HOUSE PIPING. See "Piping system."

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 igniters, 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.

INFRARED RADIANT HEATER. A heater which 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 it is also labeled. The authority having jurisdiction shall utilize the system employed by the listing organization to identify a listed product.

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 f or 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.

OFFSET (VENT). A combination of approved bends that make 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 SHUT OFF 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. Semi-rigid 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 connections with the gas utilization equipment.

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

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

POINT OF DELIVERY. 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. 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.

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").

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 that 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.

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.

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."

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.

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.

UNCONFINED SPACE. A space having a volume not less than 50 cubic feet per 1,000 Btu/h (4.8 m^3/kW) of the aggregate input rating of all appliances installed in that space. Rooms communicating directly with the space in which the appliances are installed, through openings not furnished with doors, are considered a part of the unconfined space.

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_20) 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 manufacturers' specifications.

UNUSUALLY TIGHT CONSTRUCTION. Construction meeting the following requirements:

1. Walls and ceilings exposed to the outside atmosphere having a continuous air barrier with openings gasketed or sealed; and
2. Weatherstripping on openable windows and doors; and
3. Caulking or sealants applied to areas, such as joints around window and door frames, between sole plates and floors, between wall-ceiling joints, between wall panels and at penetrations for plumbing, electrical and gas lines, and at other openings.

A building of ordinary tightness is one which does not meet the definition of unusually tight construction.

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 which 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 combus-

tion 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 non-positive 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 non-positive 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, freestanding, non-recessed 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 non-positive static pressure or a forced draft portion under positive static pressure.

a. **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.
b. **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 non-positive static vent pressure.
c. **Natural draft venting system.** A venting system designed to remove flue or vent gases under non-positive 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.

SECTION C301
GENERAL

C301.1 Code Compliance. Where differences occur between the provisions of this appendix and reference standards, the provisions of this appendix shall apply.

Equipment shall not be installed or altered in violation of this appendix nor shall the fuel input rate to equipment be increased in excess of the approved Btu/h (W) rating at the altitude where it is being used.

C301.1.1 Other fuels. The requirements for combustion and dilution air for gas-fired appliances shall be governed by Section C304.

C301.2 Listed and labeled. Appliances regulated by this code shall be listed and labeled unless otherwise approved in accordance with Section 105 of this code.

C301.3 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.

SECTION C302
STRUCTURAL SAFETY

C302.1 Structural safety. See Chapter 3, Section 302 of this code for these requirements.

SECTION C303
APPLIANCE LOCATION

C303.1 General. Appliances shall be located as required by this section, specific requirements elsewhere in this appendix and the conditions of the equipment and appliance listing.

C303.2 Hazardous locations. Appliances shall not be located in a hazardous location unless listed and approved for the specific installation.

C303.3 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 is not a confined space and the building is not of unusually tight construction.
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 6000 Btu per hour (1.76kW) and the bathroom is not a confined space.
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 per hour (2.93 kW) and the bedroom is not a confined space.
5. Appliances installed in a dedicated enclosure in which all combustion air is taken directly from the outdoors, in accordance with Section C304.9. Access to such enclosure shall be through a solid door, weather-stripped and equipped with an approved self-closing device.

C303.4 Protection from physical damage. Appliances shall not be installed in a location where subject to physical damage unless protected by approved barriers.

C303.5 Indoor locations. Furnaces and boilers installed in closets and alcoves shall be listed for such installation.

C303.6 Outdoor locations. Equipment installed in outdoor locations shall be listed for outdoor installation.

C303.7 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 C304
COMBUSTION AND DILUTION AIR

C304.1 General. The provisions of Section C304 shall apply to gas utilization equipment installed in buildings and that requires air for combustion and dilution of flue gases.

Exceptions:

1. Direct vent equipment that is constructed and installed so that all air for combustion is obtained directly from the outdoors and all flue gases are discharged to the outdoors.
2. Enclosed furnaces that incorporate an integral total enclosure and use only outdoor air for combustion and dilution of flue gases.

C304.2 Appliance/equipment location. Equipment shall be located so as not to interfere with proper circulation of combustion and dilution air.

C304.3 Outdoor air required. Where normal infiltration does not provide the necessary air, outdoor air shall be introduced in accordance with Sections C304.9 or C304.11.

C304.4 Draft hood/regulator location. 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.

C304.5 Makeup air provisions. 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.

C304.5.1 Special conditions. In buildings containing combustion appliances, equipment or fireplaces not equipped with forced or induced draft or separated from the habitable area, where an individual exhaust appliance exceeds 350 cfm (165.2L/s), make-up air of sufficient quantity to equal that being exhausted shall be supplied to the area being ventilated. In such cases, the minimum size make-up air duct shall be 6 inches (152 mm) in diameter or equivalent area.

C304.6 Combustion air methods. Air for combustion and dilution of flue gases for gas utilization equipment vented by natural draft shall be obtained by application of one of the methods covered in Sections C304.8 through C304.11.

C304.7 Unusually tight construction. Equipment located in buildings of unusually tight construction (see definitions in Section C202) shall be provided with air for combustion and dilution of flue gases using one of the methods described in Section C304.9 or C304.11.

C304.8 All air from inside the building. A confined space shall be provided with two permanent openings communicating directly with other spaces of sufficient volume so that the combined volume of all spaces meets the criteria for an unconfined space. The total input of all equipment installed in the combined spaces shall be used to determine the required minimum volume. Each opening shall have a minimum free area of not less than 1 square inch per 1,000 Btu per hour (22 cm^2 per kw) of the total input rating of all gas utilization equipment in the confined space, but not less than 100 square inches (64 415 mm^2). 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 (See Figure C304.8). The minimum dimension of air openings shall be not less than 3 inches (76 mm).

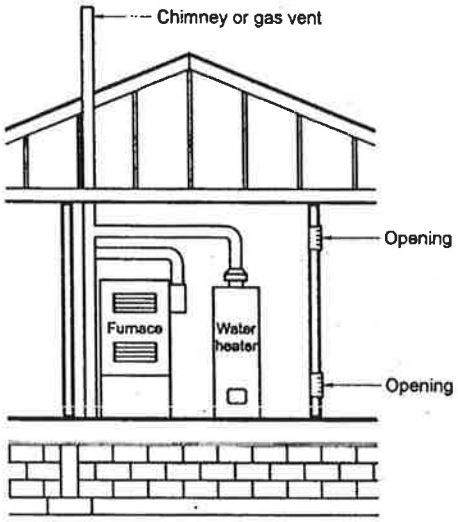


FIGURE C304.8
APPLIANCES LOCATED IN CONFINED SPACES; ALL AIR FROM INSIDE THE BUILDING (SEE C304.8)

C304.9 All air from outdoors. The confined space shall communicate with the outdoors in accordance with Sections C304.9.1 or C304.9.2. The minimum dimension of air openings shall not be less than 3 in. (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.

C304.9.1 Two opening 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 per hour (5.5 cm^2 per kw) of total input rating of all equipment in the enclosure. (See Figures C304.9(1) and C304.9(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 per hour (11 cm^2 per kw) of total input rating of all equipment in the enclosure. (See Figure C304.9(3).)

C304.9.2 One opening method. One permanent opening, commencing within 12 in. (305 mm) of the top of the enclosure, shall be provided. The equipment shall have clearances of at least 1 in. (25.4 mm) from the sides and back and 6 in. (152 mm) from the front of the appliance. The opening shall directly communicate with the outdoors or shall communicate through a vertical or horizontal duct to the outdoors or spaces that freely communicate with the outdoors, (See Figure C304.9(4).) and shall have a minimum free area of 1 sq in. per 3000 Btu per hr (7 cm^2 per 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 confined space.

C304.10 Combination of air from inside and from outdoors. Where the building in which the fuel- burning appliances are located is not unusually tight construction and the communicating interior spaces containing the fuel-burning appliances comply with all of the requirements of Section C304.8, except the volumetric requirement of Section C304.8, required combustion and dilution air shall be obtained by opening the room to the outdoors utilizing a combination of inside and outdoor air prorated in accordance with Section C304.10.6. Openings connecting the interior spaces shall comply with Section C304.8. The ratio of interior spaces shall comply with Section C304.10.5. The number, location and ratios of openings connecting the space with the outdoor air shall comply with Sections C304.10.1 through C304.10.4.

C304.10.1 Number and location of openings. At least two openings shall be provided, one within 1 foot (305 mm) of the ceiling of the room and one within 1 foot (305 mm) of the floor.

C304.10.2 Ratio of direct openings. Where direct openings to the outdoors are provided in accordance with Section C304.9.1, the ratio of direct openings shall be the sum of the net free areas of both direct openings to the outdoors, divided by the sum of the required areas for both such openings as determined in accordance with Section C304.9.1.

C304.10.3 Ratio of horizontal openings. Where openings connected to the outdoors through horizontal ducts are provided in accordance with Section C304.9.1, the ratio of horizontal openings shall be the sum of the net free areas of both such openings, divided by the sum of the required areas for both such openings as determined in accordance with Section C304.9.1.

C304.10.4 Ratio of vertical openings. Where openings connected to the outdoors through vertical ducts are provided in accordance with Section C304.9.1, the ratio of vertical openings shall be the sum of the net free areas of both such openings, divided by the sum of the required areas for both such openings as determined in accordance with Section C304.9.1.

C304.10.5 Ratio of interior spaces. The ratio of interior spaces shall be the available volume of all communicating spaces, divided by the required volume as determined in accordance with Section C304.8.

C304.10.6 Prorating of inside and outdoor air. In spaces that utilize a combination of inside and outdoor air, the sum of the ratios of all direct openings, horizontal openings, vertical openings and interior spaces shall equal or exceed 1.

C304.11 Specially engineered installations. As an alternative to the provisions of Sections C304.8, C304.9 and C304.10, the necessary supply of air for combustion and dilution of flue gases shall be provided by an approved engineered system.

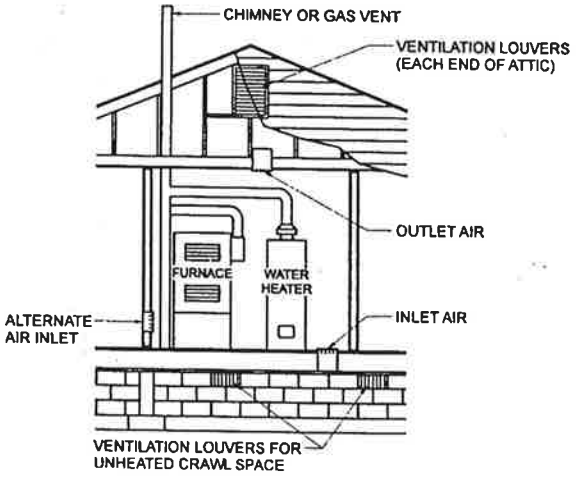
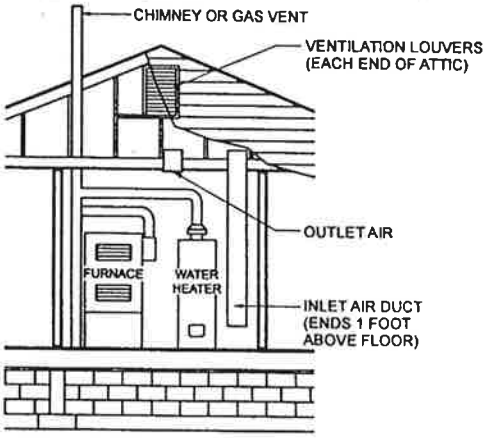


FIGURE C304.9(1)
APPLIANCES LOCATED IN CONFINED SPACES; ALL AIR FROM OUTDOORS- INLET AIR FROM VENTILATED CRAWL SPACE AND OUTLET AIR TO VENTILATED ATTIC. (SEE C304.9.1)



For **SI:** 1 foot = 304.8

FIGURE C304.9(2)
APPLIANCES LOCATED IN CONFINED SPACES; ALL AIR FROM OUTDOORS THROUGH VENTILATED ATTIC. (SEE C304.9.1)

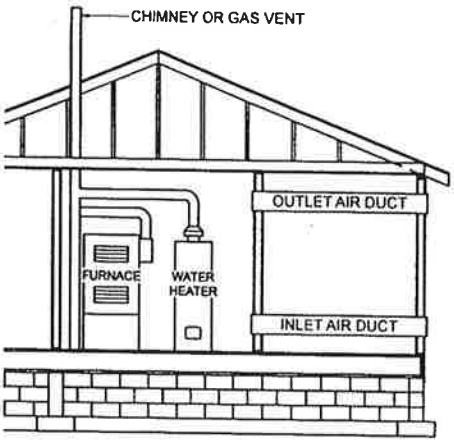


FIGURE C304.9(3)
APPLIANCES LOCATED IN CONFINED SPACES; ALL AIR FROM OUTDOORS. (SEE C304.9.1)

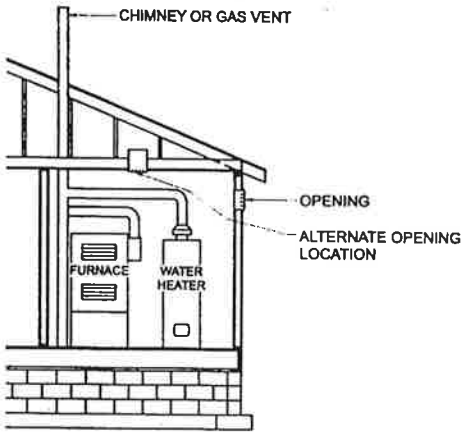


FIGURE C304.9(4)
APPLIANCES LOCATED IN CONFINED SPACES; SINGLE COMBUSTION AIR OPENING, ALL AIR FROM OUTDOORS. (SEE C304.9.2)

C304.12 Louvers and grilles. In calculating free area in Sections C304.8, C304.9 and C304.10, the required size of openings for combustion, ventilation and dilution air 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 20-25 percent free area and metal louvers and grilles will have 60-75 percent free area. Louvers and grilles shall be fixed in the open position.

Exception: Louvers 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 startup and to shut down the main burner if the louvers close during operation.

C304.13 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 this 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. Have a minimum cross-sectional dimension of 3 inches (76 mm).
3. Ducts shall terminate in an unobstructed space allowing free movement of combustion air to the appliances.
4. Have the same cross-sectional areas as the free area of the openings to which they connect.

5. Ducts shall serve a single enclosure.
6. 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.
7. Ducts shall not be screened where terminating in an attic space.
8. Horizontal upper combustion air ducts shall not slope downward toward the source of combustion air.

SECTION C305
INSTALLATION

C305.1 General. Equipment and appliances shall be installed as required by the terms of their approval. Equipment and appliances shall be installed in accordance with the conditions of listing, the manufacturer's installation instructions, and this code. Manufacturer's installation instructions shall be available on the job site at the time of inspection. Unlisted appliances approved in accordance with Section C301.2 shall be limited to uses recommended by the manufacturer and shall be installed in accordance with the manufacturer's installation instructions, the provisions of this code and the requirements determined by the code official.

C305.2 Elevation of ignition source. Heating and/or cooling equipment and water heaters covered by this code, located in a garage and which generate a glow, spark or flame capable of igniting flammable vapors shall be installed with sources of ignition at least 18 inches (457 mm) above the floor level.

C305.3 Public garages. Appliances located in public garages, service stations, 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.

C305.4 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.

SECTION C306
ACCESS AND SERVICE SPACE

C306.1 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.

C306.2 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.

C306.3 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.

Exception: The passageway and level service space are not required where the appliance is capable of being serviced and removed through the required opening.

C306.3.1 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 electrical code.

C306.4 Appliances under floors. Underfloor 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) 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.

Exception: The passageway is not required where the level service space is present when the access is open and the ap-

pliance is capable of being serviced and removed through the required opening.

C306.4.1 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 electrical code.

C306.5 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 (762 mm) high or walking on roofs having a slope greater than 4 units vertical in 12 units horizontal (33-percent slope.)

C306.5.1 Sloped roofs. Where appliances are installed on a roof having a slope of 3 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 C306.6.

C306.5.2 Electrical requirements. A receptacle outlet shall be provided at or near the equipment location in accordance with the electrical code.

C306.6 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 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 building code.

SECTION C307
CONDENSATE DISPOSAL

Note: For additional information on condensate disposal, see Chapter 3, Section 307 of this code.

C307.1 Fuel-burning appliances. Liquid combustion byproducts 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 twelve units horizontal (1-percent slope).

C307.2 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.

C307.3 Traps. Condensate drains shall be trapped as required by the equipment or appliance manufacturer.

SECTION C308
CLEARANCE REDUCTION

C308.1 Scope. This section shall govern the reduction in required clearances to combustible materials and combustible assemblies for chimneys, vents, fuel gas appliances, and fuel gas devices and equipment. Clearance requirements for gas-fired air-conditioning equipment and gas-fired central heating boilers and furnaces shall comply with Sections C308.3 and C308.4.

C308.2 Reduction table. The allowable clearance reduction shall be based on one of the methods specified in Table C308.2 or shall utilize an assembly listed for such application. Where required clearances are not listed in Table C308.2, 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 C308.2(1) through C308.2(3).]

C308.3 Clearances for indoor air-conditioning equipment. Clearance requirements for indoor air-conditioning equipment shall comply with Sections C308.3.1 through C308.3.6.

C308.3.1 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 per the terms of their listing and the manufacturer's instructions.

C308.3.2 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 C308.2, regardless of whether the enclosure is of combustible or noncombustible material.

TABLE C308.2
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(A), 308.2(B), AND 308.2(C)]	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. $3\frac{1}{2}$-inch thick masonry wall without ventilated air space	—	24	—	12	—	9	—	6	—	5
2. $\frac{1}{2}$-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 air space	18	12	9	6	6	4	5	3	3	3
4. $3\frac{1}{2}$-inch thick masonry wall with ventilated air space	—	12	—	6	—	6	—	6	—	6
5. 0.024 sheet metal with ventilated air space	18	12	9	6	6	4	5	3	3	2
6. $\frac{1}{2}$-inch thick insulation board with ventilated air space	18	12	9	6	6	4	5	3	3	3
7. 0.024 sheet metal with ventilated air space over 0.024 sheet metal with ventilated air space	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 air space.	18	12	9	6	6	4	5	3	3	3
9. Prefabricated brick $1\frac{1}{8}$-inch thick spaced out 1 inch and ventilated	30	18	15	9	12	8	9	6	3	3

For **SI:** 1 inch = 25.4 mm, °C = [(°F-32)/1.8], 1 pound per cubic foot = 16.02 kg/m^3, 1 Btu per inch per square foot per hour per °F = 0.144 W/m^2.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 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 C308.2(2) and C308.2(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. If a wall protector is mounted on a single flat wall away from corners, adequate air circulation shall be permitted to be provided by leaving only the bottom and top edges or only the side and top edges open with at least 1 inch air gap.

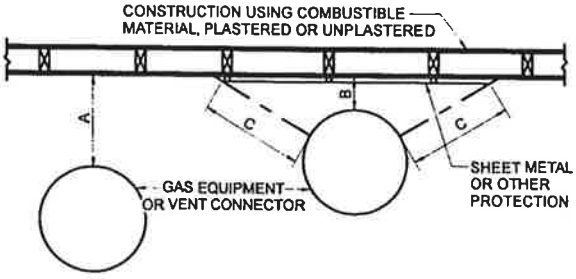
g. Mineral wool batts (blanket or board) shall have a minimum density of 8 pounds per cubic foot and a minimum melting point of 1,500°F.

h. Insulation material used as part of clearance reduction system shall have a thermal conductivity of 1.0 Btu 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 Table C308.2.

j. All clearances and thicknesses are minimum; larger clearances and thicknesses are acceptable.

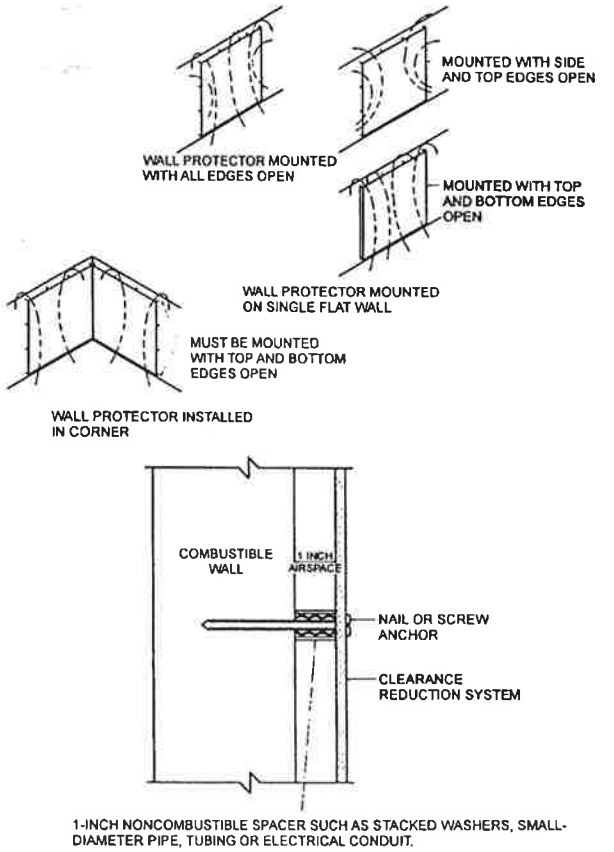
k. Listed single-wall connectors shall be permitted to be installed in accordance with the terms of their listing and the manufacturer's instructions.



"A" equals the reduced clearance with no protection.

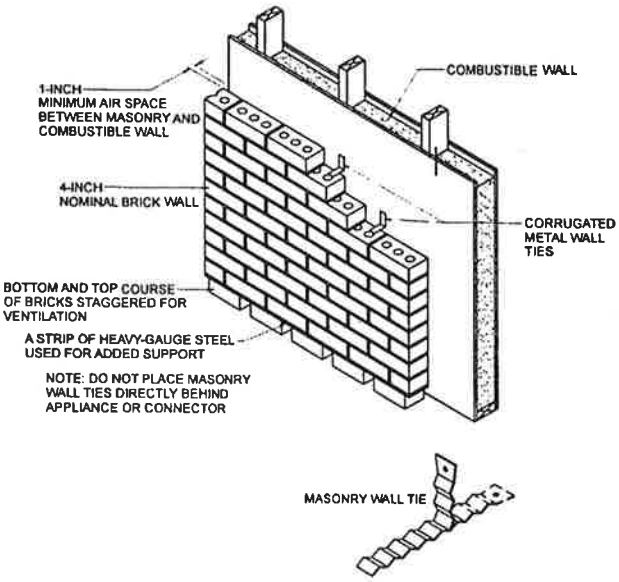
"B" equals the reduced clearance permitted in accordance with Table C308.2. The protection applied to the construction using combustible material shall extend far enough in each direction to make "C" equal to "A."

FIGURE C308.2(1)
EXTENT OF PROTECTION NECESSARY TO REDUCE CLEARANCES FROM GAS EQUIPMENT OR VENT CONNECTIONS



For SI: 1 inch = 25.4 mm.

FIGURE C308.2(2)
WALL PROTECTOR CLEARANCE REDUCTION SYSTEM



For SI: 1 inch = 25.4 mm.

FIGURE C308.2(3)
EXTENT OF PROTECTION NECESSARY TO REDUCE CLEARANCES FROM GAS EQUIPMENT OR VENT CONNECTIONS

C308.3.3 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 C308.2.

C308.3.4 Plenum clearances. Where the plenum is adjacent to plaster on metal lath or noncombustible material attached to combustible material, the clearance shall be measured to the surface of the plaster or other noncombustible finish where the clearance specified is 2 in. (51mm) or less.

C308.3.5 Clearance from supply ducts. Air-conditioning equipment shall have the clearance from supply ducts within 3 feet (914 mm) of the plenum be not less than that specified from the plenum. No clearance is necessary beyond this distance.

C308.4 Central heating boilers and furnaces. Clearance requirements for central heating boilers and furnaces shall comply with Sections C308.4.1 through C308.4.8. The clearance to this equipment shall not interfere with combustion air, draft hood clearance and relief, and accessibility for servicing.

C308.4.1 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 0of the equipment shall be installed with clearances per terms of their listing and the manufacturer's instructions.

C308.4.2 Equipment installed in rooms that are not large in comparison with the size of the equipment. Cen-

tral 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 C308.2 and illustrated in Figures C308.2(1) through C308.2(3), regardless of whether the enclosure is of combustible or noncombustible material.

C308.4.3 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 C308.2.

C308.4.4 Clearance for servicing equipment. Front clearance shall be sufficient for servicing the burner and the furnace or boiler.

C308.4.5 Plenum clearances. Where the plenum is adjacent to plaster on metal lath or noncombustible material attached to combustible material, the clearance shall be measured to the surface of the plaster or other noncombustible finish where the clearance specified is 2 inches (51 mm) or less.

C308.4.6 Clearance from supply ducts. Central heating furnaces shall have the clearance from supply ducts within 3 feet (914 mm) of the plenum be not less than that specified from the plenum. No clearance is necessary beyond this distance.

C308.4.7 Other central heating furnaces. Central heating furnaces other than those listed in C308.4.6 or C308.4.7 shall have clearances from the supply ducts of not less than 18 inches (457 mm) from the plenum for the first 3 feet (914 mm), then 6 inches (150 mm) for the next 3 feet (914 mm) and 1 inch (25 mm) beyond 6 feet (1829 mm).

SECTION C309
ELECTRICAL

C309.1 Grounding. Gas piping shall not be used as a grounding electrode.

C309.2 Connections. Electrical connections between equipment and the building wiring, including the grounding of the equipment, shall conform to the electrical code.

SECTION C401
GENERAL

C401.1 Scope. This section shall govern the installation and modification 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 and inspection of such piping systems.

C401.1.1 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 building code.

C401.2 Liquefied petroleum gas storage. The storage system for liquefied petroleum gas shall be designed and installed in accordance with the fire code and NFPA 58.

C401.2.1 Notice of installation. A "Notice of Installation" is required by the State Fire Marshal for all LP-gas tank installations. For installation requirements of LP-gas tanks and tubing or piping up to the first stage regulator, see Article 82 of the fire code.

C401.3 Modifications to existing systems. In modifying or adding to existing piping systems, sizes shall be maintained in accordance with this chapter.

C401.4 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.

C401.5 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.

C401.6 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.

C401.7 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.

C401.8 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 C402.

SECTION C402
PIPE SIZING

C402.1 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.

C402.2 Maximum gas demand. The volume of gas to be provided, in cubic feet per hour, shall be determined directly from the manufacturers' input ratings of the gas utilization equipment served. Where input rating is not indicated, the gas supplier, equipment manufacturer, or a qualified agency shall be contacted for estimating the volume of gas to be supplied. The total connected hourly load shall be used as the basis for piping 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.

C402.3 Sizing. Gas piping shall be sized in accordance with: Tables C402.3(1) through C402.3(34) or other approved methods. (See Chapter C-A).

C402.4 Allowable pressure drop. The design pressure loss in any piping system under maximum probable flow conditions, from the point of delivery to the inlet connection of the equipment, shall be such that the supply pressure at the equipment is greater than the minimum pressure required for proper equipment operation.

C402.5 Maximum design operating pressure. The maximum design operating pressure for piping systems located inside buildings shall not exceed 5 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.

C402.5.1 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.

C402.5.2 License requirements. LP-gas installers must be licensed by the State Fire Marshal in accordance with ORS 480.432 through 480.436.

TABLE C402.3(1)
MAXIMUM CAPACITY OF PIPE IN CUBIC FEET OF GAS PER HOUR FOR GAS PRESSURES OF 0.5 PSI OR LESS AND A PRESSURE DROP OF 0.3-INCH WATER COLUMN
(Based on a 0.60 Specific Gravity Gas)

NOMINAL IRON PIPE SIZE (inches)	INTERNAL DIAMETER (inches)	LENGTH OF PIPE (feet)													
		10	20	30	40	50	60	70	80	90	100	125	150	175	200
1/4	.364	32	22	18	15	14	12	11	11	10	9	8	8	7	6
3/8	.493	72	49	40	34	30	27	25	23	22	21	18	17	15	14
1/2	.622	132	92	73	63	56	50	46	43	40	38	34	31	28	26
3/4	.824	278	190	152	130	115	105	96	90	84	79	72	64	59	55
1	1.049	520	350	285	245	215	195	180	170	160	150	130	120	110	100
1 1/4	1.380	1,050	730	590	500	440	400	370	350	320	305	275	250	225	210
1 1/2	1.610	1,600	1,100	890	760	670	610	560	530	490	460	410	380	350	320
2	2.067	3,050	2,100	1,650	1,450	1,270	1,150	1,050	990	930	870	780	710	650	610
2 1/2	2.469	4,800	3,300	2,700	2,300	2,000	1,850	1,700	1,600	1,500	1,400	1,250	1,130	1,050	980
3	3.068	8,500	5,900	4,700	4,100	3,600	3,250	3,000	2,800	2,600	2,500	2,200	2,000	1,850	1,700
4	4.026	17,500	12,000	9,700	8,300	7,400	6,800	6,200	5,800	5,400	5,100	4,500	4,100	3,800	3,500

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

TABLE C402.3(2)
MAXIMUM CAPACITY OF PIPE IN CUBIC FEET OF GAS PER HOUR FOR GAS PRESSURES OF 0.5 PSI OR LESS AND A PRESSURE DROP OF 0.5-INCH WATER COLUMN
(Based on a 0.60 Specific Gravity Gas)

NOMINAL IRON PIPE SIZE (inches)	INTERNAL DIAMETER (inches)	LENGTH OF PIPE (feet)													
		10	20	30	40	50	60	70	80	90	100	125	150	175	200
1/4	.364	43	29	24	20	18	16	15	14	13	12	11	10	9	8
3/8	.493	95	65	52	45	40	36	33	31	29	27	24	22	20	19
1/2	.622	175	120	97	82	73	66	61	57	53	50	44	40	37	35
3/4	.824	360	250	200	170	151	138	125	118	110	103	93	84	77	72
1	1.049	680	465	375	320	285	260	240	220	205	195	175	160	145	135
1 1/4	1.380	1,400	950	770	660	580	530	490	460	430	400	360	325	300	280
1 1/2	1.610	2,100	1,460	1,180	990	900	810	750	690	650	620	550	500	460	430
2	2.067	3,950	2,750	2,200	1,900	1,680	1,520	1,400	1,300	1,220	1,150	1,020	950	850	800
2 1/2	2.469	6,300	4,350	3,520	3,000	2,650	2,400	2,250	2,050	1,950	1,850	1,650	1,500	1,370	1,280
3	3.068	11,000	7,700	6,250	5,300	4,750	4,300	3,900	3,700	3,450	3,250	2,950	2,650	2,450	2,280
4	4.026	23,000	15,800	12,800	10,900	9,700	8,800	8,100	7,500	7,200	6,700	6,000	5,500	5,000	4,600

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

TABLE C402.3(3)
PIPE SIZING TABLE FOR 2 PSI PRESSURE CAPACITY OF PIPES OF DIFFERENT DIAMETERS AND LENGTHS IN CUBIC FEET PER HOUR FOR AN INITIAL PRESSURE OF 2.0 PSI WITH A 1.0 PSI PRESSURE DROP
(Based on a 0.60 Specific Gravity Gas)

PIPE SIZE OF SCHEDULE 40 STANDARD PIPE (inches)	INTERNAL DIAMETER (inches)	TOTAL EQUIVALENT LENGTH OF PIPE (feet)													
		10	20	30	40	50	60	70	80	90	100	125	150	175	200
1/2	.622	1,506	1,065	869	753	673	615	569	532	502	462	414	372	344	318
3/4	.824	3,041	2,150	1,756	1,521	1,360	1,241	1,150	1,075	1,014	934	836	751	695	642
1	1.049	5,561	3,932	3,211	2,781	2,487	2,270	2,102	1,966	1,854	1,708	1,528	1,373	1,271	1,174
1 1/4	1.380	11,415	8,072	6,591	5,708	5,105	4,660	4,315	4,036	3,805	3,508	3,138	2,817	2,608	2,413
1 1/2	1.610	17,106	12,096	9,876	8,553	7,650	6,983	6,465	6,048	5,702	5,257	4,702	4,222	3,909	3,613
2	2.067	32,944	23,295	19,020	16,472	14,733	13,449	12,452	11,647	10,981	10,125	9,056	8,130	7,527	6,959
2 1/2	2.469	52,505	37,127	30,314	26,253	23,481	21,435	19,845	18,563	17,502	16,138	14,434	12,960	11,999	11,093
3	3.068	92,819	65,633	53,589	46,410	41,510	37,893	35,082	32,817	30,940	28,530	25,518	22,911	21,211	19,608
4	4.026	189,326	133,873	109,307	94,663	84,669	77,292	71,558	66,937	63,109	58,194	52,050	46,732	43,265	39,997

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

TABLE C402.3(4)
PIPE SIZING TABLE FOR 5 PSI PRESSURE CAPACITY OF PIPES OF DIFFERENT DIAMETERS AND LENGTHS IN CUBIC FEET PER HOUR FOR AN INITIAL PRESSURE OF 5.0 PSI WITH A 3.5 PSI PRESSURE DROP
(Based on a 0.60 Specific Gravity Gas)

PIPE SIZE OF SCHEDULE 40 STANDARD PIPE (inches)	INTERNAL DIAMETER (inches)	TOTAL EQUIVALENT LENGTH OF PIPE (feet)													
		10	20	30	40	50	60	70	80	90	100	125	150	175	200
1/2	.622	3,185	2,252	1,839	1,593	1,425	1,301	1,204	1,153	1,062	979	876	786	728	673
3/4	.824	6,434	4,550	3,715	3,217	2,878	2,627	2,432	2,330	2,145	1,978	1,769	1,589	1,471	1,360
1	1.049	11,766	8,320	6,793	5,883	5,262	4,804	4,447	4,260	3,922	3,617	3,235	2,905	2,690	2,487
1 1/4	1.380	24,161	17,084	13,949	12,080	10,805	9,864	9,132	8,542	8,054	7,427	6,643	5,964	5,522	5,104
1 1/2	1.610	36,206	25,602	20,904	18,103	16,192	14,781	13,685	12,801	12,069	11,128	9,953	8,937	8,274	7,649
2	2.067	69,727	49,305	40,257	34,864	31,183	28,466	26,354	24,652	23,242	21,433	19,170	17,211	15,934	14,729
2 1/2	2.469	111,133	78,583	64,162	55,566	49,700	45,370	42,004	39,291	37,044	34,159	30,553	27,431	25,396	23,478
3	3.068	196,468	138,924	113,431	98,234	87,863	80,208	74,258	69,462	65,489	60,387	54,012	48,494	44,897	41,504
4	4.026	400,732	283,361	231,363	200,366	179,213	163,598	151,463	141,680	133,577	123,173	110,169	98,911	91,574	84,656

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

TABLE C402.3(5)
PIPE SIZING TABLE FOR PRESSURES UNDER 1 POUND APPROXIMATE CAPACITY OF PIPES OF DIFFERENT DIAMETERS AND LENGTHS IN CUBIC FEET PER HOUR WITH PRESSURE DROP OF 0.3-INCH WATER COLUMN (Based on a 0.60 Specific Gravity Gas)

PIPE SIZE OF SCHEDULE 40 STANDARD PIPE (inches)	INTERNAL DIAMETER (inches)	TOTAL EQUIVALENT LENGTH OF PIPE (feet)										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	215	148	119	102	90	82	70	62	43	34	29
1.25	1.380	442	304	244	209	185	168	143	127	87	70	60
1.50	1.610	662	455	366	313	277	251	215	191	131	105	90
2.00	2.067	1,275	877	704	602	534	484	414	367	252	203	173
2.50	2.469	2,033	1,397	1,122	960	851	771	660	585	402	323	276
3.00	3.068	3,594	2,470	1,983	1,698	1,505	1,363	1,167	1,034	711	571	488
3.50	3.548	5,262	3,616	2,904	2,485	2,203	1,996	1,708	1,514	1,041	836	715
4.00	4.026	7,330	5,038	4,046	3,462	3,069	2,780	2,380	2,109	1,450	1,164	996
5.00	5.047	13,261	9,114	7,319	6,264	5,552	5,030	4,305	3,816	2,623	2,106	1,802
6.00	6.065	21,472	14,758	11,851	10,143	8,990	8,145	6,971	6,178	4,246	3,410	2,919
8.00	7.981	44,118	30,322	24,350	20,840	18,470	16,735	14,323	12,694	8,725	7,006	5,997
10.00	10.020	80,130	55,073	44,225	37,851	33,547	30,396	26,015	23,056	15,847	12,725	10,891
12.00	11.938	126,855	87,187	70,014	59,923	53,109	48,120	41,185	36,501	25,087	20,146	17,242

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

TABLE C402.3(6)
PIPE SIZING TABLE FOR PRESSURES UNDER 1 POUND APPROXIMATE CAPACITY OF PIPES OF DIFFERENT DIAMETERS AND LENGTHS IN CUBIC FEET PER HOUR WITH PRESSURE DROP OF 0.5-INCH WATER COLUMN (Based on a 0.60 Specific Gravity Gas)

PIPE SIZE OF SCHEDULE 40 STANDARD PIPE (inches)	INTERNAL DIAMETER (inches)	TOTAL EQUIVALENT LENGTH OF PIPE (feet)										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	284	195	157	134	119	108	92	82	56	45	39
1.25	1.380	583	400	322	275	244	221	189	168	115	93	79
1.50	1.610	873	600	482	412	366	331	283	251	173	139	119
2.00	2.067	1,681	1,156	928	794	704	638	546	484	333	267	229
2.50	2.469	2,680	1,842	1,479	1,266	1,122	1,017	870	771	530	426	364
3.00	3.068	4,738	3,256	2,615	2,238	1,983	1,797	1,538	1,363	937	752	644
3.50	3.548	6,937	4,767	3,828	3,277	2,904	2,631	2,252	1,996	1,372	1,102	943
4.00	4.026	9,663	6,641	5,333	4,565	4,046	3,666	3,137	2,780	1,911	1,535	1,313
5.00	5.047	17,482	12,015	9,649	8,258	7,319	6,632	5,676	5,030	3,457	2,776	2,376
6.00	6.065	28,308	19,456	15,624	13,372	11,851	10,738	9,190	8,145	5,598	4,496	3,848
8.00	7.981	58,161	39,974	32,100	27,474	24,350	22,062	18,883	16,735	11,502	9,237	7,905
10.00	10.020	105,636	72,603	58,303	49,900	44,225	40,071	34,296	30,396	20,891	16,776	14,358
12.00	11.938	167,236	114,940	92,301	78,998	70,014	63,438	54,295	48,120	33,073	26,559	22,731

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

TABLE C402.3(7)
PIPE SIZING TABLE FOR 1 POUND PRESSURE CAPACITY OF PIPES OF DIFFERENT DIAMETERS AND LENGTHS IN CUBIC FEET PER HOUR FOR AN INITIAL PRESSURE OF 1.0 PSI WITH A 10-PERCENT PRESSURE DROP
(Based on a 0.60 Specific Gravity Gas)

PIPE SIZE OF SCHEDULE 40 STANDARD PIPE (Inches)	INTERNAL DIAMETER (Inches)	TOTAL EQUIVALENT LENGTH OF PIPE (feet)										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	717	493	396	338	300	272	233	206	142	114	97
1.25	1.380	1,471	1,011	812	695	616	558	478	423	291	234	200
1.50	1.610	2,204	1,515	1,217	1,041	923	836	716	634	436	350	300
2.00	2.067	4,245	2,918	2,343	2,005	1,777	1,610	1,378	1,222	840	674	577
2.50	2.469	6,766	4,651	3,735	3,196	2,833	2,567	2,197	1,947	1,338	1,075	920
3.00	3.068	11,962	8,221	6,602	5,650	5,008	4,538	3,884	3,442	2,366	1,900	1,626
3.50	3.548	17,514	12,037	9,666	8,273	7,332	6,644	5,686	5,039	3,464	2,781	2,381
4.00	4.026	24,398	16,769	13,466	11,525	10,214	9,255	7,921	7,020	4,825	3,875	3,316
5.00	5.047	44,140	30,337	24,362	20,851	18,479	16,744	14,330	12,701	8,729	7,010	6,000
6.00	6.065	71,473	49,123	39,447	33,762	29,923	27,112	23,204	20,566	14,135	11,351	9,715
8.00	7.981	146,849	100,929	81,049	69,368	61,479	55,705	47,676	42,254	29,041	23,321	19,960
10.00	10.020	266,718	183,314	147,207	125,990	111,663	101,175	86,592	76,745	52,747	42,357	36,252
12.00	11.938	422,248	290,209	233,048	199,459	176,777	160,172	137,087	121,498	83,505	67,057	57,392

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

TABLE C402.3(8)
PIPE SIZING TABLE FOR 2 POUND CAPACITY OF PIPES OF DIFFERENT DIAMETERS AND LENGTHS IN CUBIC FEET PER HOUR FOR AN INITIAL PRESSURE OF 2.0 PSI WITH A 10-PERCENT PRESSURE DROP
(Based on a 0.60 Specific Gravity Gas)

PIPE SIZE OF SCHEDULE 40 STANDARD PIPE (Inches)	INTERNAL DIAMETER (Inches)	SCHEDULE TOTAL EQUIVALENT LENGTH OF PIPE (feet)										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	1,112	764	614	525	466	422	361	320	220	177	151
1.25	1.380	2,283	1,569	1,260	1,079	956	866	741	657	452	363	310
1.50	1.610	3,421	2,351	1,888	1,616	1,432	1,298	1,111	984	677	543	465
2.00	2.067	6,589	4,528	3,636	3,112	2,758	2,499	2,139	1,896	1,303	1,046	896
2.50	2.469	10,501	7,217	5,796	4,961	4,396	3,983	3,409	3,022	2,077	1,668	1,427
3.00	3.068	18,564	12,759	10,246	8,769	7,772	7,042	6,027	5,342	3,671	2,948	2,523
3.50	3.548	27,181	18,681	15,002	12,840	11,379	10,311	8,825	7,821	5,375	4,317	3,694
4.00	4.026	37,865	26,025	20,899	17,887	15,853	14,364	12,293	10,895	7,488	6,013	5,147
5.00	5.047	68,504	47,082	37,809	32,359	28,680	25,986	22,240	19,711	13,547	10,879	9,311
6.00	6.065	110,924	76,237	61,221	52,397	46,439	42,077	36,012	31,917	21,936	17,616	15,077
8.00	7.981	227,906	156,638	125,786	107,657	95,414	86,452	73,992	65,578	45,071	36,194	30,977
10.00	10.020	413,937	284,497	228,461	195,533	173,297	157,020	134,389	119,106	81,861	65,737	56,263
12.00	11.938	655,315	450,394	361,682	309,553	274,351	248,582	212,754	188,560	129,596	104,070	89,071

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

TABLE C402.3(9)
PIPE SIZING TABLE FOR 5 POUND PRESSURE CAPACITY OF PIPES OF DIFFERENT DIAMETERS AND LENGTHS IN CUBIC FEET PER HOUR FOR AN INITIAL PRESSURE OF 5.0 PSI WITH A 10-PERCENT PRESSURE DROP
(Based on a 0.60 Specific Gravity Gas)

PIPE SIZEOF SCHEDULE 40 STANDARD PIPE (inches)	INTERNAL DIAMETER (inches)	TOTAL EQUIVALENT LENGTH OF PIPE (feet)										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	1,989	1,367	1,098	940	833	755	646	572	393	316	270
1.25	1.380	4,084	2,807	2,254	1,929	1,710	1,549	1,326	1,175	808	649	555
1.50	1.610	6,120	4,206	3,378	2,891	2,562	2,321	1,987	1,761	1,210	972	832
2.00	2.067	11,786	8,101	6,505	5,567	4,934	4,471	3,827	3,391	2,331	1,872	1,602
2.50	2.469	18,785	12,911	10,368	8,874	7,865	7,126	6,099	5,405	3,715	2,983	2,553
3.00	3.068	33,209	22,824	18,329	15,687	13,903	12,597	10,782	9,556	6,568	5,274	4,514
3.50	3.548	48,623	33,418	26,836	22,968	20,356	18,444	15,786	13,991	9,616	7,722	6,609
4.00	4.026	67,736	46,555	37,385	31,997	28,358	25,694	21,991	19,490	13.396	10,757	9,207
5.00	5.047	122,544	84,224	67,635	57,887	51,304	46,485	39,785	35,261	24.235	19,461	16,656
6.00	6.065	198,427	136,378	109,516	93,732	83,073	75,270	64,421	57,095	39,241	31,512	26,970
8.00	7.981	407,692	280,204	225,014	192,583	170,683	154,651	132,361	117,309	80,626	64,745	55,414
10.00	10.020	740,477	508,926	408,686	349,782	310,005	280,887	240,403	213,065	146.438	117,595	100,646
12.00	11.938	1,172,269	805,694	647,001	553,749	490,777	444,680	380,588	337,309	231.830	186,168	159,336

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

TABLE C402.3(10)
PIPE SIZING TABLE FOR 10 POUND PRESSURE CAPACITY OF PIPES OF DIFFERENT DIAMETERS AND LENGTHS IN CUBIC FEET PER HOUR FOR AN INITIAL PRESSURE OF 10.0 PSI WITH A 10-PERCENT PRESSURE DROP
(Based on a 0.60 Specific Gravity Gas)

PIPE SIZE OF SCHEDULE 40 STANDARD PIPE (inches)	INTERNAL DIAMETER (inches)	TOTAL EQUIVALENT LENGTH OF PIPE (feet)										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	3,259	2,240	1,798	1,539	1,364	1,236	1,058	938	644	517	443
1.25	1.380	6,690	4,598	3,692	3,160	2,801	2,538	2,172	1,925	1,323	1,062	909
1.50	1.610	10,024	6,889	5,532	4,735	4,197	3,802	3,254	2,884	1.982	1,592	1,362
2.00	2.067	19,305	13,268	10,655	9,119	8,082	7,323	6,268	5,555	3.818	3,066	2,624
2.50	2.469	30,769	21,148	16,982	14,535	12,882	11,672	9,990	8,854	6.085	4,886	4,182
3.00	3.068	54,395	37,385	30,022	25,695	22,773	20,634	17,660	15,652	10,757	8,638	7,393
3.50	3.548	79,642	54,737	43,956	37,621	33,343	30,211	25,857	22,916	15.750	12,648	10,825
4.00	4.026	110,948	76,254	61,235	52,409	46,449	42,086	36,020	31,924	21.941	17,620	15,080
5.00	5.047	200,720	137,954	110,782	94,815	84,033	76,140	65,166	57,755	39.695	31,876	27,282
6.00	6.065	325,013	223,379	179,382	153,527	136,068	123,288	105,518	93,519	64.275	51,615	44,176
8.00	7.981	667,777	458,959	368,561	315,440	279,569	253,310	216,800	192,146	132.061	106,050	90,765
10.00	10.020	1,212,861	833,593	669,404	572,924	507,772	460,078	393,767	348,988	239.858	192,614	164,853
12.00	11.938	1,920,112	1,319,682	1,059,751	907,010	803,866	728,361	623,383	552,493	379.725	304,933	260,983

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

TABLE C402.3(11)
PIPE SIZING TABLE FOR 20 POUND PRESSURE CAPACITY OF PIPES OF DIFFERENT DIAMETERS AND LENGTHS IN CUBIC FEET PER HOUR FOR AN INITIAL PRESSURE OF 20.0 PSI WITH A 10-PERCENT PRESSURE DROP
(Based on a 0.60 Specific Gravity Gas)

PIPE SIZE OF SCHEDULE 40 STANDARD PIPE (inches)	INTERNAL DIAMETER (inches)	TOTAL EQUIVALENT LENGTH OF PIPE (feet)										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	5,674	3,900	3,132	2,680	2,375	2,152	1,842	1,633	1,122	901	771
1.25	1.380	11,649	8,006	6,429	5,503	4,877	4,419	3,782	3,352	2,304	1,850	1,583
1.50	1.610	17,454	11,996	9,633	8,245	7,307	6,621	5,667	5,022	3,452	2,772	2,372
2.00	2.067	33,615	23,103	18,553	15,879	14,073	12,751	10,913	9,672	6,648	5,338	4,569
2.50	2.469	53,577	36,823	29,570	25,308	22,430	20,323	17,394	15,416	10,595	8,509	7,282
3.00	3.068	94,714	65,097	52,275	44,741	39,653	35,928	30,750	27,253	18,731	15,042	12,874
3.50	3.548	138,676	95,311	76,538	65,507	58,058	52,604	45,023	39,903	27,425	22,023	18,849
4.00	4.026	193,187	132,777	106,624	91,257	80,879	73,282	62,720	55,538	38,205	30,680	26,258
5.00	5.047	349,503	240,211	192,898	165,096	146,322	132,578	113,470	100,566	69,118	55,505	47,505
6.00	6.065	565,926	388,958	312,347	267,329	236,928	214,674	183,733	162,840	111,919	89,875	76,921
8.00	7.981	1,162,762	799,160	641,754	549,258	486,797	441,074	377,502	334,573	229,950	184,658	158,043
10.00	10.020	2,111,887	1,451,488	1,165,596	997,600	884,154	801,108	685,645	607,674	417,651	335,388	287,049
12.00	11.938	3,343,383	2,297,888	1,845,285	1,579,326	1,399,727	1,268,254	1,085,462	962,025	661,194	530,962	454,435

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

TABLE C402.3(12)
PIPE SIZING TABLE FOR 50 POUND PRESSURE CAPACITY OF PIPES OF DIFFERENT DIAMETERS AND LENGTHS IN CUBIC FEET PER HOUR FOR AN INITIAL PRESSURE OF 50.0 PSI WITH A 10-PERCENT PRESSURE DROP
(Based on a 0.60 Specific Gravity Gas)

PIPESIZEOF SCHEDULE 40 STANDARD PIPE (inches)	INTERNAL DIAMETER (inches)	TOTAL EQUIVALENT LENGTH OF PIPE (feet)										
		50	100	150	200	250	300	400	500	1000	1500	2000
1.00	1.049	12,993	8,930	7,171	6,138	5,440	4,929	4,218	3,739	2,570	2,063	1,766
1.25	1.380	26,676	18,335	14,723	12,601	11,168	10,119	8,661	7,676	5,276	4,236	3,626
1.50	1.610	39,970	27,471	22,060	18,881	16,733	15,162	12,976	11,501	7,904	6,348	5,433
2.00	2.067	76,977	52,906	42,485	36,362	32,227	29,200	24,991	22,149	15,223	12,225	10,463
2.50	2.469	122,690	84,324	67,715	57,955	51,365	46,540	39,832	35,303	24,263	19,484	16,676
3.00	3.068	216,893	149,070	119,708	102,455	90,804	82,275	70,417	62,409	42,893	34,445	29,480
3.50	3.548	317,564	218,260	175,271	150,009	132,950	120,463	103,100	91,376	62,802	50,432	43,164
4.00	4.026	442,393	304,054	244,166	208,975	185,211	167,814	143,627	127,294	87,489	70,256	60,130
5.00	5.047	800,352	550,077	441,732	378,065	335,072	303,600	259,842	230,293	158,279	127,104	108,784
6.00	6.065	1,295,955	890,703	715,266	612,175	542,559	491,598	420,744	372,898	256,291	205,810	176,147
8.00	7.981	2,662,693	1,830,054	1,469,598	1,257,785	1,114,752	1,010,046	864,469	766,163	526,579	422,862	361,915
10.00	10.020	4,836,161	3,323,866	2,669,182	2,284,474	2,024,687	1,834,514	1,570,106	1,391,556	956,409	768,030	657,334
12.00	11.938	7,656,252	5,262,099	4,225,651	3,616,611	3,205,335	2,904,266	2,485,676	2,203,009	1,514,115	1,215,888	1,040,643

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

TABLE C402.3(13)
MAXIMUM CAPACITY OF SEMI-RIGID TUBING IN CUBIC FEET OF GAS PER HOUR FOR GAS PRESSURES OF 0.5 PSI OR LESS AND A PRESSURE DROP OF 0.3-INCH WATER COLUMN
(Based on a 0.60 Specific Gravity Gas)

OUTSIDER DIAMETER (inch)	LENGTH OF TUBING (feet)													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
3/8	20	14	11	10	9	8	7	7	6	6	5	5	4	4
1/2	42	29	23	20	18	16	15	14	13	12	11	10	9	8
5/8	86	59	47	40	36	33	30	28	26	25	22	20	18	17
3/4	150	103	83	71	63	57	52	49	46	43	38	35	32	30
7/8	212	146	117	100	89	81	74	69	65	61	54	49	45	42

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

TABLE C402.3(14)
MAXIMUM CAPACITY OF SEMI-RIGID TUBING IN CUBIC FEET OF GAS PER HOUR FOR GAS PRESSURES OF 0.5 PSI OR LESS AND A PRESSURE DROP OF 0.5-INCH WATER COLUMN
(Based on a 0.60 Specific Gravity Gas)

OUTSIDER DIAMETER (inch)	LENGTH OF TUBING (feet)													
	10	20	30	40	50	60	70	80	90	100	125	150	175	200
3/8	27	18	15	13	11	10	9	9	8	8	7	6	6	5
1/2	56	38	31	26	23	21	19	18	17	16	14	13	12	11
5/8	113	78	62	53	47	43	39	37	34	33	29	26	24	22
3/4	197	136	109	93	83	75	69	64	60	57	50	46	42	39
7/8	280	193	155	132	117	106	98	91	85	81	71	65	60	55

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

TABLE C402.3(15)
MAXIMUM CAPACITY OF SEMI-RIGID TUBING IN CUBIC FEET OF GAS PER HOUR FOR GAS PRESSURES OF 0.5 PSI OR LESS AND A PRESSURE DROP OF 1.0-INCH WATER COLUMN
(Based on a 0.60 Specific Gravity Gas)

USE THIS TABLE TO SIZE TUBING FROM HOUSE LINE REGULATOR TO THE APPLIANCE. DIAMETER: INSIDE (OUTSIDE)							
Length (feet)	1/4 in. (0.315 in.)	3/8 in. (0.430 in.)	1/2 in. (0.545 in.)	5/8 in. (0.666 in.)	3/4 in. (0.785 in.)	1 in. (1.025 in.)	1 1/4 in. (1.265 in.)
10	42	95	177	300	461	928	1,612
15	34	76	142	241	370	745	1,294
20	29	65	122	206	317	638	1,108
30	23	52	98	165	255	512	890
40	20	45	84	142	218	439	761
50	18	40	74	125	193	389	675
60	16	36	67	114	175	352	611
70	15	33	62	105	161	324	563
80	14	31	57	97	150	301	523
90	13	29	54	91	140	283	491
100	12	27	51	86	133	267	464
125	11	24	45	76	118	237	411
150	10	22	41	69	107	215	372
175	9	20	38	64	98	197	343
200	8	19	35	59	91	184	319
250	7	17	31	53	81	163	283
300	7	15	28	48	73	147	256

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

TABLE C402.3(16)
MAXIMUM CAPACITY OF SEMI-RIGID TUBING IN CUBIC FEET PER HOUR FOR A GAS PRESSURE OF 2 PSI OR LESS AND A PRESSURE DROP OF 17-INCH WATER COLUMN
(Based on a 0.60 Specific Gravity Gas)

	DIAMETER: INSIDE (OUTSIDE)						
Length (feet)	1/4 in. (0.315 in.)	3/8 in. (0.430 in.)	1/2 in. (0.545 in.)	5/8 in. (0.666 in.)	3/4 in. (0.785 in.)	1 in. (1.025 in.)	1 1/4 in. (1.265 in.)
10	201	454	845	1,435	2,200	4,428	7,690
15	161	364	678	1,152	1,766	3,556	6,175
20	138	312	581	986	1,512	3,044	5,285
30	111	250	466	792	1,214	2,444	4,244
40	95	214	399	678	1,039	2,092	3,632
50	84	190	354	601	921	1,854	3,219
60	76	172	320	544	834	1,680	2,917
70	70	158	295	501	768	1,545	2,684
80	65	147	274	466	714	1,438	2,496
90	61	139	257	437	670	1,349	2,342
100	58	131	243	413	633	1,274	2,213
125	51	116	215	366	561	1,129	1,961
150	46	105	195	332	508	1,023	1,777
175	43	96	180	305	468	941	1,635
200	40	90	167	284	435	876	1,521
250	35	80	148	251	386	776	1,348
300	32	72	134	228	349	703	1,121

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

TABLE C402.3(17)
MAXIMUM CAPACITY OF SEMI-RIGID TUBING IN CUBIC FEET OF GAS PER HOUR FOR A GAS PRESSURE OF 2.0 PSI OR LESS AND A PRESSURE DROP OF 1.0 PSI
(Based on a 0.6 Specific Gravity Gas)

NOMINAL TUBING DIAMETER INSIDE (inches)	INTERNAL DIAMETER (inches)	LENGTH OF TUBING (feet)																	
		5	10	15	20	30	40	50	60	70	80	90	100	125	150	175	200	250	300
1/4	0.315	459	306	242	204	163	139	122	110	100	93	87	82	72	65	59	54	49	43
3/8	0.430	1,071	722	569	484	382	323	285	255	234	217	204	191	168	151	139	124	119	102
1/2	0.545	2,040	1,385	1,088	918	731	620	548	493	450	416	391	365	323	289	268	246	217	195
5/8	0.666	3,527	2,363	1,827	1,581	1,258	1,062	935	850	773	722	671	629	552	497	459	425	374	336
3/4	0.785	5,524	3,697	2,932	2,507	1,955	1,700	1,487	1,326	1,215	1,130	1,045	986	871	782	718	671	586	527
1	1.025	8,923	6,459	5,269	4,589	3,739	3,229	2,847	2,592	2,380	2,252	2,125	1,997	1,785	1,615	1,530	1,445	1,275	1,147
1 1/4	1.265	17,847	12,748	10,198	8,923	7,309	6,374	5,694	5,184	4,759	4,419	4,164	3,994	3,627	3,229	3,017	2,804	2,507	2,295
1 1/2	1.505	26,345	18,696	15,297	12,748	11,048	9,348	8,328	7,649	6,969	6,544	6,119	5,779	5,184	4,759	4,419	4,164	3,654	3,399
2	1.985	49,291	34,843	28,894	24,645	20,396	16,997	15,297	14,447	12,748	11,898	11,473	10,623	9,603	8,838	8,243	7,649	6,884	6,289
2 1/2	2.465	76,485	54,390	44,192	38,243	30,594	27,195	23,795	22,096	20,396	18,696	17,847	16,997	15,297	13,597	13,172	11,898	10,623	9,773

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

TABLE C402.3(18)
MAXIMUM CAPACITY OF SEMI-RIGID TUBING IN CUBIC FEET OF GAS PER HOUR FOR A GAS PRESSURE OF 5.0 PSI OR LESS AND A PRESSURE DROP OF 3.5 PSI
(Based on a 0.60 Specific Gravity Gas)

NOMINAL TUBING DIAMETER INSIDE (inches)	INTERNAL DIAMETER (Inches)	LENGTH OF TUBING (feet)																	
		5	10	15	20	30	40	50	60	70	80	90	100	125	150	175	200	250	300
1/4	0.315	791	527	417	351	281	239	209	190	173	161	149	141	124	111	101	94	85	75
3/8	0.430	1,845	1,245	981	835	659	556	490	439	403	373	351	329	290	261	240	214	205	176
1/2	0.545	3,514	2,387	1,874	1,581	1,259	1,069	944	849	776	717	674	630	556	498	461	425	373	337
5/8	0.666	6,076	4,070	3,148	2,723	2,167	1,830	1,611	1,464	1,332	1,245	1,157	1,083	952	857	791	732	644	578
3/4	0.785	9,517	6,369	5,051	4,319	3,368	2,928	2,562	2,284	2,094	1,947	1,801	1,698	1,501	1,347	1,237	1,142	1,010	906
1	1.025	15,374	11,127	9,078	7,906	6,442	5,564	4,905	4,466	4,100	3,880	3,660	3,441	3,075	2,782	2,635	2,489	2,196	1,977
1 1/4	1.265	30,747	21,962	17,570	15,374	12,592	10,981	9,810	8,931	8,199	7,614	7,174	6,881	6,076	5,564	5,198	4,832	4,319	3,853
1 1/2	1.505	45,388	32,211	26,355	21,962	19,034	16,106	14,349	13,177	12,006	11,274	10,542	9,956	8,931	8,199	7,614	7,174	6,296	5,857
2	1.985	84,920	60,030	49,781	42,460	35,139	29,283	26,356	24,890	21,962	20,498	19,766	18,302	16,545	15,227	14,202	13,177	11,860	10,835
2 1/2	2.465	131,773	93,705	76,135	65,886	52,709	46,853	40,996	38,068	35,139	32,211	30,747	29,283	26,355	23,426	22,694	20,498	18,302	16,838

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

TABLE C402.3(19)
MAXIMUM CAPACITY OF CSST IN CUBIC FEET PER HOUR FOR GAS PRESSURE OF 0.5 PSI OR LESS AND A PRESSURE DROP OF 0.5-INCH WATER COLUMN[a]
(Based on a 0.60 Specific Gravity Gas)

EHD[b] FLOW DESIGNATION	LENGTH OF TUBING (feet)																
	5	10	15	20	25	30	40	50	60	70	80	90	100	150	200	250	300
13	46	32	25	22	19	18	15	13	12	11	10	10	9	7	6	5	5
15	63	44	35	31	27	25	21	19	17	16	15	14	13	10	9	8	7
18	115	82	66	58	52	47	41	37	34	31	29	28	26	20	18	16	15
19	134	95	77	67	60	55	47	42	38	36	33	32	30	23	21	19	17
23	225	161	132	116	104	96	83	75	68	63	60	57	54	42	38	34	32
25	270	192	157	137	122	112	97	87	80	74	69	65	62	48	44	39	36
30	471	330	267	231	206	188	162	144	131	121	113	107	101	78	71	63	57
31	546	383	310	269	240	218	188	168	153	141	132	125	118	91	82	74	67

For SI: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 m^3/h, 1 pound per square inch = 6.895 kPa, 1-inch water column = 0.2488 kPa, 1 degree = 0.01745 rad.

a. 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.

b. EHD—Equivalent Hydraulic Diameter—A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

TABLE C402.3(20)
MAXIMUM CAPACITY OF CSST IN CUBIC FEET PER HOUR FOR A GAS PRESSURE OF 0.5 PSI OR LESS AND A PRESSURE DROP OF 3-INCH WATER COLUMN[a]
(Based on a 0.60 Specific Gravity Gas)

EHD[b] FLOW DESIGNATION	TUBING LENGTH (feet)																
	5	10	15	20	25	30	40	50	60	70	80	90	100	150	200	250	300
13	120	83	67	57	51	46	39	35	32	29	27	26	24	19	17	15	13
15	160	112	90	78	69	63	54	48	44	41	38	36	34	27	23	21	19
18	277	197	161	140	125	115	100	89	82	76	71	67	63	52	45	40	37
19	327	231	189	164	147	134	116	104	95	88	82	77	73	60	52	46	42
23	529	380	313	273	245	225	196	176	161	150	141	133	126	104	91	82	75
25	649	462	379	329	295	270	234	210	192	178	167	157	149	122	106	95	87
30	1,182	828	673	580	518	471	407	363	330	306	285	268	254	206	178	159	144
31	1,365	958	778	672	599	546	471	421	383	355	331	311	295	240	207	184	168

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

a. 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.

b. EHD—Equivalent Hydraulic Diameter—A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

TABLE C402.3(21)
MAXIMUM CAPACITY OF CSST IN CUBIC FEET PER HOUR FOR A GAS PRESSURE OF 0.5 PSI OR LESS AND A PRESSURE DROP OF 6-INCH WATER COLUMN[a]
(Based on a 0.60 Specific Gravity Gas)

EHD[b] FLOW DESIGNATION	TUBING LENGTH (feet)																
	5	10	15	20	25	30	40	50	60	70	80	90	100	150	200	250	300
13	173	120	96	83	74	67	57	51	46	42	39	37	35	28	24	21	19
15	229	160	130	112	99	90	78	69	63	58	54	51	48	39	34	30	27
18	389	277	227	197	176	161	140	125	115	106	100	94	89	73	63	57	52
19	461	327	267	231	207	189	164	147	134	124	116	109	104	85	73	66	60
23	737	529	436	380	342	313	273	245	225	209	196	185	176	145	126	114	104
25	911	649	532	462	414	379	329	295	270	250	234	221	210	172	149	134	122
30	1,687	1,182	960	828	739	673	580	518	471	435	407	383	363	294	254	226	206
31	1,946	1,365	1,110	958	855	778	672	599	546	505	471	444	421	342	295	263	240

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

a. 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.

b. EHD—Equivalent Hydraulic Diameter—A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

TABLE C402.3(22)
MAXIMUM CAPACITY OF CSST IN CUBIC FEET PER HOUR FOR A GAS PRESSURE OF 2 PSI AND A PRESSURE DROP OF 1 PSI[a]
(Based on a 0.60 Specific Gravity Gas)

EHD[b] FLOW DESIGNATION	TUBING LENGTH (feet)													
	10	25	30	40	50	75	80	110	150	200	250	300	400	500
13	270	166	151	129	115	93	89	79	64	55	49	44	38	34
15	353	220	200	172	154	124	120	107	87	75	67	61	52	46
18	587	374	342	297	266	218	211	189	155	135	121	110	96	86
19	700	444	405	351	314	257	249	222	182	157	141	129	111	100
23	1,098	709	650	567	510	420	407	366	302	263	236	217	189	170
25	1,372	876	801	696	624	512	496	445	364	317	284	260	225	202
30	2,592	1,620	1,475	1,273	1,135	922	892	795	646	557	497	453	390	348
31	2,986	1,869	1,703	1,470	1,311	1,066	1,031	920	748	645	576	525	453	404

Table does not include effect of pressure drop across line regulator. If regulator loss exceeds $^3/_4$ 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.

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

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

a. 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.

b. EHD—Equivalent Hydraulic Diameter—A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

TABLE C402.3(23)
MAXIMUM CAPACITY OF CSST IN CUBIC FEET PER HOUR FOR A GAS PRESSURE OF 5 PSI AND A PRESSURE DROP OF 3.5 PSI[a]
(Based on a 0.60 Specific Gravity Gas)

EHD[b] FLOW DESIGNATION	TUBING LENGTH (feet)													
	10	25	30	40	50	75	80	110	150	200	250	300	400	500
13	523	322	292	251	223	180	174	154	124	107	95	86	74	66
15	674	420	382	329	293	238	230	205	166	143	128	116	100	89
18	1,084	691	632	549	492	403	391	350	287	249	223	204	177	159
19	1,304	827	755	654	586	479	463	415	339	294	263	240	208	186
23	1,995	1,289	1,181	1,031	926	763	740	665	548	478	430	394	343	309
25	2,530	1,616	1,478	1,284	1,151	944	915	820	672	584	524	479	416	373
30	4,923	3,077	2,803	2,418	2,157	1,752	1,694	1,511	1,228	1,060	945	860	742	662
31	5,959	3,543	3,228	2,786	2,486	2,021	1,955	1,744	1,418	1,224	1,092	995	858	766

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.

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

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

a. 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/bends.

b. EHD—Equivalent Hydraulic Diameter—A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

TABLE C402.3(24)
MULTIPLIERS TO BE USED WITH TABLES C402(1) THROUGH C402(12) WHEN THE SPECIFIC GRAVITY OF THE GAS IS OTHER THAN 0.60

SPECIFIC GRAVITY	MULTIPLIER	SPECIFIC GRAVITY	MULTIPLIER
.35	1.31	1.00	.78
.40	1.23	1.10	.74
.45	1.16	1.20	.71
.50	1.10	1.30	.68
.55	1.04	1.40	.66
.60	1.00	1.50	.63
.65	.96	1.60	.61
.70	.93	1.70	.59
.75	.90	1.80	.58
.80	.87	1.90	.56
.85	.84	2.00	.55
.90	.82	2.10	.54

TABLE C402.3(25)
PIPE SIZING
Sizing between First Stage (High Pressure Regulator) and Second Stage (Low Pressure Regulator)

Maximum undiluted propane capacities listed are based on a 10 psi first stage setting and 1 psi pressure drop. Capacities in thousands of Btu per hour.

PIPE LENGTH (feet)	SCHEDULE 40 PIPE SIZE 1 psi DROP								
	1/2 in. 0.622	3/4 in. 0.824	1 in. 1.049	1 1/4 in. 1.38	1 1/2 in. 1.61	2 in. 2.067	3 in. 3.068	3 1/2 in. 3.548	4 in. 4.026
30	1,843	3,854	7,259	14,904	22,331	43,008	121,180	177,425	247,168
40	1,577	3,298	6,213	12,756	19,113	36,809	103,714	151,853	211,544
50	1,398	2,923	5,507	11,306	16,939	32,623	91,920	134,585	187,487
60	1,267	2,649	4,989	10,244	15,348	29,559	83,286	121,943	169,877
70	1,165	2,437	4,590	9,424	14,120	27,194	76,622	112,186	156,285
80	1,084	2,267	4,270	8,767	13,136	25,299	71,282	104,368	145,393
90	1,017	2,127	4,007	8,226	12,325	23,737	66,882	97,925	136,417
100	961	2,009	3,785	7,770	11,642	22,422	63,176	92,499	128,859
150	772	1,613	3,039	6,240	9,349	18,005	50,733	74,280	103,478
200	660	1,381	2,601	5,340	8,002	15,410	43,421	63,574	88,564
250	585	1,224	2,305	4,733	7,092	13,658	38,483	56,345	78,493
300	530	1,109	2,089	4,289	6,426	12,375	34,868	51,052	71,120
350	488	1,020	1,922	3,945	5,911	11,385	32,078	46,967	65,430
400	454	949	1,788	3,670	5,499	10,591	29,843	43,694	60,870
450	426	890	1,677	3,444	5,160	9,938	28,000	40,997	57,112
500	402	841	1,584	3,253	4,874	9,387	26,449	38,725	53,948
600	364	762	1,436	2,948	4,416	8,505	23,965	35,088	48,880
700	335	701	1,321	2,712	4,063	7,825	22,047	32,280	44,969
800	312	652	1,229	2,523	3,780	7,279	20,511	30,031	41,835
900	293	612	1,153	2,367	3,546	6,830	19,245	28,177	39,253
1,000	276	578	1,089	2,236	3,350	6,452	18,178	26,616	37,078
1,500	222	464	875	1,795	2,690	5,181	14,598	21,373	29,775
2,000	190	397	748	1,537	2,302	4,434	12,494	18,293	25,483

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

TABLE C402.3(26)
PIPE SIZING
Sizing between Single or Second Stage (Low Pressure Regulator) and Appliance

Maximum undiluted propane capacities listed are based on 11-inch water column setting and a 0.5-inch water column pressure drop. Capacities in thousands of Btu per hour.

PIPE LENGTH (feet)	NOMINAL PIPE SIZE, SCHEDULE 40								
	1/2 in. 0.622	3/4 in. 0.824	1 in. 1.049	1 1/4 in. 1.38	1 1/2 in. 1.61	2 in. 2.067	3 in. 3.068	3 1/2 in. 3.548	4 in. 4.026
10	291	608	1,146	2,353	3,525	6,789	19,130	28,008	39,018
20	200	418	788	1,617	2,423	4,666	13,148	19,250	26,817
30	161	336	632	1,299	1,946	3,747	10,558	15,458	21,535
40	137	287	541	1,111	1,665	3,207	9,036	13,230	18,431
50	122	255	480	985	1,476	2,842	8,009	11,726	16,335
60	110	231	435	892	1,337	2,575	7,256	10,625	14,801
80	94	198	372	764	1,144	2,204	6,211	9,093	12,668
100	84	175	330	677	1,014	1,954	5,504	8,059	11,227
125	74	155	292	600	899	1,731	4,878	7,143	9,950
150	67	141	265	544	815	1,569	4,420	6,472	9,016
200	58	120	227	465	697	1,343	3,783	5,539	7,716
250	51	107	201	412	618	1,190	3,353	4,909	6,839
300	46	97	182	374	560	1,078	3,038	4,448	6,196
350	43	89	167	344	515	992	2,795	4,092	5,701
400	40	83	156	320	479	923	2,600	3,807	5,303

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

TABLE C402.3(27)
COPPER TUBE SIZING
Sizing between First Stage (High Pressure Regulator) and Second Stage (Low Pressure Regulator)

Maximum undiluted propane capacities listed are based on a 10-psi first stage setting and 1-psi drop. Capacities in thousands of Btu per hour.

TUBING LENGTH (feet)	OUTSIDE DIAMETER COPPER TUBING, TYPE L				
	3/8 in. 0.315	1/2 in. 0.430	5/8 in. 0.545	3/4 in. 0.666	7/8 in. 0.785
30	309	700	1,303	2,205	3,394
40	265	599	1,115	1,887	2,904
50	235	531	988	1,672	2,574
60	213	481	896	1,515	2,332
70	196	443	824	1,394	2,146
80	182	412	767	1,297	1,996
90	171	386	719	1,217	1,873
100	161	365	679	1,149	1,769
150	130	293	546	923	1,421
200	111	251	467	790	1,216
250	90	222	414	700	1,078
300	89	201	375	634	976
350	82	185	345	584	898
400	76	172	321	543	836
450	71	162	301	509	784
500	68	153	284	481	741
600	61	138	258	436	671
700	56	127	237	401	617
800	52	118	221	373	574
900	49	111	207	350	539
1,000	46	105	195	331	509
1,500	37	84	157	266	409
2,000	32	72	134	227	350

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

TABLE C402.3(28)
COPPER TUBE SIZING
Sizing between Single or Second Stage (Low Pressure Regulator) and Appliance

Maximum undiluted propane capacities are based on 11-inch water column setting and a 0.5-inch water column pressure drop. Capacities in thousands of Btu per hour.

TUBING LENGTH (feet)	OUTSIDE DIAMETER COPPER TUBING, TYPE L				
	3/8 in. 0.315	1/2 in. 0.430	5/8 in. 0.545	3/4 in. 0.666	7/8 in. 0.785
10	49	110	206	348	536
20	34	76	141	239	368
30	27	61	114	192	296
40	23	52	97	164	253
50	20	46	86	146	224
60	19	42	78	132	203
80	16	36	67	113	174
100	14	32	59	100	154
125	12	28	52	89	137
150	11	26	48	80	124
200	10	22	41	69	106
250	9	19	36	61	94
300	8	18	33	55	85
350	7	16	30	51	78
400	7	15	28	47	73

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

TABLE C402.3(29)
MAXIMUM CAPACITY OF CSST IN THOUSANDS OF BTU PER HOUR OF UNDILUTED LIQUEFIED PETROLEUM GASES AT A PRESSURE OF 11-INCH WATER COLUMN AND A PRESSURE DROP OF 0.5 INCH WATER COLUMN[a]
(Based on a 1.52 Specific Gravity Gas)

EHD[b] FLOW DESIGNATION	LENGTH OF TUBING (feet)																
	5	10	15	20	25	30	40	50	60	70	80	90	100	150	200	250	300
13	72	50	39	34	30	28	23	20	19	17	15	15	14	11	9	8	8
15	99	69	55	49	42	39	33	30	26	25	23	22	20	15	14	12	11
18	181	129	104	91	82	74	64	58	53	49	45	44	41	31	28	25	23
19	211	150	121	106	94	87	74	66	60	57	52	50	47	36	33	30	26
23	355	254	208	183	164	151	131	118	107	99	94	90	85	66	60	53	50
25	426	303	248	216	192	177	153	137	126	117	109	102	98	75	69	61	57
30	744	521	422	365	325	297	256	227	207	191	178	169	159	123	112	99	90
31	863	605	490	425	379	344	297	265	241	222	208	197	186	143	129	117	107

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

a. 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.

b. EHD—Equivalent Hydraulic Diameter—A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

TABLE C402.3(30)
MAXIMUM CAPACITY OF CSST IN THOUSANDS OF BTU PER HOUR OF UNDILUTED LIQUEFIED PETROLEUM GASES AT A PRESSURE OF 2 PSI AND A PRESSURE DROP OF 1 PSI

(Based on a 1.52 Specific Gravity Gas)

EHD[b] FLOW DESIGNATION	LENGTH OF TUBING (feet)													
	10	25	30	40	50	75	80	110	150	200	250	300	400	500
13	426	262	238	203	181	147	140	124	101	86	77	69	60	53
15	558	347	316	271	243	196	189	169	137	118	105	96	82	72
18	927	591	540	469	420	344	333	298	245	213	191	173	151	135
19	1,106	701	640	554	496	406	393	350	287	248	222	203	175	158
23	1,735	1,120	1,027	896	806	663	643	578	477	415	373	343	298	268
25	2,168	1,384	1,266	1,100	986	809	768	703	575	501	448	411	355	319
30	4,097	2,560	2,331	2,012	1,794	1,457	1,410	1,256	1,021	880	785	716	616	550
31	4,720	2,954	2,692	2,323	2,072	1,685	1,629	1,454	1,182	1,019	910	829	716	638

Table does not include effect of pressure drop across the line regulator. If regulator loss exceeds $^1/_2$ psi (based on 13 inches water column 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.

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

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

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

b. EHD—Equivalent Hydraulic Diameter—A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

TABLE C402.3(31)
MAXIMUM CAPACITY OF CSST IN THOUSANDS OF BTU PER HOUR OF UNDILUTED LIQUEFIED PETROLEUM GASES AT A PRESSURE OF 5 PSI AND A PRESSURE DROP OF 3.5 PSI[a]

(Based on a 1.52 Specific Gravity Gas)

EHD[b] FLOW DESIGNATION	LENGTH OF TUBING (feet)													
	10	25	30	40	50	75	80	100	150	200	250	300	400	500
13	826	509	461	396	352	284	275	243	196	169	150	136	117	104
15	1,065	664	603	520	463	376	363	324	262	226	202	183	156	140
18	1,713	1,092	999	867	777	637	618	553	453	393	352	322	279	251
19	2,061	1,307	1,193	1,033	926	757	731	656	535	464	415	379	328	294
23	3,153	2,037	1,866	1,629	1,463	1,206	1,169	1,051	866	755	679	622	542	488
25	3,999	2,554	2,336	2,029	1,819	1,492	1,446	1,296	1,062	923	828	757	657	589
30	7,829	4,864	4,430	3,822	3,409	2,769	2,677	2,388	1,941	1,675	1,493	1,359	1,173	1,046
31	8,945	5,600	5,102	4,404	3,929	3,194	3,090	2,756	2,241	1,934	1,726	1,572	1,356	1,210

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.

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

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

a. 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.

b. EHD—Equivalent Hydraulic Diameter—A measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

TABLE C402.3(32)
POLYETHYLENE PLASTIC PIPE SIZING
Sizing Between First-stage and Second-stage Regulator

Maximum undiluted propane capacities listed are based on 10 psi first stage setting and 1 psi pressure drop. Capacities in thousands of Btu per hour.

PLASTIC PIPE LENGTH (feet)	PLASTIC PIPE NOMINAL OUTSIDE DIAMETER (IPS) (dimensions in parentheses are inside diameter)					
	1/2 in. SDR 9.33 (.660)	3/4 in. SDR 11.0 (.860)	1 in. SDR 11.00 (1.077)	1 1/4 in. SDR 10.00 (1.328)	1 1/2 in. SDR 11.00 (1.554)	2 in. SDR 11.00 (1.943)
30	2,143	4,292	7,744	13,416	20,260	36,402
40	1,835	3,673	6,628	11,482	17,340	31,155
50	1,626	3,256	5,874	10,176	15,368	27,612
60	1,473	2,950	5,322	9,220	13,924	25,019
70	1,355	2,714	4,896	8,483	12,810	23,017
80	1,261	2,525	4,555	7,891	11,918	21,413
90	1,183	2,369	4,274	7,404	11,182	20,091
100	1,117	2,238	4,037	6,994	10,562	18,978
125	990	1,983	3,578	6,199	9,361	16,820
150	897	1,797	3,242	5,616	8,482	15,240
175	826	1,653	2,983	5,167	7,803	14,020
200	678	1,539	2,775	4,807	7,259	13,043
225	721	1,443	2,603	4,510	6,811	12,238
250	681	1,363	2,459	4,260	6,434	11,560
275	646	1,294	2,336	4,046	6,111	10,979
300	617	1,235	2,228	3,860	5,830	10,474
350	567	1,136	2,050	3,551	5,363	9,636
400	528	1,057	1,907	3,304	4,989	8,965
450	495	992	1,789	3,100	4,681	8,411
500	468	937	1,690	2,928	4,422	7,945
600	424	849	1,531	2,653	4,007	7,199
700	390	781	1,409	2,441	3,686	6,623
800	363	726	1,311	2,271	3,429	6,161
900	340	682	1,230	2,131	3,217	5,781
1,000	322	644	1,162	2,012	3,039	5,461
1,500	258	517	933	1,616	2,441	4,385
2,000	221	443	798	1,383	2,089	3,753

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

TABLE C402.3(33)
POLYETHYLENE PLASTIC TUBE SIZING
Sizing Between Single or Second Stage Regulator and Building

Maximum undiluted propane capacities listed are based on 10 psi first stage setting and 1 psi pressure drop. Capacities in thousands of Btu per hour.

PLASTIC TUBING LENGTH (feet)	PLASTIC TUBING SIZE (CTS) (dimensions in parentheses are inside diameter)	
	$^1/_2$ in. CTS SDR 7.00 (0.445)	1 in. CTS SDR 11.00 (0.927)
30	762	5,225
40	653	4,472
50	578	3,964
60	524	3,591
70	482	3,304
80	448	3,074
90	421	2,884
100	397	2,724
125	352	2,414
150	319	2,188
175	294	2,013
200	273	1,872
225	256	1,757
250	242	1,659
275	230	1,576
300	219	1,503
350	202	1,383
400	188	1,287
450	176	1,207
500	166	1,140
600	151	1,033
700	139	951
800	129	884
900	121	830
1,000	114	784
1,500	92	629
2,000	79	539

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

TABLE C402.3(34)
POLYETHYLENE PLASTIC TUBE SIZING
Sizing Between Single or Second Stage Regulator and Building

Maximum undiluted propane capacities listed are based on 11-inch water column setting and a 0.5-inch water column pressure drop. Capacities in thousands of Btu per hour.

PLASTIC TUBING LENGTH (feet)	PLASTIC TUBING SIZE (CTS) (dimensions in parentheses are inside diameter)	
	$^1/_2$ in. CTS SDR 7.00 (0.445)	1 in. CTS SDR 11.00 (0.927)
10	121	829
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 cubic foot per hour = 0.0283 m^3/h, 1 pound per square inch = 6.895 kPa.

SECTION C403
PIPING MATERIALS

C403.1 Material application. Materials and components conforming to standards or specifications listed herein and those approved by the code official shall be permitted to be used for the appropriate applications, as prescribed and limited by this code.

C403.2 Used materials. Pipe, fittings, valves, or other materials shall not be used again unless they are free of foreign materials and have been ascertained to be adequate for the service intended.

C403.3 Metallic pipe. Metallic pipe shall comply with Sections C403.3.1 through C403.3.4.

C403.3.1 Cast iron. Cast-iron pipe shall not be used.

C403.3.2 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 B36.10, 10M
2. ASTM A53; or
3. ASTM A106.

C403.3.3 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, or aluminum alloy pipe in iron pipe sizes shall be permitted to be used with gases not corrosive to such material.

C403.3.4 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.

C403.4 Metallic tubing. Seamless copper, aluminum alloy, or steel tubing shall be permitted to be used with gases not corrosive to such material.

C403.4.1 Steel tubing. Steel tubing shall comply with ASTM A539 or ASTM A254.

C403.4.2 Copper tubing. Copper tubing shall comply with Standard Type K or L of ASTM B88 or ASTM B280. 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).

C403.4.3 Aluminum tubing. Aluminum alloy tubing shall comply with ASTM B210 or ASTM B241. Aluminum-alloy tubing shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation, or is subject to repeated wettings by such liquids as water, detergent, or sewage. Aluminum-alloy tubing shall not be used in exterior locations or underground.

C403.4.4 Corrugated stainless steel tubing. Corrugated stainless steel tubing shall be tested and listed in compliance with the construction, installation, and performance requirements of ANSI/AGA LC 1.

C403.5 Plastic pipe, tubing, and fittings. Plastic pipe, tubing, and fittings shall be used outside underground only and shall conform with ASTM D2513. Pipe shall be marked "gas" and "ASTM D2513."

C403.5.1 Anodeless risers. Plastic pipe, tubing, 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 by the manufacturer and shall be designed 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 by the U.S. Department of Transportation, Code of Federal Regulations, Title 49, Part 192.283(b).

C403.5.2 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.

C403.6 Workmanship and defects. Pipe or tubing and fittings shall be clear and free from cutting burrs and defects in structure or threading, and shall be thoroughly brushed, and chip and scale blown. Defects in pipe or tubing or fittings shall not be repaired. Defective pipe, tubing, and fittings shall be replaced. (See Section C406.1.2.)

C403.7 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.

C403.8 Metallic pipe threads. Metallic pipe and fitting threads shall be taper pipe threads and shall comply with ASME B1.20.1.

C403.8.1 Damaged threads. Pipe with threads that are stripped, chipped, corroded, or otherwise damaged shall not be used. If a weld opens during the operation of cutting or threading, that portion of the pipe shall not be used.

C403.8.2 Number of threads. Field threading of metallic pipe shall be in accordance with Table C403.8.2.

C403.8.3 Thread compounds. Thread (joint) compounds (pipe dope) shall be resistant to the action of liquefied petroleum gas or to any other chemical constituents of the gases to be conducted through the piping.

TABLE C403.8.2
SPECIFICATIONS FOR THREADING METALLIC PIPE

IRON PIPE SIZE (inches)	APPROXIMATE LENGTH OF THREADED PORTION	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.

C403.9 Metallic piping joints and fittings. The type of piping joint used shall be suitable for the pressure-temperature conditions and shall be selected giving consideration to joint tightness and mechanical strength under the service conditions. The joint shall be able to sustain the maximum end force due to the internal pressure and any additional forces due to temperature expansion or contraction, vibration, fatigue, or to the weight of the pipe and its contents.

C403.9.1 Pipe joints. Pipe joints shall be threaded, flanged, or welded, and nonferrous pipe shall be permitted to also be brazed with materials having a melting point in excess of 1,000°F (538°C). Brazing alloys shall not contain more than 0.05 percent phosphorus.

C403.9.2 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.

C403.9.3 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.

C403.9.4 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 to be used.
   - 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. Brass, bronze, or copper fittings. Fittings, if exposed to soil, shall have a minimum 80 percent copper content.
7. Aluminum alloy fittings. Threads shall not form the joint seal.
8. Zinc-aluminum alloy fittings. Fittings shall not be used in systems containing flammable gas-air mixtures.
9. Special fittings. Fittings such as couplings, proprietary type joints, saddle, gland-type compression fittings, flared, flareless, or compression type tubing fittings shall be permitted to be used provided they are used within the fitting manufacturers' 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 approved.

C403.10 Plastic piping, joints and fittings. Plastic pipe, tubing, and fittings shall be joined in accordance with the manufacturers' 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 D2513."
3. Where compression type mechanical joints are used, the gasket material in the fitting shall be compatible with the plastic piping and with the gas distributed by the system. An internal tubular rigid stiffener shall be used in conjunction with the fitting. The stiffener shall be flush with the end of the pipe or tubing and shall extend at least to the outside end of the pipe or tubing and shall extend at least to the outside end of the compression fitting when installed. The stiffener shall be free of rough or sharp edges and shall not be a force fit in the plastic. Split tubular stiffeners shall not be used.
4. Plastic piping joints and fittings for use in liquefied petroleum gas piping systems shall be in accordance with NFPA 58.

C403.11 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.

C403.11.1 Flange facings. Standard facings shall be permitted for use under this Code. Where 150-pound steel flanges are bolted to Class 125 cast-iron flanges, the raised face on the steel flange shall be removed.

C403.11.2 Lapped flanges. Lapped flanges shall be permitted to be used only aboveground or in exposed locations accessible for inspection.

C403.12 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 C404
PIPING SYSTEM INSTALLATION

C404.1 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.

C404.2 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.

C404.3 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.

C404.4 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.

C404.5 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 (25.4 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.

C404.6 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.

C404.7 Aboveground piping outdoors. Piping installed aboveground outdoors 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.

C404.8 Corrosion and covering protection. Nonmetallic gas piping and coated and cathodically protected piping shall have a minimum of 18 inches (457 mm) of earth cover or other equivalent protection. Risers, including prefabricated risers inserted with plastic pipe, shall be metallic and shall be protected in an approved manner to a point at least 6 inches (153 mm) above grade. When a riser connects to plastic pipe underground, the horizontal metallic portion underground shall be at least 30 inches (762 mm) in length before connecting to the plastic service pipe. An approved transition fitting or adapter shall be used where the plastic joins the metallic riser.

Ferrous metals in exposed exterior locations shall be protected from corrosion in a manner approved by the building official after consulting with the gas supplier.

Ferrous pipes installed underground shall not be placed in contact with other metallic objects such as pipes or wires.

Zinc coatings (galvanizing) shall not be deemed adequate protection for piping below grade. Ferrous gas piping installed underground in exterior locations shall be protected from corrosion by either:

C404.8.1 Coated and cathodically protected pipe. All gas pipe protective coatings shall be approved types, machine applied and conform to recognized standards. Field wrapping shall provide equivalent protection and is restricted to those short sections and fittings necessarily stripped for threading or welding. Underground coated and wrapped gas piping shall be cathodically protected with galvanic anodes or rectifiers and electrically isolated from the rest of the system by insulating unions 6 inches (153 mm) above grade.

C404.8.2 Unwrapped (bare) pipe and special covering. Unwrapped ferrous gas piping being installed underground in exterior locations shall be protected from corrosion by being installed within a minimum 6-inch (153 mm) protective bed of sand around the gas piping, the pipe being centrally located within the sand backfill, and all such horizontal piping shall have a minimum of 18 inches (457 mm) of earth cover or other equivalent protection. Underground piping shall be electrically isolated from the rest of the system by insulating unions placed a minimum of 6 inches (153 mm) above grade.

C404.8.3 Electrical isolation of fuel gas piping. Underground ferrous gas piping shall be electrically isolated from the rest of the gas system with listed or approved isolation fittings installed a minimum of 6 inches (153 mm) above grade.

C404.9 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 C404.9.1.

C404.9.1 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, pro-

vided that such installation is approved and is installed in locations not susceptible to physical damage.

C404.10 Trenches. The trench shall be graded so that the pipe has a firm, substantially continuous bearing on the bottom of the trench.

C404.10.1 Underground gas pipe separation. Underground gas piping shall be separated vertically or horizontally from other underground piping as follows:

1. Sewer pipe — not less than 18 inches (457 mm) from any underground sewer line.
2. Water pipe — not less than 12 inches (305 mm) from any underground water line.
3. Drainage pipe — not less than 12 inches (305 mm) from any underground drainage line.

C404.11 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 C404.8.

C404.12 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.

C404.13 Location of outlets. The unthreaded portion of piping outlets shall extend not less than 1 inch (25.4 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.

C404.14 Plastic pipe. The installation of plastic pipe shall comply with C404.14.1 through C404.14.3.

C404.14.1 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:

1. Plastic pipe shall be permitted to terminate aboveground outside of buildings where installed in prefabricated anodeless risers or service head adapter risers that are installed in accordance with that 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.

C404.14.2 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 D2513.

C404.14.3 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.

C404.15 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.

C404.16 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 C406.

SECTION C405
PIPING BENDS AND CHANGES IN DIRECTION

C405.1 General. Changes in direction of pipe shall be permitted to be made by the use of fittings, factory bends, or field bends.

C405.2 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 6 times the outside diameter of the pipe.

C405.3 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.

C405.4 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).

C405.5 Elbows. Factory made welding elbows or transverse segments cut therefrom shall have an arc length measured along the crotch at least 1 inch (25.4 mm) in pipe sizes 2 inches (51 mm) and larger.

SECTION C406
INSPECTION, TESTING AND PURGING

C406.1 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.

C406.1.1 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.

C406.1.1.1 Rough piping inspection. This inspection shall be made after piping authorized by the permit has been installed and before such piping has been covered or concealed or a fixture or appliance has been attached thereto. This inspection shall include a determination that the gas piping size, material and installation meet the requirements of this appendix.

C406.1.1.2 Final piping inspection. This inspection shall be made after piping authorized by the permit has been installed and after all portions thereof which are to be covered or concealed are so concealed and after fixtures, appliances or shutoff valves have been attached thereto.

C406.1.2 Repairs and additions. In the event repairs or additions are made following the pressure test, the affected piping shall be tested.

Exception: Minor repairs or additions, provided the work is inspected and connections are tested with a non corrosive leak-detecting fluid or other leak-detecting methods approved by the code official.

C406.1.3 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 "tell-tale" 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.

C406.1.4 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.

C406.2 Test medium. The test medium shall be air or an inert gas. Oxygen shall not be used.

C406.3 Test preparation. Pipe joints, including welds, shall be left exposed for examination during the test. If the pipe end joints have been previously tested in accordance with this appendix, they shall be permitted to be covered or concealed.

C406.3.1 Expansion joints. Expansion joints shall be provided with temporary restraints, if required, for the additional thrust load under test.

C406.3.2 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.

C406.3.3 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).

C406.3.4 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).

C406.3.5 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.

C406.4 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 due to leakage during the pressure test period. The source of pressure shall be isolated before the pressure tests are made.

C406.4.1 Test pressure. Gas piping systems under 14 inches (3.5 kPa) water column pressure, shall be tested at a pressure of not less than 10 pounds per square inch (69 kPa) gage. Test pressures shall be held for not less than 15 minutes with no perceptible drop in pressure. For welded piping, and for piping carrying gas at pressures exceeding 14 inches water column (3484 Pa) pressure, the test pressure shall be at least 60 pounds per square inch (0.0422 kg/mm^2) for not less than 30 minutes.

Exception: Testing, inspection and purging of gas piping systems performed by using NFPA 54 shall be permitted.

SECTION C407
PIPING SUPPORT

C407.1 General. Piping shall be provided with support in accordance with Section C407.2.

C407.2 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 C415. 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 C408
DRIPS AND SLOPED PIPING

C408.1 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.

C408.2 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.

C408.3 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.

C408.4 Sediment trap. Where a sediment trap is not incorporated as a part of the gas utilization equipment, a sediment trap shall be installed 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 C409
SHUTOFF VALVES

C409.1 General. Piping systems shall be provided with shutoff valves in accordance with this section.

C409.1.1 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 B16.33. Shutoff valves installed in a portion of a piping system operating at 0.5 psig or less shall comply with ANSI Z21.15 or ASME B16.33.

C409.1.2 Prohibited locations. Shutoff valves shall be prohibited in concealed locations and spaces used as plenums.

C409.1.3 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.

C409.2 Meter valve. Every meter shall be equipped with a shutoff valve located on the supply side of the meter.

C409.3 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.

C409.3.1 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.

C409.3.2 Individual buildings. In a common system serving more than one building, shutoff valves shall be installed outdoors at each building.

C409.3.3 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.

C409.4 MP Regulator valves. A listed shutoff valve shall be installed immediately ahead of each MP regulator.

C409.5 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 access. Such valves shall be permanently identified and shall serve no other equipment.

C409.5.1 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 C410
FLOW CONTROLS

C410.1 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.

C410.2 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 C410.3.
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 down stream of the MP regulator outlet. Such tee fitting shall be positioned to allow connection of a pressure measuring instrument.

C410.3 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.

SECTION C411
APPLIANCE CONNECTIONS

C411.1 Connecting appliances. Appliances shall be connected to the piping system by one of the following:

1. Rigid metallic pipe and fittings.
2. Semi-rigid 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. Semi-rigid 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.

C411.1.1 Protection from damage. Connectors and tubing shall be installed so as to be protected against physical damage.

C411.1.2 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 C409.5. 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.

C411.1.3 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 C412
LIQUEFIED PETROLEUM GAS MOTOR VEHICLE FUEL-DISPENSING STATIONS

C412.1 General. Service stations for LP–gas fuel shall be regulated by the fire code.

SECTION C413
COMPRESSED NATURAL GAS MOTOR VEHICLE FUEL–DISPENSING STATIONS

C413.1 General. Service stations for CNG fuel shall be regulated by the fire code.

SECTION C414
SUPPLEMENTAL AND STANDBY GAS SUPPLY

C414.1 Special supplementary gas. Where air, oxygen or other special supplementary gas is introduced into the gas piping system, an approved backflow preventer shall be installed. The backflow preventer shall be on the gas line to the equipment or appliance supplied by the special gas and located between the source of the special gas and the gas meter.

C414.2 Interconnections for stand-by fuels. Where a supplementary gas for stand-by 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 stand-by supply and at the same time shut off the regular supply shall be permitted to be used for this purpose.

SECTION C415
PIPING SUPPORT INTERVALS

C415.1 Interval of support. Piping shall be supported at intervals not exceeding the spacing specified in Table C415.1.

TABLE C415.1
SUPPORT OF PIPING

STEEL PIPE, NOMINAL SIZE OF PIPE (inches)	SPACING OF SUPPORTS (feet)	NOMINAL SIZE OF TUBING (inch O.D.)	SPACING OF SUPPORTS (feet)
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	8
1 1/4 or larger (vertical)	every floor level		

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

TABLE C416.1
MINIMUM DEMAND FACTORS FOR CALCULATING GAS PIPING SYSTEMS IN MANUFACTURED STRUCTURE PARKS

NUMBER OF MANUFACTURED STRUCTURE LOTS	DEMAND FACTOR Btu/h MANUFACTURED STRUCTURE LOT x 0.293 071 FOR W
1	250,000
2	234,000
3	208,000
4	198,000
5	184,000
6	174,000
7	166,000
8	162,000
9	158,000
10	154,000
11-20	132,000
21-30	124,000
31-40	118,000
41-60	112,000
Over 60	102,000

SECTION C416
FUEL-GAS EQUIPMENT AND INSTALLATIONS IN MANUFACTURED STRUCTURE (MOBILE HOME OR RECREATIONAL VEHICLE) PARKS

C416.1 Required gas supply. The minimum hourly volume of gas required at each manufactured structure (mobile home or recreational vehicle) lot outlet or any section of the manufactured structures park gas-piping system shall be calculated as shown in Table C416.1.

Required gas supply for buildings or other fuel-gas-consuming appliances connected to the manufactured structure park gas-piping system shall be calculated as provided in this code.

C416.2 Mechanical protection. Customer-owned gas outlet risers, regulators, meters, valves or other exposed equipment shall be protected from mechanical damage. Such protection may consist of posts, fencing or other permanent barriers.

Atmospherically controlled regulators shall be installed in such a manner that moisture cannot enter the regulator vent and accumulate above the diaphragm. When the regulator vent may be obstructed by snow or ice, shields, hoods or other suitable devices shall be provided to guard against obstruction of the vent opening.

C416.3 Gas meters. Customer-owned meters shall be installed in ventilated and accessible locations, not closer than 3 feet (914 mm) to sources of ignition.

When meters are installed, they shall not depend on the gas outlet riser for support, but shall be adequately supported by a post or bracket placed on a firm footing, or other approved means providing equivalent support.

C416.4 Gas piping size. The size of each section of natural gas or LP-gas piping systems shall be determined as specified in this appendix.

SECTION C501
GENERAL

C501.1 Scope. This section shall govern the installation, 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, repair and approval of factory-built chimneys, chimney liners, vents and connectors serving appliances burning fuels other than fuel gas shall be regulated by this code. The construction, repair and approval of masonry chimneys shall be regulated by the building code.

C501.2 General. Every appliance shall discharge the products of combustion to the outdoors, except for appliances exempted by Section C501.8.

C501.3 Masonry chimneys. Masonry chimneys shall be constructed in accordance with the building code.

C501.4 Minimum size of chimney or vent. Chimneys and vents shall be sized in accordance with Section C504.

C501.5 Abandoned inlet openings. Abandoned inlet openings in chimneys and vents shall be closed by an approved method.

C501.6 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.

C501.7 Connection to fireplace. Connection of appliances to chimney flues serving fireplaces shall be in accordance with Sections C501.7.1 through C501.7.3.

C501.7.1 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.

C501.7.2 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.

C501.7.3 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.

C501.8 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 Chapter 5, Section 504 of this code.)
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 1 through 11 above are installed so that the aggregate input rating exceeds 20 Btu per hour per cubic foot (207 watts per m^3) 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^3) 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.

C501.9 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.

C501.10 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.

C501.11 Masonry chimneys. Masonry chimneys utilized to vent appliances shall be sized as specified in the manufacturer's installation instructions for the appliances being vented and Section C503.

C501.12 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 C315 or equivalent. Clay flue lining shall be installed in accordance with the 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.).

C501.13 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 C501.12.
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.

C501.14 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.

C501.15 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 C501.15.1 through C501.15.4.

C501.15.1 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 C502.

C501.15.2 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.

C501.15.3 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 lo-

cated not less than 6 inches (152 mm) below the lowest chimney inlet opening. The cleanout shall be provided with a tight-fitting, noncombustible cover.

C501.15.4 Clearances. Chimneys and vents shall have airspace clearance to combustibles in accordance with the building code and the chimney or vent manufacturer's installation instructions. Noncombustible firestopping or fireblocking shall be provided in accordance with the 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 C502
VENTS

C502.1 General. All vents, except as provided in Section C503.7, 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.

C502.2 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 C503.

C502.3 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.

C502.4 Installation. Vent systems shall be sized, installed and terminated in accordance with the vent and appliance manufacturer's installation instructions and Section C503.

C502.5 Support of vents. All portions of vents shall be adequately supported for the design and weight of the materials employed.

SECTION C503
VENTING OF EQUIPMENT

C503.1 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 may condense in the venting system. See Section C202 for the definition of these vented appliance categories.

C503.2 Venting systems required. Except as permitted in Sections C503.2.1 through C503.2.4 and C501.8, all equipment shall be connected to venting systems.

C503.2.1 Ventilating hoods. Ventilating hoods and exhaust systems shall be permitted to be used to vent equipment installed in commercial applications (see Section C503.3.4) and to vent industrial equipment, such as where the process itself requires fume disposal.

C503.2.2 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.

C503.2.3 Direct-vent equipment. Listed direct-vent equipment shall be considered properly vented where installed in accordance with the terms of its listing, the manufacturers' instructions, and Section C503.8, Item 3.

C503.2.4 Equipment with integral vents. Equipment incorporating integral venting means shall be considered properly vented when installed in accordance with its listing, the manufacturers' instructions, and Sections C503.8, Items 1 and 2.

C503.3 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.

C503.3.1 Equipment draft requirements. A venting system shall satisfy the draft requirements of the equipment in accordance with the manufacturers' instructions.

C503.3.2 Design and construction. Gas utilization equipment required to be vented shall be connected to a venting system designed and constructed in accordance with the provisions of Sections C503.4 through C503.15.

C503.3.3 Mechanical Draft Systems. Mechanical draft systems shall comply with the following:

1. Equipment, except incinerators, requiring venting shall be permitted to be vented by means of mechanical draft systems of either forced or induced draft design.
2. 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.
3. Vent connectors serving equipment vented by natural draft shall not be connected into any portion of mechanical draft systems operating under positive pressure.
4. 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.

5. The exit terminals of mechanical draft systems shall be not less than 7 feet (2133 mm) above grade where located adjacent to public walkways and shall be located as specified in Section C503.8, items 1 and 2.
6. Mechanical draft systems shall be installed in accordance with the terms of their listing and the manufacturers' instructions.

C503.3.4 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.

C503.3.5 Circulating air ducts and plenums. No portion of a venting system shall extend into or pass through any circulating air duct or plenum.

C503.4 Type of venting system to be used. The type of venting system to be used shall be in accordance with Table C503.4.

C503.4.1 Plastic piping. Approved plastic piping shall be permitted to be used for venting equipment listed for use with such venting materials.

C503.4.2 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.

C503.5 Masonry, metal, and factory-built chimneys. Masonry, metal and factory-built chimneys shall comply with Sections C503.5.1 through C503.5.10.

C503.5.1 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.

C503.5.2 Metal chimneys. Metal chimneys shall be built and installed in accordance with NFPA 211.

C503.5.3 Masonry chimneys. Masonry chimneys shall be built and installed in accordance with the building code 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 manufacturers' 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 C503.6.6.

TABLE C503.4
TYPE OF VENTING SYSTEM TO BE USED

GAS UTILIZATION EQUIPMENT	TYPE OF VENTING SYSTEM
Listed Category I equipment	Type B gas vent (C503.6)
Listed equipment equipped with draft hood	Chimney (C503.5)
Equipment listed for use with Type B gas vent	Single-wall metal pipe (C503.7) Listed Chimney lining system for gas venting (C503.5.1c). Special Gas Vent listed for this equipment (C503.4.3)
Listed vented wall furnaces	Type B-W gas vent (C503.6, C607)
Category II equipment	As specified or furnished by manufacturers of listed equipment (C503.4.1, C503.4.2)
Category III equipment	As specified or furnished by manufacturers of listed equipment (C503.4.1, C503.4.2)
Category IV equipment	As specified or furnished by manufacturers of listed equipment (C503.4.1, C503.4.2)
Incinerators, indoors	Chimney (C503.5)
Incinerators, outdoors	Single-wall metal pipe (C503.7, C503.7.6)
Equipment that may be converted to use of solid fuel	Chimney (C503.5)
Unlisted combination gas and oil-burning equipment	Chimney (C503.5)
Listed combination gas and oil-burning equipment	Type L vent (C503.6) or chimney (C503.5)
Combination gas and solid-fuel burning equipment	Chimney (C503.5)
Equipment listed for use with chimneys only	Chimney (C503.5)
Unlisted equipment	Chimney (C503.5)
Decorative appliance in vented fireplace	Chimney
Gas-fired toilets	Single-wall metal pipe (C625)
Direct vent equipment	See C503.2.3
Equipment with integral vent	See C503.2.4
Equipment in commercial and industrial installations	Chimney, ventilating hood, and exhaust system (C503.3.4)

C503.5.4 Chimney termination. 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.

C503.5.5 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 in accordance with Section C504 or other approved engineering methods.

Exceptions:

1. As an alternate method of 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.
2. As an alternate method 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.

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 (25.4 mm) larger in equivalent diameter than the diameter of the incinerator flue outlet.

C503.5.6 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 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.

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.

C503.5.6.1 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 the building code or this code, and it shall be suitable for the equipment to be vented.

C503.5.7 Chimney serving equipment burning other fuels. Chimneys serving equipment burning other fuels shall comply with Sections C503.5.7.1 through C503.5.7.4.

C503.5.7.1 Solid fuel-burning appliances. Gas utilization equipment shall not be connected to a chimney flue serving a separate appliance designed to burn solid fuel.

C503.5.7.2 Liquid fuel-burning appliances. Gas utilization equipment and equipment burning liquid fuel shall be permitted to be connected to one chimney flue through separate openings or shall be permitted to be connected through a single opening if joined by a suitable fitting located as close as practical to the chimney. If two or more openings are provided into one chimney flue, they shall be at different levels. If the gas utilization equipment is automatically controlled, it shall be equipped with a safety shutoff device.

C503.5.7.3 Combination gas and solid fuel-burning appliances. A combination gas- and solid fuel-burning appliance equipped with a manual reset device to shut off gas to the main burner in the event of sustained backdraft or flue gas spillage shall be permitted to be connected to a single chimney flue. The chimney flue shall be sized to properly vent the appliance.

C503.5.7.4 Combination gas and oil fuel-burning appliances. A listed combination gas- and oil-burning appliance shall be permitted to be connected to a single chimney flue. The chimney flue shall be sized to properly vent the appliance.

C503.5.8 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 manufacturers' instructions.

C503.5.9 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.

C503.5.10 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.

Exception: The insertion of another liner or vent with-in the chimney as provided in this code and the liner or vent manufacturer's instructions.

C503.6 Gas vents. Gas vents shall comply with sections C503.6.1 through C503.6.12. (See Section C202, Definitions.)

C503.6.1 Installation, general. Gas vents shall be installed in accordance with the terms of their listings and the manufacturers' instructions.

C503.6.2 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.

C503.6.3 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.

C503.6.4 Offsets. Type B and Type L vents shall extend in a generally vertical direction with offsets not exceeding 45 degrees, except that a vent system having not more than one 60-degree offset shall be permitted. Any angle greater than 45 degrees 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 C504 or in accordance with other approved engi-

neering methods. Vents serving Category I fan-assisted appliances shall be installed in accordance with the appliance manufacturers' instructions and Section C504 or other approved engineering methods.

C503.6.5 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 manufacturers' 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."

C503.6.6 Gas vent terminations. A gas vent shall terminate 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 terminated in accordance with Figure C503.6.6, 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).

Exceptions:

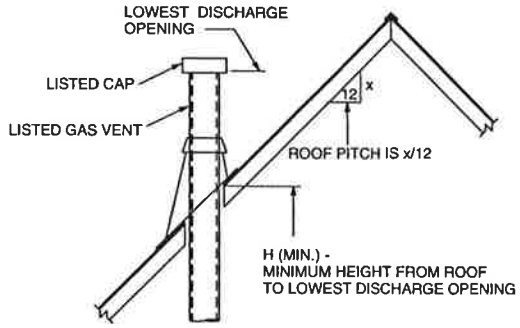
1. Direct vent systems as provided in C503.2.3.
2. Equipment with integral vents as provided in C503.2.4.
3. Mechanical draft systems as provided in C503.3.3.
4. Ventilating hoods and exhaust systems as provided in C503.3.4.

C503.6.7 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.

C503.6.8 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 C503.2.3 and C503.3.3.

C503.6.9 Size of gas vents. Venting systems shall be sized and constructed in accordance with Section C504 or other approved engineering methods and the gas vent and gas equipment manufacturers' instructions.

C503.6.9.1 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 Section C504 or in accordance with sound engineering practice. Category I appliances are either draft hood-equipped or fan-assisted combustion system in design. Different vent design methods are required for draft hood-equipped and fan-assisted combustion system appliances.



ROOF PITCH	H (min) feet
Flat to $^{6}/_{12}$	1.0
$^{6}/_{12}$ 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 C506.6.6
GAS VENT TERMINATION LOCATIONS FOR LISTED CAPS 12 INCHES OR LESS IN SIZE AT LEAST 8 FEET FROM A VERTICAL WALL

Exceptions:

1. As an alternate method 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. Vents serving fan-assisted combustion system appliances shall be sized in accordance with Section C504 or other approved engineering methods.
2. As an alternate method 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 smaller draft hood outlets, nor greater than seven times the smallest draft hood outlet area. Vents serving fan-assisted combustion system appliances, or combinations of fan-assisted combustion system and draft hood-equipped appliances, shall be sized in accordance with Section C504 or other approved engineering methods.

C503.6.9.2 Category II, Category III, and Category IV appliances. The sizing of gas vents for Category II, Category III, and Category IV equipment shall be in accordance with the equipment manufacturers' instructions.

C503.6.10 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.

C503.6.10.1 Equipment separation. All equipment connected to the common vent shall be located in rooms separated from habitable space. Each of these rooms shall have provisions for an adequate supply of combustion, ventilation, and dilution air that is not sup-plied from habitable space. (See Figure C503.6.10.1.)

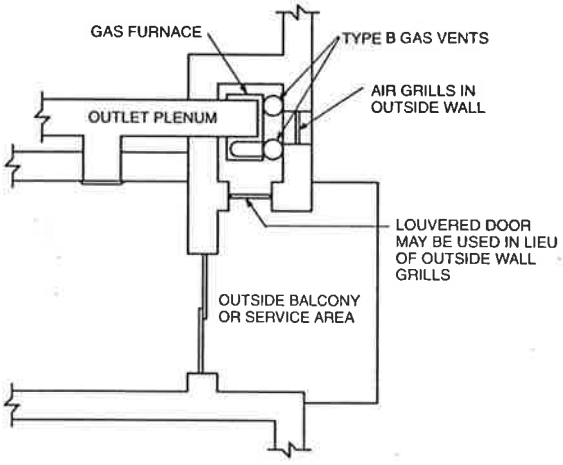


FIGURE C503.6.10.1
PLAN VIEW OF PRACTICAL SEPARATION METHOD FOR MULTISTORY GAS VENTING

C503.6.10.2 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 C504.3(1) and Figures C-B-13 and C-B-14 in Appendix C-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 center-line of the next highest interconnection tee. (See Figure C-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.

C503.6.11 Support of gas vents. Gas vents shall be supported and spaced in accordance with their listings and the manufacturers' instructions.

C503.6.12 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 determination 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."

C503.7 Single-wall metal pipe. Single-wall metal pipe vents shall comply with Sections C503.7.1 through C503.7.12.

C503.7.1 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.

C503.7.2 Cold climate. Uninsulated single-wall metal pipe shall not be used outdoors in cold climates for venting gas utilization equipment.

C503.7.3 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). An approved cap or roof assembly shall be attached to the terminus of a single- wall metal pipe. [Also see Section C503.7.8 item 3.]

C503.7.4 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.

C503.7.5 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 C503.10.16.

C503.7.6 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 C503.10.16. 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.

C503.7.7 Clearances. Minimum clearances from single-wall metal pipe to combustible material shall be in accordance with Table C503.7.7. 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 C308.2.

C503.7.8 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 C504.
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.

C503.7.9 Pipe geometry. Any shaped single-wall metal pipe shall be permitted to be used, provided its equivalent effective area is equal to the effective area of the round pipe for which it is substituted and provided the minimum internal dimension of the pipe is not less than 2 inches (51 mm).

C503.7.10 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.

C503.7.11 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.

C503.7.12 Marking. Single-wall metal pipe shall comply with the marking provisions of C503.6.12.

C503.8 Venting system termination location. The location of venting system terminations shall comply with the following (See Appendix Chapter C-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, 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 in. (152 mm) from any air opening into a building, and such an appliance with an input over 10,000 Btu per hr (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/hr. (14.7 kW) shall have at least a 12-in. (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 Category 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 Category III appliances, this provision shall also apply.

TABLE C503.7.7
CLEARANCES FOR CONNECTORS[a]

EQUIPMENT	MINIMUM DISTANCE FROM COMBUSTIBLE MATERIAL			
	Listed Type B Gas Vent Material	Listed Type L Vent Material	Single-Wall Metal Pipe	Factory-Built Chimney Sections
Listed equipment with draft hoods and equipment listed for use with-Type B Gas Vents	as listed	as listed	6 inches	as listed
Residential boilers and furnaces with listed gas conversion burner and with draft hood	6 inches	6 inches	9 inches	as listed
Residential appliances listed for use with type L vents	not permitted	as listed	9 inches	as listed
Residential incinerators	not permitted	9 inches	18 inches	as listed
Listed gas-fired toilets	not permitted	as listed	as listed	as listed
Unlisted residential appliances with draft hood	not permitted	6 inches	9 inches	as listed
Residential and low-heat equipment other than those above	not permitted	9 inches	18 inches	as listed
Medium-heat equipment	not permitted	not permitted	36 inches	as listed

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.

C503.9 Condensation drainage. Provision shall be made to collect and dispose of condensate from venting systems serving Category II and Category IV equipment and noncategorized condensing appliances in accordance with Section C503.8, 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 Category III equipment in accordance with Section C503.8, Item 4.

C503.10 Vent connectors for Category I equipment. Vent connectors for Category I equipment shall comply with Sections C503.10.1 through C503.10.17.

C503.10.1 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.

C503.10.2 Materials. Vent connectors shall be constructed in accordance with Sections C503.10.2.1 through C503.10.2.5.

C503.10.2.1 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.

C503.10.2.2 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 an attic space or other unconditioned area, that portion of the vent connector shall be listed Type B or Type L or listed vent material or listed material having equivalent insulation qualities.

C503.10.2.3 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 in. (0.46 mm) thick;
3. Aluminum (1100 or 3003 alloy or equivalent) sheet not less than 0.027 in. (0.69 mm) thick;
4. Stainless steel sheet not less than 0.012 in. (0.31 mm) thick;
5. Smooth interior wall metal pipe having resistance to heat and corrosion equal to or greater than that of Items 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.

C503.10.2.4 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 C503.10.2.4. Factory-built chimney sections shall be joined together in accordance with the chimney manufacturers' instructions.

C503.10.2.5 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 C503.10.2.5 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 C64, 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 C503.10.2.4
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.

TABLE C503.10.2.5
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 inch^2 = 645.16 mm^2.

C503.10.3 Size of vent connector. Vent connectors shall be sized in accordance with Sections C503.10.3.1 through C503.10.3.6.

C503.10.3.1 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 constructed in accordance with Section C504 and other approved engineering methods.

C503.10.3.2 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. If 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.

C503.10.3.3 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 C504 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.

C503.10.3.4 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 C504 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 areas of the smaller flue collar outlet.

C503.10.3.5 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.

C503.10.3.6 Approved engineering practices. The effective area of the vent connector, where connected to one or more appliances requiring draft for operation, shall be obtained by the application of approved engineering practices to perform as specified in Sections C503.3 and C503.3.1.

C503.10.4 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 Category IV appliances.

C503.10.5 Clearance. Minimum clearances from vent connectors to combustible material shall be in accordance with Table C503.7.7.

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 C308.2.

C503.10.6 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.

C503.10.7 Joints. Joints between sections of connector piping and connections to flue collars and hood outlets shall be fastened by sheet-metal screws or other approved means.

Exception: Vent connectors of listed vent material, assembled and connected to flue collars and draft hood outlets in accordance with the manufacturers' instructions.

C503.10.8 Slope. A vent connector shall be installed without dips or sags and shall slope upward toward the vent or chimney at least ¼ inch per foot (2 mm/m).

C503.10.9 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 pro-vided for in Section C503.10.3, 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 C503.10.3, 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 sys-tem 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.

C503.10.10 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.

C503.10.11 Location. Where the vent connector used for equipment having a draft hood or for Category I appliances is located in or passes through an attic, crawl space, or other unconditioned area subject to low ambient temperatures, that portion of the vent connector shall be of listed double-wall Type B, Type L vent material or listed material having equivalent insulation qualities.

C503.10.12 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. A thimble or slip joint shall be permitted to be used to facilitate removal of the connector. The connector shall be firmly attached to or inserted into the thimble or slip joint to prevent the connector from falling out. Means shall be employed 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 C501.9)

C503.10.13 Inspection. The entire length of a vent connector shall be provided with ready access for inspection, cleaning, and replacement.

C503.10.14 Fireplaces. A vent connector shall not be connected to a chimney flue serving a fireplace unless the fireplace flue opening is permanently sealed.

C503.10.15 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 connectors are installed with not less than the listed clearance to combustible material.

C503.10.16 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 equipment equipped with draft hoods and equipment 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 equipment having draft hoods, the thimble shall be not less than 6 inches (152 mm) larger in diameter than the vent connector
3. For residential incinerators and all other residential and low-heat equipment, 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.

C503.10.17 Medium-heat connectors. Vent connectors for medium-heat equipment shall not pass through walls or partitions constructed of combustible material.

C503.11 Vent connectors for Category II, Category III, and Category IV gas utilization equipment. Vent connectors for Category II, III and IV appliances shall be as specified for the venting systems in accordance with Section C503.4.

C503.12 Draft hoods and draft controls. The installation of draft hoods and draft controls shall comply with Sections C503.12.1 through C503.12.8.

C503.12.1 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.

C503.12.2 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. 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 instructions, 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.

Exception: 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.

C503.12.3 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.

C503.12.4 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.

C503.12.5 Incinerator draft regulator. A listed incinerator shall be permitted to be equipped with a listed single acting barometric draft regulator where recommended by the incinerator manufacturer. This draft regulator shall be installed in accordance with the incinerator manufacturer's instructions

C503.12.6 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.

C503.12.7 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.

C503.12.8 Clearance. A draft hood shall be located so its relief opening is not less than 6 inches (15 cm) 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.

C503.13 Manually operated dampers. A manually operated damper shall not be placed in the vent connector for any equipment, except in a connector serving a listed incinerator where

recommended by the incinerator manufacturer and installed in accordance with the incinerator manufacturer's instructions. Fixed baffles shall not be classified as manually operated dampers.

C503.14 Automatically operated vent dampers. An automatically operated vent damper shall be of a listed type.

C503.15 Obstructions. A device that retards the flow of vent gases shall not be installed in a vent connector, chimney, or vent. The tables in Section C504 shall not apply where the devices covered in this section are installed in the vent. Other approved engineering methods shall be used to size such vents.

Exceptions:

1. Draft regulators and safety controls specifically listed for installation in venting systems and installed in accordance with the terms of their listing.
2. Draft regulators and safety controls that are designed and installed in accordance with approved engineering methods and that are approved.
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 the gas utilization equipment manufacturer's instructions cover the installation of such a device in the venting system and performance in accordance with Section C503.3 and Section C503.3.1 is obtained.

SECTION C504
SIZING OF CATEGORY I APPLIANCE VENTING SYSTEMS

C504.1 Definitions. The following definitions apply to the tables in this section.

Appliance categorized vent diameter/area. The mini-mum 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.

C504.2 Application of single appliance vent tables C504.2(1) through C504.2(5). The application of Tables C504.2(1) through C504.2(5) shall be subject to the requirements of Sections C504.2.1 through C504.2.13.

C504.2.1 Vent obstructions. These venting tables shall not be used where obstructions, as described in the exceptions to Section C503.15, 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 correspond-ing "FAN Min" is "NA," the vent configuration shall not be permitted and an alternative venting configuration shall be utilized.

C504.2.2 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 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 x maximum table capacity).
5. The draft hood outlet is greater than 4 inches (102 mm) in diameter. Do not connect a 3-inch (76 mm) diameter vent to a 4-inch (102mm) diameter draft hood outlet. This provision shall not apply to fan-assisted appliances.

C504.2.3 Vent offsets. Single-appliance venting configurations with zero (0) lateral lengths in Tables C504.2(1), C504.2(2), and C504.2(5) shall not have elbows in the venting system. For vent configurations with lateral lengths, the venting tables include allowance for two 90-degree turns. For each additional 90-degree (1.6 rad) turn, or equivalent, the maximum capacity listed in the venting tables shall be reduced by 10 percent (0.90 x maximum table capacity). Two or more turns, the combined angles of which equal 90 degrees, shall be considered equivalent to one 90-degree (1.6 rad) turn.

C504.2.4 Zero lateral. Zero (0) lateral (L) shall apply only to a straight vertical vent attached to a top outlet draft hood or flue collar.

C504.2.5 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.

C504.2.6 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.

C504.2.7 Liner system sizing. Listed corrugated metallic chimney liner systems in masonry chimneys shall be sized by using Table C504.2(1) or C504.2(2) for Type B vents with the maximum capacity reduced by 20 percent (0.80 x maximum capacity) and the minimum capacity as shown in Table C504.2(1) or C504.2(2). Corrugated metallic liner systems installed with bends or offsets shall have their maximum capacity further reduced in accordance with Section C504.2.3.

C504.2.8 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 designated in accordance with approved engineering methods.

C504.2.9 Chimney and vent locations. Tables C504.2(1), C504.2(2), C504.2(3), C504.2(4) and C504.2(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 C504.2(3) in combination with Table C504.3(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 $1^1/_2$ feet (457 mm) 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 C504.2(2).
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 C504.3(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.

C504.2.10 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.

C504.2.11 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.

C504.2.12 Table interpolation. Interpolation shall be permitted in calculating capacities for vent dimensions that fall between the table entries (See Example 3, Appendix B.)

C504.2.13 Extrapolation prohibited. Extrapolation beyond the table entries shall not be permitted.

C504.2.14 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.

C504.3 Application of multiple appliance vent tables C504.3(1) through C504.3(8). The application of Tables C504.3(1) through C504.3(8) shall be subject to the requirements of Sections C504.3.1 through C504.3.23.

C504.3.1 Vent obstructions. These venting tables shall not be used where obstructions, as described in the exceptions to Section C503.15, 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.

C504.3.2 Connector length limit. The vent connector shall be routed to the vent utilizing the shortest possible route. Except as provided in Section C504.3.3, the maximum vent connector horizontal length shall be $1^1/_2$ feet (457 mm)

for each inch (18 mm per mm) of connector diameter as shown in Table C504.3.2:

TABLE C504.3.2
MAXIMUM VENT CONNECTOR LENGTH

CONNECTOR DIAMETER MAXIMUM (inches)	CONNECTOR HORIZONTAL LENGTH (feet)
3	4 1/2
4	6
5	7 1/2
6	9
7	10 1/2
8	12
9	13 1/2
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.

C504.3.3 Connectors with longer lengths. Connectors with longer horizontal lengths than those listed in Section C504.3.2 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 x 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 x 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 C504.2(1) shall be used. For single-wall connectors, Table C504.2(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.

C504.3.4 Combined connectors. Where the vent connectors are combined prior to entering the common vent, the maximum common vent capacity listed in the common venting tables shall be reduced by 10 percent (0.90 (maximum common vent capacity). The length of the common vent connector manifold *(L_M)* shall not exceed 1 ½ feet (457 mm) for each inch (18 mm per mm) of common vent connector manifold diameter *(D)*. (See Figure C-B-11.)

C504.3.5 Common vertical vent offset. Where the common vertical vent is offset as shown in Figure C-B-12, the maximum common vent capacity listed in the common venting tables shall be reduced by 20 percent (0.80 x maximum common vent capacity), the equivalent of two 90-degree (1.6 rad) turns. The horizontal length of the common vent offset *(L_M)* shall not exceed 1 1/2 feet (457 mm) for each inch (18 mm per mm) of common vent diameter *(D)*.

C504.3.6 Additional capacity reduction. Excluding elbows counted in Section C504.3.5, for each additional 90-degree turn in excess of two, the maximum capacity of that portion of the venting system shall be reduced by 10 percent (0.90 x maximum common vent capacity). Two or more turns, the combined angles of which equal 90 degrees, shall be considered equivalent to one 90-degree turn.

C504.3.7 Common vent minimum size. The cross-section-al area of the common vent shall be equal to or greater than the cross-sectional area of the largest connector.

C504.3.8 Common vent fittings. Interconnection fittings shall be the same size as the common vent.

C504.3.9 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.

C504.3.10 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.

C504.3.11 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.

C504.3.12 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 C-B-13.)

C504.3.13 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 C504.2(1) or C504.2(2) for available total height *(H)* up to the lowest interconnection. (See Figure C-B-14.)

C504.3.14 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. A multistory common vertical vent shall be permitted to have a single offset, provided all of the following requirements are met:

1. The offset angle does not exceed 45 degrees.

2. The horizontal length of the offset does not exceed $1^1/_2$ feet for each inch (18 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 is reduced by 20 percent (0.80 x maximum common vent capacity).
4. A multistory common vent shall not be reduced in size above the offset.

C504.3.15 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.

C504.3.16 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.

C504.3.17 Liner system sizing. Listed, corrugated metallic chimney liner systems in masonry chimneys shall be sized by using Table C504.3(1) or C504.3(2) for Type B vents, with the maximum capacity reduced by 20 percent (0.80 x maximum capacity) and the minimum capacity as shown in Table C504.3(1) or C504.3(2). Corrugated metallic liner systems installed with bends or offsets shall have their maximum capacity further reduced in accordance with Sections C504.3.5 and C504.3.6.

C504.3.18 Chimney and vent location. Tables C504.3(1), C504.3(2), C504.3(3), C504.3(4), and C504.3(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 C504.3(7) and C504.3(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 C504.3(7a) for NAT+NAT or Table C504.3(8a) for FAN+NAT.
4. The input rating of each space-heating appliance is greater than the minimum input rating given by Table C504.3(7b) for NAT+NAT or Table C504.3(8b) for FAN+NAT.
5. The vent connector sizing is in accordance with Table C504.3(3).

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.

C504.3.19 Connector maximum 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 smaller size(s) shall be permitted to be used provided all of the following conditions are met:

1. Vent connectors for fan-assisted appliance flue collars 12 in. (305 mm) in diameter or smaller are not reduced by more than one table size [e.g., 12 in. to 10 in. (305 mm to 254 mm) is a one-size reduction] and those larger than 12 in. (305 mm) in diameter are not reduced more than two table sizes [e.g., 24 in. to 20 in. (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).

C504.3.20 Component commingling. All combination 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, the common vent must be sized using Table C504.3(2) or C504.3(4) as appropriate.

C504.3.21 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.

C504.3.22 Table interpolation. Interpolation shall be permitted in calculating capacities for vent dimensions that fall between table entries. (See Example 3, Appendix C-B.)

C504.3.23 Extrapolation prohibited. Extrapolation beyond the table entries shall not be permitted.

C504.3.24 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.

TABLE C504.2(1)
CAPACITY OF TYPE B DOUBLE-WALL GAS VENTS WHEN CONNECTED DIRECTLY TO A SINGLE CATEGORY I APPLIANCE

HEIGHT (H) (feet)	LATERAL (L) (feet)	VENT DIAMETER (D)																				
		3″			4″			5″			6″			7″			8″			9″		
		APPLIANCE INPUT RATING 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	0	0	78	46	0	152	86	0	251	141	0	375	205	0	524	285	0	698	370	0	897	470
	2	13	51	36	18	97	67	27	157	105	32	232	157	44	321	217	53	425	285	63	543	370
	4	21	49	34	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
8	0	0	84	50	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	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
	8	28	49	35	39	98	66	51	164	109	64	247	165	84	347	227	99	463	303	117	596	396
10	0	0	88	53	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	81	23	194	129	26	289	195	40	402	272	48	544	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
	10	30	51	36	41	104	70	54	176	115	67	267	175	88	376	245	104	504	330	122	651	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
	15	35	53	37	48	112	76	61	195	128	76	301	198	98	429	275	115	580	373	134	755	491
20	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
	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
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
50	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
	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
100	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)

TABLE C504.2(1) continued
CAPACITY OF TYPE B DOUBLE-WALL GAS VENTS WHEN CONNECTED DIRECTLY TO A SINGLE CATEGORY I APPLIANCE

HEIGHT (H) (feet)	LATERAL (L) (feet)	VENT DIAMETER (D)																							
		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
		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	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
8	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
	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
10	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
	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
15	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
	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
20	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
	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
30	0	0	1,977	1060	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
50	0	0	2,231	1195	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	1010	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
	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
100	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
	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 Btu/h = 0.2931 W.

TABLE C504.2(2)
CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH SINGLE-WALL METAL CONNECTORS SERVING A SINGLE CATEGORY I APPLIANCE

HEIGHT (H) (feet)	LATERAL (L) (feet)	VENT DIAMETER (D)																											
		3″			4″			5″			6″			7″			8″			9″			10″			12″				
		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	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	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		
8	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		
	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		
10	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		
	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		
20	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		
	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		
30	0	34	99	63	53	211	127	76	372	219	110	584	334	144	849	472	184	1,168	647	229	1,542	852	312	1,971	1056	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	1,243		
	15	NA	NA	NA	113	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		
	30	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		
50	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		
	20	NA	NA	NA	NA	NA	NA	176	257	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		
100	0	NA	NA	NA	49	214	NA	69	403	NA	100	659	395	131	991	555	166	1,404	765	207	1,900	1033	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		
	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	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 Btu/h = 0.2931 W.

TABLE C504.2(3)
CAPACITY OF MASONRY CHIMNEY FLUE WITH TYPE B DOUBLE-WALL VENT CONNECTORS SERVING A SINGLE CATEGORY I APPLANCE

HEIGHT (H) (feet)	LATERAL (L) (feet)	TYPE B DOUBLE-WALL CONNECTOR DIAMETER (D) To be used with chimney areas within the size limits at bottom																											
		3"			4"			5"			6"			7"			8"			9"			10"			12"				
		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	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	2	NA	NA	28	NA	NA	52	NA	NA	86	NA	NA	130	NA	NA	180	NA	NA	247	NA	NA	320	NA	NA	401	NA	NA	581		
	5	NA	NA	25	NA	NA	49	NA	NA	82	NA	NA	117	NA	NA	165	NA	NA	231	NA	NA	298	NA	NA	376	NA	NA	561		
8	2	NA	NA	29	NA	NA	55	NA	NA	93	NA	NA	145	NA	NA	198	NA	NA	266	84	590	350	100	728	446	139	1,024	651		
	5	NA	NA	26	NA	NA	52	NA	NA	88	NA	NA	134	NA	NA	183	NA	NA	247	NA	NA	328	149	711	423	201	1,007	640		
	8	NA	NA	24	NA	NA	48	NA	NA	83	NA	NA	127	NA	NA	175	NA	NA	239	NA	NA	318	173	695	410	231	990	623		
10	2	NA	NA	31	NA	NA	61	NA	NA	103	NA	NA	162	NA	NA	221	68	519	298	82	655	388	98	810	491	136	1,144	724		
	5	NA	NA	28	NA	NA	57	NA	NA	96	NA	NA	148	NA	NA	204	NA	NA	277	124	638	365	146	791	466	196	1,124	712		
	10	NA	NA	25	NA	NA	50	NA	NA	87	NA	NA	139	NA	NA	191	NA	NA	263	155	610	347	182	762	444	240	1,093	668		
15	2	NA	NA	35	NA	NA	67	NA	NA	114	NA	NA	179	53	475	250	64	613	336	77	779	441	92	968	562	127	1,376	841		
	5	NA	NA	35	NA	NA	62	NA	NA	107	NA	NA	164	NA	NA	231	99	594	313	118	759	416	139	946	533	186	1,352	828		
	10	NA	NA	28	NA	NA	55	NA	NA	97	NA	NA	153	NA	NA	216	126	565	296	148	727	394	173	912	567	229	1,313	777		
	15	NA	NA	NA	NA	NA	48	NA	NA	89	NA	NA	141	NA	NA	201	NA	NA	281	171	698	375	198	880	485	259	1,280	742		
20	2	NA	NA	38	NA	NA	74	NA	NA	124	NA	NA	201	51	522	274	61	678	375	73	867	491	87	1,083	627	121	1,548	953		
	5	NA	NA	36	NA	NA	68	NA	NA	116	NA	NA	184	80	503	254	95	658	350	113	845	463	133	1,059	597	179	1,523	933		
	10	NA	NA	NA	NA	NA	60	NA	NA	107	NA	NA	172	NA	NA	237	122	627	332	143	811	440	167	1,022	566	221	1,482	879		
	15	NA	NA	NA	NA	NA	NA	NA	NA	97	NA	NA	159	NA	NA	220	NA	NA	314	165	780	418	191	987	541	251	1,443	840		
	20	NA	NA	NA	NA	NA	NA	NA	NA	83	NA	NA	148	NA	NA	206	NA	NA	296	186	750	397	214	955	513	277	1,406	807		
30	2	NA	NA	41	NA	NA	82	NA	NA	137	NA	NA	216	47	581	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	75	561	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 foot = 304.8 mm, 1 Btu/h = 0.2931 W.

TABLE C504.2(4)
CAPACITY OF MASONRY CHIMNEY FLUE WITH SINGLE-WALL VENT CONNECTORS SERVING A SINGLE CATEGORY I APPLIANCE

HEIGHT (H) (feet)	LATERAL (L) (feet)	SINGLE-WALL METAL CONNECTOR DIAMETER (D) To be used with chimney areas within the size limits at bottom																											
		3"			4"			5"			6"			7"			8"			9"			10"			12"			
		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	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	2	NA	NA	28	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	382	725	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		
	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		
10	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		
	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		
15	2	NA	NA	35	NA	NA	67	NA	NA	113	NA	NA	178	166	473	219	211	611	335	264	776	440	382	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	755	414	444	942	531	637	1,348	825		
	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	NA	NA	252	255	655	348	317	842	461	433	1,055	594	623	1,518	930		
	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	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		
30	2	NA	NA	41	NA	NA	81	NA	NA	136	NA	NA	215	158	578	302	200	759	420	249	982	556	340	1,237	715	489	1,789	1,110		
	5	NA	NA	NA	NA	NA	75	NA	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	NA	66	NA	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	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	NA	88	NA	NA	155	NA	NA	223	NA	NA	327	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	182	NA	NA	281	NA	NA	408	NA	NA	544	1055	1,539	865		
50	2	NA	NA	NA	NA	NA	91	NA	NA	160	NA	NA	250	NA	NA	350	191	837	475	230	1103	651	323	1,408	810	463	2,076	1,240		
	5	NA	NA	NA	NA	NA	NA	NA	NA	149	NA	NA	228	NA	NA	321	NA	NA	442	293	1078	593	398	1,381	770	571	2,044	1,220		
	10	NA	NA	NA	NA	NA	NA	NA	NA	136	NA	NA	212	NA	NA	301	NA	NA	420	355	1038	562	447	1,337	728	674	1,994	1,140		
	15	NA	NA	NA	NA	NA	NA	NA	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	NA	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	NA	NA	NA	NA	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 foot = 304.8 mm, 1 Btu/h = 0.2931 W.

TABLE C504.2(5)
CAPACITY OF SINGLE-WALL METAL PIPE OR TYPE B ASBESTOS CEMENT VENTS SERVING A SINGLE DRAFT HOOD EQUIPPED APPLIANCE

HEIGHT *(H)* (feet)	LATERAL *(L)* (feet)	VENT DIAMETER *(D)*							
		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	24	49	86	131	180	250	406	625
10	0	45	84	138	202	279	372	606	912
	2	35	67	111	168	233	311	505	760
	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
15	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
	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
20	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
	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
30	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
	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
	30	NA	NA	NA	NA	192	295	540	890
50	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
	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 Btu/h = 0.2931 W.

TABLE C504.3(1)
CAPACITY OF TYPE B DOUBLE-WALL VENTS WITH TYPE B DOUBLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY I APPLIANCES

VENT CONNECTOR CAPACITY

VENT HEIGHT (H) (feet)	CONNECTOR RISE (R) (feet)	TYPE B DOUBLE-WALL VENT AND CONNECTOR DIAMETER (D)																							
		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	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	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	117	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	200	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)																							
	4"			5"			6"			7"			8"			9"			10"					
	COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF Btu/h																							
	FAN +FAN	FAN +FAN	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 C504.3(1) continued

VENT CONNECTOR CAPACITY

VENT HEIGHT (H) (feet)	CONNECTOR RISE (R) (feet)	TYPE B DOUBLE-WALL VENT AND DIAMETER (D)																				
		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	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	NA
	6	NA	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	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	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	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	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	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	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	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)																					
	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 Btu/h = 0.2931 W.

TABLE C504.3(2)
CAPACITY OF TYPE B DOUBLE-WALL VENT WITH SINGLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY I APPLIANCES

VENT CONNECTOR CAPACITY

VENT HEIGHT (H) (feet)	CONNECTOR RISE (R) (feet)	SINGLE-WALL METAL VENT CONNECTOR DIAMETER (D)																							
		3″			4″			5″			6″			7″			8″			9″			10″		
		APPLIANCE INPUT RATING IN THOUSANDS OF Btu/h																							
		FAN		NAT	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
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	239	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 VENT AND DIAMETER (D)																							
	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	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 Btu/h = 0.2931 W.

TABLE C504.3(3)
CAPACITY OF MASONRY CHIMNEY WITH TYPE B DOUBLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY I APPLIANCES

VENT CONNECTOR CAPACITY

VENT HEIGHT (H) (feet)	CONNECTOR RISE (R) (feet)	TYPE B DOUBLE-WALL VENT CONNECTOR DIAMETER (D)																							
		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	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	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	1011	452
	3	26	63	35	40	123	65	57	204	104	75	353	157	104	493	222	129	661	301	156	851	396	187	1067	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 +FAN	NAT +NAT	FAN +FAN	FAN +FAN	NAT +NAT	FAN +FAN	FAN +FAN	NAT +NAT	FAN +FAN	FAN +FAN	NAT +NAT	FAN +FAN	FAN +FAN	NAT +NAT	FAN +FAN	FAN +FAN	NAT +NAT	FAN +FAN	FAN +FAN	NAT +NAT	FAN +FAN	FAN +FAN	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 inch² = 645.16 mm², 1 foot = 304.8 mm, 1 Btu/h = 0.2931 W.

TABLE C504.3(4)
CAPACITY OF MASONRY CHIMNEY WITH SINGLE-WALL CONNECTORS SERVING TWO OR MORE CATEGORY I APPLIANCES

VENT CONNECTOR CAPACITY

VENT HEIGHT (H) (feet)	CONNECTOR RISE (R) (feet)	SINGLE-WALL METAL VENT CONNECTOR DIAMETER (D)																							
		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	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	339	518	236	436	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	387
	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	771	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 inch² = 645.16 mm², 1 foot = 304.8 mm, 1 Btu/h = 0.2931 W.

TABLE C504.3(5)
CAPACITY OF SINGLE-WALL METAL PIPE OR TYPE B ASBESTOS CEMENT VENT SERVING TWO OR MORE DRAFT HOOD-EQUIPPED APPLIANCES

VENT CONNECTOR CAPACITY

TOTAL VENT HEIGHT *(H)* (feet)	CONNECTOR RISE *(R)* (feet)	VENT CONNECTOR DIAMETER *(D)*					
		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 *(H)* (feet)	COMMON VENT DIAMETER						
	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 Btu/h = 0.2931 W.

TABLE C504.3(6)
EXTERIOR MASONRY CHIMNEY, SINGLE NAT INSTALLATIONS WITH TYPE B DOUBLE-WALL VENT CONNECTORS

VENT HEIGHT (feet)	MINIMUM ALLOWABLE INPUT RATING OF SPACE-HEATING APPLIANCE IN THOUSANDS OF BTU/h							
	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							

For SI: °C – [(°F) - 32]/1.8, 1 inch = 25.4 mm, 1 inch² = 645.16 mm², 1 foot = 304.8 mm, 1 Btu/h = 0.2931 W.

TABLE C504.3(7)
EXTERIOR MASONRY CHIMNEY, NAT + NAT INSTALLATIONS WITH TYPE B DOUBLE-WALL VENT CONNECTORS

C504.3(7a) Combined Appliance Maximum Input Rating in Thousands of Btu/h

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

C504.3(7b) Minimum Allowable Input Rating of Space-Heating Appliance in Thousands of Btu/h

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	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
27 to 36°F	Local 99% Winter Design Temperature: 27 to 36°F							
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
17 to 26°F	Local 99% Winter Design Temperature: 17 to 26°F							
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
5 to 16°F	Local 99% Winter Design Temperature: 5 to 16°F							
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
4°F or Lower	Local 99% Winter Design Temperature: 4°F or Lower							
	Not recommended for any vent configurations							

For SI: °C = [(°F) - 32]/1.8, 1 inch = 25.4 mm, 1 inch² = 645.16 mm², 1 foot = 304.8 mm, 1 Btu/h = 0.2931 W.

TABLE C504.3(8)
EXTERIOR MASONRY CHIMNEY, FAN + NAT INSTALLATIONS WITH TYPE B DOUBLE-WALL VENT CONNECTORS

C504.3(8a) Combined Appliance Maximum Input Rating in Thousands of Btu/h

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

C504.3(8b) Minimum Allowable Input Rating of Space-Heating Appliance in Thousands of Btu/h

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	334	398	393	334	0
50	NA	NA	NA	NA	NA	714	707	579
100	NA	NA	NA	NA	NA	NA	NA	1,600
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	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
17 to 26°F	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
5 to 16°F	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
-10 to 4°F	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
-11°F or Lower	Local 99% Winter Design Temperature: -11°F or Lower							
	Not recommended for any vent configurations							

For SI: °C = [(°F) - 32]/1.8, 1 inch = 25.4 mm, 1 inch^2 = 645.16 mm^2, 1 foot = 304.8 mm, 1 Btu/h = 0.2931 W.

SECTION C505
DIRECT-VENT, INTEGRAL VENT, MECHANICAL VENT AND VENTILATION/EXHAUST HOOD VENTING

C505.1 The installation of direct-vent and integral vent appliances shall be in accordance with Section C503. Mechanical venting systems and exhaust hood venting systems shall be designed and installed in accordance with Section C503.

SECTION C506
FACTORY-BUILT CHIMNEYS

C506.1 Building heating appliances. Factory-built chimneys for building heating appliances producing flue gases having a temperature not greater than 1000° 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.

C506.2 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.

C506.3 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.

SECTION C601
GENERAL

C601.1 Scope. This chapter shall govern the approval, design, installation, construction, alteration and repair of the appliances and equipment specifically identified herein.

SECTION C602
DECORATIVE APPLIANCES FOR INSTALLATION IN FIREPLACES

C602.1 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.

C602.2 Flame safeguard device. Decorative appliances for installation in approved solid fuel burning fireplaces shall utilize a direct ignition device, an igniter 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.

C602.3 Prohibited installations. Decorative appliances for installation in fireplaces shall not be installed where prohibited by Section C303.3.

SECTION C603
LOG LIGHTERS

C603.1 General. Log lighters shall be installed in accordance with the manufacturer's installation instructions.

SECTION C604
VENTED DECORATIVE APPLIANCES

C604.1 General. Vented decorative appliances 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 C602.2.

C604.2 Access. Panels, grilles, and access doors that are required to be removed for normal servicing operations shall not be attached to the building.

SECTION C605
INCINERATORS AND CREMATORIES

C605.1 General. Incinerators and crematories shall be installed in accordance with the manufacturer's installation instructions.

SECTION C606
COMMERCIAL-INDUSTRIAL INCINERATORS

C606.1 Incinerators, commercial industrial. Commercial industrial type incinerators shall be constructed and installed in accordance with NFPA 82.

SECTION C607
VENTED WALL FURNACES

C607.1 General. Vented wall furnaces shall be tested in accordance with ANSI Z21.49 and shall be installed in accordance with the manufacturer's installation instructions.

C607.2 Venting. Vented wall furnaces shall be vented in accordance with Section C503.

C607.3 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.

C607.4 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.

C607.5 Ducts prohibited. Ducts shall not be attached to wall furnaces. Casing extension boots shall not be installed unless listed as part of the appliance.

C607.6 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 C608
FLOOR FURNACES

C608.1 General. Floor furnaces shall be tested in accordance with ANSI Z21.48 and shall be installed in accordance with the manufacturer's installation instructions.

C608.2 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 exit way 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.

C608.3 Bracing. The floor around the furnace shall be braced and headed with a support framework designed in accordance with the building code.

C608.4 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 18inch (457 mm) minimum clearance.

C608.5 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 C608.6 and shall project into a nonhabitable space.

C608.6 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 and combustion air in accordance with Section C304.

SECTION C609
DUCT FURNACES

C609.1 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.

C609.2 Access panels. Ducts connected to duct furnaces shall have removable access panels on both the upstream and downstream sides of the furnace.

C609.3 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.

C609.4 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 C610
DIRECT FIRED MAKEUP AIR HEATERS

C610.1 General. Direct fired makeup air heaters shall be tested in accordance with ANSI Z83.4 and shall be installed in accordance with the manufacturer's installation instructions.

C610.2 Installation. Direct fired makeup air heaters shall not be used to supply any area containing sleeping quarters.

C610.3 Outdoor air. All air handled by a direct fired makeup air heater, including combustion air, shall be brought in from outdoors.

Exception: Indoor air added to the outdoor air stream after the outdoor air stream has passed the combustion zone.

C610.4 Outdoor air louvers. If outdoor air louvers of either the manual or automatic type are used, such devices shall be proved in the open position prior to allowing the main burners to operate.

C610.5 Controls. Direct-fired makeup air heaters shall be equipped with airflow sensing devices, safety shutoff devices, operating temperature controls, and thermally actuated temperature limit controls in accordance with the terms of their listings.

C610.6 Atmospheric vents and gas reliefs or bleeds. Direct fired makeup 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 out-

doors. 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.

C610.7 Relief opening. The design of the installation shall include provision to permit direct fired makeup 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 C611
DIRECT FIRED INDUSTRIAL AIR HEATERS

C611.1 General. Direct fired industrial air heaters shall be tested in accordance with ANSI Z83.18 and shall be installed in accordance with the manufacturer's installation instructions.

C611.2 Location. Direct fired industrial air heaters shall be installed only in industrial and commercial occupancies. Direct fired air heaters shall not be installed in any area intended for sleeping. Direct fired heaters shall not be installed in hazardous locations where room air is recirculated across the burner or which contain substances that are made toxic by exposure to flames.

C611.3 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 permitted to provide fresh air ventilation.

C611.4 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 manufacturers' instructions.

C611.5 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 cfm per 1,000 Btu per hour (0.38 m^3 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. If outside air dampers or closing louvers are used, they shall be verified to be in the open position prior to main burner operation.

C611.6 Atmospheric vents or 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.

C611.7 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 C612
CLOTHES DRYERS

C612.1 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 and Chapter 5 of this code.

SECTION C613
CLOTHES DRYER EXHAUST

C613.1 C613.1 Installation. See Chapter 5, Section 504 of this code.

SECTION C614
SAUNA HEATERS

C614.1 General. Sauna heaters shall be installed in accordance with the manufacturer's installation instructions and Chapter 9 of this code.

C614.2 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.

C614.3 Combustion air. Combustion air shall not be taken from inside the sauna room. Combustion 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 C304.

SECTION C615
ENGINE AND GAS TURBINE-POWERED EQUIPMENT

C615.1 Powered equipment. Permanently installed equipment powered by internal combustion engines and turbines shall be installed in accordance with the manufacturer's installation instructions and in accordance with NFPA 37.

SECTION C616
POOL AND SPA HEATERS

C616.1 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 C617
FORCED-AIR WARM-AIR FURNACES

C617.1 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.

C617.2 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 mm²/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 warm air furnace shall be not less than 2 square inches for each 1,000 Btu/h (4402 mm²/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.

C617.3 Dampers. Volume dampers shall not be placed in the air inlet to a furnace in a manner which will reduce the required air to the furnace.

C617.4 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 airtight ducts.

C617.5 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.

   Exception: Listed outdoor appliances which provide both circulating air and vent discharge.

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 this 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 C617.2, 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.

   Exceptions: This shall not apply where:

   1. The appliance is a direct-vent appliance or an appliance not requiring a vent in accordance with C501.8.
   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 fire box of such appliances.
6. A closet, bathroom, toilet room, kitchen, garage, mechanical room, boiler room or furnace room.

C617.6 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 nonresidential 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 (25.4 mm).

C617.7 Return air limitation. Return air from one dwelling unit shall not be discharged into another dwelling unit.

SECTION C618
CONVERSION BURNERS

C618.1 Conversion burners. The installation of conversion burners shall conform to ANSI Z21.8.

SECTION C619
UNIT HEATERS

C619.1 General. Unit heaters shall be tested in accordance with ANSI Z83.8 and shall be installed in accordance with the manufacturer's installation instructions.

C619.2 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.

C619.3 Ductwork. Ducts shall not be connected to a unit heater unless the heater is listed for such installation.

C619.4 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 inches (152 mm) clearance shall be measured from the draft hood of 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 C620
UNVENTED ROOM HEATERS

C620.1 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 this code.

C620.2 Prohibited use. One or more unvented room heaters shall not be used as the sole source of comfort heating in a dwelling unit.

C620.3 Input rating. Unvented room heaters shall not have an input rating in excess of 40,000 Btu/h (11.7 kW).

C620.4 Prohibited locations. Unvented room heaters shall not be installed within occupancies in Use Groups A, E and I. The location of unvented room heaters shall also comply with Section C303.3.

C620.5 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^3) 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.

C620.6 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 specified 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.

C620.7 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 C621
VENTED ROOM HEATERS

C621.1 General. Vented room heaters shall be tested in accordance with ANSI Z21.11.1 and shall comply with Section C602.2 and shall be installed in accordance with the manufacturer's installation instructions.

SECTION C622
COOKING APPLIANCES

C622.1 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.

C622.2 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.

C622.3 Domestic appliances. Cooking appliances installed within dwelling units and within areas where domestic cooking operations occur shall be listed and labeled as house hold type appliances for domestic use.

C622.4 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.

C622.4.1 Installation of a listed cooking appliance or microwave over a listed cooking top appliance. The installation of a listed cooking appliance or microwave oven over a listed cooking top appliance shall conform to the conditions of the upper appliance's listing and the manufacturer's installation instructions.

C622.5 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.

C622.5.1 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.

SECTION C623
WATER HEATERS

C623.1 General. Water heaters shall be tested in accordance with ANSI Z21.10.1 and ANSI Z21.10.3 and shall be installed in accordance with the manufacturer's installation instructions. Water heaters utilizing fuels other than fuel gas shall be regulated by this code.

C623.1.1 Installation requirements. The requirements for water heaters relative to installation, sizing, relief valves, drain pans and scald protection shall be in accordance with the plumbing code.

C623.2 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, this code and the plumbing code.

SECTION C624
REFRIGERATORS

C624.1 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 (51 mm) shall be provided between the back of the refrigerator and the wall and at least 12 inches (305 mm) above the top.

SECTION C625
GAS-FIRED TOILETS

C625.1 General. Gas-fired toilets shall be tested in accordance with ANSI Z21.61 and shall be installed in accordance with the manufacturer's installation instructions.

C625.2 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 C626
AIR CONDITIONING EQUIPMENT

C626.1 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

C626.2 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 C402.)

C626.3 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.

C626.4 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 C308.3 except that air conditioning equipment listed for installation at lesser clearances than those specified in Section C308.3, 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 C308.3, 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 C308.2.

C626.5 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 C308.2.

C626.6 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.

C626.7 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.

C626.8 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 suf-

ficiently 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.

C626.9 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 may be exposed to refrigerated air circulation, such boiler piping systems shall be equipped with flow control valves or other automatic means to prevent gravity circulation of the boiler water during the cooling cycle.

C626.10 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 C627
ILLUMINATING APPLIANCES

C627.1 General. Illuminating appliances shall be tested in accordance with ANSI Z21.42 and shall be installed in accordance with the manufacturer's installation instructions.

C627.2 Mounting on buildings. Illuminating appliances designed for wall or ceiling mounting shall be securely attached to substantial structures in such a manner that they are not dependent on the gas piping for support.

C627.3 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 2½-inch (64 mm) diameter post constructed of 0.064-inch (1.6 mm) thick steel or a 1inch (25.4 mm) Schedule 40 steel pipe. Posts 3 feet (914 mm) or less in height shall not be smaller than a ¾-inch (19 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.

C627.4 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 C628
SMALL CERAMIC KILNS

C628.1 General. Listed fuel-gas ceramic kilns with a maximum interior volume of 20 cubic feet (0.566 m^3) and used for hobby and noncommercial purposes shall be installed in accordance with the manufacturer's installation instructions and the provisions of this appendix.

C628.2 Unlisted fuel-gas kiln installation. Unlisted fuel-gas kilns shall be installed in accordance with the manufacturer's installation instructions and the provisions of this appendix.

C628.2.1 Installations inside buildings. In addition to other requirements specified in this section, interior installation shall meet the following requirements:

C628.2.2 Clearances for interior installation. The sides and tops of kilns shall be located a minimum of 18 inches (457 mm) from any noncombustible wall surface and 3 feet (914 mm) from any combustible wall surface. Kilns shall be installed on noncombustible flooring, consisting of at least 2 inches (51 mm) of solid masonry or concrete extending at least 12 inches (305 mm) beyond the base or supporting members of the kiln.

Exception: These clearances may be reduced, provided that independent testing is submitted to and approved by the building official.

C628.2.3 Control side clearance. The clearance on the gas or electrical control side of a kiln shall not be reduced to less than 30 inches (762 mm).

C628.2.4 Hoods. A canopy type hood shall be installed directly above each kiln. The face opening area of the hood shall be equal to or greater than the top horizontal surface area of the kiln. The hood shall be constructed of not less than 0.024-inch (0.61 mm) (No. 24 U.S. gage) galvanized steel or equivalent and be supported at a height of between 12 inches and 30 inches (305 mm and 762 mm) above the kiln by noncombustible supports.

Exception: Electric kilns installed with listed exhaust blowers may be used when marked as being suitable for the kiln and installed in accordance with manufacturer's instructions.

C628.2.5 Gravity ventilation ducts. Each kiln hood shall be connected to a gravity ventilation duct extending in a vertical direction to outside the building. This duct shall be of the same construction as the hood and shall have a cross-sectional area of not less than one fifteenth of the face opening of the hood. The duct shall terminate a minimum of 12 inches (305 mm) above any portion of a building within 4 feet (1219 mm) and terminate no less than 4 feet (1219 mm) from any openable windows or other opening into the building or adjacent property line. The duct to the outside shall be shielded, without reduction of duct area, to prevent entrance of rain into the duct. The duct shall be supported at each section by noncombustible supports.

C628.2.6 Hood and duct clearances. Every hood and duct serving a fuel-gas burning kiln shall have a clearance from combustible construction of at least 18 inches (457 mm). This clearance may be reduced in accordance with Table C308.2.

C628.2.6.1 Makeup air. Provisions shall be made for air to enter the room in which a kiln is installed at a rate at least equal to the air being removed through the kiln hood.

C628.3 Exterior Installations. Kilns shall be installed with minimum clearances as specified in Section C628.2.2. Kilns

located under a roof and enclosed by two or more vertical wall surfaces, shall have a hood and gravity ventilation duct installed to comply with Sections, C628.2.4 and C628.2.5.

SECTION C629
INFRARED RADIANT HEATERS

C629.1 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.

C629.2 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 C630
BOILERS

C630.1 Standards. Boilers shall be listed in accordance with Chapter 10 of this code.

SECTION C631
CHIMNEY DAMPER OPENING AREA

C631.1 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 C631.1.

TABLE C631.1
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)[a]						
	8	13	20	29	39	51	64
	Appliance Input Rating (Btu/h)						
6	7,800	14,000	23,200	34,000	46,400	62,400	80,000
8	8,400	15,200	25,200	37,000	50,400	68,000	86,000
10	9,000	16,800	27,600	40,400	55,800	74,400	96,400
15	9,800	18,200	30,200	44,600	62,400	84,000	108,800
20	10,600	20,200	32,600	50,400	68,400	94,000	122,200
30	11,200	21,600	36,600	55,200	76,800	105,800	138,600

For SI: 1 foot = 304.8 mm, 1 inch^2 = 645.16 mm^2, 1,000 Btu/h = 0.2931 W.

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

SECTION C-7
REFERENCED STANDARDS

ANSI

American National Standards Institute
11 West 42nd Street
New York, NY 10036

Standard reference number	Title	Referenced in code section number
LC 1-97	Gas Piping Systems Using Corrugated Stainless Steel Tubing	C403.4.4
Z21.1-96	Household Cooking Gas Appliances	C622.1
Z21.5.1-95	Gas Clothes Dryers—Volume I—Type 1 Clothes Dryers	C612.1
Z21.5.2-95	Gas Clothes Dryers—Volume II—Type 2 Clothes Dryers—with 1999 Addendum	C612.1
Z21.8-94	Installation of Domestic Gas Conversion Burners	C618.1
Z21.10.1-98	Gas Water Heaters—Volume I—Storage, Water Heaters with Input Ratings of 75,000 Btu per Hour or Less	C623.1
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	C623.1
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	C621.1
Z21.11.2-96	Gas-Fired Room Heaters—Volume II—Unvented Room Heaters with Addendum Z21.11.2a - 1997	C620.1
Z21.15-97	Manually Operated Gas Valves for Appliances, Appliance Connector Valves, and Hose End Valves	C409.1
Z21.19-90 (R 1999)	Refrigerators Using Gas Fuel—with Addenda Z21.19a - 1992 (R1999) and Z21.19b - 1995 (R1999)	C624.1
Z21.40.1-96	Gas-Fired Absorption Summer Air-Conditioning Appliances	C626.1
Z21.40.2-96	Gas-Fired Work-Activated Air-Conditioning and Heat-Pump Appliances (Internal Combustion)	C626.1
Z21.42-93	Gas-Fired Illuminating Appliances	C627.1
Z21.47-93	Gas-Fired Central Furnaces—with Addendum Z21.47a - 1995	C617.1
Z21.48-92	Gas-Fired Gravity- and Fan-Type Floor Furnaces—with 1993 Addenda (Replaced by Z21.86/CSA 2.32-M98, Vented Gas-Fired Space Hearing Appliances)	C608.1
Z21.49-92	Gas-Fired Gravity- and Fan-Type Vented Wall Furnaces—with 1993 Addendum (Replaced by Z21.86-98/CSA 2.32-M98, Vented Gas-Fired Space Heating Appliances)	C607.1
Z21.50-96	Vented Gas Fireplaces	C604.1
Z21.56-94	Gas-Fired Pool Heaters—with Addendum Z21.56a 1996	C616.1
Z21.58-95	Outdoor Cooking Appliances—with Addendum Z21.58a-1998	C622.1
Z21.60-96	Decorative Gas Appliances for Installation in Solid-Fuel Burning Fireplaces	C602.1
Z21.61-83 (R 1996)	Gas-Fired Toilets	C625.1
Z21.69-97	Connectors for Movable Gas Appliances	C411.1
Z83.4-91	Direct Gas-Fired Make-Up Air Heaters	C610.1
Z83.6-90	Gas-Fired Infrared Heaters	C629.1
Z83.8-96	Gas Unit Heaters—with Z83.8a - 1997	C619.1
Z83.9-90	Gas-Fired Duct Furnaces—with Addendum Z83.9a - 1992	C609.1
Z83.11-96	Gas Food-Service Equipment (Ranges and Unit Broilers), Baking and Roasting Ovens, Fat Fryers, Counter Appliances and Kettles, Steam Cookers, and Steam Generators—with Addendum Z83.11a - 1997	C622.1
Z83.18-90	Direct Gas-Fired Industrial Air Heaters—with Addendum Z83.18a - 1991 and Z83.18b - 1992	C611.1

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)	C403.8
B16.1-99	Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800	C403.11
B16.20-93	Metallic Gaskets for Pipe Flanges - Ring-Joint, Spiral-Wound, and Jacketed—with 1994 Errata, Addenda B16.20a - 1994 and B16.20b - 1997	C403.11
B16.33-91	Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 125 psig (Sizes $^1/_2$ through 2)	C409.1.1
B36.10M-97	Welded and Seamless Wrought-Steel Pipe	C403.3.2

ASTM

American Society for Testing and Materials
100 Barr Harbor Drive
West Conshohocken, PA 19428

Standard reference number	Title	Referenced in code section number
A 53-97b	Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless	C403.3.2

A 106-97a	Specification for Seamless Carbon Steel Pipe for High-Temperature Service	C403.3.2
A 254-97	Specification for Copper Brazed Steel Tubing	C403.4.1
A 539-96	Specification for Electric Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines	C403.4.1
B 88-96	Specification for Seamless Copper Water Tube	C403.4.2
B 210-95	Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes	C403.4.3
B 241-96	Specification for Aluminum and Aluminum-Alloy, Seamless Pipe and Seamless Extruded Tube	C403.3.4, C403.4.3
B 280-98	Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service	C403.4.2
C 64-94	Specification for Refractories for Incinerators and Boilers	C503.10.2.5
C 315-96	Specification for Clay Flue Linings	C501.12
D 2513-95	Specification for Thermo-plastic Gas Pressure Pipe, Tubing, and Fittings	C403.5, C403.10, C404.14.2

AWWA

American Water Works Association
6666 West Quincy Avenue
Denver, CO 80235

Standard reference number	Title	Referenced in code section number
C111-95	Rubber-Gasket Joints—A21.11-95 for Ductile-Iron Pressure Pipe and Fittings	C403.11

DOT

Department of Transportation General Service Administration
7th & D Streets Specification Section, Room 6039
Washington, DC 20407

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	C403.5.1

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	C403.11
SP-58-93	Pipe Hangers and Supports - Materials, Design and Manufacture	C407.2

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	Stationary Combustion Engines and Gas Turbines	C615.1
58-98	Liquified Petroleum Gases Code	C401.2, C402.5.1, C403.5.2, C403.10
82-99	Incinerators, Waste and Linen Handling Systems and Equipment	C606.1
211-96	Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances	C503.5.2

UL Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, IL 60062

Standard reference number	Title	Referenced in code section number
103-95	Factory-Built Chimneys, Residential Type and Building Heating Appliance—with Revisions thru February 1996	C506.1
127-96	Factory-Built Fireplaces—with Revisions through January 1998	C620.7
441-96	Gas Vents—with Revisions thru October 1997	C502.1
641-95	Low Temperature Venting Systems, Type L	C502.1
795-95	Commercial-Industrial Gas Heating Equipment—with Revisions thru January 1996	C609.1, C617.1
959-95	Medium Heat Appliance Factory-Built Chimneys—with Revisions thru April 15, 1998	C506.3
1738-93	Venting Systems for Gas-Burning Appliances, Categories II, III and IV	C502.1
1777-96	Chimney Liners—with Revisions thru August 1998	C501.12, C501.15.4

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CHAPTER C-A

SIZING AND CAPACITIES OF GAS PIPING

(This Chapter is informative and is not part of the Appendix.)

In order to determine the size of piping to be used in designing 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, for special gas utilization equipment, or for conditions other than those covered by Tables C402.3.1(1) through C402.3(4), or Tables C402.3(15), C402.3(16), or C402.3(17) such as longer runs, greater gas demands, or greater pressure drops, the size of each gas piping system should be determined by standard engineering practices acceptable to the authority having jurisdiction.

Description of table

(a) The quantity of gas to be provided at each outlet should be determined, whenever possible, directly from the manufacturer's Btu input rating of the equipment that will be installed. In case the ratings of the equipment to be installed are not known, Table C-A-1 shows the approximate consumption of average appliances of certain types in Btu/h.

To obtain the cubic feet per hour (cfh) of gas required, divide the total Btu input of all equipment by the average Btu heating value per cubic foot of the gas. The average Btu per cubic foot of the gas in the area of the installation may be obtained from the serving gas supplier.

(b) Capacities for gas at low pressure [0.5 psig (3.5 kPa gage) or less] in cfh of 0.60 specific gravity gas for different sizes and lengths are shown in Tables C402.3(1) and C402.3(2) for iron pipe or equivalent rigid pipe, in Tables C402.3(3) and C402.3(4) for smooth wall semirigid tubing, and Tables C402.3(18), C402.3(19), and C402.3(20) for corrugated stainless steel tubing Tables C402.3(1) and C402.3(3) are based upon a pressure drop of 0.3 inch (75 Pa) water column, whereas Tables C402.3(2), C402.3(4), and C402.3(18) are based upon a pressure drop of 0.5 inch (125 Pa) water column. Tables C402.3(19) and C402.3(20) are special low-pressure applications based upon pressure drops greater than 0.5-inch water column (125 Pa). In using these tables, no additional allowance is necessary for an ordinary number of fittings.

(c) Capacities in thousands of Btu/h of undiluted liquefied petroleum gases based on a pressure drop of 0.5-inch (125 Pa) water column for different sizes and lengths are shown in Table C402.3(14) for iron pipe or equivalent rigid pipe and in Table C402.3(15) for smooth wall semirigid tubing, and in Table C402.3(23) for corrugated stainless steel tubing. Tables C402.3(24) and C402.3(25) for corrugated stainless steel tubing are based on pressure drops greater than 0.5-inch water column (125 Pa). In using these tables, no additional allowance is necessary for an ordinary number of fittings.

(d) Gas piping systems that are to be supplied with gas of a specific gravity of 0.70 or less can be sized directly from Tables C402.3(1) through C402.3(4), unless the authority having jurisdiction 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 Tables C402.3(1) through C402.3(4) to capacities with another gas of different specific gravity. Such application is accomplished by multiplying the capacities given in Tables C402.3(1) through C402.3(4) by the multipliers shown in Table (C402.3(13). In case the exact specific gravity does not appear in the table, choose the next higher value specific gravity shown.

(e) Capacities for gas at pressures greater than 0.5 psig (3.5 kPa gage) in cfh of 0.60 specific gravity gas for different sizes and lengths are shown in Tables C402.3(5) to C402.3(12) for iron pipe or equivalent rigid pipe and Tables C402.3(23) and C402.3(24) for corrugated stainless steel tubing.

Use of capacity tables

To determine the size of each section of gas piping in a system within the range of the capacity tables, proceed as follows: (Also see sample calculation at the end of Chapter C-A.)

1. Determine the gas demand of each appliance to be attached to the piping system. Where Tables C402.3(1) through C402.3(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 Table C402.3(25) through C402.3(34) are to be used to select the piping size, calculate the gas demand in terms of thousands of Btu/h for each piping system outlet.
2. 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 the specific gravity of the gas to be used in the piping system.
3. Measure the length of piping from the point of delivery to the most remote outlet in the building. Where a multipressure gas piping system is used, gas piping shall be sized for the maximum length of pipe measured from the gas pressure regulator to the most remote outlet of each similarly pressured section.
4. In the appropriate capacity table, select the column showing the measured length, or the next longer length if the table does not give the exact length. This is the only length used in determining the size of any section of gas piping. If the gravity factor is to be applied, the values in the selected

column of the table are multiplied by the appropriate multiplier from Table C402.3(24).

Capacities of smooth wall pipe or tubing may also be determined by using the following formulae*:

High pressure [1.5 psig (10.3 kPa) and above]:

$$Q = 181.6 \sqrt{\frac{D^5 \cdot (P_1^2 - P_2^2) \cdot Y}{Cr \cdot fba \cdot L}}$$

$$= 2237\, D^{2.623} \left[\frac{(P_1^2 - P_2^2)\, Y}{Cr.L}\right]^{0.541}$$

Low pressure [Less than 1.5 psig (10.3 kPa)]:

$$Q = 187.3 \sqrt{\frac{D^5 \cdot \Delta H}{Cr \cdot fba \cdot L}}$$

$$= 2313\, D^{2.623} \left(\frac{\Delta H}{Cr.L}\right)^{0.541}$$

where:

Q = Rate, cu ft/h at 60°F and 30-inch mercury column

D = Inside diameter of pipe, inch (mm)

P_1 = Upstream pressure, psia

P_2 = Downstream pressure, psia

Y = Superexpansibility factor = 1/supercompressibility factor

Cr = Factor for viscosity, density, and temperature

$$= 0.00354\, ST \left(\frac{Z}{S}\right)^{.152}$$

S = Specific gravity of gas at 60°F and 30-inch mercury column

T = Absolute temperature, °F or = $t + 460$

t = Temperature, °F

Z = Viscosity of gas, centipoise (0.012 for natural gas, 0.008 for propane), or = 1488μ

m = Viscosity, pounds per second ft

fba = Base friction factor for air at 60°F (CF = 1)

L = Length of pipe, ft

ΔH = Pressure drop, inch water column (27.7 in H_2O = 1 psi)

CF = Factor CF = $\left(\frac{fb}{fba}\right)$

fb = Base friction factor for any fluid at a given temperature, °F

*For further details on the formulae, refer to "Polyflo Flow Computer," available from Polyflo Company 3412 High Bluff, Dallas, Texas 75234.

†For values for natural gas, refer to Manual for Determination of Supercompressibility Factors for Natural Gas, available from American Gas Association, 1515 Wilson Boulevard, Arlington, Virginia 22209. For values for liquefied petroleum gases, refer to *Engineering Data Book*, available from Gas Processors Association, 1812 First Place, Tulsa, Oklahoma 74102.

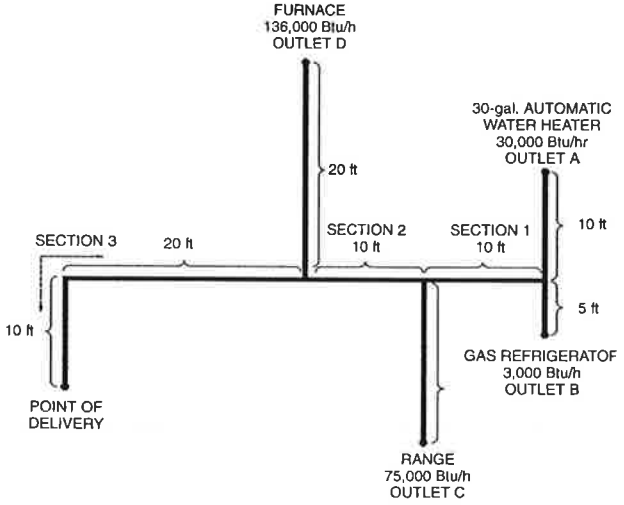
5. Use this vertical column to locate ALL gas demand figures for this particular system of piping.
6. Starting at the most remote outlet, find, in the vertical column just selected, the gas demand for that outlet. If the exact figure of demand is not shown, choose the next larger figure below in the column.
7. Opposite this demand figure, in the first column at the left, will be found the correct size of gas piping.
8. Proceed in a similar manner for each outlet and each section of gas piping. For each section of piping, determine the total gas demand supplied by that section.

TABLE C-A-1
APPROXIMATE GAS INPUT FOR TYPICAL APPLIANCES

APPLIANCE	Input Btu/h (approx.)
Range, Free Standing, Domestic	65,000
Built-In Oven or Broiler Unit, Domestic	25,000
Built-In Top Unit, Domestic	40,000
Water Heater, Automatic Storage 30-to 40-Gal. Tank	45,000
Water Heater, Automatic Storage 50-Gal. Tank	55,000
Water Heater, Automatic Instantaneous	
Capacity — 2 gal. per minute	142,800
Capacity — 4 gal. per minute	285,000
Capacity — 6 gal. per minute	428,000
Water Heater, Domestic, Circulating or Side-Arm	35,000
Refrigerator	3,000
Clothes Dryer, Type I (Domestic)	35,000
Gas Light	2,500
Incinerator, Domestic	35,000

For **SI**: 1 gallon = 3.785 L, 1 Btu/h = 0.293 W.

For specific appliances or appliances not shown above, the input should be determined from the manufacturer's rating.



For **SI:** 1 foot = 304.8 mm, 1 gallon = 3.785 L, 1,000 Btu/h = 0.293 kW.

EXHIBIT 1

Example of piping system design:

Determine the required pipe size of each section and outlet of the piping system shown in Exhibit 1, with a designated pressure drop of 0.50-inch water column (125 Pa). The gas to be used has 0.65 specific gravity and a heating value of 1,000 Btu per cubic foot (37.3 MJ/m^3).

EXHIBIT 1

Solution:

(1) Maximum gas demand for outlet A:

$$\frac{\text{Consumption (rating plate input, or Table C-A-1 if necessary)}}{\text{Btu of gas}} =$$

$$\frac{\text{30,000 Btu per hour rating}}{\text{1,000 Btu per cubic foot}} = \frac{\text{30 cubic feet per hour}}{\text{(or 30 cfh)}}$$

Maximum gas demand for outlet B:

$$\frac{\text{Consumption}}{\text{Btu of gas}} = \frac{3{,}000}{1{,}000} = 3 \text{ cfh}$$

Maximum gas demand for outlet C:

$$\frac{\text{Consumption}}{\text{Btu of gas}} = \frac{75{,}000}{1{,}000} = 75 \text{ cfh}$$

Maximum gas demand for outlet D:

$$\frac{\text{Consumption}}{\text{Btu of gas}} = \frac{136{,}000}{1{,}000} = 136 \text{ cfh}$$

(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 column marked 60 feet (18 288 mm) in Table C402.3(2):

Outlet A, supplying 30 cfh (0.8 m^3/hr), requires $^3/_8$-inch pipe.

Outlet B, supplying 3 cfh (0.08 m^3/h), requires $^1/_4$-inch pipe.

Section 1, supplying outlets A and B, or 33 cfh (0.9 m^3/h), requires $^3/_8$-inch pipe.

Outlet C, supplying 75 cfh (2.1 m^3/h), requires $^3/_4$-inch pipe.

Section 2, supplying outlets A, B, and C, or 108 cfh (3.0 m^3/hr), requires $^3/_4$-inch pipe.

Outlet D, supplying 136 cfh (3.8 m^3/h), requires $^3/_4$-inch pipe.

Section 3, supplying outlets A, B, and C, or 244 cfh (6.8 m^3/h), requires 1-inch pipe.

(4) If the gravity factor [*see (d) under Description of Tables*] is applied to this example, the values in the column marked 60 feet (18 288 mm) of Table C402.3(2) would be multiplied by the multiplier (0.962) from Table C402.3(13) and the resulting cfh values would be used to size the piping.

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CHAPTER C-B

SIZING OF VENTING SYSTEMS SERVING APPLIANCES EQUIPPED WITH DRAFT HOODS, CATEGORY I APPLIANCES, AND APPLIANCES LISTED FOR USE AND TYPE B VENTS

(This Chapter is informative and is not part of the Appendix.)

EXAMPLES USING SINGLE APPLIANCE VENTING TABLES

Example 1: Single draft hood-equipped appliance

An installer has a 120,000 Btu/h (35.2kW/h) input appliance with a 5-inch-diameter (127 mm) draft hood outlet that needs to be vented into a 10-foot-high (3048 mm) Type B vent system. What size vent should be used assuming: (a) a 5-foot-lateral (1524 mm) single-wall metal vent connector is used with two 90-degree elbows, or (b) a 5-foot-lateral (1524 mm) single-wall metal vent connector is used with three 90-degree elbows in the vent system?

Solution:

Table C504.2(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 (3048 mm) height and 5-foot-lateral (1524 mm) is found. Read across this row until a vent capacity greater than 120,000 Btu/h (35.2 kW/h) is located in the shaded columns labeled "NAT Max" for draft hood-equipped appliances. In this case, a 5-inch-diameter (127 mm) vent has a capacity of 122,000 Btu/h (35.2 kW/h) 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 C504.2.3 for Single Appliance Vents). This implies that the 5-inch-diameter (127 mm) vent has an adjusted capacity of only 110,000 Btu/h (32.2 kW/h). In this case, the vent system must be increased to 6 inches (152 mm) in diameter. See calculations below.

122,000 (0.90) = 110,000 for 5-inch (127 mm) vent
From Table 502(2), Select 6-inch (152 mm) vent
186,000 (0.90) = 167,000; This is greater than the required 120,000. Therefore, use a 6-inch (152 mm) vent and connector where three elbows are used.

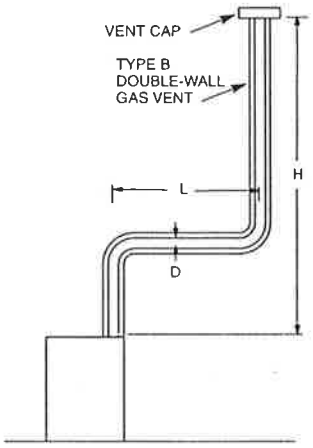


Table C504.2(1) is used when sizing Type B double-wall gas vent connected directly to the appliance.

Note: The appliance may be either Category I draft hood-equipped or fan-assisted type.

FIGURE C-B-1
TYPE B DOUBLE-WALL VENT SYSTEM SERVING A SINGLE APPLIANCE WITH A TYPE B DOUBLE-WALL VENT

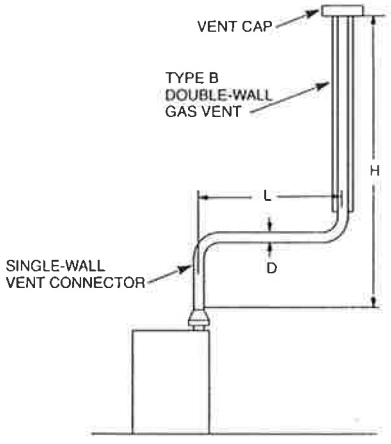


Table C504.2(2) is used when sizing a single-wall metal vent connector attached to a Type B double-wall gas vent.

Note: The appliance may be either Category I draft hood-equipped or fan-assisted type.

FIGURE C-B-2
TYPE B DOUBLE-WALL VENT SYSTEM SERVING A SINGLE APPLIANCE WITH A SINGLE-WALL METAL VENT CONNECTOR

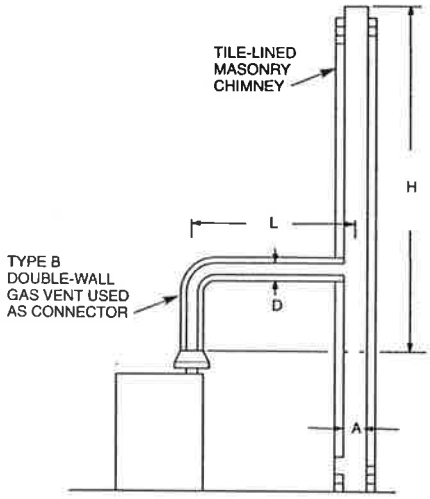
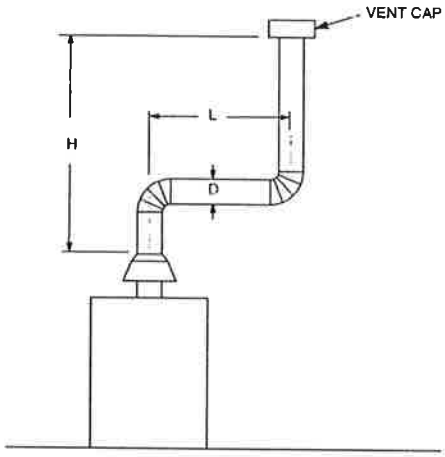


Table C504.2(3) is used when sizing a Type B double-wall gas vent connector attached to a tile-lined masonry chimney.
Note: "A" is the equivalent cross-sectional area of the tile liner

Note: The appliance may be either Category I draft hood-equipped or fan-assisted type.

FIGURE C-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 C504.2(5)].

FIGURE C-B-5
ASBESTOS CEMENT TYPE B OR SINGLE-WALL METAL VENT SYSTEM SERVING A SINGLE DRAFT HOOD-EQUIPPED APPLIANCE

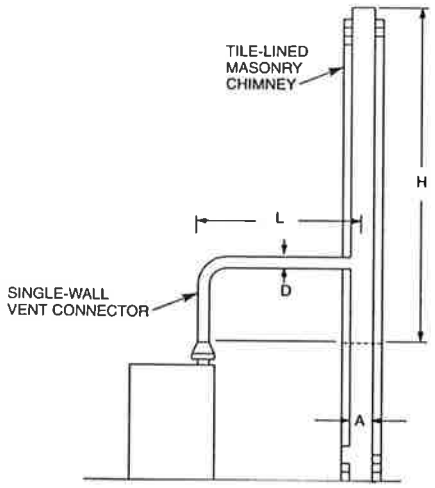


Table C504.2(4) is used when sizing a single-wall vent connector attached to a tile-lined masonry chimney.
Note: "A" is the equivalent cross-sectional area of the tile liner.

Note: The appliance may be either Category I draft hood-equipped or fan-assisted types.

FIGURE C-B-4
VENT SYSTEM SERVING A SINGLE APPLIANCE USING A MASONRY CHIMNEY AND A SINGLE-WALL METAL VENT CONNECTOR

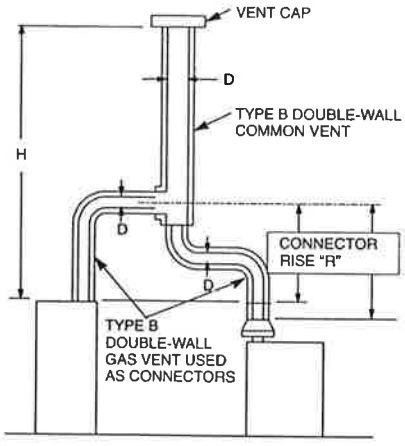


Table C504.3(1) is used when sizing Type B double-wall vent connectors attached to a Type B double-wall common vent.

Note: Each appliance may be either Category I draft hood-equipped or fan-assisted type.

FIGURE C-B-6
VENT SYSTEM SERVING TWO OR MORE APPLIANCES WITH TYPE B DOUBLE-WALL VENT AND TYPE B DOUBLE-WALL VENT CONNECTOR

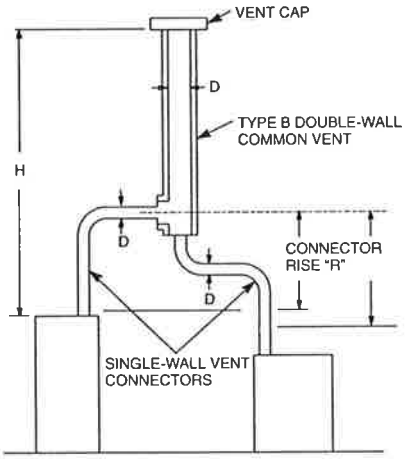


Table C504.3(2) is used when sizing single-wall vent connectors attached to a Type B double-wall common vent.

Note: Each appliance may be either Category I draft hood-equipped or fan-assisted type.

FIGURE C-B-7
VENT SYSTEM SERVING TWO OR MORE APPLIANCES WITH TYPE B DOUBLE-WALL VENT AND SINGLE-WALL METAL VENT CONNECTORS

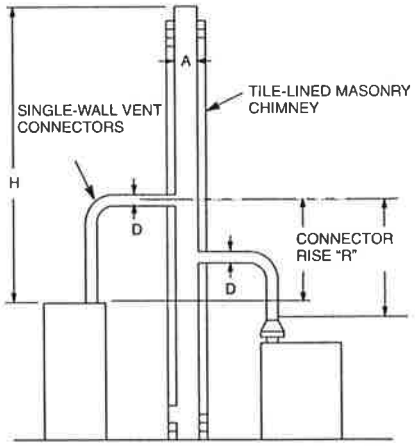


Table C504.3(4) is used when sizing single-wall metal vent connectors attached to a tile-lined masonry chimney.
Note: "A" is the equivalent cross-sectional area of the tile liner.

Note: Each appliance may be either Category I draft hood-equipped or fan-assisted type.

FIGURE C-B-9
MASONRY CHIMNEY SERVING TWO OR MORE APPLIANCES WITH SINGLE-WALL METAL VENT CONNECTORS

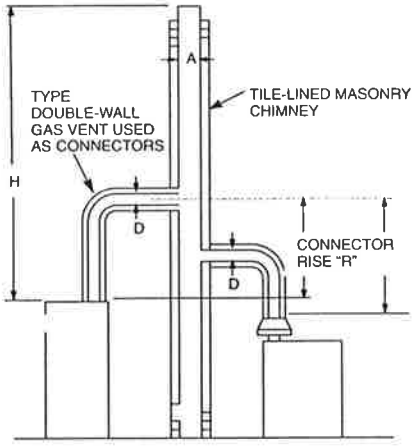
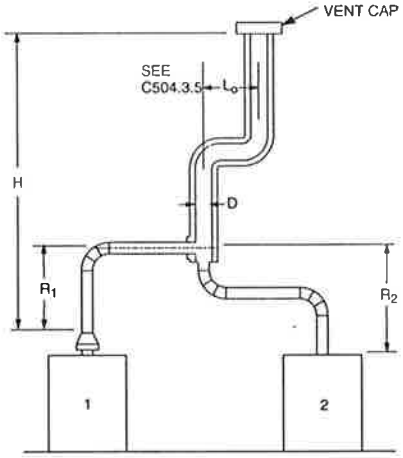


Table C504.3(3) is used when sizing Type B double-wall vent connectors attached to a tile-lined masonry chimney.
Note: "A" is the equivalent cross-sectional area of the tile liner.

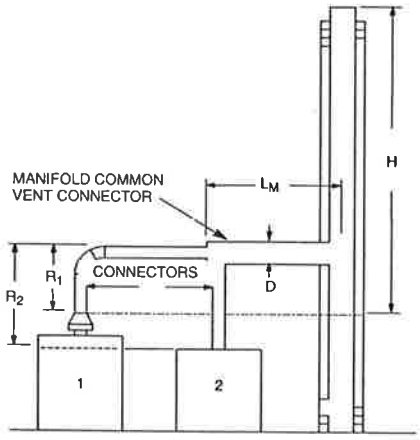
Note: Each appliance may be either Category I draft hood-equipped or fan-assisted type.

FIGURE C-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 C504.2(5)].

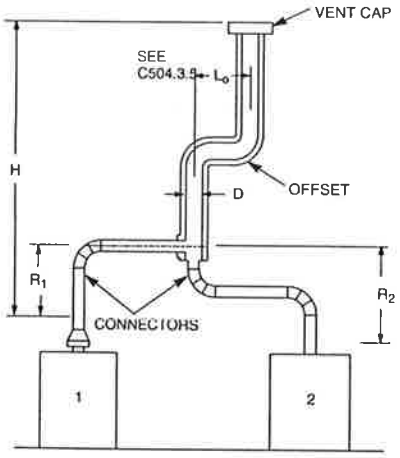
FIGURE C-B-10
ASBESTOS CEMENT TYPE B OR SINGLE-WALL METAL VENT SYSTEM SERVING TWO OR MORE DRAFT HOOD-EQUIPPED APPLIANCES



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 C504.3.4)

Note: This is an illustration of a typical manifolded vent connector. Different appliance, vent connector, or common vent types are possible. Consult Section C502.3.

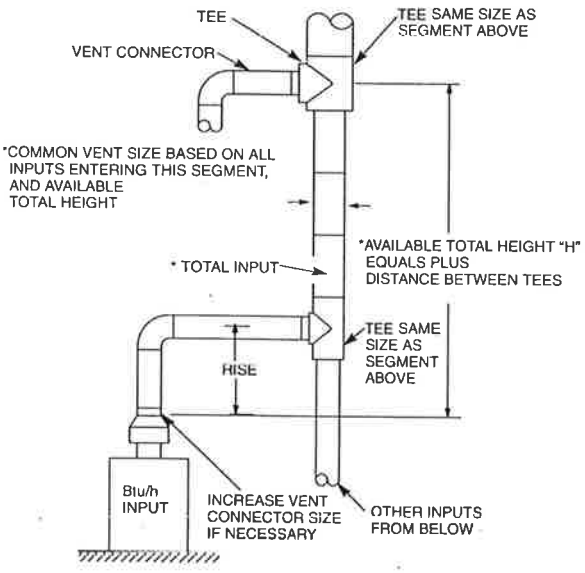
FIGURE C-B-11
USE OF MANIFOLD COMMON VENT CONNECTOR



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 C504.2 and C504.3.

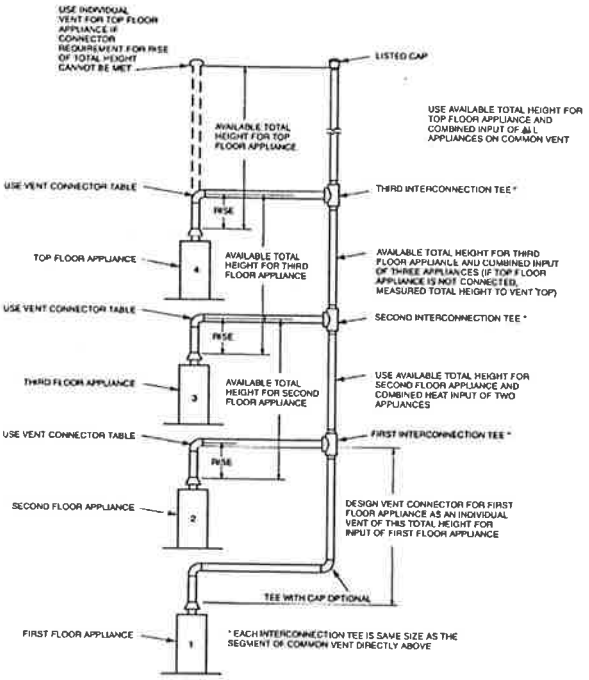
FIGURE C-B-12
USE OF OFFSET COMMON VENT



Vent connector size depends on:
- Input
- Rise
- Available total height *"H"*
- Table C504.3(1) connectors

Common vent size depends on:
- Combined inputs
- Available total height *"H"*
- Table C504.3(1) common vent

FIGURE C-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 C504.3.10 through C504.3.15).

FIGURE C-B-14
MULTISTORY VENT SYSTEMS.

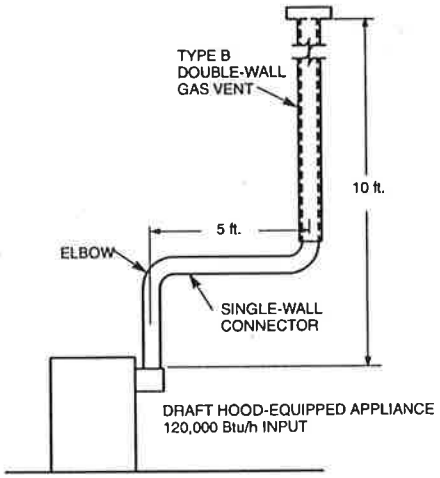


FIGURE C-B-15 (Example 1)
SINGLE DRAFT HOOD-EQUIPPED APPLIANCE

For SI: 1 foot = 304.8 mm, 1,000 Btu/h = 0.2931 kW.

Example 2: Single fan-assisted appliance

An installer has an 80,000-Btu/h-input (23.4 kW) fan-assisted appliance that must be installed using 10 feet (3048 mm) of lateral connector attached to a 30-foot-high (9144 mm) 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 C504.2(2) refers to the use of single-wall metal vent connectors with a Type B vent. In the first column find the row associated with a 30-foot (9144 mm) height and a 10-foot (3048 mm) lateral. Read across this row, looking at the FAN Min and FAN Max columns, to find that a 3-inch-diameter (76 mm) single-wall metal vent connector is not recommended. Moving to the next larger size single-wall connector, we find that a 4-inch-diameter (102 mm) single-wall metal connector has a recommended minimum vent capacity of 91,000 Btu/h (26.7 kW) and a recommended maximum vent capacity of 144,000 Btu/h (42.2 kW). The 80,000-Btu/h (23.4 kW) 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 (3048 mm) of lateral for the connector.

However, if the 80,000-Btu/h-input (23.4 kW) appliance could be moved to within 5 feet (1524 mm) of the vertical vent, then a 4-inch (102 mm) single-wall metal connector could be used to vent the appliance. Table C504.2(2) shows the acceptable range of vent capacities for a 4-inch vent with 5 feet (1524 mm) of lateral to be between 72,000 Btu/h (21.1 kW) and 157,000 Btu/h (46.0 kW).

If the appliance cannot be moved closer to the vertical vent, then a Type B vent could be used as the connector material. In this case, Table C504.2(1) shows that for a 30-foot-high (9144 mm) vent with 10 feet (3048 mm) of lateral, the acceptable range of vent capacities for a 4-inch-diameter (102 mm) vent attached to a fan-assisted appliance is between 37,000 Btu/h (10.8 kW) and 150,000 Btu/h (44.0 kW).

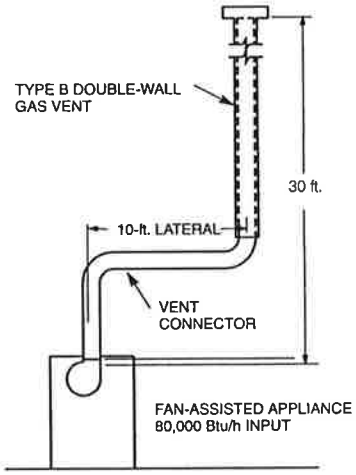


FIGURE C-B-16 (Example 2)
SINGLE FAN-ASSISTED APPLIANCE

For SI: 1 foot = 304.8 mm, 1,000 Btu/h = 0.2931 kW.

Example 3: Interpolating between table values

An installer has an 80,000-Btu/h-input (23.4 kW) appliance with a 4-inch-diameter (102 mm) draft hood outlet that needs to be vented into a 12-foot-high (3658 mm) Type B vent. The vent connector has a 5-foot-lateral (1524 mm) length and is also Type B. Can this appliance be vented using a 4-inch-diameter (102 mm) vent?

Solution:

Table C504.2(1) is used in the case of an all Type B vent system. However, because there is no entry in Table C504.2(1) for a height of 12 feet (3658 mm), interpolation must be used. Read down the 4-inch-diameter (102 mm) NAT Max column to the row associated with 10-foot (3048 mm) height and 5-foot (1524 mm) lateral to find the capacity value of 77,000 Btu/h (22.6 kW). Read further down to the 15-foot-height (4572 mm), 5-foot-lateral (1524 mm) row to find the capacity value of 87,000 Btu/h (25.5 kW). The difference between the 15-foot-height (4572 mm) capacity value and the 10-foot-height (3048 mm) capacity value is 10,000 Btu/h (29.3 kW). The capacity for a vent system with a 12-foot (3658 mm) height is equal to the capacity for a 10-foot-height (3048mm) plus $^2/_5$ of the difference between the 10-foot (3048 mm) and 15-foot-height (4572 mm) values, or 77,000 (22.6 kW) + $^2/_5$ (10,000) (29.3 kW) = 81,000 Btu/h (23.7 kW).) Therefore, a 4-inch-diameter (102 mm) 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/h (10.3 kW) water heater is to be common vented with a 150,000-Btu/h (44.0 kW) furnace using a common vent with a total height of 30 feet (9144 mm). The connector rise is 2 feet (610 mm) for the water heater with a horizontal length of 4 feet (1219 mm). The connector rise for the furnace is 3 feet (914 mm) with a horizontal length of 8 feet (2438 mm). Assume single-wall metal connectors will be used with a Type B vent.

What size connectors and combined vent should be used in this installation?

Solution:

Table C504.3(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 C504.3(2), find the row associated with a 30-foot (9144 mm) vent height. For a 2-foot (610 mm) 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 (76 mm) vent connector has a capacity of 37,000 Btu/h (10.8 kW). Therefore, a 3-inch (76 mm) single-wall metal vent connector may be used with the water heater. For a draft hood-equipped furnace with a 3-foot (914 mm) rise, read across the appropriate row to find that a 5-inch-diameter (127 mm) vent connector has a maximum capacity of 120,000 Btu/h (35.2 kW) (which is too small for the furnace) and a 6-inch-diameter (152 mm) vent connector has a maximum vent capacity of 172,000 Btu /h (50.1 kW). Therefore, a 6-inch-diameter vent connector should be used with the 150,000-Btu/h (44.0 kW) furnace. Since both vent connector horizontal lengths are less than the maximum lengths listed in Section C504.3.2, the table values may be used without adjustments.

In the common vent capacity portion of Table C504.3(2), find the row associated with a 30-foot (9144 mm) vent height and read over to the NAT + NAT portion of the 6-inch-diameter (152 mm) column to find a maximum combined capacity of 257,000 Btu/h (75.3 kW). Because the two appliances total only 185,000 Btu/h (54.2 kW), a 6-inch (152 mm) common vent may be used.

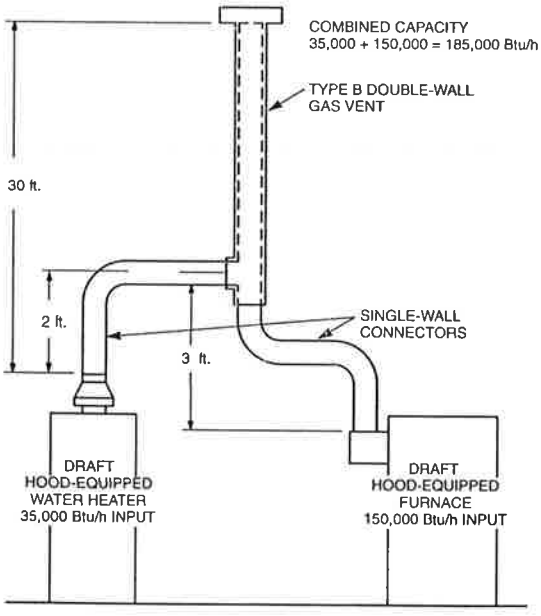


FIGURE C-B-17 (Example 4)
COMMON VENTING TWO DRAFT HOOD-EQUIPPED APPLIANCES

For SI: 1 foot = 304.8 mm; 1,000 Btu per hour = 0.2931 kW.

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/h-input (10.3 kW) draft hood-equipped water heater with a 4-inch-diameter (102 mm) draft hood outlet, 2 feet (610 mm) of connector rise, and 4 feet (1219 mm) of horizontal length is to be common vented with a 100,000-Btu/h (29.3 kW) fan-assisted furnace with a 4-inch-diameter (102 mm) flue collar, 3 feet (914 mm) of connector rise, and 6 feet (1828 mm) of horizontal length. The common vent consists of a 30-foot (9144 mm) 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 C504.3(2)]

Water Heater Vent Connector Diameter. Since the water heater vent connector horizontal length of 4 feet (1219 mm) is less than the maximum value listed in Section C504.3.2, the venting table values may be used without adjustments. Using the Vent Connector Capacity portion of Table C504.3(2), read down the Total Vent Height *(H)* column to 30 feet (9144 mm) and read across the 2-foot (610 mm) 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 (76 mm) vent connector has a maximum input rating of 37,000 Btu/h (10.8 kW). Although this is greater than the water heater input rating, a 3-inch (76 mm) vent connector is prohibited by Section C504.3.19. A 4-inch (102 mm) vent connector has a maximum input rating of 67,000 Btu/h and is equal to the draft hood outlet diameter. A 4-inch (102 mm) 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 C504.3(2), read down the Total Vent Height *(H)* column to 30 feet (9144 mm) and across the 3-foot (914 mm) Connector Rise *(R)* row. Since the furnace has a fan-assisted combustion system, find the first FAN Max column with a Btu/h rating greater than the furnace input rating. The 4-inch (102 mm) vent connector has a maximum input rating of 119,000 Btu/h (34.9 kW) and a minimum input rating of 85,000 Btu/h (24.9 kW). The 100,000-Btu/h (29.3 kW) furnace in this example falls within this range, so a 4-inch (102 mm) connector is adequate. Since the furnace vent connector horizontal length of 6 feet (1828 mm) does not exceed the maximum value listed in Section C504.3.2 for Multiple Appliance Vents, Tables C504.3(1) through C504.3(5), Note 2, the venting table values may be used without adjustment. If the furnace had an input rating of 80,000 Btu/h (23.4 kW), then a Type B vent connector (see Table C504.3(1)) would be needed to meet the minimum capacity limit.

Common Vent Diameter. The total input to the common vent is 135,000 Btu/h (39.6 kW). Using the Common Vent Capacity portion of Table C504.3(2), read down the Total Vent Height *(H)* column to 30 feet (9144 mm) and across this row to find the smallest vent diameter in the FAN + NAT column that has a Btu/h rating equal to or greater than 135,000 Btu/h (39.6 kW). The 4-inch (102 mm) common vent has a capacity of 132,000 Btu/h (38.7 kW) and the 5-inch (127 mm) common vent has a capacity of 202,000 Btu/h (59.2 kW). Therefore, the 5-inch (127 mm) common vent should be used in this example.

Summary. In this example, the installer may use a 4-inch-diameter (102 mm), single-wall metal vent connector for the water heater and a 4-inch-diameter (102 mm), single-wall metal vent connector for the furnace. The common vent should be a 5-inch-diameter (127 mm) Type B vent.

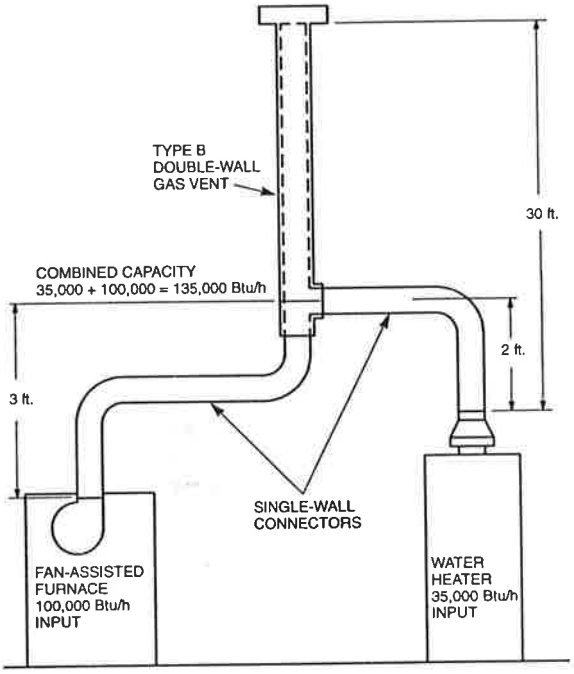


FIGURE C-B-18 (Example 5A)
COMMON VENTING A DRAFT HOOD WITH A FAN-ASSISTED FURNACE INTO A TYPE B DOUBLE-WALL COMMON VENT

For **SI:** 1 foot = 304.8 mm; 1,000 Btu per hour = 0.2931 kW.

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 (9144 mm). 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 (203 mm by 305 mm). 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 C504.3(4) is used to size common venting installations involving single-wall connectors into masonry chimneys.

Water Heater Vent Connector Diameter. Using Table C504.3(4), Vent Connector Capacity, read down the Total Vent Height *(H)* column to 30 feet (9144 mm), and read across the 2-foot (610 mm) 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 (76 mm) vent connector has a maximum input of only 31,000 Btu/h (9.1 kW) while a 4-inch (102 mm) vent connector has a maximum input of 57,000 Btu/h (16.7 kW). A 4-inch (102 mm) vent connector must therefore be used.

Furnace Vent Connector Diameter. Using the Vent Connector Capacity portion of Table C504.3(4), read down the Total Vent Height *(H)* column to 30 feet (9144 mm) and across the 3-foot (914 mm) Connector Rise *(R)* row. Because the furnace has a fan-assisted combustion system, find the first FAN Max column with a Btu/h rating greater than the furnace input rating. The 4-inch (102 mm) vent connector has a maximum input rating of 127,000 Btu/h (37.2 kW) and a minimum input rating of 95,000 Btu/h (27.8 kW). The 100,000-Btu/h (29.3 kW) furnace in this example falls within this range, so a 4-inch (102 mm) connector is adequate.

Masonry Chimney. From Table C-B-1, the equivalent area for a nominal liner size of 8 inches by 12 inches (203 mm by 305 mm) is 63.6 square inches (41 032 mm^2). Using Table C504.3(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 (9144 mm) height to find a capacity value of 739,000 Btu/h (217 kW). The combined input rating of the furnace and water heater, 135,000 Btu/h (39.6 kW), is less than the table value, so this is an acceptable installation.

Section C504.3.15 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 (102 mm) outlets. From Table C-B-1, the equivalent area for an inside diameter of 4 inches (102 mm) is 12.2 square inches (7871 mm^2). 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 C504.3.18, Type B vent connectors are required to be used with exterior masonry chimneys. Use Table C504.3(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 C504.3(8) can be found in ASHRAE Handbook of Fundamentals. For Charlotte, North Carolina, this design temperature is 19°F (-7°C).

Chimney Liner Requirement. As in Example 5b, use the 63-square inch (40 645 mm^2) Internal Area columns for this size clay tile liner. Read down the 63-square inch (40 645 mm^2) column of Table C504.3(8a) to the 30-foot-height (9144 mm) row to find that the combined Appliance Maximum Input is 747,000 Btu/h (219 kW). The combined input rating of the appliances in this installation, 135,000 Btu/h (39.6 kW), is less than the maximum value, so this criterion is satisfied. Table C504(8b), at a 19°F (-7°C) 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/h (138 kW). The furnace input rating of 100,000 Btu/h (29.3 kW) 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 C504.3.17, Tables C504.3(1) or C504.3(2) are 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 C504.3(1), Vent Connector Capacity, read down the Total Vent Height *(H)* column to 30 feet (9144 mm), and read across the 2-foot (610 mm) 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 (76 mm) vent connector has a maximum capacity of 39,000 Btu/h (11.4 kW). So the 35,000-Btu/h (10.3 kW) water heater in this example can use a 3-inch (76 mm) connector.

Furnace Vent Connector Diameter. Using Table C504.3(1), Vent Connector Capacity, read down the Total Vent Height *(H)* column to 30 feet (9144 mm), and read across the 3-foot (9144 mm) Connector Rise *(R)* row to the first Btu/h rating in the FAN Max column that is equal to or greater than the furnace input rating. The 100,000-Btu/h (29.3 kW) furnace in this example falls within this range, so a 4-inch (102 mm) connector is adequate.

Chimney Liner Diameter. The total input to the common vent is 135,000 Btu/h (39.6 kW). Using the Common Vent Capacity portion of Table C504.3(1), read down the Total Vent Height *(H)* column to 30 feet (9144 mm) and across this row to find the smallest vent diameter in the FAN+NAT column that has a Btu/h rating greater than 135,000 Btu/h (39.6 kW). The 4-inch (102 mm) common vent has a capacity of 138,000 Btu/h (40.4 kW). Reducing the maximum capacity by 20 percent (502.3.17) results in a maximum capacity for a 4-inch corrugated liner of 110,000 Btu/h (32.2 kW), less than the total input of 135,000 Btu/h (39.6 kW). So a larger liner is needed. The 5-inch (127 mm) common vent capacity listed in Table C504.3(1) is 210,000 Btu/h (61.6 kW), and after reducing by 20 percent is 168,000 Btu/h (49.2 kW). Therefore, a 5-inch (127 mm) 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 C504.3(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 C-B-1
MASONRY CHIMNEY LINER DIMENSIONS WITH CIRCULAR EQUIVALENTS[a]

NOMINAL LINER SIZE (Inches)	INSIDE DIMENSIONS OF LINER (Inches)	INSIDE DIAMETER OR EQUIVALENT DIAMETER (Inches)	EQUIVALENT AREA (Square Inches)
4 x 8	$2^1/_2$ x $6^1/_2$	4	12.2
		5	19.6
		6	28.3
		7	38.3
8 x 8	$6^3/_4$ x $6^3/_4$	7.4	42.7
		8	50.3
8 x 12	$6^1/_2$ x $10^1/_2$	9	63.6
		10	78.5
12 x 12	$9^3/_4$ x $9^3/_4$	10.4	83.3
		11	95
12 x 16	$9^1/_2$ x $13^1/_2$	11.8	107.5
		12	113.0
		14	153.9
16 x 16	$13^1/_4$ x $13^1/_4$	14.5	162.9
		15	176.7
16 x 20	13 x 17	16.2	206.1
		18	254.4
20 x 20	$16^3/_4$ x $16^3/_4$	18.2	260.2
		20	314.1
20 x 24	$16^1/_2$ x $20^1/_2$	20.1	314.2
		22	380.1
24 x 24	$20^1/_4$ x $20^1/_4$	22.1	380.1
		24	452.3
24 x 28	$20^1/_4$ x $24^1/_4$	24.1	456.2
28 x 28	$24^1/_4$ x $24^1/_4$	26.4	543.3
		27	572.5
30 x 30	$25^1/_2$ x $25^1/_2$	27.9	607
		30	706.8
30 x 36	$25^1/_2$ x $31^1/_2$	30.9	749.9
		33	855.3
36 x 36	$31^1/_2$ x $31^1/_2$	34.4	929.4
		36	1017.9

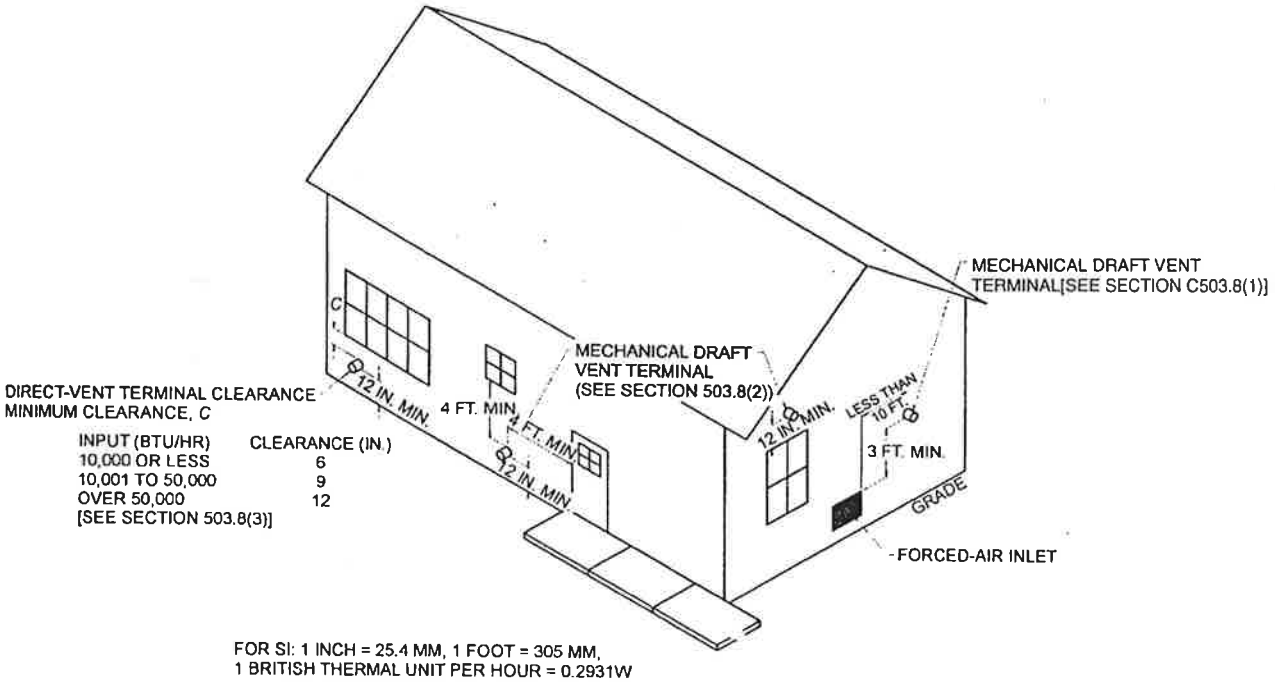
For **SI:** 1 inch = 25.4 mm, 1 inch^2 = 645.16 mm^2.

a. Where liner sizes differ dimensionally from those shown in Table C-B-1, equivalent diameters may be determined from published tables for square and rectangular ducts of equivalent carrying capacity or by other engineering methods.

CHAPTER C-C

EXIT TERMINALS OF MECHANICAL DRAFT AND DIRECT-VENT VENTING SYSTEMS

(This Chapter is informative and is not part of the Appendix.)



FOR SI: 1 INCH = 25.4 MM, 1 FOOT = 305 MM,
1 BRITISH THERMAL UNIT PER HOUR = 0.2931W

APPENDIX C-C
EXIT TERMINALS OF MECHANICAL DRAFT AND DIRECT-VENT SYSTEM

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CHAPTER C-D

RECOMMENDED PROCEDURE FOR SAFETY INSPECTION OF AN EXISTING APPLIANCE INSTALLATION

(This Chapter is informative and is not part of the Appendix.)

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.

1. This procedure should be performed prior to any attempt at modification of the appliance or of the installation.
2. 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.

These 16 steps should be followed when making the safety inspection:

1. Conduct a test for gas leakage.
2. Visually inspect the venting system for proper size and horizontal pitch and determine there is no blockage or restriction, leakage, corrosion, or 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 C304 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 re-establishing 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 the flame of a match or candle or smoke from a cigarette, cigar, or pipe.
12. Turn on all other fuel-gas-burning appliances within the same room so each will operate at its full input. **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 appliances 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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INDEX

E

F

G

H

I

J

K

L

M

N

O

P

R

S

T

U

V

W