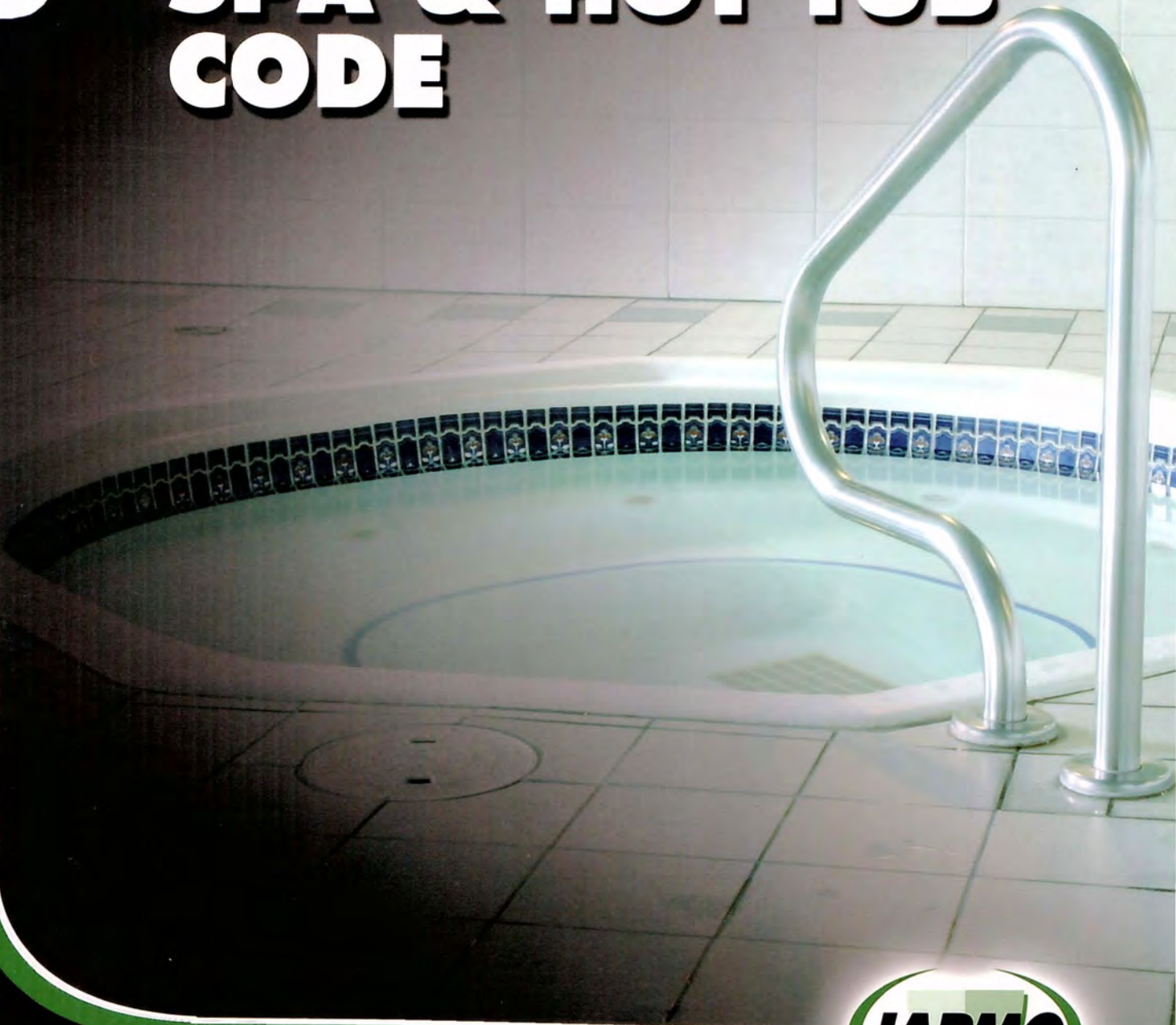


2006

# UNIFORM SWIMMING POOL, SPA & HOT TUB CODE



Safe Plumbing System Requirements



## FOREWORD

The advantages of a Uniform Swimming Pool, Spa and Hot Tub Code, acceptable in the various jurisdictions, have long been recognized. The increasing needs for such a code induced the International Association of Plumbing and Mechanical Officials to pass a resolution at their 46th Annual Business Conference, which directed the president to form a committee to develop a basic solar energy document.

After months of concerted endeavor, this committee, composed of representatives from industry and public utility companies, inspectors, plumbers, and engineers, successfully completed the first edition of the Uniform Swimming Pool, Spa and Hot Tub Code which was officially adopted by the International Association of Plumbing and Mechanical Officials in September 1976.

In presenting the 2006 edition, IAPMO recognizes that the ultimate code has not yet been attained. All extractions indicated in this code are referenced from the 2003 Uniform Plumbing Code. Users of this code are respectfully urged to present whatever amendments their experience may dictate to the IAPMO headquarters, not later than March 1 of each year, so that by formal adoption of such, uniformity may be maintained and all will benefit. Amendments adopted by the membership are incorporated and published every three years. This process serves to keep this basic document abreast of technological development.

The use of this document is intended to provide a safe and functional swimming pool, spa and hot tub system with minimum regulations. Users of the Uniform Swimming Pool, Spa and Hot Tub Code are urged to strive for not just the minimum good swimming pool, spa and hot tub system, but to keep the consumer in mind. With the exception of "high use and wear portions" of the system, the swimming pool, spa and hot tub system should have the same life as other components of the building.

The Uniform Swimming Pool, Spa and Hot Tub Code is dedicated to all those who have unselfishly devoted their time and effort to create and maintain it.





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## CHAPTER 1

### ADMINISTRATION

#### **101.0 Title, Purpose and Scope.**

##### **101.1 Title.**

This document shall be known as the "Uniform Swimming Pool, Spa and Hot Tub Code" and will be referred to as "this code" herein.

##### **101.2 Purpose.**

This code is an ordinance providing minimum requirements and standards for the protection of the public health, safety, and welfare. [UPC 101.2]

##### **101.3 Plans Required.**

The Authority Having Jurisdiction may require the submission of plans, specifications, drawings, and such other information as the Authority Having Jurisdiction may deem necessary, prior to the commencement of, and at any time during the progress of, any work regulated by this code.

The issuance of a permit upon plans and specifications shall not prevent the Authority Having Jurisdiction from thereafter requiring correction of errors in said plans and specifications or from preventing construction operations being carried on thereunder when in violation of this code or of any other pertinent ordinance or from revoking any certificate of approval when issued in error. [UPC 101.3]

##### **101.4 Scope.**

**101.4.1** The provisions of this code shall apply to the erection, installation, alteration, addition, repair, relocation, replacement, addition to, use or maintenance of swimming pools, spas, or hot tub plumbing systems within this jurisdiction.

**101.4.1.1 Repairs and Alterations.** In existing buildings or premises in which swimming pools, spas or hot tub plumbing installations are to be altered, repaired, or renovated, deviations from the provisions of this code are permitted, provided such deviations are found to be necessary and are first approved by the Authority Having Jurisdiction. [UPC 101.4.1.1.1]

**101.4.1.2 Maintenance.** The plumbing and drainage system of any premises under the jurisdiction of the Authority Having Jurisdiction shall be maintained in a sanitary and safe operating condition by the owner or the owner's agent. [UPC 101.4.1.2]

**101.4.1.3 Existing Construction.** No provision of this code shall be deemed to

require a change in any portion of a swimming pool, spa, or hot tub plumbing system or any other work regulated by this code in or on an existing building or lot when such work was installed and is maintained in accordance with law in effect prior to the effective date of this code, except when any such swimming pool, spa, or hot tub plumbing system or other work regulated by this code is determined by the Authority Having Jurisdiction to be in fact dangerous, unsafe, insanitary, or a nuisance and a menace to life, health, or property. [UPC 101.4.1.3]

##### **101.4.1.4 Conflicts Between Codes.**

When the requirements within the jurisdiction of this code conflict with the requirements of the plumbing or mechanical code, this code shall prevail. [UPC 101.4.1.4]

**101.4.2** Additions, alterations, repairs, and replacement of swimming pool, spa, or hot tub plumbing systems shall comply with the provisions for new systems except as otherwise provided in Section 101.5. [UPC 101.4.2]

#### **101.5 Application to Existing Swimming Pool, Spa, or Hot Tub Plumbing System.**

**101.5.1 Additions, Alterations, or Repairs.** Additions, alterations, or repairs may be made to any swimming pool, spa, or hot tub plumbing system without requiring the existing swimming pool, spa, or hot tub plumbing system to comply with all the requirements of this code, provided the addition, alteration, or repair conforms to that required for a new swimming pool, spa, or hot tub plumbing system. Additions, alterations, or repairs shall not cause an existing system to become unsafe, insanitary, or overloaded. [UPC 101.5.1]

**101.5.2 Health and Safety.** Whenever compliance with all the provisions of this code fails to eliminate or alleviate a nuisance, or any other dangerous or insanitary condition that may involve health or safety hazards, the owner or the owner's agent shall install such additional swimming pool, spa, or hot tub facilities

or shall make such repairs or alterations as may be ordered by the Authority Having Jurisdiction. [UPC 101.5.2]

**101.5.3 Existing Installations.** Any swimming pool, spa, or hot tub plumbing system lawfully in existence at the time of the adoption of this code may have their use, maintenance, or repair continued if the use, maintenance, or repair is in accordance with the original design and location and no hazard to life, health, or property has been created by such system. [UPC 101.5.3]

**101.5.4 Changes in Building Occupancy.** Swimming pool, spa, or hot tub plumbing systems that are a part of any building or structure undergoing a change in use or occupancy, as defined in the Building Code, shall comply to all requirements of this code that may be applicable to the new use or occupancy. [UPC 101.5.4]

**101.5.5 Maintenance.** All swimming pool, spa, or hot tub plumbing systems, materials, and appurtenances, both existing and new, and all parts thereof shall be maintained in proper operating condition. All devices or safeguards required by this code shall be maintained in conformance with the code edition under which installed. The owner or the owner's designated agent shall be responsible for maintenance of swimming pool, spa, or hot tub plumbing systems. To determine compliance with this subsection, the Authority Having Jurisdiction may cause any swimming pool, spa, or hot tub plumbing system to be reinspected. [UPC 101.5.5]

**101.5.6 Moved Buildings.** Swimming pool, spa, or hot tub plumbing systems that are part of buildings or structures moved into this jurisdiction shall comply with the provisions of this code for new installations except as provided for in Section 103.5.5.2. [UPC 101.5.6]

## **102.0 Organization and Enforcement.**

### **102.1 Authority Having Jurisdiction.**

The Authority Having Jurisdiction shall be the Authority duly appointed to enforce this code. [UPC 102.1]

### **102.2 Duties and Powers of the Authority Having Jurisdiction.**

**102.2.1** The Authority Having Jurisdiction may appoint such assistants, deputies, inspectors, or other employees as are authorized to carry out the functions of the department and this code. [UPC 102.2.1]

**102.2.2 Right of Entry.** Whenever it is necessary to make an inspection to enforce any of the provisions of this code, or whenever the Authority Having Jurisdiction or its authorized representative has reasonable cause to believe that there exists in any building or upon any premises any condition or violation of this code that makes the swimming pool, spa, or hot tub unsafe, insanitary, dangerous, or hazardous, the Authority Having Jurisdiction may enter the building or premises at all reasonable times to inspect or to perform the duties imposed upon the Authority Having Jurisdiction by this code provided that if such building or premises is occupied, the Authority Having Jurisdiction shall present credentials to the occupant and request entry. If the building or premises is unoccupied, the Authority Having Jurisdiction shall first make a reasonable effort to locate the owner or other persons having charge or control of the building or premises and request entry. If entry is refused, the Authority Having Jurisdiction has recourse to every remedy provided by law to secure entry.

When the Authority Having Jurisdiction shall have first obtained a proper inspection warrant or other remedy provided by law to secure entry, no owner, occupant or person having charge, care, or control of any building or premises shall fail or neglect, after proper request is made as herein provided, to properly permit entry therein by the Authority Having Jurisdiction for the purpose of inspection and examination pursuant to this code. [UPC 102.2.2]

**102.2.3 Stop Orders.** Whenever any work is being done contrary to the provisions of this code, the Authority Having Jurisdiction may order the work stopped by notice in writing served on any persons engaged in the doing or causing such work to be done, and any such persons shall forthwith stop such work until authorized by the Authority Having Jurisdiction to proceed with the work. [UPC 102.2.3]

**102.2.4 Authority to Disconnect Utilities in Emergencies.** The Authority Having Jurisdiction shall have the authority to disconnect a swimming pool, spa, or hot tub

plumbing system to a building, structure, or equipment regulated by this code in case of emergency where necessary to eliminate an immediate hazard to life or property. [UPC 102.2.4]

**102.2.5 Authority to Condemn.** Whenever the Authority Having Jurisdiction ascertains that any swimming pool, spa, or hot tub plumbing system or portion thereof, regulated by this code, has become hazardous to life, health, property, or has become insanitary, the Authority Having Jurisdiction shall order in writing that such swimming pool, spa, or hot tub plumbing system either be removed or placed in a safe or sanitary condition, as appropriate. The order shall fix a reasonable time limit for compliance. No person shall use or maintain a defective swimming pool, spa, or hot tub plumbing system after receiving such notice.

When such swimming pool, spa, or hot tub plumbing system is to be disconnected, written notice shall be given. In cases of immediate danger to life or property, such disconnection may be made immediately without such notice. [UPC 102.2.5]

**102.2.6 Liability.** The Authority Having Jurisdiction charged with the enforcement of this code, acting in good faith and without malice in the discharge of the Authority Having Jurisdiction's duties, shall not thereby be rendered personally liable for any damage that may accrue to persons or property as a result of any act or by reason of any act or omission in the discharge of duties. A suit brought against the Authority Having Jurisdiction or employee because of such act or omission performed in the enforcement of any provision of this code shall be defended by legal counsel provided by this jurisdiction until final termination of such proceedings. [UPC 102.2.6]

### **102.3 Violation and Penalties.**

**102.3.1 Violations.** It shall be unlawful for any person, firm, or corporation to erect, construct, enlarge, alter, repair, move, improve, remove, convert, demolish, equip, use, or maintain any swimming pool, spas and hot tub plumbing system or permit the same to be done in violation of this code. [UPC 102.3.1]

**102.3.2 Penalties.** Any person, firm, or corporation violating any provision of this code shall be deemed guilty of a misdemeanor and upon conviction thereof shall be punishable by a fine and/or by imprisonment

set forth by the governing laws of the jurisdiction. Each separate day or any portion thereof during which any violation of this code occurs or continues shall be deemed to constitute a separate offense. [UPC 102.3.2]

### **103.0 Permits and Inspections.**

#### **103.1 Permits.**

**103.1.1 Permits Required.** It shall be unlawful for any person, firm or corporation to make any installation, alteration, repair, replacement or remodel of any swimming pool, spa or hot tub, gas or drainage piping work; swimming pool heater; or treating equipment regulated by this code except as permitted in Section 103.1.2 or to cause the same to be done without first obtaining a separate permit for each building, structure or swimming pool, spa or hot tub. [UPC 103.1.1]

**103.1.2 Exempt Work.** A permit shall not be required for the following: [UPC 103.1.2]

**103.1.2.1** The stopping of leaks in drains, soil, waste or vent pipe, provided, however, that should any trap, drainpipe or soil, waste or vent pipe be or become defective and it becomes necessary to remove and replace the same with new material, the same shall be considered as new work and a permit shall be procured and inspection made, as provided in this code. [UPC 103.1.2.1]

**103.1.2.2** The clearing of stoppages or the repairing of leaks in pipes, valves or fixtures, provided such repairs do not involve or require the replacement or rearrangement of valves, pipes, or fixtures. Exemption from the permit requirements of this code shall not be deemed to grant authorization for any work to be done in violation of the provisions of the code or any other laws or ordinances of this jurisdiction. [UPC 103.1.2.2]

#### **103.2 Application for Permit.**

**103.2.1 Application.** To obtain a permit, the applicant shall first file an application therefor in writing on a form furnished by the Authority Having Jurisdiction for that purpose. Every such application shall: [UPC 103.2.1]

**103.2.1.1** Identify and describe the work to be covered by the permit for which application is made. [UPC 103.2.1.1]

**103.2.1.2** Describe the land upon which the proposed work is to be done by legal description, street address, or similar

description that will readily identify and definitely locate the proposed building or work. [UPC 103.2.1.2]

**103.2.1.3** Indicate the use or occupancy for which the proposed work is intended. [UPC 103.2.1.3]

**103.2.1.4** Be accompanied by plans, diagrams, computations, and other data as required in Section 103.2.2. [UPC 103.2.1.4]

**103.2.1.5** Be signed by permittee or the permittee's authorized agent, who may be required to submit evidence to indicate such authority. [UPC 103.2.1.5]

**103.2.1.6** Give such other data and information as may be required by the Authority Having Jurisdiction. [UPC 103.2.1.6]

**103.2.2 Plans and Specifications.** Plans, engineering calculations, diagrams, and other data shall be submitted in one or more sets with each application for a permit. The Authority Having Jurisdiction may require plans, computations, and specifications to be prepared by and the plumbing designed by an engineer and/or architect licensed by the state to practice as such.

**Exception:** The Authority Having Jurisdiction may waive the submission of plans, calculations, or other data if the Authority Having Jurisdiction finds that the nature of the work applied for is such that reviewing of plans is not necessary to obtain compliance within the code. [UPC 103.2.2]

**103.2.3 Information on Plans and Specifications.** Plans and specifications shall be drawn to scale upon substantial paper or cloth and shall be of sufficient clarity to indicate the location, nature, and extent of the work proposed and show in detail that it will conform to the provisions of this code and relevant laws, ordinances, rules, and regulations. [UPC 103.2.3]

**103.2.4** A structural plan showing at least the following shall be provided:

**103.2.4.1** The type of construction, whether gunite, poured concrete, prefabricated, or other.

**103.2.4.2** The dimension, including the depth, and adequate cross-sections drawn to scale.

**103.2.4.3** Computations, stress diagrams, and other data sufficient to show the correctness of the plans, including the reinforcing steel schedule and detail.

**103.2.5** A mechanical plan showing at least the following shall be provided:

**103.2.5.1** The volume, system flow rate in gallons per minute, and turnover in hours.

**103.2.5.2** The type and size of filtration system and means of waste disposal.

**103.2.5.3** The type and size of pool, spa or hot tub heater, if included, including the method of venting and provisions for combustion air.

**103.2.5.4** The pool, spa or hot tub piping layout with all sizes shown and types of material to be used, and showing the location of the main outlet, surface skimmers, and inlets.

**103.2.5.5** The rated capacity of the pool pump in gpm (liters/sec.) at the design head with the size and type of motor indicated and identified as to type of pump.

**103.2.5.6** The means of adding makeup water.

**103.2.5.7** The size, length from source to heater and routing of the gas line, if applicable.

**103.2.5.8** Plans for other than private swimming pools shall be submitted for approval by the Health Officer before any water supply or waste discharge permit is issued.

**Note:** The foregoing applies to all public swimming, spa, hot tub, bathing, or wading facilities. Plans and specifications for all indoor installations, public or private, shall be submitted to the Authority Having Jurisdiction for approval prior to commencement of any work, and all piping, equipment, and construction shall be equal to the types prescribed in the installation requirements of the UPC for indoor work.

### **103.3 Permit Issuance.**

**103.3.1 Issuance.** The application, plans, and specifications and other data filed by an applicant for a permit shall be reviewed by the Authority Having Jurisdiction. Such plans may be reviewed by other departments of this jurisdiction to verify compliance with applicable laws under their jurisdiction. If the Authority Having Jurisdiction finds that the work described in an application for permit and the plans, specifications, and other data filed therewith conform to the requirements of the code and other pertinent laws and



ordinances, and that the fees specified in Section 103.4 have been paid, the Authority Having Jurisdiction shall issue a permit therefor to the applicant. When the Authority Having Jurisdiction issues the permit where plans are required, the Authority Having Jurisdiction shall endorse in writing or stamp the plans and specifications "APPROVED." Such approved plans and specifications shall not be changed, modified, or altered without authorization from the Authority Having Jurisdiction, and all work shall be done in accordance with approved plans.

The Authority Having Jurisdiction may issue a permit for the construction of a part of a plumbing system before the entire plans and specifications for the whole 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 may proceed at the holder's risk without assurance that the permit for the entire building, structure, or plumbing system will be granted. [UPC 103.3.1]

**103.3.2 Retention of Plans.** One set of approved plans, specifications, and computations shall be retained by the Authority Having Jurisdiction until final approval of the work covered therein. One set of approved plans and specifications shall be returned to the applicant, and said set shall be kept on the site of the building or work at all times during which the work authorized thereby is in progress. [UPC 103.3.2]

**103.3.3 Validity of Permit.** The issuance of a permit or approval of plans and specifications 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 any other ordinance of the jurisdiction. No permit presuming to give authority to violate or cancel the provisions of this code shall be valid.

The issuance of a permit based upon plans, specifications, or other data shall not prevent the Authority Having Jurisdiction from thereafter requiring the correction of errors in said plans, specifications, and other data or from preventing building operations being carried on thereunder when in violation of this code or of other ordinances of this jurisdiction. [UPC 103.3.3]

**103.3.4 Expiration.** Every permit issued by the Authority Having Jurisdiction 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 can be recommenced, a new permit shall first be obtained to do so, and the fee therefor 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 plans and specifications for such work, and provided further that such suspensions or abandonment has not exceeded one (1) year.

Any permittee holding an unexpired permit may apply for an extension of the time within which work may commence under that permit when the permittee is unable to commence work within the time required by this section for good and satisfactory reasons. The Authority Having Jurisdiction may extend the time for action by the permittee for a period not exceeding one hundred eighty (180) days upon written request by the permittee showing that circumstances beyond the control of the permittee have prevented action from being taken. No permit shall be extended more than once. In order to renew action on a permit after expiration, the permittee shall pay a new full permit fee. [UPC 103.3.4]

**103.3.5 Suspension or Revocation.** The Authority Having Jurisdiction may, in writing, suspend or revoke a permit issued under provisions of this code, whenever the permit is issued in error or on the basis of incorrect information supplied, or in violation of any ordinance or regulation of the jurisdiction. [UPC 103.3.5]

#### **103.4 Fees.**

**103.4.1 Permit Fees.** Fees shall be assessed in accordance with the provisions of this section and as set forth in the fee schedule Table 1-1. The fees are to be determined and adopted by this jurisdiction. [UPC 103.4.1]

**103.4.2 Plan Review Fees.** When a plan or other data is required to be submitted by Section 103.2.2, a plan review fee shall be paid at the time of submitting plans and specifications for review.

The plan review fees for work to install, alter, or repair a swimming pool, spa or hot

tub system or part thereof shall be determined and adopted by this jurisdiction. The plan review fees specified in this subsection are separate fees from the permit fees specified in this section and are in addition to the permit fees.

When plans are incomplete or changed so as to require additional review, a fee shall be charged at the rate shown in Table 1-1. [UPC 103.4.2]

#### **103.4.3 Investigation Fees: Work Without a Permit.**

**103.4.3.1** Whenever any work for which a permit is required by this code has been commenced without first obtaining said permit, a special investigation shall be made before a permit may be issued for such work. [UPC 103.4.4.1]

**103.4.3.2** An investigation fee, in addition to the permit fee, shall be collected whether or not a permit is then or subsequently issued. The investigation fee shall be equal to the amount of the permit fee that would be required by this code if a permit were to be issued. The payment of such investigation fee shall not exempt any person from compliance with all other provisions of this code, nor from any penalty prescribed by law. [UPC 103.4.4.2]

#### **103.4.4 Fee Refunds.**

**103.4.4.1** The Authority Having Jurisdiction may authorize the refunding of any fee paid hereunder that was erroneously paid or collected. [UPC 103.4.5.1]

**103.4.4.2** The Authority Having Jurisdiction may authorize the refunding of not more than a percentage, as determined by this jurisdiction when no work has been done under a permit issued in accordance with this code. [UPC 103.4.5.2]

**103.4.4.3** The Authority Having Jurisdiction 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. [UPC 103.4.5.3]

#### **103.5 Inspections.**

**103.5.1 General.** All plumbing systems for which a permit is required by this code shall be inspected by the Authority Having Jurisdiction. No portion of any plumbing system shall be concealed until inspected and

approved. Neither the Authority Having Jurisdiction nor the jurisdiction shall be liable for expense entailed in the removal or replacement of material required to permit inspection. When the installation of a plumbing system is complete, an additional and final inspection shall be made. Plumbing systems regulated by this code shall not be connected to the water, the energy fuel supply, or the sewer system until authorized by the Authority Having Jurisdiction. [UPC 103.5.1]

**103.5.1.1 Inspection.** No water supply system or portion thereof shall be covered or concealed until it first has been tested, inspected, and approved. [UPC 103.5.1.1]

**103.5.1.2 Scope.** All new plumbing work and such portions of existing systems as may be affected by new work, or any changes, shall be inspected by the Authority Having Jurisdiction to ensure compliance with all the requirements of this code and to ensure that the installation and construction of the plumbing system is in accordance with approved plans. [UPC 103.5.1.2]

**103.5.1.3 Covering or Using.** No plumbing or drainage system, building sewer, private sewer disposal system, or part thereof, shall be covered, concealed, or put into use until it has been tested, inspected, and accepted as prescribed in this code. [UPC 103.5.1.3]

**103.5.1.4 Uncovering.** If any drainage or plumbing system, building sewer, private sewage disposal system, or part thereof, which is installed, altered, or repaired, is covered or concealed before being inspected, tested, and approved as prescribed in this code, it shall be uncovered for inspection after notice to uncover the work has been issued to the responsible person by the Authority Having Jurisdiction. [UPC 103.5.1.4]

**103.5.2 Operation of Plumbing Equipment.** The requirements of this section shall not be considered to prohibit the operation of any plumbing installed to replace existing equipment or fixtures serving an occupied portion of the building in the event a request for inspection of such equipment or fixture has been filed with the Authority Having Jurisdiction not more than seventy-two (72) hours after such replacement work is completed, and before

any portion of such plumbing system is concealed by any permanent portion of the building. [UPC 103.5.2]

**103.5.3 Testing of Systems.** All plumbing systems shall be tested and approved as required by this code or the Authority Having Jurisdiction. [UPC 103.5.3]

**103.5.3.1 Test.** Tests shall be conducted in the presence of the Authority Having Jurisdiction or the Authority Having Jurisdiction's duly appointed representative. [UPC 103.5.3.1]

**103.5.3.2 Test Waived.** No test or inspection shall be required where a plumbing system, or part thereof, is set up for exhibition purposes and has no connection with a water or drainage system. [UPC 103.5.3.2]

**103.5.3.3 Exceptions.** In cases where it would be impractical to provide the required water or air tests, or for minor installations and repairs, the Authority Having Jurisdiction may make such inspection as deemed advisable in order to be assured that the work has been performed in accordance with the intent of this code. [UPC 103.5.3.3]

**103.5.3.4 Protectively Coated Pipe.** Protectively coated pipe shall be inspected and tested, and any visible void, damage, or imperfection to the pipe coating shall be repaired to comply with Section 325.0 titled "Protection of Piping, Materials, and Structures." (see IAPMO IS-13, listed in Appendix I of the Uniform Plumbing Code). [UPC 103.5.3.4]

**103.5.3.5 Tightness.** Joints and connections in the plumbing system shall be gastight and watertight for the pressures required by test. [UPC 103.5.3.5]

**103.5.4 Inspection Requests.** It shall be the duty of the person doing the work authorized by a permit to notify the Authority Having Jurisdiction that such work is ready for inspection. The Authority Having Jurisdiction may require that every request for inspection be filed at least one (1) working day before such inspection is desired. Such request may be in writing or by telephone, at the option of the Authority Having Jurisdiction.

It shall be the duty of the person requesting inspections required by this code to provide access to and means for proper inspection of such work. [UPC 103.5.4]

**103.5.4.1 Advance Notice.** It shall be the duty of the person doing the work authorized by the permit to notify the

Authority Having Jurisdiction, orally or in writing, that said work is ready for inspection. Such notification shall be given not less than twenty-four (24) hours before the work is to be inspected. [UPC 103.5.4.1]

**103.5.4.2 Responsibility.** It shall be the duty of the holder of a permit, to make sure that the work will stand the test prescribed before giving the notification.

The equipment, material, and labor necessary for inspection or tests shall be furnished by the person to whom the permit is issued or by whom inspection is requested. [UPC 103.5.4.2]

**103.5.5 Other Inspections.** In addition to the inspections required by this code, the Authority Having Jurisdiction may require other inspections of any plumbing work to ascertain compliance with the provisions of this code and other laws that are enforced by the Authority Having Jurisdiction. [UPC 103.5.5]

**103.5.5.1 Defective Systems.** An air test shall be used in testing the sanitary condition of the drainage or plumbing system of any building premises when there is reason to believe that it has become defective. In buildings or premises condemned by the proper Authority Having Jurisdiction because of an insanitary condition of the plumbing system or part thereof, the alterations in such system shall conform to the requirements of this code. [UPC 103.5.5.1]

**103.5.5.2 Moved Structures.** All parts of the plumbing systems of any building or part thereof that is moved from one foundation to another, or from one location to another, shall be completely tested as prescribed elsewhere in this section for new work, except that walls or floors need not be removed during such test when other equivalent means of inspection acceptable to the Authority Having Jurisdiction are provided. [UPC 103.5.5.2]

**103.5.6 Reinspections.** A reinspection fee may be assessed for each inspection or reinspection when such portion of work for which inspection is called is not complete or when required corrections have not been made.

This provision is not to be interpreted as requiring reinspection fees the first time a job is rejected for failure to comply with the requirements of this code, but as controlling the practice of calling for inspections before

the job is ready for inspection or reinspection. Reinspection fees may be assessed when the approved plans are not readily available to the inspector, for failure to provide access on the date for which the inspection is requested, or for deviating from plans requiring the approval of the Authority Having Jurisdiction.

To obtain reinspection, the applicant shall file an application therefor in writing upon a form furnished for that purpose and pay the reinspection fee in accordance with Table 1-1.

In instances where reinspection fees have been assessed, no additional inspection of the work will be performed until the required fees have been paid. [UPC 103.5.6]

**103.5.6.1 Corrections.** Notices of correction or violation shall be written by the Authority Having Jurisdiction and may be posted at the site of the work or mailed or delivered to the permittee or his authorized representative. Refusal, failure, or neglect to comply with any such notice or order within ten (10) days of receipt thereof, shall be considered a violation of this code and shall be subject to the penalties set forth elsewhere in this code for violations. [UPC 103.5.6.1]

**103.5.6.2 Retesting.** If the Authority Having Jurisdiction finds that the work will not pass the test, necessary corrections shall be made and the work shall then be resubmitted for test or inspection. [UPC 103.5.6.2]

**103.5.6.3 Approval.** Upon the satisfactory completion and final test of the plumbing system, a certificate of approval shall be issued by the Authority Having Jurisdiction to the permittee on demand. [UPC 103.5.6.3]

### **103.6 Connection Approval.**

**103.6.1 Energy Connections.** No person shall make connections from a source of energy or fuel to any plumbing system or equipment regulated by this code and for which a permit is required until approved by the Authority Having Jurisdiction. [UPC 103.6.1]

**103.6.2 Other Connections.** No person shall make connection from any water-supply line nor shall connect to any sewer system regulated by this code and for which a permit is required until approved by the Authority Having Jurisdiction. [UPC 103.6.2]

**103.6.3 Temporary Connections.** The Authority Having Jurisdiction may authorize temporary connection of the plumbing equipment to the source of energy or fuel for the purpose of testing the equipment. [UPC 103.6.3]

### **103.7 Unconstitutionality.**

**103.7.1** If any section, subsection, sentence, clause or phrase of this code is, for any reason, held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this code. The Legislative Body hereby declares that it would have passed this code, and each section, subsection, sentence, clause or phrase thereof, irrespective of the fact that any one or more sections, subsections, sentences, clauses, and phrases be declared unconstitutional. [UPC 103.7.1]

### **103.8 Validity.**

**103.8.1** If any provision of this code, or the application thereof to any person or circumstance, is held invalid, the remainder of the code, or the application of such provision to other persons or circumstances, shall not be affected thereby. [UPC 103.8.1]

TABLE 1-1

## Swimming Pool, Spa, and Hot Tub Permit Fees

**Permit Issuance**

1. For issuing each permit ..... \*
2. For issuing each supplemental permit..... \*

**Unit Fee Schedule** (in addition to items 1 and 2 above)

1. For each swimming pool, spa, or hot tub:
  - Public ..... \*
  - Private..... \*
2. For each pool filling system including backflow protection: ..... \*
  - 2-inch (50 mm) diameter and smaller ..... \*
  - Over 2-inch (50 mm) diameter..... \*
3. For each water heater and/or vent ..... \*
4. For each gas-piping system of one to five outlets ..... \*
5. For each additional gas piping system outlet, per outlet ..... \*
6. For each replacing of filter and/or water treating equipment ..... \*
7. For each installation, alteration or repair of water piping..... \*
8. For each repair or alteration of drainage or vent piping..... \*
9. For atmospheric-type vacuum breakers not included in item 2:
  - 1 to 5..... \*
  - over 5, each..... \*
10. For each backflow protective device other than atmospheric type vacuum breakers not included in item 2:
  - 2-inch (50 mm) diameter and smaller ..... \*
  - over 2-inch (50 mm) diameter..... \*
11. For each repair or alteration of a backwash receptor..... \*
12. For each miscellaneous repair or alteration not covered in items 1 through 11 ..... \*

**Other Inspections and Fees**

1. Inspections outside of normal business hours..... \*
2. Reinspection fee..... \*
3. Inspections for which no fee is specifically indicated..... \*
4. Additional plan review required by changes, additions or revisions to approved plans (minimum charge – one-half hour)..... \*

\* Jurisdiction will indicate their fees here.





## CHAPTER 2

### DEFINITIONS

#### 201.0 General

For the purpose of this code, the following terms shall have the meanings indicated in this chapter.

No attempt is made to define ordinary words which are used in accordance with their established dictionary meanings, except where the word has been loosely used and it is necessary to define its meaning as used in this code to avoid misunderstanding.

The definitions of terms are arranged alphabetically according to the first word of the term. [UPC 201]

#### 202.0 Definition of Terms

##### 203.0

– A –

**ABS** – Acrylonitrile-butadiene-styrene. [UPC 203]

**Accessible** – When applied to a fixture, connection, appliance, or equipment, *accessible* means having access thereto, but which first may require the removal of an access panel, door, or similar obstruction. *Readily accessible* shall mean direct access without the necessity of removing any panel, door, or similar obstruction. [UPC 203]

**Airbreak** – A physical separation that may be a low inlet into the indirect waste receptor from the fixture, appliance or device indirectly connected. [UPC 203]

**Airgap, Drainage** – The unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe, plumbing fixture, appliance, or appurtenance conveying waste to the flood-level rim of the receptor. [UPC 203]

**Airgap, Water Distribution** – The unobstructed vertical distance through the free atmosphere between the lowest opening from any pipe or faucet conveying potable water to the flood level rim of any tank, vat, or fixture. [UPC 203]

**Approved** – Acceptable to the Authority Having Jurisdiction. [UPC 203]

**Approved Testing Agency** – An organization primarily established for the purpose of testing to approved standards and approved by the Authority Having Jurisdiction. [UPC 203]

**Area Drain** – A receptor designed to collect surface or storm water from an open area. [UPC 203]

**Authority Having Jurisdiction** – The organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, installations, or procedures. The Authority Having Jurisdiction shall be a federal, state, local, or other regional department or an individual such as a plumbing official, mechanical official, labor department official, health department official, building official or others having statutory authority. In the absence of a statutory authority, the Authority Having Jurisdiction may be some other responsible party. This definition shall include the Authority Having Jurisdiction's duly authorized representative. [UPC 203]

##### 204.0

– B –

**Backflow** – The flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from any sources other than its intended source. See **Back-Siphonage, Back-Pressure Backflow**. [UPC 204]

**Backflow Preventer** – A device or means to prevent backflow into the potable water system. [UPC 204]

**Back-Pressure Backflow** – Backflow due to an increased pressure above the supply pressure, which may be due to pumps, boilers, gravity, or other sources of pressure. [UPC 204]

**Back-Siphonage** – The flowing back of used, contaminated, or polluted water from a plumbing fixture or vessel into a water supply pipe due to a pressure less than atmospheric in such pipe. See **Backflow**. [UPC 204]

**Backwash Pipe** – See **Filter Waste Discharge Piping**.

**Body Feed** – The continuous addition of small amounts of filter aid during the operation of a diatomaceous earth filter.

**Building Drain Sanitary** – That part of the lowest piping of a drainage system that receives the discharge from soil, waste, and other drainage pipes inside the walls of the building and conveys it to the building sewer beginning two (2) feet (610 mm) outside the building wall. [UPC 204.0]

**Building Sewer** – That part of the horizontal piping of a drainage system that extends from the end of the building drain and that receives the discharge of the building drain and conveys it to a public sewer, private sewer, private sewage disposal system, or other point of disposal. [UPC 204.0]

## 205.0

## – C –

**Cartridge Filter** – A filter that operates through a disposable cartridge. These are two general types: The surface or area type where the suspended matter is removed at the surface, and the depth type in which the interstices vary from large to small in depth.

**Certified Backflow Assembly Tester** – A person who has shown competence to test and maintain backflow assemblies to the satisfaction of the Authority Having Jurisdiction. [UPC 205.0]

**Chemical Piping** – Piping that conveys concentrated chemical solutions from a feeding apparatus to the circulation piping.

**Circulation Piping System** – The piping between a pool, spa or hot tub structure and the mechanical equipment. Usually includes suction piping, face piping, and return piping.

**Confined Space** – A room or space having a volume less than fifty (50) cubic feet per 1,000 Btu/h (1.4 m<sup>3</sup>/293 W) of the aggregate input rating of all fuel-burning appliances installed in that space. [UPC 205.0]

**CPVC** – Chlorinated Poly (Vinyl Chloride). [UPC 205]

**Critical Level** – The critical level (C-L or C/L) marking on a backflow prevention device or vacuum breaker is a point conforming to approved standards and established by the testing laboratory (usually stamped on the device by the manufacturer) that determines the minimum elevation above the flood-level rim of the fixture or receptor served at which the device may be installed. When a backflow prevention device does not bear a critical level marking, the bottom of the vacuum breaker, combination valve, or the bottom of any such approved device shall constitute the critical level. [UPC 205]

**Cross-Connection** – Any connection or arrangement, physical or otherwise, between a potable water supply system and any plumbing fixture or any tank, receptor, equipment, or device, through which it may be possible for non-potable, used, unclean, polluted and contaminated

water, or other substances to enter into any part of such potable water system under any condition. [UPC 205]

## 206.0

## – D –

**Department Having Jurisdiction** – The Authority Having Jurisdiction, including any other law enforcement agency affected by any provision of this code, whether such agency is specifically named or not. [UPC 206]

**Developed Length** – The length along the center line of a pipe and fittings. [UPC 206]

**Design Head** – The total head requirement of the circulation system at the design rate of flow.

**Design Rate of Flow (Design Filter Rate)** – The rate of flow in a system that is used for design calculation. (The volume of the pool, spa, or hot tub in gallons divided by the number of minutes in the turnover time.)

**Diameter** – Unless specifically stated, “diameter” is the nominal diameter as designated commercially. [UPC 206]

**Diatomite Filter** – A filter designed to filter water through a thin layer of filter aid such as diatomaceous earth or volcanic ash. Diatomite filters may be of the pressure or vacuum type.

**Drain** – Any pipe that carries waste or water-borne wastes in a building drainage system. [UPC 206.0]

**Drainage System** – Includes all the piping within public or private premises that conveys sewage or other liquid wastes to a legal point of disposal, but does not include the mains of a public sewer system or a public sewage treatment or disposal plant. [UPC 206]

## 207.0

## – E –

**Effective Opening** – The minimum cross-sectional area at the point of water supply discharge measured or expressed in terms of (1) diameter of a circle or (2) if the opening is not circular, the diameter of a circle of equivalent cross-sectional area. (This is applicable also to airgap.) [UPC 207.0]

## 208.0

## – F –

**Filter Aid** – A type of finely divided media used to coat a septum-type filter, usually diatomaceous earth or volcanic ash. (Note: Alum, as used on the bed of a sand filter, is also referred to as a filter aid.)

**Filter Element** – That part of a filter that supports the surface upon which the filter aid is deposited (usually in diatomite filters).

**Filter Media** – The finely graded material that entraps suspended particles (sand, anthracite, etc.).

**Filter Rate** – The rate of application of water to a filter expressed in gallons per minute per square foot of effective filter area.

**Filter Rock** – Graded, rounded rock, and/or gravel not subject to degradation by common pool chemical used to support filter media.

**Filter, Sand** – A type of filter media composed of hard sharp silica, quartz, or similar particles with proper grading for size and uniformity.

**Filter Waste Discharge Piping** – Piping that conducts wastewater from a filter to a drainage system. Connection to drainage system is made through an airgap or other approved methods.

**Flammable Vapor or Fumes** - Is the concentration of flammable constituents in air that exceeds 25 percent of its lower flammability limit (LFL). [UPC 208.0]

**Flood Level** – See **Flooded**. [UPC 208.0]

**Flood-Level Rim** – The top edge of a receptor from which water overflows. [UPC 208.0]

**Flooded** – A fixture is flooded when the liquid therein rises to the flood-level rim. [UPC 208.0]

**Fresh Water** – Those waters having a specific conductivity less than a solution containing 6,000 parts per million of sodium chloride.

## 209.0

### – G –

**Grade** – The slope or fall of a line of pipe in reference to a horizontal plane. In drainage, it is usually expressed as the fall in a fraction of an inch (mm) or percentage slope per foot (meter) length of pipe. [UPC 209]

## 210.0

### – H –

**High-Rate Sand Filter** – A sand filter designed for flows in excess of five (5) gallons per minute (gpm) per square foot (22.0 L/Min/0.09m<sup>2</sup>). But not in excess of twenty (20) gpm per square foot (75.7L/min/0.09m<sup>2</sup>).

**Hot Tub** – Refers specifically to a hydrotherapy unit normally constructed of wood designed and assembled in the traditional manner of tubs or casks, with side and bottoms formed of separate

boards and the whole shaped to join together by pressure of the surrounding hoops, bands, or rods as distinct from spa units formed of plastic, concrete, metal, or other materials.

**Hydrojet Booster Pump System** – A system whereby one or more hydrojets are activated by the use of a pump that is completely independent of the filtration and heating system of the spa.

**Hydrojets** – A fitting that blends air and water creating a high-velocity, turbulent stream of air-enriched water.

## 211.0

### – I –

**Indirect Waste Pipe** – A pipe that does not connect directly with the drainage system but conveys liquid wastes by discharging into a plumbing fixture, interceptor or receptacle that is directly connected to the drainage system. [UPC 211.0]

**Inlet Fitting** – A fitting or fixture through which circulated or hydrojetted water enters the pool, spa, or hot tub.

**Insanitary** – A condition that is contrary to sanitary principles or is injurious to health.

Conditions to which “insanitary” shall apply include the following:

- (1) Any trap that does not maintain a proper trap seal.
- (2) Any opening in a drainage system, except where lawful, that is not provided with an approved water-sealed trap.
- (3) Any plumbing fixture or other waste-discharging receptor or device that is not supplied with water sufficient to flush and maintain the fixture or receptor in a clean condition.
- (4) Any defective fixture, trap, pipe, or fitting.
- (5) Any trap, except where in this code exempted, directly connected to a drainage system, the seal of which is not protected against siphonage and back-pressure by a vent pipe.
- (6) Any connection, cross-connection, construction, or condition, temporary or permanent, that would permit or make possible by any means whatsoever for any unapproved foreign matter to enter a water distribution system used for domestic purposes.

- (7) The foregoing enumeration of conditions to which the term "insanitary" shall apply shall not preclude the application of that term to conditions that are, in fact, insanitary. [UPC 211.0]

**212.0****- J -**

**Joint, Brazed** – Any joint obtained by joining of metal parts with alloys that melt at temperatures higher than 840°F (449°C), but lower than the melting temperature of the parts to be joined. [UPC 212.0]

**Joint, Soldered** – A joint obtained by the joining of metal parts with metallic mixtures or alloys that melt at a temperature up to and including 840°F (449°C). [UPC 212.0]

**213.0****- K -**

No definitions.

**214.0****- L -**

**Labeled** – Equipment or materials bearing a label of a listing agency (accredited conformity assessment body). See **Listed (Third Party Certified)**. [UPC 214.0]

**Liquid Waste** – The discharge from any fixture, appliance, or appurtenance in connection with a plumbing system that does not receive fecal matter. [UPC 214.0]

**Listed (Third Party Certified)** – Equipment or materials included in a list published by a listed agency (accredited conformity assessment body) that maintains periodic inspection on current production of listed equipment or materials and whose listing states either that the equipment or material complies with approved standards or has been tested and found suitable for use in a specified manner. [UPC 214.0]

**Listing Agency** – An agency accredited by an independent and authoritative conformity assessment body to operate a material and product listing and labeling (certification) system and that is accepted by the Authority Having Jurisdiction, which is in the business of listing or labeling. The system includes initial and ongoing product testing and a periodic inspection program on current production of listed (certified) products, and that makes available a published report of such listing in which specific information is included that the material or product conforms

to applicable standards and has been found safe for use in a specified manner. [UPC 214.0]

**215.0****- M -**

**Main Outlet** – The outlet fitting(s) at the bottom of a swimming pool, spa, or hot tub through which passes water to the recirculating pump (often erroneously referred to as the "main drain"). [UPC 215.0]

**May** – A permissive term.

**Multiport Valves** – A valve for various filter operations that combines in one unit the function of two or more single direct flow valves.

**216.0****- N -**

**Nuisance** – Includes, but is not limited to:

- (1) Any public nuisance known at common law or in equity jurisprudence.
- (2) Whenever any work regulated by this code is dangerous to human life or is detrimental to health and property.
- (3) Inadequate or unsafe water supply or sewage disposal system. [UPC 216.0]

**217.0****- O -**

**Offset** – A combination of elbows or bends in a line of piping that brings one section of the pipe out of line but into a line parallel with the other section. [UPC 217.0]

**218.0****- P -**

**Perimeter Overflow System** – A continuous channel formed into the sidewall entirely around the perimeter of the pool, unless interrupted by steps, into which surface pool water is continuously drawn during normal operation to provide a skimming action.

**PB** – Polybutylene. [UPC 218.0]

**PE** – Polyethylene. [UPC 218.0]

**PE-AL-PE** – Polyethylene-aluminum-polyethylene.

**PEX** – Cross-linked polyethylene. [UPC 218.0]

**PEX-AL-PEX** – Cross-linked polyethylene—aluminum-cross-linked polyethylene. [UPC 218.0]

**Person** – A natural person, his heirs, executor, administrators, or assigns and shall also include a firm, corporation, municipal or quasi-municipal

corporation, or governmental agency. Singular includes plural; male includes female. [UPC 218.0]

**Pipe** – A cylindrical conduit or conductor conforming to the particular dimensions commonly known as “pipe size.” [UPC 218.0]

**Plumbing** – The business, trade, or work having to do with the installation, removal, alteration, or repair of plumbing systems or parts thereof. [UPC 218.0]

**Plumbing Official** – See **Authority Having Jurisdiction**. [UPC 218.0]

**Plumbing System** – Includes all potable water, building supply, and distribution pipes; all plumbing fixtures and traps; all drainage and vent pipes; and all building drains and building sewers, including their respective joints and connections, devices, receptors, and appurtenances within the property lines of the premises and shall include potable water piping, potable water treating or using equipment, medical gas and medical vacuum systems, liquid and fuel gas piping, and water heaters and vents for same. [UPC 218.0]

**Pool** – See **Swimming Pool**.

**Pool Depths** – The distance between the floor of pool and the maximum operating water level.

**Pool Plumbing** – Includes all chemical, circulation, filter waste discharge piping, deck drainage, and water filling system.

**Potable Water** – Water that is satisfactory for drinking, culinary, and domestic purposes and that meets the requirements of the Health Authority Having Jurisdiction. [UPC 218.0]

**Precoat** – The precoat or initial coating of filter aid on the septum of a diatomaceous earth filter.

**Pressure** – The normal force exerted by a homogeneous liquid or gas, per unit of area, on the wall of the container.

(1) **Static Pressure** – The pressure existing without any flow.

(2) **Residual Pressure** – The pressure available at the fixture or water outlet after allowance is made for pressure drop due to friction loss, head, meter, and other losses in the system during maximum demand periods. [UPC 218.0]

**PVC** – Poly (Vinyl Chloride) [UPC 218.0]

**PVC Hose** – Flexible Poly (Vinyl Chloride)

## 219.0

## – Q –

No definitions.

## 220.0

## – R –

**Rapid Sand Filter** – A filter designed to be used with sand as the filter media and for flows not to exceed three (3) gpm per square foot (11.4 L/0.09 m<sup>2</sup>) in commercial pools and five (5) gpm per square foot (18.9 L/0.09 m<sup>2</sup>) in residential pools.

**Receptor** – An approved plumbing fixture or device of such material, shape, and capacity as to adequately receive the discharge from indirect waste piping, so constructed and located as to be readily cleaned. [UPC 220.0]

**Recirculation System** – The interconnected system traversed by the recirculated water from the pool until it is returned to the pool.

**Regulating Equipment** – Includes all valves and controls used in a plumbing system that are required to be accessible or readily accessible. [UPC 220.0]

**Return Piping** – That part of the piping between the filter and the pool, spa, or hot tub through which passes the filtered water.

## 221.0

## – S –

**Salt (Saline) Water** – Those waters having a specific conductivity in excess of a solution containing 6,000 parts per million of sodium chloride.

**Separation Tank** – A device used to clarify filter rinse or wastewater (sometimes called a reclamation tank).

**Septum** – That part of the filter element consisting of cloth, wire screen, or other porous material on which the filter cake is deposited.

**Sewage** – Any liquid waste containing animal or vegetable matter in suspension or solution and that may include liquids containing chemicals in solution. [UPC 221.0]

**Shall** – A mandatory term. [UPC 221.0]

**Should** – Indicates a recommendation or that which is advised but not required. [UPC 221.0]

**Skim Filter** – A surface skimmer combined with a vacuum filter.

**Slope** – See **Grade**. [UPC 221.0]

**Solar Energy Code** – For the purpose of this code, any reference to the Solar Energy Code shall mean the Uniform Solar Energy Code as

promulgated by the International Association of Plumbing and Mechanical Officials (IAPMO).

**Spa** – A unit primarily designed for therapeutic use that is not drained, cleaned, or refilled for each individual. It may include, but is not limited to, hydrojet circulation, hot water, cold water, mineral baths, air induction bubbles, or any combination thereof. Industry terminology for spa includes, but is not limited to, therapeutic pool, hydrotherapy pool, whirlpool, hot spa, etc.

**Spa Pool** – A pool, not under medical supervision, that incorporated water jets and/or an aeration system used for hydromassage.

**SDR** – An abbreviation for "standard dimensional ratio," which is the specific ratio of the average specified outside diameter to the minimum wall thickness for outside controlled diameter plastic pipe. [UPC 221.0]

**Standard** – A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix, footnote, or fine-print note and are not to be considered a part of the requirements of a standard. [UPC 221.0]

**Suction Piping** – That portion of the circulation piping located between the pool structure and the inlet side of the pump and that usually includes the following: main outlet piping, skimmer piping, vacuum piping, and surge tank piping.

**Surface Skimmer** – Sometimes called a "recirculating overflow." A device designed to continuously remove surface film and water and return it through the filter as part of the recirculation system, usually incorporating a self-adjusting weir, a collection tank and a means to prevent air lock of the pump (sometimes referred to as a "recirculating overflow," or a "mechanical" or "automatic skimmer").

**Swimming Pool** – Any constructed or prefabricated pool used for swimming or bathing, more than eighteen (18) inches (457 mm) in depth.

**Swimming Pool – Private** – Shall include all constructed pools that are used as a swimming pool in connection with a single-family residence and available only to the family of the householder and his private guests.

**Swimming Pool - Public** – Any constructed or prefabricated pool other than a private swimming pool.

## 222.0

## – T –

**Trap** – A fitting or device so designed and constructed as to provide, when properly vented, a liquid seal that will prevent the back passage of air without materially affecting the flow of sewage or wastewater through it. [UPC 222.0]

**Trap Seal** – The vertical distance between the crown weir and the top dip of the trap. [UPC 222.0]

**Crown Weir (Trap Weir)** – The lowest point in the cross section of the horizontal waterway at the exit of the trap. [UPC 222.0]

**Top Dip (of trap)** – The highest point in the internal cross section of the trap at the lowest part of the bend (inverted siphon). By contrast, the bottom dip is the lowest point in the internal cross section. [UPC 222.0]

**Turnover Time** – The time in hours required for the circulation system to filter and recirculate a volume of water equal to the pool volume.

## 223.0

## – U –

**Unconfined Space** – A room or space having a volume equal to at least fifty cubic feet per 1,000 Btu/h (1.4 m<sup>3</sup>/293 W) of the aggregate input rating of all fuel-burning 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. [UPC 223.0]

## 224.0

## – V –

**Vacuum** – Any pressure less than that exerted by the atmosphere. [UPC 224.0]

**Vacuum Breaker** – See **Backflow Preventer**. [UPC 224.0]

**Vacuum Piping** – The pipe from the suction side of a pump connected to a vacuum fitting located at the pool and below the water level to which underwater cleaning equipment may be attached.

**Velocity** – The measurement of the motion of liquids, expressed in feet per second.

**Vent** – Any pipe provided to ventilate a plumbing system, to prevent trap siphonage and back-pressure, or to equalize the air pressure within the drainage system. [UPC 224.0]

**Vent Pipe** – See **Vent**. [UPC 224.0]

**Vent Stack** – The vertical vent pipe installed primarily for the purpose of providing circulation of air to and from any part of the drainage system. [UPC 224.0]



**Vent System** – A pipe or pipes installed to provide a flow of air to or from a drainage system or to provide a circulation of air within such system to protect trap seals from siphonage and back-pressure. [UPC 224.0]

**Vertical Pipe** – Any pipe or fitting that is installed in a vertical position or that makes an angle of not more than forty-five (45) degrees with the vertical. [UPC 224.0]

**225.0****– W –**

**Wading Pool** – Any constructed or prefabricated pool used for wading that is eighteen (18) inches (457 mm) or less in depth.

**Waste Pipe** – A pipe that conveys only liquid waste, free of fecal matter. [UPC 225.0]

**Waste Piping** – See **Filter Waste Discharge Piping**.

**Wastewater** – The water from any filter, perimeter overflow, pool emptying line, or similar apparatus or appurtenance.

**Water Conditioning or Treating Device** – A device that conditions or treats a water supply so as to change its chemical content or remove suspended solids by filtration. [UPC 225.0]

**Welded Joint or Seam** – Any joint or seam obtained by the joining of metal parts in the plastic molten state. [UPC 225.0]

**Width and/or Length** – The actual water dimension taken from wall to wall at the maximum operating water level.

**226.0****– X –**

No definitions.

**227.0****– Y –**

No definitions.

**228.0****– Z –**

No definitions.



## CHAPTER 3

### GENERAL REQUIREMENTS

#### **301.0 General.**

All design, construction, and workmanship shall be in conformity with accepted engineering practices and shall be of such character as to secure the results sought to be obtained by this Code.

**301.1** Every swimming pool, spa, or hot tub shall be equipped complete with approved mechanical equipment consisting of filter, pump, piping valves, and component parts.

**Exception:** Pools with a supply of fresh water equivalent to the volume of the pool in the specified turnover time will be allowed.

**301.2 Sizing for Velocity.** Water piping systems shall not exceed the maximum velocities listed in this section or Appendix A of the Uniform Plumbing Code. [UPC 610.12]

**301.3** The circulating piping system shall be designed so that the water velocity will not exceed ten (10) feet (3048 mm) per second, except that the water velocity shall not exceed eight (8) feet (2438 mm) per second in all suction piping.

**301.3.1 Copper Tube Systems.** Maximum velocities in copper and copper alloy tube and fitting systems shall be limited to a maximum of eight (8) feet per second (fps) (2.4 mps) in cold water and five (5) fps in hot water (1.52 mps). [UPC 610.12.1]

**301.3.2 Tubing Systems Using Copper Alloy Fittings.** Maximum velocities through copper alloy fittings in tubing other than copper shall be limited to a maximum of eight (8) feet per second (fps) (2.4 mps) in cold water and five (5) fps in hot water (1.52 mps). [UPC 610.12.2]

**Exception:** Jet inlet fittings shall not be deemed subject to this requirement.

#### **302.0 Materials – Standards and Alternates.**

##### **302.1 Minimum Standards.**

**302.1.1 Approvals.** All pipe, pipe fittings, traps, fixtures, material, and devices used in a swimming pool, spa, hot tub, or plumbing system shall be listed or labeled (third-party certified) by a listing agency (accredited conformity assessment body) and shall

conform to approved applicable recognized standards referenced in this code, and shall be free from defects. Unless otherwise provided for in this code, all materials, fixtures, or devices used or entering into the construction of plumbing systems, or parts thereof, shall be submitted to the Authority Having Jurisdiction for approval. [UPC 301.1.1]

**302.1.2 Marking.** Each length of pipe and each pipe fitting, trap, fixture, material, and device used in a swimming pool, spa, hot tub, or plumbing system shall have cast, stamped, or indelibly marked on it the manufacturer's mark or name that shall readily identify the manufacturer to the end user of the product when such marking is required by the approved standard that applies. When required by the approved standard that applies, the product shall be marked with the weight and the quality of the product. All materials and devices used or entering into the construction of swimming pools, spas, hot tubs, or plumbing and drainage systems, or parts thereof, shall be marked and identified in a manner satisfactory to the Authority Having Jurisdiction. All such marking shall be done by the manufacturer. Field marking shall not be acceptable. [UPC 301.1.2]

**302.1.3 Standards.** Standards listed or referred to in this chapter or other chapters cover materials that will conform to the requirements of this code, when used in accordance with the limitations imposed in this or other chapters thereof and their listing. Where a standard covers materials of various grades, weights, quality, or configurations, there may be only a portion of the listed standard that is applicable. Design and materials for special conditions or materials not provided for herein may be used only by special permission of the Authority Having Jurisdiction after the Authority Having Jurisdiction has been satisfied as to their adequacy. A list of accepted product and materials standards is included in Table 6-1. [UPC 301.1.3]

**302.1.4 Existing Buildings.** In existing buildings or premises in which swimming

pool, spa, hot tub, or plumbing installations are to be altered, repaired, or renovated, the Authority Having Jurisdiction has discretionary powers to permit deviation from the provisions of this code, provided that such a proposal to deviate is first submitted for proper determination in order that health and safety requirements, as they pertain to plumbing, shall be observed. [UPC 301.1.4]

**302.2 Alternate Materials and Methods Equivalency.** Nothing in this code is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this code. Technical documentation shall be submitted to the Authority Having Jurisdiction to demonstrate equivalency. The system, method, or device shall be approved for the intended purpose by the Authority Having Jurisdiction. [UPC 301.2]

**302.2.1 Intent.** The provisions of this code are not intended to prevent the use of any alternate material or method of construction provided any such alternate has been first approved and its use authorized by the Authority Having Jurisdiction.

However, the exercise of this discretionary approval by the Authority Having Jurisdiction shall have no effect beyond the jurisdictional boundaries of said Authority Having Jurisdiction. Any alternate material or method of construction so approved shall not be considered as conforming to the requirements and/or intent of this code for any purpose other than installation or use within the jurisdiction granting the exception. [UPC 301.2.1.]

**302.2.2 Compliance.** The Authority Having Jurisdiction may approve any such alternate provided that the Authority Having Jurisdiction finds that the proposed design is satisfactory and complies with the intent of this code and the material offered is for the purpose intended, at least the equivalent of that prescribed in this code, in quality, strength, effectiveness, durability, and safety or that the methods of installation proposed conform to other acceptable nationally recognized plumbing standards. [UPC 301.2.2]

**302.2.3 Requirements.** The Authority Having Jurisdiction shall require that sufficient evidence or proof be submitted to substantiate any claims that may be made

regarding the sufficiency of any proposed material or type of construction. [UPC 301.2.3]

**302.2.4 Testing.** When there is insufficient evidence to substantiate claims for alternates, the Authority Having Jurisdiction shall have the authority to require tests, as proof of equivalency compliance, to be made by an approved testing agency at the expense of the applicant. [UPC 301.2.4]

**302.2.4.1** Tests shall be made in accordance with approved standards, but in the absence of such standards, the Authority Having Jurisdiction shall specify the test procedure. [UPC 301.2.4.1]

**302.2.4.2** The Authority Having Jurisdiction may require tests to be made or repeated if, at any time, there is reason to believe that any material or device no longer conforms to the requirements on which its approval was based. [UPC 301.2.4.2]

### **303.0 Turnover Time.**

The entire design of matched components shall have sufficient capacity to provide a complete turnover of pool water in:

**303.1** Private Pools – twelve (12) hours or less.

**303.2** Public Pools – six (6) hours or less.

**303.3** Wading Pools – two (2) hours or less.

**303.4** Private Spas and Hot Tubs – one (1) hour or less.

**303.5** Public Spas and Hot Tubs – one-half (1/2) hour or less.

### **304.0 Pumps.**

**304.1** Circulating pumps shall be equipped with an approved-type hair and lint strainer on the inlet side when used in conjunction with pressure filters. Pumps used with vacuum filters do not require strainers except where filter elements are removed for cleaning.

**304.2** Pumps shall be mounted on a substantial base in a manner that will eliminate strain on piping.

**304.3** Pumps shall have design capacity at the following heads:

(1) Pressure Diatomaceous Earth – at least sixty (60) feet (18,288 mm).

- (2) Vacuum Diatomaceous Earth – twenty (20) inches (508 mm) vacuum on the suction side and forty (40) total head.
- (3) Rapid Sand – at least forty-five (45) feet (13,716 mm).
- (4) High-Rate Sand – at least sixty (60) feet (18,288 mm).
- (5) Cartridge – at least fifty (50) feet (15,240 mm).

### 305.0 Valves.

Fullway valves shall be installed to ensure proper functioning of the filtration and piping system.

**305.1** When any equipment is located below the overflow rim of the pool or spa, valves shall be placed in the circulation piping system to isolate the equipment from the pool or spa.

**305.2** Valves shall not be located below the surrounding grade unless first approved by the Authority Having Jurisdiction. Valves located below the surrounding grade shall be set in a pit having a least dimension of five (5) pipe diameters, with a minimum of at least ten (10) inches (254 mm), and fitted with a suitable cover.

**305.3** Where check valves are installed, they shall be of the swing or vertical check patterns.

**Note:** When multiport valves are installed, they shall be listed or approved.

**305.4** Valves up to and including two (2) inches (51 mm) in size shall be brass or other approved material. Sizes over two (2) inches (51 mm) may have bodies of cast iron or brass bodies. Each gate or ball valve shall be a fullway type with working parts made from noncorrosive material. [UPC 605.1]

### 306.0 Water Supply Inlets.

**306.1** Water supply inlets to swimming pools, when protected by an approved vacuum breaker shall have such device installed on the discharge side of the last valves with the critical level not less than six (6) inches (152 mm) above the overflow rim of such equipment. Water supply inlets not protected by vacuum breakers shall be installed not less than two (2) pipe diameters, but in no case less than one (1) inch (25.4 mm) above the overflow rim of such swimming pool. No over-the-rim fill spout shall be installed unless it is located under a diving board or is properly guarded.

**306.2** Automatic fresh water makeup control valves shall be provided with manual override.

### 307.0 Filters.

**307.1 Rapid Sand Filters.** (Flow of up to five (5) gpm per square foot (18.9 L/min/0.09 m<sup>2</sup>) private and three (3) gpm (11.3 L/min/0.09 m<sup>2</sup>) public) – Shall be constructed in accordance with approved standards. The circulation system and backwash piping shall be adequate for proper backwashing of said filter and shall provide backwash flow rates of at least twelve (12) gpm per square foot (45.4 L/min/0.09 m<sup>2</sup>).

**307.2 High-Rate Sand Filters.** (Flow up to twenty (20) gpm per square foot (75.7 L/min/0.09 m<sup>2</sup>) – Shall be of an approved type. The circulation system and backwash piping shall be adequate for proper backwashing of said filter and shall provide backwash flow rates of at least twelve (12) gpm per square foot (45.4 L/min/0.09 m<sup>2</sup>).

**307.3 Diatomite Type Filters.** Shall be designed for operation under either pressure or vacuum. The design capacity shall not exceed two (2) gpm per square foot (7.6 L/min/0.09 m<sup>2</sup>) of effective filter area.

Provision shall be provided to introduce filter aid into pressure filters through the skimmer or precoat pot.

**307.4 Cartridge Filters.** Shall be constructed in accordance with approved standards. Filter can be designed to work either pressure or vacuum. The designed flow rate shall not exceed one (1) gpm (3.8 L/min) residential or three hundred seventy-five hundredths (0.375) gpm (1.4 L/min) public.

**307.5** Every filter system shall be provided with written operating instructions.

**307.6** The pressure filter system shall be equipped with the following:

**307.6.1** An influent pressure gauge.

**307.6.2** An effluent pressure gauge for public use only.

**307.6.3** A means for air relief at the top of each filter.

**307.6.4** A backwash sight glass\* shall be installed adjacent to the backwash discharge outlet to the receptor if not visible from the backwash control valve.

**307.6.5** A means to drain the tank.

\*Not required on cartridge filters.

**308.0 Gas Chlorinators.** Gas chlorinators, when used, shall be listed.

**308.1** All gas-type chlorinators shall have protection against siphoning of gas into the recirculation system. The booster pump shall be interlocked electrically with the recirculation pump to prevent operation of the booster pump when recirculation system is not operating.

**308.2** The chlorine and chlorinating equipment shall be in a separate well-ventilated room located at/or above ground level. In addition to vents in the ceiling and at floor level that terminate to the outside, the room shall be provided with a motor-driven exhaust fan capable of producing at least one (1) air exchange per minute and that draws air from floor level.

**308.3** The chlorine equipment shall be of a design capable of withstanding wear without developing leaks.

**308.4** Chlorine cylinders, including empty cylinders, shall be secured to prevent their falling.

**308.5** A valve wrench shall be maintained on the chlorine cylinder valve so the supply can be shut off quickly in the case of an emergency. Valve protection hoods shall be kept in place except when the cylinder is connected.

**308.6** The chlorine feeding device shall be designed so that during accidents or interruptions of the chlorinator booster pump leaking chlorine gas will be conducted to the outdoors.

**308.7** The feeding device shall be a solution feed type, capable of delivering chlorine at its maximum rate without releasing chlorine gas to the atmosphere.

**308.8** The chlorinator shall be designed to prevent the backflow of water into the chlorine solution container.

**308.9** The recirculating pump and chlorine booster pump motor controls shall be interlocked so that the booster pump cannot operate when the recirculating pump is off, or during the backwash cycle. No connection shall be made to an external water supply for chlorinator operation.

**308.10** A scale for determining weight of chlorine shall be provided.

### **309.0 Pool, Spa and Hot Tub Fittings.**

Pool, spa and hot tub fittings shall be of an approved-type design as to be appropriate for the specific application.

**309.1** All swimming pools, spas and hot tubs shall be provided with a listed surface skimmer or a perimeter overflow system.

**Exception:** Spas constructed with a circulation piping system, which is common to a swimming pool, and having a design, which will provide for skimming of the spa into the swimming pool, may be considered as meeting this requirement without an additional skimmer being provided.

**309.2 Surface Skimmers.** Listed surface skimmers, where used in lieu of a perimeter overflow system, shall be installed in strict accordance with the manufacturers' installation instructions. For public pools, spas, and hot tubs, there shall be at least one (1) skimmer for each 500 square feet (1,524.0 m<sup>2</sup>) of surface area, or fraction thereof. For private pools, spas, and hot tubs, there shall be at least one (1) skimmer for each 900 square feet (274.3 m<sup>2</sup>) of surface area or fraction thereof. In public pools, a minimum of 75 percent of the turnover rate through the surface skimmers must be provided.

**309.3 Perimeter Overflow Systems.** A perimeter overflow system shall comply with all of the following provisions:

**309.3.1** The overflow system shall be built into the walls and extend completely around the pool except where steps require interruption.

**309.3.2 Channel Slope.** The overflow channel shall be not less than three (3) inches (76 mm) deep, the section shall not diverge with depth, and the width of the bottom shall be not less than three (3) inches (76 mm). The opening into the overflow system shall be a minimum of four (4) inches (102 mm) beneath the coping in any direction measured radially from the inner edge of the overflow channel lip.

**309.3.3 Channel Lip.** The overflow channel lip shall not be more than twelve (12) inches (305 mm) below the level of the deck. The lip edge shall be rounded and shall not be thicker than two and one-half (2-1/2) inches (64 mm) nor thinner than one (1) inch (25.4 mm) from the top two (2) inches (51 mm).

**309.3.4 Channel Covering.** Covered overflow channels shall be permitted, providing a bather cannot enter it or get his arms or legs caught in the cover.

**309.3.5 Channel Outlets<sup>1</sup>.** Overflow channel outlets shall not be less than one and one-half (1-1/2) inches (64 mm) in diameter, spaced not more than fifteen (15) feet (4,572 mm) apart and the channel bottom slope to the



drain shall be not less than one-quarter (1/4) inch per foot (6.4 mm/304.8 mm).

<sup>1</sup>Other drain spacing or channel bottom slope shall be permitted if hydraulically designed in accordance with acceptable engineering principals.

**309.3.6 Channel Outlet Covers.** Overflow channel outlets shall be provided with a clear opening area in the grating not less than one-fifth (1/5) times the cross-sectional area of the outlet required in Section 309.3.5.

**309.3.7 Overflow Drain Piping.** Overflow drain piping shall provide drainage of the overflow system, shall carry overflow water to a surge storage chamber, and shall establish hydraulic equilibrium in the pool and return to skimming within ten (10) minutes after being flooded by a sudden large use of the pool by bathers.

**309.3.8 Surge Storage Capacity.** A perimeter overflow system shall be provided with a minimum surge storage of not less than one (1) gallon per square foot (40.6 l/m<sup>2</sup>) of pool water surface area. Surge storage shall be permitted in the perimeter overflow channel, the overflow water drain piping returning to the surge chamber, and in the surge chamber.

**309.3.9 Surge Flow Control.** Automatic water flow controls with a manual override provision shall be provided to maintain the proper operating pool water level.

The top of the channel lip shall not vary more than one-quarter (1/4) inch (6.4 mm) from the lowest point to the highest point.

**309.3.10** When overflow drains are provided they shall be installed in accordance with the requirements of the Authority Having Jurisdiction.

**309.4 Pool, Spa and Hot Tub Outlets.** All pool, spa and hot tub outlets shall be listed to standards for anti-body and hair entrapment.

All outlets shall be installed in one of the following manners:

**309.4.1** For each system, a minimum of two (2) outlets separated by a minimum of three (3) feet (914 mm), or located on two different design planes: i.e., one (1) on the bottom and one (1) on a vertical side wall; two (2) separate vertical walls. The bottom of all outlets other than skimmers shall be no more than three (3) inches (76 mm) from the spa floor. At least one (1) pool outlet shall be located on the

bottom of the pool through which circulation shall take place and by which the pool can be emptied. Branch lines connecting separate drains to a common drain line shall be no smaller in diameter than the common drain line.

**309.4.2** A listed outlet cover twelve (12) inches square (7742 mm<sup>2</sup>) or greater.

**309.4.3** A listed skimmer with a bottom outlet on the filtration suction line. The filtration suction line shall be connected to a second outlet to relieve suction in the event blockage occurs.

**309.4.4** Any other listed method or devices.

**309.4.5** Suction cleaner device outlets shall remain covered when not in use so as not to pose an entrapment hazard.

**309.5 Hydrostatic Relief.** An approved hydrostatic relief shall be installed on all pools and spas built in areas of anticipated high water table. (Not applicable to plastic liner pools where there is no structural bottom to the pool.)

**309.6 Inlet Fittings.** Approved or listed manufactured inlet fittings for the return of recirculated pool water shall be provided on the basis of at least one (1) per 15,000 gallons (56,780 L) of pool capacity. Such inlet fitting shall be of such design and construction as to ensure an adequate seal to the pool structure and shall provide a convenient means of sealing for pressure testing of the pool circulation piping. Where more than one (1) inlet is required, the shortest distance between any two (2) required inlets shall be at least ten (10) feet (3,048 mm).

### **310.0 Piping Materials.**

**310.1** Listed plastic circulating piping and fittings for nonthreaded applications between all mechanical equipment and pools, spas, or hot tubs shall be not less than Schedule 40.

**310.2** Listed plastic threaded circulating pipe between all mechanical equipment and pools, spas, and hot tubs shall be not less than Schedule 80. Threading of plastic pipe in the field is prohibited. Threads shall be molded.

**310.3** Plastic piping, up to a maximum of two (2) inch (51 mm), may be cold bent in the field to a minimum radius of five (5) feet (1524 mm) without the application of heat. Bends of small radii and larger than two (2) inch (51 mm) shall be

manufactured with the use of thermostatically controlled equipment and shall be listed.

**310.4** Changes in direction in copper tubing may be made with bends provided that such bends are made with bending equipment that does not deform or create a loss in the cross-sectional area of the tubing.

**310.5** Circulating piping shall be protected from excessive high water temperature. (See Section 408.2 and 408.3.)

**310.6** Burred ends of all pipe and tubing shall be reamed to the full bore of the pipe or tube and all chips shall be removed.

### **311.0 Materials.**

**311.1** Pipe and fittings for water supply and circulating systems for swimming pools, spas, and hot tubs shall be of brass, copper, cast iron, CPVC, galvanized malleable iron, galvanized wrought iron, galvanized steel, PEX, or other approved materials. PE, PVC, PEX-AL-PEX, or PE-AL-PE water pipe manufactured to recognized standards may be used for cold water supply systems outside a building. PEX-AL-PEX water pipe, tubing, and fittings manufactured to recognized standards may be used for hot and cold water systems within a building. PE-AL-PE water pipe and fittings may be used for cold water systems within a building. All materials used in the water supply or circulating system, except valves and similar devices, shall be of a like material, except where otherwise approved by the Authority Having Jurisdiction. [UPC 604.1]

**311.2** Copper tube shall have a weight of not less than Type L.

**Exception:** Type M copper tubing may be used when piping is aboveground in, or on, a building or underground outside of structures. [UPC 604.2]

**311.3** All hard-drawn copper tubing, in addition to the required incised marking, shall be marked in accordance with sections 19.3.1 and 19.3.2 of ASTM B 88-99 *Seamless Copper Water Tube*. The colors shall be: Type K, green; Type L, blue; Type M, red; Type DWV, yellow. [UPC 604.3]

**311.4** Listed flexible copper water connectors shall be installed in readily accessible locations, unless otherwise listed. [UPC 604.4]

**311.5** Cast-iron fittings up to and including two (2) inches (51 mm) in size, when used in

connection with potable water piping, shall be galvanized. [UPC 604.5]

**311.6** All malleable iron water fittings shall be galvanized. [UPC 604.6]

**311.7** Piping and tubing that has previously been used for any purpose other than for potable water systems shall not be used. [UPC 604.7]

**311.8** Approved plastic materials may be used, provided that, where metal piping is used for electrical grounding purposes, replacement piping therefor shall be of like materials.

**Exception:** Where a grounding system acceptable to the Authority Having Jurisdiction is installed, inspected, and approved, metallic pipe may be replaced with nonmetallic pipe. [UPC 604.8]

**311.9** Solder shall conform to the requirements of Section 316.1.3 titled "Soldered Joints." [UPC 604.9]

**311.10** Water pipe and fittings with a lead content that exceeds 8 percent shall be prohibited in piping systems used to convey potable water. [UPC 604.10]

**311.11 PEX.** Cross-linked polyethylene (PEX) tubing shall be marked with the appropriate standard designation(s) listed in Table 6-1 for which the tubing has been approved. PEX tubing shall be installed in compliance with the provisions of this section. [UPC 604.11]

**311.11.1 PEX Fittings.** Metal insert fittings, metal compression fittings, and cold expansion fittings used with PEX tubing shall be manufactured to and marked in accordance with the standards for the fittings in Table 6-1. [UPC 604.11.1]

**311.11.2 Water Heater Connections.** PEX tubing shall not be installed within the first eighteen (18) inches (457 mm) of piping connected to a water heater. [UPC 604.11.2]

**311.12 Flexible Corrugated Connectors.** Flexible corrugated connectors of copper or stainless steel for water heaters shall be limited to twenty-four (24) inches (609 mm). [UPC 604.12]

**311.13 PEX-AL-PEX and PE-AL-PE.** Cross-linked polyethylene-aluminum-cross-linked polyethylene (PEX-AL-PEX) and polyethylene-aluminum-polyethylene (PE-AL-PE) composite pipe shall be marked with the appropriate standard designations listed in Table 6-1 for which the

piping has been listed or approved. PEX-AL-PEX and PE-AL-PE piping shall be installed in compliance with the provisions of this section. [UPC 604.13]

**311.13.1 PEX-AL-PEX and PE-AL-PE.**

Fittings used with PEX-AL-PEX and PE-AL-PE piping shall be manufactured to and marked in accordance with the standard for the fittings in Table 6-1. [UPC 604.13.1]

**311.13.2 Water Heater Connections.** PEX-AL-PEX or PE-AL-PE tubing shall not be installed within the first eighteen inches (18) (457 mm) of piping connected to a water heater. [UPC 604.13.2]

**311.14** Copper tube for underground and above ground drainage and vent piping shall have a weight of not less than that of copper drainage tube Type DWV. [UPC 701.1.4]

**312.0 Wastewater Disposal.**

**312.1** Waste shall be disposed of as hereinafter set forth in this section and the type of disposal proposed shall be approved by the Authority Having Jurisdiction prior to the commencement of any work. A means of disposal of the total contents of the pool (periodic emptying) without surface runoff shall be established to the satisfaction of the Authority Having Jurisdiction.

**312.2** No direct connection shall be made between any storm drain, sewer, drainage system, seepage pit, underground leaching pit, or subsoil drainage line, and any line connected to a swimming pool, spa or hot tub.

**312.3** When the wastewater is to be disposed of through a public sewer, a minimum of three (3) inch (76 mm) P-trap shall be required. Such drains shall not be installed in patios, floors or sidewalks. The tailpiece from the trap shall extend a minimum of three (3) inches (76 mm) above finished grade and below finished floor grade. Traps need not be vented when located on the exterior of the building. The connection between the filter waste discharge piping and the P-trap shall be made by means of an airgap.

Plans and specifications for any deviation from the above manner of installation shall first be approved by the Authority Having Jurisdiction before any portion of any such system is installed. When wastewater disposal is to a seepage pit installation, it shall be installed in

accordance with the approval granted by the Authority Having Jurisdiction.

**312.4** Except as provided in Section 312.5, when a public sewer or storm drain of adequate capacity is available for use, wastewater shall be discharged thereto and permission shall be obtained in writing from the proper authority to do so. A copy of such permission stating the maximum size of the waste line between the receptor and the sewer, and other specific requirements, shall accompany the applications for a permit made to the Authority Having Jurisdiction.

**312.5** Where space and conditions are such that no hazard, nuisance or insanitary condition is evidenced, wastewater may be used for irrigation by surface or subsurface spreading.

**312.6** When no other means of wastewater disposal is available, a dry well may be installed. Each such dry well shall be constructed in the manner prescribed for cesspools in Appendix K of the UPC, and drywells receiving only filter backwash shall have a capacity of at least twice the amount of effluent discharged during one (1) normal backwash operation, but shall in no case have less than a five (5) foot (1,524 mm) vertical sidewall. When draining, the size and leaching capacity of such dry well shall be proportionately increased to the satisfaction of the Authority Having Jurisdiction. No wastewater, other than that from a swimming pool, spa, or hot tub, shall discharge into any such drywell, and no wastewater from any swimming pool, spa or, hot tub shall discharge into a private sewage disposal system.

**313.0 Separation Tank.**

A separation tank of an approved type may be used in lieu of the forementioned means of wastewater disposal when connected as a reclamation system. A relief valve shall be installed on each such separation tank to relieve pressure when the filters are being serviced.

**314.0 Drain Piping.**

Drainage piping to waste-serving gravity overflow gutter drains and deck drains shall be installed to provide continuous grade to point of discharge.

**315.0 Deck Drain Piping Materials.**

**315.1** Deck drain piping placed within the interior of a building shall be of cast iron, galvanized steel, wrought iron, brass, copper, lead, ABS, PVC, or other approved materials.

**315.2** Deck drain piping commencing two (2) feet (610 mm) from the exterior of a building may be of any approved material.

**315.3** Deck drain piping installed in locations where they may be subjected to damage shall be protected.

**315.4** Deck drains and overflow drains when concealed within the construction of the building, shall be tested in conformity with the provisions of this code for testing drain, waste, and vent systems.

**315.5** Deck strainers, if used, shall be of an approved flat-surface type that is level with the deck. Such drains shall have an inlet area not less than two (2) times the area of the pipe to which the drain is connected.

**316.0 Joints and Connections.****316.1 Types of Joints.**

**316.1.1 Caulked Joints.** Caulked joints for cast-iron bell-and-spigot soil pipe and other similar joints shall be firmly packed with oakum or hemp and filled with molten lead to a depth of not less than one (1) inch (25.4 mm). The lead shall be caulked thoroughly at the inside and outside edges of the joint. After caulking, the finished joint shall not extend more than one-eighth (1/8) inch (3.2 mm) below the rim of the hub. No paint, varnish, or other coatings shall be permitted on the joining material until after the joint has been tested and approved. [UPC 705.1.1]

**316.1.2 Threaded Joints.** Threads on iron pipe size (IPS) pipe and fittings shall be standard taper pipe threads. Threads on tubing shall be approved types. Threads on plastic shall be factory-cut or molded. Threaded plastic pipe shall be Schedule 80 minimum wall thickness. Tubing threads shall conform to fine tubing thread standards. When a pipe joint material is used, it shall be applied only on male threads and such materials shall be of approved types, insoluble in water and nontoxic. Cleanout plugs and caps shall be lubricated with a water-insoluble nonhardening material or tape. Thread tape or

thread lubricants and sealants specifically intended for use with plastics shall be used on plastic threads. Conventional pipe thread compounds, putty, linseed oil-based products, and unknown lubricants and sealants shall not be used on plastic threads. [UPC 316.1.1]

**316.1.3 Soldered Joints.** Joints in copper tubing shall be made by the appropriate use of approved copper or copper alloy fittings. Surfaces to be joined by soldering shall be cleaned bright by manual or mechanical means. The joints shall be properly fluxed with an approved type flux and made up with approved solder. All solder and fluxes shall be manufactured to approved standards. Solders and fluxes with a lead content that exceeds two-tenths (0.20) of 1 percent are prohibited in piping systems used to convey potable water. [UPC 316.1.3]

**316.1.4 Flared Joints.** Flared joints for soft-copper water tubing shall be made with fittings meeting approved standards. The tubing shall be reamed to the full inside diameter, resized to round, and expanded with a proper flaring tool. [UPC 316.1.4 and 606.1.1]

**316.1.5 Mechanically Formed Tee Fittings.** Mechanically extracted collars shall be formed in a continuous operation consisting of drilling a pilot hole and drawing out the tube surface to form a collar having a height not less than three (3) times the thickness of the branch tube wall.

The branch tube shall be notched to conform with the inner curve of the run tube and shall have two (2) dimple/depth stops to ensure that penetration of the branch tube into the collar is of sufficient depth for brazing and that the branch tube does not obstruct the flow in the main line tube. Dimple/depth stops shall be in line with the run of the tube. The second dimple shall be one-quarter (1/4) inch (6.35 mm) above the first and shall serve as a visual point of inspection.

All joints shall be brazed in accordance with Section 316.1.14. Soft soldered joints shall not be allowed. [UPC 606.1.3]

**316.1.6 Packing Additives Prohibited.** The addition of leak-sealing additives to joint packing is prohibited. [UPC 705.1.5]

**316.1.7 Flexible Compression Factory Fabricated Joints.** When pipe is joined by means of flexible compression joints, such joints shall conform to approved standards and shall not be considered as slip joints. [UPC 316.1.5]

**316.1.8 Solvent Cement Plastic Pipe Joints.** Plastic pipe and fittings designed to be joined by solvent cementing shall comply with appropriate IAPMO installation standards.

ABS pipe and fittings shall be cleaned and then joined with solvent cement(s).

CPVC pipe and fittings shall be cleaned and then joined with listed primer(s) and solvent cement(s).

**Exception:** Listed solvent cements that do not require the use of primer shall be permitted for use with CPVC pipe and fittings manufactured in accordance with ASTM D2846, one-half (1/2) inch through two (2) inches in diameter.

PVC pipe and fittings shall be cleaned and joined with primer(s) and solvent cement(s). [UPC 316.1.6]

**316.1.9 Mechanical Compression Joints.** Mechanical compression joints shall consist of a listed solid stainless-steel outer shield with a suitable tightening mechanism and a synthetic rubber inner sleeve with built in O-rings.

**316.1.10 Molded Rubber Coupling Joints.** When pipe is joined by means of molded rubber coupling joints, such joints shall conform to approved standards and shall not be considered as slip joints. When required, appropriate rubber bushings shall be used to allow for any difference in piping material diameters. [UPC 705.1.6]

**316.1.11 Shielded Coupling Joints.** When piping systems are joined by means of shielded couplings, such couplings shall conform to approved standards and shall not be considered as slip joints. [UPC 705.1.8]

**316.1.12 Mechanical Joints.** Mechanical joints for cast-iron water pipe shall conform to nationally recognized standards. [UPC 606.1.2]

**316.1.13 Hubless Cast-Iron Pipe Joints.** Joints for hubless cast-iron soil pipe and fittings shall conform to appropriate IAPMO Installation Standards and shall not be considered as slip joints. [UPC 705.1.9]

**316.1.14 Brazing and Welding.** Brazing and welding shall conform to the applicable standard(s) in Table 6-1. [UPC 316.1.7]

**316.1.15 Pressure-Lock Type Connection.** This is mechanical connection that depends on an internal retention device to prevent pipe or tubing separation. Connection is made by inserting the pipe or tubing into the fitting to a prescribed depth. [UPC 316.1.8]

**316.1.16 Pressed Fitting.** This is a mechanical connection for joining copper tubing that uses a crimping tool to affix the O-ring seal copper or copper alloy fitting to the tubing. The tubing shall be inserted into the fitting, and the crimp shall be made using the tool recommended by the manufacturer. [UPC 316.1.9]

## **316.2 Use of Joints.**

**316.2.1 Clay and Sewer Pipe.** Joints in vitrified clay pipe or between such pipe and metal pipe shall be made as provided in Section 316.1.7, 316.1.11, 316.1.12, or 316.1.13.

**316.2.2 Cast-Iron Pipe.** Joints in cast-iron pipe shall be made as provided in Section 316.1.1, 316.1.2, 316.1.7, 316.1.11, 316.1.12 or 316.1.13.

**316.2.3 Screw Pipe to Cast-Iron.** Joints between wrought-iron, steel, brass, or copper pipe and cast-iron pipe shall be either caulked or threaded joints made as provided in Section 316.1.1 or 316.1.2 or shall be made with approved adaptor fittings.

**316.2.4 Copper Water Tube.** Joints in copper tubing shall be made by the appropriate use of approved fittings properly soldered or brazed together as provided in Section 316.1.3 titled "Soldered Joints" or 316.1.14 titled "Brazing and Welding" or by means of approved compression fittings as provided in Section 316.1.4 titled "Flared Joints" or 316.1.5 titled "Mechanically Formed Tee Fittings." Solder and soldering flux shall conform to the requirements of Section 316.1.3. Mechanically formed tee fittings shall be made by brazing only and shall conform to the requirements of Section 316.1.5. [UPC 606.2.1]

**316.2.5 ABS and PVC Pipe.** Joints in ABS and PVC pipe shall be made as provided in Section 316.1.8 titled "Solvent Cement Plastic Pipe Joints."

**316.2.5.1 Plastic Fittings.** Female PVC screwed fittings for water piping shall be used with plastic male fittings and plastic male threads only. [UPC 606.2.2]

**316.2.6** A listed stainless-steel mechanical compression coupling, in straight and reducing sizes, may be used in lieu of other listed joints, for joining ABS, PVC, copper DWV, steel pipe, or other approved materials, in sizes one (1) inch (25.4 mm) through four (4) inch (102 mm). Pipe shall be sufficiently restrained to prevent movement.

### **316.3 Special Joints.**

**316.3.1 Copper Tubing to Screw Pipe Joints.** Joints from copper tubing to threaded pipe shall be made by the use of brass adapter fittings. The joint between the copper tubing and the fitting shall be properly sweated or soldered, and the connection between the threaded pipe and the fitting shall be made with a standard pipe size screw joint. Solder shall conform to the requirements of Section 316.1.3. [UPC 316.2.1]

**316.3.2 Unions.** Approved unions may be used in drainage work when accessibility located in the trap seal or between a fixture and its trap in the vent system, except underground or in wet vents at any point in the water supply system, and in gas piping as permitted by Section 511.3.2(4). [UPC 316.2.2]

**316.3.3 Plastic Pipe to Other Materials.** When connecting plastic pipe to other types of piping, only approved types of fittings and adapters designed for the specific transition intended shall be used. [UPC 316.2.3]

### **317.0 Equipment Foundations and Enclosures.**

**317.1** All mechanical equipment shall be supported on level concrete or other approved base designed to handle the anticipated loads. Equipment installed at ground level shall not be less than three (3) inches (76 mm) above the adjoining ground level. All piping, equipment and appurtenances shall be secured in accordance with the requirements of this code and the manufacturer's installation instructions and as approved by the Authority Having Jurisdiction. All heating and electrical equipment, unless approved for outdoor installation, shall be adequately protected against the weather or

installed within a building. All enclosed equipment rooms shall be adequately ventilated.

**317.2** Wooden hot tubs, installed below grade, shall have a minimum of twelve (12) inches (305 mm) of clearance between the outside walls of the tub and the interior wall of a properly supported sump or pit.

### **318.0 Accessibility and Clearances.**

Equipment shall be so installed as to provide ready accessibility for cleaning, operating, maintenance, and servicing.

### **319.0 Tests and Test Gauges.**

**319.1** All pool, spa, and hot tub piping shall be inspected and approved before being covered or concealed. It shall be tested and proved tight to the satisfaction of the Authority Having Jurisdiction, under a static water or air pressure test of not less than thirty-five (35) psi (241.3 kPa) for fifteen (15) minutes.

**Exception:** All exposed equipment shall be tested as required by the Authority Having Jurisdiction and/or the manufacturers' installation instructions.

**319.2** All drainage and vent piping, except outside deck drains, shall be inspected and approved before being covered or concealed. They shall be tested by plugging all outlets and completely filling with water. All joints shall be tight.

**319.3** Tests required by this code, which are performed utilizing dial gauges, shall be limited to gauges having the following pressure graduations or incrementations. [UPC 319.0]

**319.4** Required pressure tests of ten (10) psi (69 kPa) or less shall be performed with gauges of 1/10 pound (0.7 kPa) incrementation or less. [UPC 319.1]

**319.5** Required pressure tests exceeding ten (10) pounds (69 kPa) but less than or equal to one hundred (100) psi (689 kPa) shall be performed with gauges of one (1) psi (6.9 kPa) incrementation or less. [UPC 319.2]

**319.6** Required pressure tests exceeding one hundred (100) psi (689 kPa) shall be performed with gauges incremented for 2 percent or less of the required test pressure. [UPC 319.3]

**319.7** Test gauges shall have a pressure range not greater than twice the test pressure applied. [UPC 319.4]

**320.0 Final Inspection.**

All swimming pool, spa or hot tub installations must be completed. The pool shall be completely filled with water and in operation before final inspection.

**321.0 Electrical.**

Electrical wiring and equipment shall comply with the National Electric Code (NEC) or local ordinance.

**322.0 Prohibited Fittings and Practices.**

**322.1** No drainage or vent piping shall be drilled and tapped for the purpose of making connections thereto, and no cast-iron soil pipe shall be threaded. [UPC 311.2]

**322.2** Except for necessary valves, where intermembering or mixing of dissimilar metals occurs, the point of connection shall be confined to exposed or accessible locations. [UPC 311.6]

**322.3** All valves, pipes, and fittings shall be installed in correct relationship to the direction of flow. [UPC 311.7]

**323.0 Increases and Reducers.**

Where different sizes of pipes or pipes and fittings are to be connected, the proper size increasers or reducers or reducing fittings shall be used between the two sizes. Brass or cast-iron body cleanouts shall not be used as a reducer or adapter from cast-iron drainage pipe to iron pipe size (IPS) pipe. [UPC 317.0]

**324.0 Screwed Fittings.**

Screwed fittings shall be ABS, cast iron, copper, copper alloy, malleable iron, PVC, steel, or other approved materials. Threads shall be tapped out of solid metal or molded in solid ABS or PVC. [UPC 311.8]

**325.0 Protection of Piping, Materials, and Structures.**

**325.1** All piping in connection with a plumbing system shall be so installed that piping or connections will not be subject to undue strains or stresses, and provisions shall be made for expansion, contraction, and structural settlement. No plumbing piping shall be directly embedded in concrete or masonry. No structural member

shall be seriously weakened or impaired by cutting, notching, or otherwise, as defined in the Building Code. [UPC 313.2]

**325.2** All trenches deeper than the footing of any building or structure and paralleling the same shall be at least forty-five (45) degrees (0.79 rad) therefrom, unless permission be otherwise granted by the Authority Having Jurisdiction. [UPC 313.3]

**325.3** No building sewer or other drainage piping or part thereof, constructed of materials other than those approved for use under or within a building, shall be installed under or within two (2) feet (610 mm) of any building or structure, or less than one (1) foot (305 mm) below the surface of the ground. [UPC 313.4]

**325.4** Piping subject to corrosion, erosion, or mechanical damage shall be protected in an approved manner. [UPC 313.5]

**325.5** No water, soil, or waste pipe shall be installed or permitted outside of a building or in an exterior wall unless, where necessary, adequate provision is made to protect such pipe from freezing. [UPC 313.6]

**325.6** All piping penetrations of fire-resistance-rated walls, partitions, floors, floor/ceiling assemblies, roof/ceiling assemblies, or shaft enclosures shall be protected in accordance with the requirements of the Building Code, IAPMO Installation Standards, and Chapter 15 of the Uniform Plumbing Code, "Firestop Protection." [UPC 313.7]

**325.7 Waterproofing of Openings.** Joints at the roof around pipes, ducts, or other appurtenances shall be made watertight by the use of lead, copper, galvanized iron, or other approved flashings or flashing material. Exterior wall openings shall be made watertight. Counterflashing shall not restrict the required internal cross-sectional area of the vent. [UPC 313.8]

**325.8** Plastic and copper piping run through framing members to within one (1) inch (25.4 mm) of the exposed framing shall be protected by steel nail plates not less than 18 gauge. [UPC 313.9]

**Exception:** See Section 1211.3.4 of the Uniform Plumbing Code.

**325.9 Sleeves.**

**325.9.1** Sleeves shall be provided to protect all piping through concrete and masonry walls. [UPC 313.10.1]

**325.9.2** Piping through concrete or masonry walls shall not be subject to any load from building construction. [UPC 313.10.2]

**325.9.3** In exterior walls, annular space between sleeves and pipes shall be sealed and made watertight as approved by the Authority Having Jurisdiction. Any penetration through fire-resistive construction shall be in accordance with Section 325.6. [UPC 313.10.3]

**325.9.4** Any pipe sleeve through a firewall shall have the space around the pipe completely sealed with an approved fire-resistive material in accordance with all other codes. [UPC 313.10.4]

**325.10** Any structural member weakened or impaired by cutting, notching, or otherwise shall be reinforced, repaired, or replaced so as to be left in a safe structural condition in accordance with the requirements of the Building Code or as required by the proper Authority Having Jurisdiction. [UPC 313.11]

**325.11 Ratproofing.**

**325.11.1** Strainer plates on drain inlets shall be designed and installed so that no opening is greater than one-half (1/2) inch (12.7 mm) in the least dimension. [UPC 313.12.1]

**325.11.2** In or on buildings where openings have been made in walls, floors, or ceilings for the passage of pipes, such openings shall be closed and protected by the installation of approved metal collars securely fastened to the adjoining structure. [UPC 313.12.3]

**326.0 Trenching, Excavation, and Backfill.**

**326.1** All trenches deeper than the footing of any building or structure and paralleling the same shall be at least forty-five (45) degrees (0.79 rad) therefrom, unless permission is otherwise granted by the Authority Having Jurisdiction. [UPC 315.1]

**326.2** Tunneling and driving may be done in yards, courts, or driveways of any building site. Where sufficient depth is available to permit, tunnels may be used between open-cut trenches. Tunnels shall have a clear height of two (2) feet (610 mm) above the pipe and shall be limited in length to one-half (1/2) the depth of the trench, with a maximum length of eight (8) feet (2438 mm). When pipes are driven, the drive pipe shall be at least one (1) size larger than the pipe to be laid. [UPC 315.2]

**326.3 Open Trenches.** All excavations required to be made for the installation of a swimming pool, spa hot tub, or related piping system or any part thereof, shall be open trench work and shall be kept open until the piping has been inspected, tested, and accepted. [UPC 315.3]

**326.4** All excavations shall be completely backfilled as soon after inspection as practicable. Adequate precaution shall be taken to ensure proper compactness of backfill around piping without damage to such piping. Trenches shall be backfilled in thin layers to twelve (12) inches (305 mm) above the top of the piping with clean earth, which shall not contain stones, boulders, cinderfill, frozen earth, construction debris, or other materials that would damage or break the piping or cause corrosive action. Mechanical devices such as bulldozers, graders, etc., may then be used to complete backfill to grade. Fill shall be properly compacted. Suitable precautions shall be taken to ensure permanent stability for pipe laid in filled or made ground. [UPC 315.4]



## CHAPTER 4

### WATER HEATERS AND VENTS

#### 401.0 General.

The regulations of this chapter shall govern the construction, location, and installation of all fuel-burning water heaters or boilers specifically designed and listed for swimming pool, spa or hot tub service, together with all chimneys, vents, and their connectors. All design, construction, and workmanship shall be in conformity with accepted engineering practices, manufacturers' installation instructions, and applicable standards and shall be of such character as to secure the results sought to be obtained by this code. No water heater shall be hereinafter installed that does not comply in all respects with the type of model of each size, thereof, approved by the Authority Having Jurisdiction. (For the convenience of users of this code, a list of generally accepted gas equipment standards is included in Table 6-1 in Chapter 6 of this code.)

#### 402.0 Definitions.

**402.1 Chimney** - One or more passageways, vertical or nearly so, for conveying flue or vent gases to the outside atmosphere. [NFPA 54: 3.3.39]

**402.2 Chimney, Factory-Built** - A chimney composed of listed factory-built components assembled in accordance with the terms of listing to form the completed chimney. [NFPA 54: 3.3.40]

**402.3 Chimney, Masonry** - A field-constructed chimney of solid masonry units, bricks, stones, listed masonry chimney units, or reinforced portland cement concrete, lined with suitable chimney flue liners. [NFPA 54: 3.3.41]

**402.4 Chimney, Metal** - A field-constructed chimney of metal. [NFPA 54: 3.3.42]

**402.5 Chimney Connector** - The pipe that connects a fuel-burning appliance to a chimney.

**402.6 Combustible Material** - As pertaining to materials adjacent to or in contact with heat-producing appliances, vent connectors, gas vents, chimneys, steam and hot water pipes, and warm air ducts, shall mean materials made of or surfaced with wood, compressed paper, plant fibers, or other materials that are capable of being ignited and burned. Such material shall be considered combustible even though flame-proofed, fire-retardant treated, or plastered. [NFPA 54: 3.3.46]

**402.7 Direct Vent Appliances** - Appliances 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. [UPC 502.7]

**402.8 Flue Collar** - That portion of an appliance designed for the attachment of a draft hood, vent connector, or venting system. [NFPA 54: 3.3.93]

**402.9 Gas Vent, Type B** - A vent for venting listed gas appliances with draft hoods and other Category I gas appliances listed for use with Type B gas vents. [NFPA 54: 3.3.114]

**402.10 Gas Vent, Type L** - A vent for venting appliances listed for use with Type L vents and appliances listed for use with Type B gas vents. [NFPA 54: 3.3.116]

**402.11 Vent Connector** - The pipe or duct that connects a fuel-gas-burning appliance to a vent or chimney. [NFPA 54: 3.3.224]

**402.12 Vent** - A passageway used to convey flue gases from gas utilization equipment or their vent connectors to the outside atmosphere. [NFPA 54: 3.3.223]

**402.13 Vent Collar** - The outlet opening of an appliance provided for connection of the vent system.

**402.14 Venting System** - A continuous open passageway from the flue collar or draft hood of a gas-burning appliance to the outside atmosphere for the purpose of removing flue or vent gases. [NFPA 54: 3.3.236]

**402.15 Stackless Vents** - A factory-supplied venting system that is an integral part of a listed pool heater intended for outdoor installations.

**402.16 Water Heater** - An appliance for supplying hot water for swimming pools, spas, and hot tubs.

#### 403.0 Permits.

It shall be unlawful for any person to install, remove, or replace or cause to be installed, removed, or replaced any swimming pool, spa, or hot tub water heater without first obtaining a permit from the Authority Having Jurisdiction to do so. [UPC 503.0]

**404.0 Inspections.**

**404.1 Inspection of Chimneys or Vents.** This inspection shall be made after all chimneys, vents or parts thereof, authorized by the permit, have been installed and before any such vent or part thereof has been covered or concealed. [UPC 504.1]

**404.2 Final Water Heater Inspection.** This inspection shall be made after all work authorized by the permit has been installed. The Authority Having Jurisdiction will make such inspection as he deems necessary to ensure that the work has been installed in accordance with the intent of this code. No equipment or part thereof shall be covered or concealed until the same has been inspected and approved by the Authority Having Jurisdiction. [UPC 504.2]

**405.0 Water Heater Requirements.** Water heaters of other than the direct-vent type shall be located as close as practical to the chimney or gas vent. [NFPA 54:9.28.1.2]

**405.1 Clearance.**

**405.1.1** The clearances shall not be such as to interfere with combustion air, draft hood clearance and relief, and accessibility for servicing. Listed water heaters shall be installed in accordance with their listing and the manufacturers' instructions. [NFPA 54:9.28.2.1]

**405.1.2** Unlisted water heaters shall be installed with a clearance of twelve (12) inches (300 mm) on all sides and rear. Combustible floors under unlisted water heaters shall be protected in an approved manner. [NFPA 54:9.28.2.2]

**405.2 Pressure-Limiting Devices.** A water heater installation shall be provided with overpressure protection by means of an approved listed device, and installed in accordance with the terms of its listing and the manufacturer's instructions. [NFPA 54: 9.28.3]

**405.3 Temperature-Limiting Devices.** Water heater installation or a hot water storage vessel installation shall be provided with over temperature protection by means of an approved listed device installed in accordance with the terms of its listing and the manufacturers' instructions. [NFPA 54: 9.28.4]

**405.4 Temperature, Pressure, and Vacuum Relief Devices.** The installation of temperature, pressure, and vacuum relief devices or combinations thereof, and automatic gas shutoff devices, shall be in accordance with the terms of

their listing and the manufacturers' instructions. A shutoff valve shall not be placed between the relief valve and the water heater or on discharge pipes between such valves and the atmosphere. The hourly Btu discharge capacity or the rated steam relief capacity of the device shall not be less than the input rating of the water heater. [NFPA 54: 9.28.5]

**406.0 Gas-Fired Swimming Pool Heater Approval Requirements.**

**406.1** Water heating equipment shall meet the requirements of standards for gas-fired water heaters. The water heater shall bear the label of a recognized testing agency.

**406.2** Except when reconditioned by the manufacturer or his approved agent in accordance with its original approval requirements and reinstalled at its original location, each reconditioned water heater or hot water boiler shall be tested for safety and conformity to approved standards, and shall bear the label of an approved testing agency, certifying and attesting that such equipment has been tested and inspected and meets the requirements of applicable standards. Such label shall also state clearly that the water heater has been reconditioned and shall give the name and address of the reconditioner. Every person applying for a permit to install a used or reconditioned water heater shall clearly state on his application for permit that such equipment is used or reconditioned.

**407.0 Oil-Burning and Other Swimming Pool, Spa or Hot Tub Heaters.**

**407.1** Water heaters deriving heat from fuels or types of energy other than gas shall be constructed and installed in accordance with approved standards in a manner satisfactory to the Authority Having Jurisdiction. Vents or chimneys for fuel-burning water heaters shall be approved or listed types and shall be installed in conformity with their conditions of approval. Proper provision shall be made for an adequate supply of air for combustion and for adequate ventilation of water heater rooms or compartments. Each such appliance shall be installed in an approved location satisfactory to the Authority Having Jurisdiction and to local and state fire prevention agencies. [UPC 506.1]

**407.2** All storage-type water heaters and hot water boilers deriving heat from fuels or types of

energy other than gas shall be provided with, in addition to the primary temperature controls, an over-temperature safety protection device constructed, listed, and installed in accordance with nationally recognized applicable standards for such devices. [UPC 506.2]

**407.3** Oil-fired water heaters shall be installed in accordance with NFPA 31, *Standard for the Installation of Oil-Burning Equipment*. [UPC 506.3]

#### **408.0 Installation Requirements for Water Heaters.**

**408.1** To prevent excessive condensation, the water heater shall be installed with a manual or automatic bypass installed between the inlet and outlet piping of the water heater, unless the water heater is constructed with an automatic bypass.

**408.2** A check valve shall be installed between the filter and water heater system to prevent reverse flow of water when the pump cycles off. In systems designed to prevent damage from backflow, the foregoing is not required.

**408.3** Unless otherwise listed, inlet and outlet piping between the check valve and the water heater base respectively shall be metallic or of other listed materials per the water heater manufacturer's recommendations.

**408.4** When the water heater is installed in a pit, the pit shall be provided with approved drainage facilities.

**408.5** All water heating equipment shall be installed with flanges or union connections within twelve (12) inches (305 mm) of the water heater. [UPC 609.5]

**408.6** When swimming pool, spa or hot tub heating equipment is installed with a shutoff valve between the outlet of the heater and the pool, spa or hot tub, a pressure relief valve shall be installed on the discharge side of the water heating equipment. For units up to and including two hundred thousand (200,000) Btu/hour (58,575 W) input, the relief valve shall be listed, and for inputs over two hundred thousand (200,000) Btu/hour (58,575 W), the valve shall be A.S.M.E. rated.

Relief valves located inside a building shall be provided with a drain, not smaller than the relief valve outlet, of galvanized steel, hard-drawn copper piping and fittings, CPVC, or listed relief valve drain tube with fittings that will not reduce the internal bore of the pipe or tubing (straight lengths as opposed to coils) and shall extend from the valve to the outside of the building, with the

end of the pipe not more than two (2) feet (610 mm) nor less than six (6) inches (152 mm) above the ground and pointing downward. Such drains may terminate at other approved locations. No part of such drain pipe shall be trapped and the terminal end of the drain pipe shall not be threaded. [UPC 608.5]

#### **409.0 Air for Combustion and Ventilation.**

##### **409.1 General.**

**409.1.1** Air for combustion, ventilation, and dilution of flue gases for gas utilization equipment installed in buildings shall be obtained by application of one of the methods covered in 409.2.1–409.7. Gas utilization equipment of other than natural draft and Category I vented water heaters shall be provided with combustion, ventilation, and dilution air in accordance with the equipment manufacturer's instructions. Where infiltration does not provide the necessary air, outdoor air shall be introduced in accordance with methods covered in 409.4 – 409.7.

**Exception:** This provision shall not apply to direct-vent appliances. [UPC 507.1.1]

**409.1.2** Gas water heaters for swimming pool, spa, and hot tubs other than natural draft design and other than Category I vented appliances shall be provided with combustion, ventilation, and dilution air in accordance with the appliance manufacturer's instructions. [UPC 507.1.2]

**409.1.3** Where used, a draft hood or a barometric draft regulator shall be installed in the same room or enclosure as the equipment served so as to prevent any difference in pressure between the hood or regulator and the combustion air supply. [NFPA 54:8.3.1.4]

**409.1.4** Makeup air requirements for the operation of swimming pool, spa, and hot tub water heaters shall be considered in determining the adequacy of a space to provide combustion air requirements. [UPC 507.1.4]

**409.2 Indoor Combustion Air.** The required volume of indoor air shall be determined in accordance with method 409.2.1 or 409.2.2, except that where the air infiltration rate is known to be less than 0.40 ACH, method 409.2.2 shall be used. The total required volume shall be the sum of the required volume calculated for all appliances located within the space. Rooms communicating directly with the space in which the water heaters

are installed through openings not furnished with doors and through combustion air openings sized and located in accordance with 409.3 are considered a part of the required volume. [NFPA 54:8.3.2]

**409.2.1 Standard Method:** The minimum required volume shall be fifty (50) cubic feet per 1,000 Btu/hour (4.8 m<sup>3</sup>/kW). [NFPA 54:8.3.2.1]

**409.2.2 Known Air Infiltration Rate Method:** Where the air infiltration rate of a structure is known, the minimum required volume shall be determined as follows:

For water heaters having other than fan-assisted combustion systems: Calculate using Equation 4-1 but no smaller than 35 cubic feet per 1,000 Btu/hour (3.4 m<sup>3</sup>/kW).

For fan-assisted combustion system water heaters: Calculate using Equation 4-2 but no smaller than 25 cubic feet per 1,000 Btu/hour (2.4 m<sup>3</sup>/kW). [NFPA 54:8.3.2.2]

#### Equation 4-1:

Required Volume<sub>other</sub> > (21 ft<sup>3</sup> / ACH) × (I<sub>other</sub> / 1,000 Btu/h)

#### Equation 4-2:

Required Volume<sub>fan</sub> > (15 ft<sup>3</sup> / ACH) × (I<sub>fan</sub> / 1,000 Btu/h)

Where:

I<sub>other</sub> = All Water Heaters other than Fan-Assisted

Input in Btu/hour

I<sub>fan</sub> = Fan-Assisted Water Heater Input in Btu/hour

ACH = Air Change per Hour (Percent of volume of space exchanged per hour, expressed as a decimal)

### 409.3 Indoor Opening Size and Location.

Openings used to connect indoor spaces shall be sized and located in accordance with the following.

- (1) Combining spaces on the same story. Each opening shall have a minimum free area of 1 inch<sup>2</sup>/1,000 Btu/h (220 mm<sup>2</sup>/kW) of the total input rating of all gas utilization equipment in the space, but not less than 100 inch<sup>2</sup> (0.06 m<sup>2</sup>). One opening shall commence within twelve (12) inches (300 mm) of the top, and one opening shall commence within twelve (12) inches (300

mm) of the bottom, of the enclosure [see Figure 4-8]. The minimum dimension of air openings shall be not less than three (3) inches (80 mm). [NFPA 54:8.3.2.3(1)]

- (2) Combining spaces in different stories. The volumes of spaces in different stories shall be considered as communicating spaces where such spaces are connected by one or more openings in doors or floors having a total minimum free area of 2 inch<sup>2</sup>/1000 Btu/h of total input rating of all gas water heaters. [NFPA 54:8.3.2.3(2)]

**409.4 Outdoor Combustion Air.** Outdoor combustion air shall be provided through openings to the outdoors in accordance with methods 409.4.1 or 409.4.2. The minimum dimension of air openings shall not be less than three (3) inches (80 mm). [NFPA 54:8.4]

#### 409.4.1 Two Permanent Openings Method:

Two permanent openings, one commencing within twelve (12) inches (300 mm) of the top and one commencing within twelve (12) inches (300 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. [See Figure 4-11.] [NFPA 54: 8.3.3.1]

- (1) Where directly communicating with the outdoors or where communicating to the outdoors through vertical ducts, each opening shall have a minimum free area of 1 inch<sup>2</sup>/4,000 Btu/h (550 mm<sup>2</sup>/kW) of total input rating of all equipment in the enclosure. [See Figures 4-9 and 4-10.] [NFPA 54: 8.3.3.1 (1)]
- (2) Where communicating with the outdoors through horizontal ducts, each opening shall have a minimum free area of 1 inch<sup>2</sup>/2,000 Btu/h (1,100 mm<sup>2</sup>/kW) of total input rating of all equipment in the enclosure. [See Figure 4-11] [NFPA 54: 8.3.3.1 (2)]

#### 409.4.2 One Permanent Opening Method:

One permanent opening, commencing within twelve (12) inches (300 mm) of the top of the enclosure, shall be provided. The equipment shall have clearances of at least one (1) inch (25 mm) from the sides and back and six (6) inches (160 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 4-12) and shall have a minimum free area of [NFPA 54: 8.3.3.2]:

- (1) 1 inch<sup>2</sup>/3,000 Btu/h (700 mm<sup>2</sup>/kW) of the total input rating of all equipment located in the enclosure, and [NFPA 54: 8.3.3.2 (1)]
- (2) Not less than the sum of the areas of all vent connectors in the space. [NFPA 54: 8.3.3.2 (2)]

**409.5 Combination Indoor and Outdoor Combustion Air.** The use of a combination of indoor and outdoor combustion air shall be in accordance with 409.5.1 through 409.5.3 (see example calculation in NFPA 54 Annex J and this chapter – Part II). [NFPA 54: 8.3.4]

**409.5.1 Indoor Openings.** Where used, openings connecting the interior spaces shall comply with Section 409.3. [NFPA 54: 8.3.4 (1)]

**409.5.2 Outdoor openings** shall be located in accordance with Section 409.4.1 and 409.4.2. [NFPA 54: 8.3.4 (2)]

**409.5.3 Outdoor Openings Size.** The outdoor openings size shall be calculated in accordance with the following: [NFPA 54: 8.3.4 (3)]

- (1) The ratio of interior spaces shall be the available volume of all communicating spaces divided by the required volume. [NFPA 54:8.3.4(3)(a)]
- (2) The outdoor size reduction factor shall be 1 minus the ratio of interior spaces. [NFPA 54:8.3.4(3)(b)]
- (3) The minimum size of outdoor openings shall be the full size of outdoor openings calculated in accordance with Section 409.4.1 or 409.4.2, multiplied by the reduction factor. The minimum dimension of air openings shall not be less than three (3) inches (80 mm). [NFPA 54:8.3.4(3)(c)]

**409.6 Engineered Installations.** Engineered combustion air installations shall provide adequate supply of combustion, ventilation, and dilution air and shall be approved by the Authority Having Jurisdiction. [NFPA 54: 8.3.5]

**409.7 Mechanical Combustion Air Supply.** Where all combustion air is provided by a mechanical air supply system, the combustion air shall be supplied from outdoors at the minimum

rate of 0.35 feet<sup>3</sup>/min per 1,000 Btu/h (0.034 m<sup>3</sup>/min per kW for all appliances located within the space. [NFPA 54:8.3.6]

**409.7.1** Where exhaust fans are installed, additional air shall be provided to replace the exhausted air. [NFPA 54:8.3.6.1]

**409.7.2** Each of the water heaters served shall be interlocked to the mechanical air supply system to prevent main burner operation where the mechanical air supply system is not in operation. [NFPA 54:8.3.6.2]

**409.7.3** Where combustion air is provided by the building's mechanical ventilation system, the system shall provide the specified combustion air rate in addition to the required ventilation air. [NFPA 54:8.3.6.3]

**409.8 Reserved.**

**409.9 Louvers and Grilles.**

**409.9.1** The required size of openings for combustion, ventilation, and dilution air shall be based on the net free area of each opening. Where the free area through a design of louver or grille is known, it shall be used in calculating the size opening required to provide the free area specified. Where the design and free area are not known, it shall be assumed that wood louvers will have 25 percent free area and metal louvers and grilles will have 75 percent free area. Non-motorized louvers and grilles shall be fixed in the open position. [NFPA 54: 8.3.7.1]

**409.9.2** Motorized louvers shall be interlocked with the equipment so they are proven 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 should the louver fail to open during burner startup and to shut down the main burner if the louvers close during burner operation. [NFPA 54: 8.3.7.2]

**409.10 Combustion Air Ducts.** Combustion air ducts shall comply with the following:

- (1) Ducts shall be of galvanized steel or an equivalent corrosion-resistant material.

**Exception:** Within dwelling units, unobstructed stud and joist spaces shall not be prohibited from conveying combustion air, provided that not more than one (1) fireblock is removed. [NFPA 54:8.3.8.1]

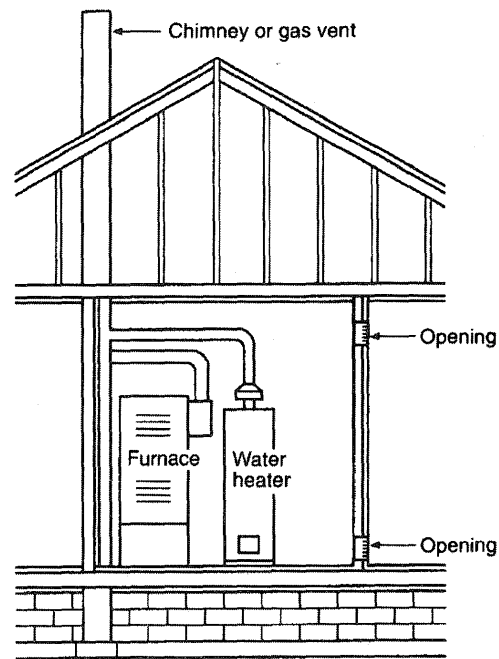
- (2) Ducts shall terminate in an unobstructed space, allowing free movement of combustion air to the appliances. [NFPA 54:8.3.8.2]
- (3) Ducts shall serve a single space. [NFPA 54:8.3.8.3]
- (4) Ducts shall not service both upper and lower combustion air openings where both such openings are used. The separation between ducts serving upper and lower combustion air openings shall be maintained to the source of combustion air. [NFPA 54:8.3.8.4]
- (5) Ducts shall not be screened where terminating in an attic space. [NFPA 54:8.3.8.5]
- (6) Intakes for combustion air ducts located exterior to the building shall have the lowest side of the combustion air intake openings located at least twelve (12) inches vertically from the adjoining grade level. [NFPA 54:8.3.8.6]
- (7) Horizontal upper combustion air ducts shall not slope downward toward the source of combustion air. [NFPA 54:8.3.8.7]
- (8) The remaining space surrounding a chimney liner, gas vent, special gas vent, or plastic piping installed within a masonry chimney flue, metal or factory-built chimney, shall not be used to supply combustion air, unless it is listed and shown in the manufacturer's installation instructions. [NFPA 54: 8.3.8]

#### 410.0 Other Water Heater Installation Requirements.

**410.1** The Authority Having Jurisdiction may require the use of an approved dielectric insulator on the water piping connections of water heaters and related water heating equipment. [UPC 508.1]

**410.2** In seismic design categories C, D, E, and F, water heaters shall be anchored or strapped to resist horizontal displacement due to earthquake motion. Strapping shall be at points within the upper one-third ( $1/3$ ) and lower one-third ( $1/3$ ) of its vertical dimensions. At the lower point, a minimum distance of four (4) inches (102 mm) shall be maintained above the controls with the strapping. [UPC 508.2]

**Exception:** Non storage-type water heaters may be anchored at the base only in accordance with



**FIGURE 4-8 All Combustion Air from Indoor Spaces Through Indoor Combustion Air Openings.**

the requirements of the manufacturers' installation instructions and the approval of the Authority Having Jurisdiction.

**410.3** A water heater supported from the ground shall rest on level concrete or other approved base extending not less than three (3) inches (76 mm) above the adjoining ground level. [UPC 508.3]

**410.4** When a water heater is located in an attic, attic-ceiling assembly, floor-ceiling assembly, or floor-subfloor assembly where damage may result from a leaking water heater, a watertight pan of corrosion-resistant materials shall be installed beneath the water heater with a minimum three-quarter ( $3/4$ ) inch (20 mm) diameter drain to an approved location. [UPC 508.4]

**410.5 Relief Valve Discharge.** Discharge from a relief valve into a water heater pan shall be prohibited. [UPC 508.5]

**410.6 Added or Converted Equipment.** When additional or replacement equipment is installed or an appliance is converted to gas from another fuel, the location in which the equipment is to be operated shall be checked to verify the following [NFPA 54:8.1.2]:

**410.6.1** Air for combustion and ventilation is provided where required, in accordance with

the provisions of Section 409.0. Where existing facilities are not adequate, they shall be upgraded to Section 409.0 specifications. [NFPA 54:8.1.2 (1)]

**410.6.2** The installation components and equipment meet the clearances to combustible material provisions of Section 410.6.2.1. It shall be determined that the installation and operation of the additional or replacement equipment does not render the remaining equipment unsafe for continued operation. [NFPA 54:8.1.2 (2)]

**410.6.2.1 Clearance to Combustible Materials.** Gas utilization equipment and its vent connectors shall be installed with clearances from combustible material so their operation will not create a hazard to persons or property. Minimum clearances between combustible walls and the back and sides of various conventional types of equipment and their vent connectors are specified in Chapters 9 and 10 of NFPA 54. (Reference can also be made to NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*.) [NFPA 54:8.2.2]

**410.6.3** The venting system is constructed and sized in accordance with the provisions of this chapter. Where the existing venting system is not adequate, it shall be upgraded to comply with this chapter. [NFPA 54: 8.1.2 (3)]

**410.7 Types of Gases.** It shall be determined whether the gas-utilization equipment has been designed for use with the gas to which it will be connected. No attempt shall be made to convert the equipment from the gas specified on the rating plate for use with a different gas without consulting the installation instructions, the serving gas supplier, or the equipment manufacturer for complete instructions. [NFPA 54: 8.1.3]

**410.8 Flammable Vapors.** Water heaters shall not be installed in areas where the open use, handling, or dispensing of flammable liquids occurs, unless the design, operation, or installation reduces the potential of ignition of the flammable vapors. Water heaters installed in compliance with 410.9 or 410.10 shall be considered to comply with the intent of this provision. [NFPA 54: 8.1.9]

**410.9 Installation in Residential Garages.**

- (1) Water heaters in residential garages and in adjacent spaces that open to the garage and are not part of the living space of a dwelling

unit shall be installed so that all burners and burner-ignition devices are located not less than eighteen (18) inches (450 mm) above the floor unless listed as flammable vapor ignition resistant. [NFPA 54: 8.1.10.1]

- (2) Such equipment shall be located or protected so it is not subject to physical damage by a moving vehicle. [NFPA 54: 8.1.10.2]
- (3) When water heaters are installed in a separate, enclosed space having access only from outside of the garage, such equipment may be installed at floor level, providing the required combustion air is taken from the exterior of the garage. [NFPA 54: 8.1.10.3]

**410.10 Installation in Parking Structures.** Gas utilization equipment installed in enclosed, basement, and underground parking structures shall be installed in accordance with NFPA 88A, *Standard for Parking Structures*. [NFPA 54:8.1.11.1]

**410.11 Gas Equipment Physical Protection.** Where it is necessary to locate gas utilization equipment close to a passageway traveled by vehicles or equipment, guardrails or bumper plates shall be installed to protect the equipment from damage. [NFPA 54: 8.1.13]

**410.12 Venting of Flue Gases.** Gas utilization equipment shall be vented in accordance with the provisions of this chapter and NFPA 54, Chapter 10. [NFPA 54: 8.1.14]

**410.13 Extra Device or Attachment.** No device or attachment shall be installed on any gas utilization equipment that could in any way impair the combustion of gas. [NFPA 54: 8.1.15]

**410.14 Adequate Capacity of Piping.** When additional gas utilization equipment is being connected to a gas piping system, the existing piping shall be checked to determine if it has adequate capacity. (See Section 510.4.3.) Where inadequate, the existing system shall be enlarged as necessary, or separate gas piping of adequate capacity shall be run from the point of delivery to the equipment. [NFPA 54: 8.1.16]

**410.15 Avoiding Strain on Gas Piping.** Gas utilization equipment shall be supported and so connected to the piping as not to exert undue strain on the connections. [NFPA 54: 8.1.17]

**410.16 Gas Appliance Pressure Regulators.** Where the gas supply pressure is higher than that at which the gas utilization equipment is designed to operate or varies beyond the design pressure limits of the equipment, a gas appliance pressure regulator shall be installed. [NFPA 54: 8.1.18]

**410.17 Venting of Gas Appliance Pressure Regulators.** Venting of gas appliance pressure regulators shall comply with the following requirements:

**410.17.1** Gas appliance pressure regulators requiring access to the atmosphere for successful operation shall be equipped with vent piping leading outdoors or, if the regulator vent is an integral part of the equipment, into the combustion chamber adjacent to a continuous pilot, unless constructed or equipped with a vent limiting means to limit the escape of gas from the vent opening in the event of diaphragm failure. [NFPA 54: 8.1.19(1)]

**410.17.2** Vent limiting means shall be employed on listed gas appliance pressure regulators only. [NFPA 54: 8.1.19(2)]

**410.17.3** In the case of vents leading outdoors, means shall be employed to prevent water from entering this piping and also to prevent blockage of vents by insects and foreign matter. [NFPA 54: 8.1.19(3)]

**410.17.4** Under no circumstances shall a regulator be vented to the gas utilization equipment flue or exhaust system. [NFPA 54: 8.1.19(4)]

**410.17.5** In the case of vents entering the combustion chamber, the vent shall be located so the escaping gas will be readily ignited by the pilot and the heat liberated thereby will not adversely affect the normal operation of the safety shutoff system. The terminus of the vent shall be securely held in a fixed position relative to the pilot. For manufactured gas, the need for a flame arrester in the vent piping shall be determined. [NFPA 54: 8.1.19(5)]

**410.17.6** Vent lines from a gas appliance pressure regulator and a bleed lines from a diaphragm-type valve shall not be connected to a common manifold terminating in a combustion chamber. Vent lines shall not terminate in positive-pressure-type combustion chambers. [NFPA 54: 8.1.19(6)]

**410.18 Bleed Lines for Diaphragm-Type Valves.** Bleed lines shall comply with the following requirements:

**410.18.1** Diaphragm-type valves shall be equipped to convey bleed gas to the outside

atmosphere or into the combustion chamber adjacent to a continuous pilot. [NFPA 54: 8.1.20 (1)]

**410.18.2** In the case of bleed lines leading outdoors, means shall be employed to prevent water from entering this piping and also to prevent blockage of vents by insects and foreign matter. [NFPA 54: 8.1.20 (2)]

**410.18.3** Bleed lines shall not terminate in the gas utilization equipment flue or exhaust system. [NFPA 54: 8.1.20 (3)]

**410.18.4** In the case of bleed lines entering the combustion chamber, the bleed line shall be located so the bleed gas will be readily ignited by the pilot and the heat liberated thereby will not adversely affect the normal operation of the safety shutoff system. The terminus of the bleed line shall be securely held in a fixed position relative to the pilot. For manufactured gas, the need for a flame arrester in the bleed line piping shall be determined. [NFPA 54: 8.1.20 (4)]

**410.18.5** Bleed lines from a diaphragm-type valve and vent lines from a gas appliance pressure regulator shall not be connected to a common manifold terminating in a combustion chamber. Bleed lines shall not terminate in positive-pressure-type combustion chambers. [NFPA 54: 8.1.20 (5)]

**410.19 Combination of Equipment.** Any combination of gas utilization equipment, attachments, or devices used together in any manner shall comply with the standards that apply to the individual equipment. [NFPA 54: 8.1.21]

**410.20 Installation Instructions.** The installing agency shall conform with the equipment manufacturers' recommendations in completing an installation. The installing agency shall leave the manufacturers' installation, operating, and maintenance instructions in a location on the premises where they will be readily available for reference and guidance of the Authority Having Jurisdiction, service personnel, and the owner or operator. [NFPA 54: 8.1.22]

**410.21 Protection of Outdoor Equipment.** Gas utilization equipment not listed for outdoor installation but installed outdoors shall be provided with protection to the degree that the environment requires. Equipment listed for outdoor installation shall be permitted to be installed without protection in accordance with the provisions of its listing. (See 410.22.) [NFPA 54: 8.1.23]



**410.22 Accessibility and Clearance.**

**410.22.1 Accessibility for Service.** All gas utilization equipment shall be located with respect to building construction and other equipment so as to permit access to the gas utilization equipment. Sufficient clearance shall be maintained to permit cleaning of heating surfaces; the replacement of filters, blowers, motors, burners, controls, and vent connections; the lubrication of moving parts where necessary; the adjustment and cleaning of burners and pilots; and the proper functioning of explosion vents, if provided. For attic installation, the passageway and servicing area adjacent to the equipment shall be floored. [NFPA 54:8.2.1]

**411.0 Equipment on Roofs.****411.1 General.**

- (1) Gas-utilization equipment on roofs shall be designed or enclosed so as to withstand climatic conditions in the area in which it is installed. Where enclosures are provided, each enclosure shall permit easy entry and movement, shall be of reasonable height, and shall have at least a thirty (30) inch (760 mm) clearance between the entire service access panel(s) of the equipment and the wall of the enclosure. [NFPA 54: 8.4.1.1]
- (2) Roofs on which equipment is to be installed shall be capable of supporting the additional load or shall be reinforced to support the additional load. [NFPA 54: 8.4.1.2]
- (3) All access locks, screws, and bolts shall be of corrosion-resistant material. [NFPA 54: 8.4.1.3]

**411.2 Installation of Equipment on Roofs.**

- (1) Gas utilization equipment shall be installed in accordance with its listing and the manufacturer's installation instructions. [NFPA 54:8.4.2.1]
- (2) Equipment shall be installed on a well-drained surface of the roof. At least six (6) feet (1.8m) of clearance shall be available between any part of the equipment and the edge of a roof or similar hazard or rigidly fixed rails, guards, parapets, or other building structures at least forty-two (42) inches (1.1m) in height shall be provided on the exposed side. [NFPA 54:8.4.2.2]

- (3) All equipment requiring an external source of electrical power for its operation shall be provided with (1) a readily accessible electrical disconnecting means within sight of the equipment that will completely deenergize the equipment, and (2) a 120-V AC grounding-type receptacle outlet on the roof adjacent to the equipment. The receptacle outlet shall be on the supply side of the disconnect switch. [NFPA 54:8.4.2.3]
- (4) Where water stands on the roof at the equipment or in the passageways to the equipment, or where the roof is of a design having a water seal, a suitable platform, walkway, or both shall be provided above the waterline. Such platforms or walkways shall be located adjacent to the equipment and control panels so that the equipment can be safely serviced where water stands on the roof. [NFPA 54: 8.4.2.4]

**411.3 Access to Equipment on Roofs.**

**411.3.1** Gas utilization equipment located on roofs or other elevated locations shall be accessible. [NFPA 54:8.4.3.1]

**411.3.2** Buildings more than fifteen (15) feet (4.6 m) in height shall have an inside means of access to the roof, unless other means acceptable to the Authority Having Jurisdiction are used. [NFPA 54:8.4.3.2]

**411.3.3** The inside means of access shall be a permanent, or fold-away inside stairway or ladder, terminating in an enclosure, scuttle, or trap door. Such scuttles or trap doors shall be at least twenty-two (22) inches x twenty-four (24) inches (560 mm x 610 mm) in size, shall open easily and safely under all conditions, especially snow, and shall be constructed so as to permit access from the roof side unless deliberately locked on the inside.

At least six (6) feet (1.8 m) of clearance shall be available between the access opening and the edge of the roof or similar hazard, or rigidly fixed rails or guards a minimum of forty-two (42) inches (1.1 m) in height shall be provided on the exposed side. Where parapets or other building structures are utilized in lieu of guards or rails, they shall be a minimum of forty-two (42) inches (1.1 m) in height. [NFPA 54:8.4.3.3]

**411.3.4** Permanent lighting shall be provided at

the roof access. The switch for such lighting shall be located inside the building near the access means leading to the roof. [NFPA 54: 8.4.3.4]

#### **412.0 Clearances, Gas Fired Water Heaters**

Uninsulated water heaters shall not be installed closer than six (6) inches (152 mm) to unprotected combustible construction nor closer than three (3) inches (76 mm) to protected combustible construction. Insulated water heaters shall not be installed closer than two (2) inches (51 mm) to unprotected combustible construction nor closer than one (1) inch (25.4 mm) to protected combustible construction. The clearances may be reduced for water heaters which are designed and listed or approved for installation adjacent to combustible materials and installed in accordance with the conditions of such approval. Protected combustible construction will be considered as such if it has one-quarter (1/4) inch (6.4 mm) of insulating millboard\*, covered with a No. 26 gauge metal covering, or not less than one-hour fire resistive protection.

**\*Note:** Insulating millboard is a factory-made product formed of noncombustible materials, normally fibers, and having an thermal conductivity of one (1) Btu/inch thickness/hour/square foot/°F (0.144 W/m/°C) or less.

#### **413.0 Access and Working Space.**

Every water heater installation shall be accessible for inspection, repair, or replacement. The appliance space shall be provided with an opening or doorway of sufficient size to remove the water heater. In no case shall such opening or doorway be less than twenty-four (24) inches (610 mm) in width. Such access shall be continuous and shall be one or any combination of the following means:

**413.1** By a passageway not less than three (3) feet (914 mm) in door width and six (6) feet three (3) inches (1904 mm) in door height. Stairways and ramps leading to or a part of such passageways shall comply with the Building Code.

#### **414.0 Venting of Equipment.**

**414.1 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 gas utilization equipment. The operating characteristics of vented gas utilization 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 can condense in the venting system. See Section 3.3 of NFPA 54 for the definition of these vented appliance categories. [NFPA 54:10.1]

**414.2 Specification for Venting.** All gas water heaters for swimming pools, spas, and hot tubs shall be vented.

**414.2.1 Direct-Vent Equipment.** Listed direct-vent gas utilization equipment shall be considered properly vented where installed in accordance with the terms of its listing, the manufacturers' instructions, and Section 414.8.3 of this code. [NFPA 54:10.2.5]

#### **414.3 Design and Construction.**

**414.3.1 Minimum Safe Performance.** A venting system shall be designed and constructed so as to develop a positive flow adequate to remove flue or vent gases to the outside atmosphere. [NFPA 54:10.3.1]

**414.3.2 Equipment Draft Requirements.** A venting system shall satisfy the draft requirements of the equipment in accordance with the manufacturer's instructions. [NFPA 54:10.3.2]

**414.3.3 Design and Construction.** Gas utilization equipment required to be vented shall be connected to a venting system designed and installed in accordance with the provisions of Sections 414.4 through 414.15 of this code. [NFPA 54:10.3.3]

#### **414.3.4 Mechanical Draft Systems.**

**414.3.4.1** Mechanical draft systems shall be listed and shall be installed in accordance with the terms of their listing and both the appliance and the mechanical draft system manufacturers' instructions. [NFPA 54:10.3.4.1]

**414.3.4.2** Gas utilization equipment requiring venting shall be permitted to be vented by means of mechanical draft systems of either forced or induced draft design. [NFPA 54:10.3.4.2]

**414.3.4.3** Forced draft systems and all portions of induced draft systems under positive pressure during operation shall be designed and installed so as to prevent leakage of flue or vent gases into a building. [NFPA 54:10.3.4.3]

**414.3.4.4** Vent connectors serving equipment vented by natural draft shall not be connected into any portion of mechanical draft systems operating under positive pressure. [NFPA 54:10.3.4.4]

**414.3.4.5** Where 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. [NFPA 54:10.3.4.5]

**414.3.4.6** The exit terminals of mechanical draft systems shall be not less than seven (7) feet (2.1 m) above grade where located adjacent to public walkways and shall be located as specified in Sections 414.8.1 and 414.8.2 of this code. [NFPA 54:10.3.4.6]

#### **414.4 Type of Venting System to Be Used.**

**414.4.1** The type of venting system to be used shall be in accordance with the requirements of its listing, Tables 4-3 and the Authority Having Jurisdiction.

**414.4.2 Plastic Piping.** Plastic piping used for venting equipment listed for use with such venting materials shall be approved. [NFPA 54:10.4.2]

**414.4.3 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. [NFPA 54:10.4.3]

#### **414.5 Masonry, Metal, and Factory-Built Chimneys.**

##### **414.5.1 Listing or Construction.**

**414.5.1.1** 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. [NFPA 54:10.5.1.1]

**414.5.1.2** Metal chimneys shall be built and installed in accordance with NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*. [NFPA 54:10.5.1.2]

**414.5.1.3** Masonry chimneys shall be built and installed in accordance with NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances*, and 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 lined with a chimney lining system specifically listed for use with listed gas appliances with draft hoods, Category I appliances, and other gas appliances listed for use with Type B vents shall be permitted. The liner shall be installed in accordance with the liner manufacturer's instructions and the terms of the listing. A permanent identifying label shall be attached at the point where the connection is to be made to the liner. The label shall read: "This chimney liner is for appliances that burn gas only. Do not connect to solid or liquid-fuel-burning appliances or incinerators." [NFPA 54:10.5.1.3]

##### **414.5.2 Termination.**

**414.5.2.1** A chimney for residential-type or low-heat gas utilization equipment shall extend at least three (3) feet (0.9 m) above the highest point where it passes through a roof of a building and at least two (2) feet (0.6 m) higher than any portion of a building within a horizontal distance of ten (10) feet (3.0 m). [See Figure 4-1.] [NFPA 54:10.5.2.1]

**414.5.2.2** A chimney for medium-heat equipment shall extend at least ten (10) feet (3.0 m) higher than any portion of any building within twenty-five (25) feet (7.6 m). [NFPA 54:10.5.2.2]

**414.5.2.3** A chimney shall extend at least five (5) feet (1.5 m) above the highest connected equipment draft hood outlet or flue collar. [NFPA 54:10.5.2.3]

**414.5.2.4** 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 manufacturers' installation instructions. [NFPA 54:10.5.2.4]

**414.5.3 Size of Chimneys.** The effective area of a chimney venting system serving listed gas appliances with draft hoods, Category I appliances, and other appliances listed for use with Type B vents shall be in accordance with one of the following methods [NFPA 54:10.5.3]:

- (1) This chapter and NFPA 54, Chapter 13.
- (2) For sizing an individual chimney venting system for a single appliance with a draft hood, the effective areas of the vent

connector and chimney flue shall be not less than the area of the appliance flue collar or draft hood outlet or greater than seven (7) times the draft hood outlet area. [NFPA 54:10.5.3.1 (2)]

- (3) For sizing a chimney venting system connected to two (2) 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, or greater than seven (7) times the smallest draft hood outlet area. [NFPA 54:10.5.3.1 (3)]
- (4) Other approved engineering methods. [NFPA 54:10.5.3.1 (5)]
- (5) Chimney venting systems using mechanical draft shall be sized in accordance with approved engineering methods. [NFPA 54:10.5.3.1 (4)]

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 one (1) inch (25 mm) larger in equivalent diameter than the diameter of the incinerator flue outlet. [NFPA 54:10.5.3.2]

#### 414.5.4 Inspection of Chimneys.

- (A) 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 shall be cleaned if previously used for venting solid- or liquid-fuel-burning appliances or fireplaces. [NFPA 54:10.4.5.1]
- (B) Chimneys shall be lined in accordance with NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid-Fuel Burning Appliances*. [NFPA 54:10.4.5.2]
- (C) Cleanouts shall be examined to determine that they will remain tightly closed when not in use. [NFPA 54:10.4.5.3]
- (D) When inspection reveals that an existing chimney is not safe for the intended application, it shall be repaired, rebuilt, lined, relined, or replaced with a vent or chimney to conform to NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid-Fuel-Burning Appliances*, and shall be suitable for the equipment to be attached. [NFPA 54:10.4.5.4]

#### 414.5.5 Chimney-Serving Equipment Burning Other Fuels.

**414.5.5.1** Gas utilization equipment shall not be connected to a chimney flue serving a separate appliance designed to burn solid fuel. [NFPA 54:10.5.5.1]

**414.5.5.2** Where one chimney serves gas utilization equipment and equipment burning liquid fuel, the equipment shall be connected through separate openings or shall be connected through a single opening where joined by a suitable fitting located as close as practical to the chimney. Where two or more openings are provided into one chimney flue, they shall be at different levels. Where the gas utilization equipment is automatically controlled, it shall be equipped with a safety shutoff device. [NFPA 54:10.5.5.2]

**TABLE 4-3**  
**Type of Venting System to Be Used**

Gas Utilization Equipment	Type of Venting System
Listed Category I equipment	Type B gas vent (414.6)
Listed equipment equipped with draft hood	Chimney (414.5)
Equipment listed for use with Type B gas vent system for gas venting	Single-wall metal pipe (414.7)
	Listed chimney lining (414.5.1.3)
	Special gas vent listed for this equipment (414.4.3)
Category II equipment	As specified or furnished
Category III equipment	by manufacturers of listed
Category IV equipment	equipment (414.4.2, 414.4.3)
Equipment listed for use with chimneys only	Chimney (414.5)
Unlisted equipment	
Listed combination gas- and oil-burning equipment	Type L vent (414.6) or chimney (414.5)
Direct-vent equipment	See 414.2.1

[NFPA 54: Table 10.4.1]

**414.5.5.3** A single chimney flue serving a listed combination gas- and oil-burning appliance shall be sized to properly vent the appliance. [NFPA 54:10.5.5.4]

**414.5.6 Support of Chimneys.** All portions of chimneys shall be supported for the design and weight of the materials employed. Listed factory-built chimneys shall be supported and spaced in accordance with their listings and the manufacturers' instructions. [NFPA 54:10.5.6]

**414.5.7 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 be installed so its upper edge is at least six (6) inches (150 mm) below the lower edge of the lowest chimney inlet opening. [NFPA 54:10.5.7]

**414.5.8 Space Surrounding Lining or Vent.**

**414.5.8.1** 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. [NFPA 54:10.5.8.1]

**Exception:** The insertion of another liner or vent within the chimney as provided in this code and the liner or vent manufacturer's instructions.

**414.5.8.2** 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 supply combustion air. [NFPA 54: 10.5.8.2]

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

**414.6 Gas Vents.**

**414.6.1 Application.** The installation of gas vents shall comply with the following requirements [NFPA 54:10.6.1]:

**414.6.1.1** Gas vents shall be installed in accordance with the terms of their listings and the manufacturers' instructions. [NFPA 54:10.6.1 (1)]

**414.6.1.2** A gas vent passing through a roof shall extend through the entire roof flashing, roof jack, or roof thimble and be terminated with a listed termination cap. [NFPA 54:10.6.1 (3)]

**414.6.1.3** Type B or Type L vents shall extend in a generally vertical direction with offsets not exceeding forty-five (45) degrees, except that a vent system having not more than one sixty (60) degree offset shall be permitted. Any angle greater than forty-five (45) degrees from the vertical is considered horizontal. The total horizontal distance of a vent plus the horizontal vent connector serving draft-hood-equipped appliances shall not be greater than seventy-five (75) percent of the vertical height of the vent. [NFPA 54:10.6.1 (4)]

**Exception:** Systems designed and sized as provided in this chapter or in accordance with other approved engineering methods.

**414.6.1.4** Vents serving Category I fan-assisted appliances shall be installed in accordance with the appliance manufacturers' instructions and NFPA 54 Chapter 10 or other approved engineering methods. [NFPA 54:10.6.1 (5)]

**414.6.1.5** 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." [NFPA 54:10.6.1 (6)]

**414.6.2 Gas Vent Termination.** The termination of gas vents shall comply with the following requirements [NFPA 54:10.6.2]:

**414.6.2.1** A gas vent shall terminate in accordance with one of the following:

- (1) Above the roof surface with a listed cap or listed roof assembly. Gas vents twelve (12) inches (300 mm) in size or smaller with listed caps shall be permitted to be terminated in accordance with Figure 4-2, provided they are at least eight (8) feet (2.4 m) from a vertical wall or similar obstruction. All other gas vents shall terminate not less than two (2) feet (0.6 m) above the highest point where they pass through the roof and at least

two (2) feet (0.6 m) higher than any portion of a building within ten (10) feet (3.1 m). [NFPA 54:10.6.2 (1)(a)]

- (2) Direct-vent systems as provided in Section 414.2.1. [NFPA 54:10.6.2 (1)(c)]
- (3) Mechanical draft systems as provided in Section 414.3.4. [NFPA 54:10.6.2 (1)(e)]

**414.6.2.2** A Type B or a Type L gas vent shall terminate at least five (5) feet (1.5 m) in vertical height above the highest connected equipment draft hood or flue collar. [NFPA 54:10.6.2 (2)]

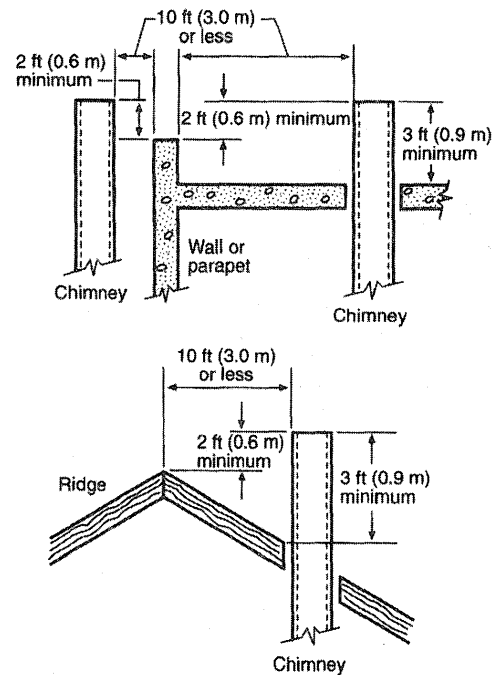
**414.6.2.3** A gas vent extending through an exterior wall shall not terminate adjacent to the wall or below eaves or parapets, except as provided in Sections 414.2.1 and 414.3.4. [NFPA 54:10.6.2 (4)]

**414.6.2.4** Decorative shrouds shall not be installed at the termination of gas vents except where such shrouds are listed for use with the specific gas venting system and are installed in accordance with manufacturers' installation instructions. [NFPA 54:10.6.2 (5)]

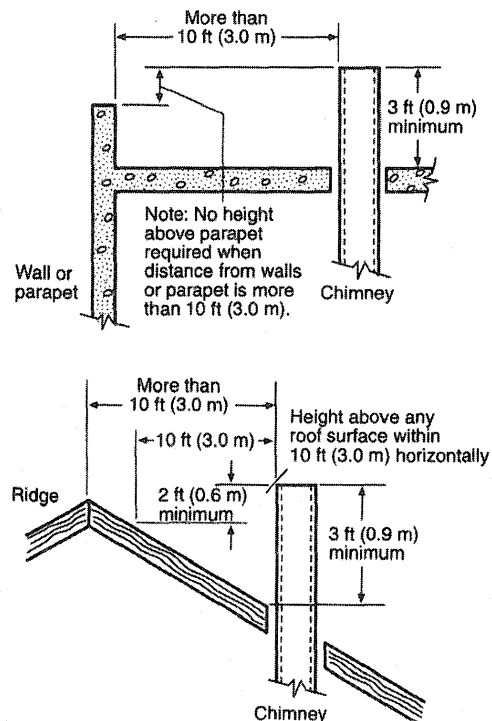
**414.6.3 Size of Gas Vents.** Venting systems shall be sized and constructed in accordance with NFPA 54 Chapter 10 or other approved engineering methods and the gas vent and gas equipment manufacturers' instructions. [NFPA 54:10.6.3]

**414.6.3.1 Category I Appliances.** The sizing of natural draft venting systems serving one or more listed appliances equipped with a draft hood or appliances listed for use with Type B gas vent, installed in a single story of a building, shall be in accordance with one of the following methods. [NFPA 54:10.6.3.1]

- (1) The provisions of this chapter.
- (2) 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 this chapter or other approved engineering methods. [NFPA 54:10.6.3.1 (2)]
- (3) 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 or



(a) Termination 10 ft (3.0 m) or Less from Ridge, Wall, or Parapet



(b) Termination More Than 10 ft (3.0 m) from Ridge, Wall, or Parapet

**FIGURE 4-1 Typical Termination Locations for Chimneys and Single-Wall Metal Pipes Serving Residential-Type and Low-Heat Equipment**  
[NFPA 54:Figure 10.5.2.1]

greater than seven (7) times the draft hood outlet area. [NFPA 54:10.6.3.1 (3)]

- (4) For sizing a gas vent connected to two appliances with draft hoods, the effective area of the vent shall be not less than the area of the larger draft hood outlet plus 50 percent of the area of the smaller draft hood outlet or greater than seven (7) times the smaller draft hood outlet area. [NFPA 54:10.6.3.1 (4)]
- (5) Approved engineering practices. [NFPA 54:10.6.3.1 (5)]

**414.6.3.2 Category II, Category III, and Category IV Appliances.** The sizing of gas vents for Category II, Category III, and Category IV gas utilization equipment shall be in accordance with the equipment manufacturers' instructions. [NFPA 54:10.6.3.2]

**414.6.3.3 Sizing.** Chimney venting systems using mechanical draft shall be sized in accordance with approved engineering methods. [NFPA 54:10.6.3.3]

**414.6.4 Support of Gas Vents.** Gas vents shall be supported and spaced in accordance with their listings and the manufacturers' instructions. [NFPA 54:10.6.5]

**414.6.5 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 label shall read: "This gas vent is for appliances that burn gas. Do not connect to solid- or liquid-fuel-burning appliances or incinerators." The Authority Having Jurisdiction shall determine whether its area constitutes such a locality. [NFPA 54:10.6.6]

#### **414.7 Single-Wall Metal Pipe.**

**414.7.1 Construction.** Single-wall metal pipe shall be constructed of galvanized sheet steel not less than 0.0304 inch (0.7 mm) thick or of other approved, noncombustible, corrosion-resistant material. [NFPA 54:10.7.1]

**414.7.2 Cold Climate.** Uninsulated single-wall metal pipe shall not be used outdoors in cold climates for venting gas utilization equipment. [NFPA 54:10.7.2]

**414.7.3 Termination.** The termination of single-wall metal pipe shall comply with the following requirements [NFPA 54:10.7.3]:

**414.7.3.1** Single-wall metal pipe shall terminate at least five (5) feet (1.5 m) in

vertical height above the highest connected equipment draft hood outlet or flue collar. [NFPA 54:10.7.3 (1)]

**414.7.3.2** Single-wall metal pipe shall extend at least two (2) feet (0.6 m) above the highest point where it passes through the roof of a building and at least two (2) feet (0.6 m) higher than any portion of a building within a horizontal distance of ten (10) feet (3.1 m). (See Figure 4-1) [NFPA 54:10.7.3 (2)]

**414.7.3.3** An approved cap or roof assembly shall be attached to the terminus of a single-wall metal pipe. [NFPA 54:10.7.3 (3)]

#### **414.7.4 Installation with Equipment Permitted by 414.4.1.**

**414.7.4.1** Single-wall metal pipe shall be used only for runs directly from the space in which the gas utilization equipment is located through the roof or exterior wall to the outer air. A pipe passing through a roof shall extend without interruption through the roof flashing, roof jacket, or roof thimble. [NFPA 54:10.7.4.1]

**414.7.4.2** 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. For the installation of a single-wall metal pipe through an exterior combustible wall, see Section 414.10.14.2. [NFPA 54:10.7.4.2]

**414.7.4.3** Minimum clearances from single-wall metal pipe to combustible material shall be in accordance with Table 4-4. Reduced clearances from single-wall metal pipe to combustible material shall be as specified for vent connectors in Table 4-5. [NFPA 54:10.7.4.4]

**414.7.4.4** 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 eighteen (18) inches (460 mm) above and six (6) inches (150 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 414.10.14.2. [NFPA 54:10.7.4.5]

**414.7.5 Size of Single-Wall Metal Pipe.** Single-wall metal piping shall comply with the following requirements [NFPA 54:10.7.5]:

**414.7.5.1** A venting system of a single-wall metal pipe shall be sized in accordance with one of the following methods and the gas equipment manufacturer's instructions [NFPA 54:10.7.5 (1)]:

- (1) For a draft-hood-equipped appliance, in accordance with this chapter. [NFPA 54:10.7.5 (1)(a)]
- (2) For a venting system for a single appliance with a draft hood, the areas of the connector and the pipe each shall not be 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 (7) times the draft hood outlet area. [NFPA 54:10.7.5 (1)(b)]
- (3) Other approved engineering methods. [NFPA 54:10.7.5 (1)(c)]

**414.7.5.2** Where a single-wall metal pipe is used and has a shape other than round, it shall have an equivalent effective area equal to the effective area of the round pipe for which it is substituted, and the minimum internal dimension of the pipe shall be two (2) inches (50 mm). [NFPA 54:10.7.5 (2)]

**414.7.5.3** The vent cap or a roof assembly shall have a venting capacity not less than that of the pipe to which it is attached. [NFPA 54:10.7.5 (3)]

**414.7.6 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. [NFPA 54:10.7.6]

**414.7.7 Marking.** Single-wall metal pipe shall comply with the marking provisions of 414.6.5. [NFPA 54:10.7.7]

**414.8 Through-the-Wall Vent Termination.**(See Figure 4-13) [NFPA 54:10.8]

**414.8.1** A mechanical draft venting system shall terminate at least three (3) feet (0.9 m) above any forced air inlet located within ten (10) ft (3.1 m).

**Exception No. 1:** This provision shall not apply to the combustion air intake of a direct-vent appliance.

**Exception No. 2:** This provision shall not apply to the separation of the integral outdoor air inlet and flue gas discharge of listed outdoor appliances. [NFPA 54:10.8.1]

**414.8.2** A mechanical draft venting system of other than direct-vent type shall terminate at

least four (4) feet (1.2 m) below, four (4) feet (1.2 m) horizontally from, or one (1) foot (300 mm) above any door, operable window, or gravity air inlet into any building. The bottom of the vent terminal shall be located at least twelve (12) inches (300 mm) above grade. [NFPA 54:10.8.2]

**414.8.3** The vent terminal of a direct-vent appliance with an input of 10,000 Btu/h (3 kW) or less shall be located at least six (6) inches (150 mm) from any air opening into a building, and such an appliance with an input over 10,000 Btu/h (3 kW) but not over 50,000 Btu/h (14.7 kW) shall be installed with a nine (9) inch (230 mm) vent termination clearance, and an appliance with an input over 50,000 Btu/h (14.7 kW) shall have at least a twelve (12) inch (300 mm) vent termination clearance. The bottom of the vent terminal and the air intake shall be located at least twelve (12) inch (300 mm) above grade. [NFPA 54:10.8.3]

**414.8.4** Through-the-wall vents for Category II and Category IV appliances and non-categorized condensing appliances shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance of 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. [NFPA 54:10.8.4]

**414.9 Condensation Drain.**

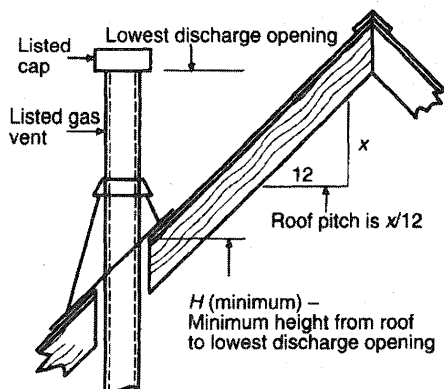
**414.9.1** Provision shall be made to collect and dispose of condensate from venting systems serving Category II and Category IV gas utilization equipment and noncategorized condensing appliances in accordance with 414.8.4. [NFPA 54:10.9.1]

**414.9.2** 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 gas utilization equipment in accordance with 414.8.4. [NFPA 54:10.9.2]

**414.10 Vent Connectors for Category I Gas Utilization Equipment.**

**414.10.1 Where Required.** A vent connector shall be used to connect gas utilization 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. [NFPA 54:10.10.1]



**Roof pitch heights**

Roof pitch	H(minimum) ft	m
Flat to 6/12	1.0	0.30
Over 6/12 to 7/12	1.25	0.38
Over 7/12 to 8/12	1.5	0.46
Over 8/12 to 9/12	2.0	0.61
Over 9/12 to 10/12	2.5	0.76
Over 10/12 to 11/12	3.25	0.99
Over 11/12 to 12/12	4.0	1.22
Over 12/12 to 14/12	5.0	1.52
Over 14/12 to 16/12	6.0	1.83
Over 16/12 to 18/12	7.0	2.13
Over 18/12 to 20/12	7.5	2.27
Over 20/12 to 21/12	8.0	2.44

**FIGURE 4-2 Gas Vent Termination Locations for Listed Caps 12 in. (300 mm) or Less in Size at Least 8 ft (2.4 m) from a Vertical Wall [NFPA 54: Figure 10.6.2]**

#### 414.10.2 Materials.

**414.10.2.1** A vent connector shall be made of noncombustible, corrosion resistant material capable of withstanding the vent gas temperature produced by the gas utilization equipment and of sufficient thickness to withstand physical damage. [NFPA 54:10.10.2.1]

**414.10.2.2** Where the vent connector used for gas utilization equipment having a draft hood or a Category I appliance is located in or passes through an unconditioned area, that portion of the vent connector shall be listed Type B, Type L or listed vent material having equivalent insulation qualities. [NFPA 54:10.10.2.2]

**414.10.2.3** Vent connectors for residential-type appliances shall comply with the following [NFPA 54:10.10.2.4]:

- (1) Vent Connectors Not Installed in Attics, Crawl Spaces, or Other Unconditioned Areas. Vent connectors for listed gas

appliances having draft hoods and for appliances having draft hoods and equipped with listed conversion burners that are not installed in attics, crawl spaces, or other unconditioned areas shall be one of the following [NFPA 54:10.10.2.4 (1)]:

- (a) Type B or Type L vent material [NFPA 54:10.10.2.4 (1)(a)]
- (b) Galvanized sheet steel not less than 0.018 inch (0.46 mm) thick [NFPA 54:10.10.2.4 (1)(b)]
- (c) Aluminum (1100 or 3003 alloy or equivalent) sheet not less than 0.027 inch (0.69 mm) thick [NFPA 54:10.10.2.4 (1)(c)]
- (d) Stainless steel sheet not less than 0.012 inch (0.31 mm) thick [NFPA 54:10.10.2.4 (1)(d)]
- (e) Smooth interior wall metal pipe having resistance to heat and corrosion equal to or greater than that of b, c, or d above [NFPA 54:10.10.2.4 (1)(e)]
- (f) A listed vent connector [NFPA 54:10.10.2.4 (1)(f)]

- (2) Vent connectors shall not be covered with insulation.

**Exception:** Listed insulated vent connectors shall be installed according to the terms of their listing. [NFPA 54:10.10.2.4 (2)]

**414.10.2.4** 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 4-6. Factory-built chimney sections shall be joined together in accordance with the chimney manufacturers' instructions. [NFPA 54:10.10.2.5]

**Note:** For vent connectors for medium-heat equipment, see Table 4-7.

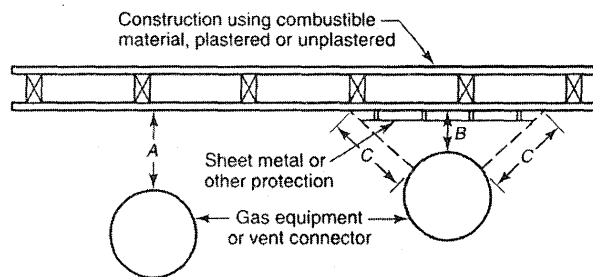
#### 414.10.3 Size of Vent Connector.

**414.10.3.1** A vent connector for gas utilization equipment with a single draft hood or for a Category I fan-assisted combustion system appliance shall be sized and installed in accordance with this chapter or other approved engineering methods. [NFPA 54:10.10.3.1]

**414.10.3.2** For a single appliance having more than one draft hood outlet or flue collar, the manifold shall be constructed according to the instructions of the appliance manufacturer. Where there are no instructions, the manifold shall be designed and constructed in accordance with approved engineering practices. As an alternate method, the effective area of the manifold shall equal the combined area of the flue collars or draft hood outlets, and the vent connectors shall have a minimum one (1) foot (0.3 m) rise. [NFPA 54:10.10.3.2]

**414.10.3.3** Where two or more gas appliances are connected to a common vent or chimney, each vent connector shall be sized in accordance with this chapter or other approved engineering methods. [NFPA 54:10.10.3.3]

As an alternative method applicable only when all of the appliances are draft-hood-



Notes:

A – equals the clearance with no protection specified in Tables 4-4 and 4-5 and in the sections applying to various types of equipment.

B – equals the reduced clearance permitted in accordance with Table 4-4. The protection applied to the construction using combustible material shall extend far enough in each direction to make C equal to A.

**FIGURE 4-5 Extent of Protection Necessary to Reduce Clearances From Gas Equipment or Vent Connectors.**

**TABLE 4-4**  
**Clearance for Connectors [NFPA 54: Table 10.7.4.4]**

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 in.	As listed
Residential boilers and furnaces with listed gas conversion burner and with draft hood	6 in.	6 in.	9 in.	As listed
Residential appliances listed for use with Type L vents	Not permitted	As listed	9 in.	As listed
Residential incinerators	Not permitted	9 in.	18 in.	As listed
Listed gas-fired toilets	Not permitted	As listed	As listed	As listed
Unlisted residential appliances with draft hood	Not permitted	6 in.	9 in.	As listed
Residential and low-heat equipment other than those above	Not permitted	9 in.	18 in.	As listed
Medium-heat equipment	Not permitted	Not permitted	36 in.	As listed

For SI units, 1 in. = 25.4 mm.

Note: These clearances shall apply unless the listing of an appliance or connector specifies clearances, in which case the listed clearances shall apply.

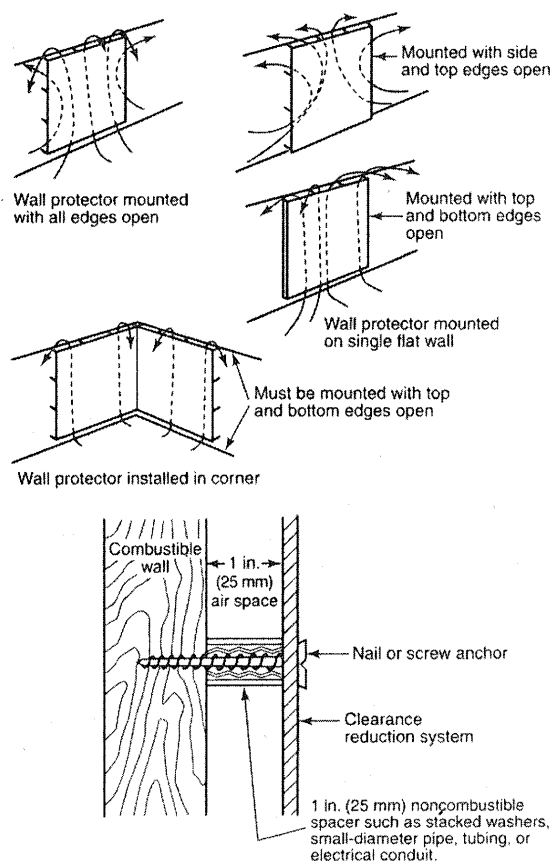
**Table 4-5**  
**Reduction of Clearances with Specified Forms of Protection**

Where the required clearance with no protection from appliance, vent connector, or single-wall metal pipe is:										
	36 in.		18 in.		12 in.		9 in.		6 in.	
	Allowable Clearances With Specified Protection (in.)									
Type of protection applied to and covering all surfaces of combustible material within the distance specified as the required clearance with no protection [See Figure 4-5 through Figure 4-7.]	Use Col. 1 for clearances above appliance or horizontal connector. Use Col. 2 for clearances from appliances, vertical connector, and single-wall metal pipe.									
	Above Col. 1	Sides and Rear Col. 2	Above Col. 1	Sides and Rear Col. 2	Above Col. 1	Sides and Rear Col. 2	Above Col. 1	Sides and Rear Col. 2	Above Col. 1	Sides and Rear Col. 2
(1) 3-1/2 in. thick masonry wall without ventilated air space	--	24	--	12	--	9	--	6	--	5
(2) 1/2 in. insulation board over 1 in. glass fiber or mineral wool batts	24	18	12	9	9	6	6	5	4	3
(3) 0.024 sheet metal over 1 in. 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) 3-1/2 in. 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) 1/2 in. 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 in. 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

For SI units, 1 in. = 25.4 mm.

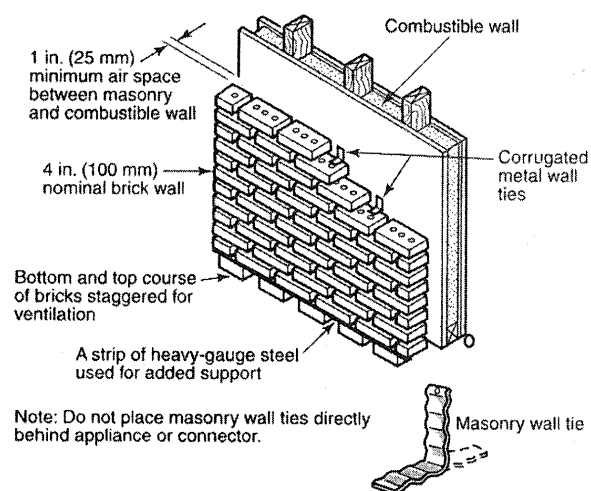
**Notes:**

- Reduction of clearances from combustible materials shall not interfere with combustion air, draft hood clearance and relief, and accessibility of servicing.
- All clearances shall be measured from the outer surface of the combustible material to the nearest point on the surface of the appliance, disregarding any intervening protection applied to the combustible material.
- Spacers and ties shall be of noncombustible material. No spacer or tie shall be used directly opposite the appliance or connector.
- Where all clearance reduction systems use a ventilated air space, adequate provision for air circulation shall be provided as described. [See Figure 4-6 and Figure 4-7]
- There shall be at least 1 in. (25 mm) between clearance reduction systems and combustible walls and ceilings for reduction systems using a ventilated air space.
- Where a wall protector is mounted on a single flat wall away from corners, it shall have a minimum 1 in. (25 mm) airgap. To provide adequate air circulation, the bottom and top edges, or only the side and top edges, or all edges shall be left open.
- Mineral wool batts (blanket or board) shall have a minimum density of 8 lb/ft<sup>3</sup> (128 kg/m<sup>3</sup>) and a minimum melting point of 1500°F (816°C).
- Insulation material used as part of a clearance reduction system shall have a thermal conductivity of 1.0 Btu in./ft<sup>2</sup> /h-°F (0.144 W/m-K) or less.
- There shall be at least 1 in. (25 mm) between the appliance and the protector. In no case shall the clearance between the appliance and the combustible surface be reduced below that allowed in this table.
- All clearances and thicknesses are minimum; larger clearances and thicknesses are acceptable.
- Listed single-wall connectors shall be installed in accordance with the terms of their listing and the manufacturers' instructions.



Masonry walls can be attached to combustible walls using wall ties. Spacers should not be used directly behind appliance or connector.

**FIGURE 4-6 Wall Protection Reduction System.**



**FIGURE 4-7 Masonry Clearance Reduction System.**

**TABLE 4-6**  
**Minimum Thickness for Galvanized Steel Vent Connector for Low-Heat Appliances**

Diameter of Connector (in.)	Minimum Thickness (in.)*
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 units, 1 in. = 25.4 mm; 1 in.<sup>2</sup> = 645 mm<sup>2</sup>.

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. [NFPA 54:10.10.3.4]

**414.10.3.4** 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 clearance to combustible material and shall be sized in accordance with this chapter or other approved engineering methods. [NFPA 54:10.10.3.5]

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 smaller flue collar outlets. [NFPA 54:10.10.3.6]

**TABLE 4-7**  
**Minimum Thickness for Steel Vent Connectors for Medium-Heat Equipment and Commercial and Industrial Incinerators**

Vent Connector Size		Minimum
Diameter (in.)	Area (in. <sup>2</sup> )	Thickness (in.)
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 units, 1 in. = 25.4 mm; 1 in.<sup>2</sup> = 645 mm<sup>2</sup>.

[NFPA 54: Table 9.10.2 (f)]

**414.10.3.5** 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. [NFPA 54:10.10.3.7]

**414.10.4 Two or More Appliances Connected to a Single Vent.**

**414.10.4.1** 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. [NFPA 54:10.10.4.1]

**414.10.4.2** 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. [NFPA 54:10.10.4.2]

**414.10.5 Clearance.** Minimum clearances from vent connectors to combustible material shall be in accordance with Table 4-4.

**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 4-5. [NFPA 54:10.10.5]

**414.10.6 Avoid Unnecessary Bends.** A vent connector shall be installed so as to avoid turns or other construction features that create excessive resistance to flow of vent gases. [NFPA 54:10.10.6]

**414.10.7 Joints.** Joints between sections of connector piping and connections to flue collars or draft hood outlets shall be fastened in accordance with one of the following methods [NFPA 54:10.10.7]:

- (1) By sheet metal screws. [NFPA 54:10.10.7 (1)]
- (2) Vent connectors of listed vent material shall be assembled and connected to flue collars or draft hood outlets in accordance with the manufacturers' instructions. [NFPA 54:10.10.7 (2)]
- (3) Other approved means. [NFPA 54:10.10.7 (3)]

**414.10.8 Slope.** A vent connector shall be installed without any dips or sags and shall slope upward toward the vent or chimney at least 1/4 inch/ft ( 20 mm/m ).

**Exception:** Vent connectors attached to a mechanical draft system installed in accordance with the manufacturers' instructions. [NFPA 54:10.10.8]

**414.10.9 Length of Vent Connector.**

**414.10.9.1** A vent connector shall be as short as practical and the gas utilization equipment located as close as practical to the chimney or vent. [NFPA 54:10.10.9.1]

**414.10.9.2** Except as provided for in 414.10.3, 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 414.10.3, the maximum horizontal length of a Type B double-wall connector shall be 100 percent of the height of the chimney or vent. For a chimney or vent system serving multiple appliances, the maximum length of an individual connector, from the appliance outlet to the junction with the common vent or another connector, shall be 100 percent of the height of the chimney or vent. [NFPA 54:10.10.9.2]

**414.10.10 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. [NFPA 54:10.10.10]

**414.10.11 Chimney Connection.** Where entering a flue in a masonry or metal chimney, the vent connector shall be installed above the extreme bottom to avoid stoppage. Where a thimble or slip joint is used to facilitate removal of the connector, the connector shall be firmly attached to or inserted into the thimble or slip joint to prevent the connector from falling out. Means shall be employed to prevent the connector from entering so far as to restrict the space between its end and the opposite wall of the chimney flue. [NFPA 54:10.10.11]

**414.10.12 Inspection.** The entire length of a vent connector shall be readily accessible for inspection, cleaning, and replacement. [NFPA 54:10.10.12]

**414.10.13 Fireplaces.** A vent connector shall not be connected to a chimney flue serving a fire place unless the fireplace flue opening is permanently sealed.

**414.10.14 Passage Through Ceilings, Floors or Walls.**

**414.10.14.1** 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 that pass through walls or partitions constructed of combustible material shall be installed with not less than the listed clearance to combustible material. [NFPA 54:10.10.14.1]

**414.10.14.2** 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 [NFPA 54:10.10.14.2]:

- (1) For listed appliances equipped with draft hoods and appliances listed for use with Type B gas vents, the thimble shall be a minimum of four (4) inches (100 mm) larger in diameter than the vent connector. Where there is a run of not less than six (6) feet (1.8 m) of vent connector in the opening between the draft hood outlet and the thimble, the thimble shall be a minimum of two (2) inches (50 mm) larger in diameter than the vent connector. [NFPA 54:10.10.14.2 (1)]
- (2) For unlisted appliances having draft hoods, the thimble shall be a minimum of six (6) inches (150 mm) larger in diameter than the vent connector. [NFPA 54:10.10.14.2 (2)]
- (3) For residential and low-heat appliances, the thimble shall be a minimum of twelve (12) inches (300 mm) larger in diameter than the vent connector. [NFPA 54:10.10.14.2 (3)]

**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.

**414.10.14.3** Vent connectors for medium-heat equipment shall not pass through walls or partitions constructed of combustible material. [NFPA 54:10.10.14.3]

**414.11 Vent Connectors for Category II, Category III, and Category IV Gas Utilization Equipment.** (See Section 414.4.) [NFPA 54:10.11]

**414.12 Draft Hoods and Draft Controls.**

**414.12.1 Equipment Requiring Draft Hoods.**

Vented gas utilization equipment shall be installed with draft hoods.

**Exception:** 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/h (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. [NFPA 54:10.12.1]

**414.12.2 Installation.** A draft hood supplied with or forming a part of listed vented gas utilization equipment shall be installed without alteration, exactly as furnished and specified by the equipment manufacturer. [NFPA 54:10.12.2]

**414.12.2.1** If a draft hood is not supplied by the equipment manufacturer where one is required, a draft hood shall be installed, be of a listed or approved type, and, in the absence of other instructions, be of the same size as the equipment flue collar. Where a draft hood is required with a conversion burner, it shall be of a listed or approved type. [NFPA 54:10.12.2.1]

**414.12.2.2** 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 with the approval of the Authority Having Jurisdiction. [NFPA 54:10.12.2.2]

**414.12.3 Draft-Control Devices.** Where a draft-control device is part of the gas utilization equipment or is supplied by the equipment manufacturer, it shall be installed in accordance with the manufacturer's instructions. In the absence of manufacturer's instructions, the device shall be attached to the flue collar of the equipment or as near to the equipment as practical. [NFPA 54:10.12.3]

**414.12.4 Additional Devices.** Gas utilization 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 manufacturer's instructions. [NFPA 54:10.12.4]

**414.12.5 Location.** Draft hoods and barometric draft regulators shall be installed in the same room or enclosure as the equipment in such a manner as to prevent any difference in pressure between the hood or regulator and the combustion air supply. [NFPA 54:10.12.5]

**414.12.6 Positioning.** Draft hoods and draft regulators shall be installed in the position for which they were designed with reference to the horizontal and vertical planes and shall be located so that the relief opening is not obstructed by any part of the equipment or adjacent construction. The equipment and its draft hood shall be located so that the relief opening is accessible for checking vent operation. [NFPA 54:10.12.6]

**414.12.7 Clearance.** A draft hood shall be located so that its relief opening is not less than six (6) inches (150 mm) from any surface except that of the equipment it serves and the venting system to which the draft hood is connected. Where a greater or lesser clearance is indicated on the equipment label, the clearance shall not be less than that specified on the label. Such clearances shall not be reduced. [NFPA 54:10.12.7]

**414.13 Manually Operated Dampers.** A manually operated damper shall not be placed in any equipment vent connector. Fixed baffles shall not be classified as manually operated dampers. [NFPA 54:10.13]

**414.14 Automatically Operated Vent Dampers.** An automatically operated vent damper shall be of a listed type. [NFPA 54:10.14]

**414.15 Obstructions.** Devices that retard the flow of vent gases shall not be installed in a vent connector, chimney, or vent. The following shall not be considered as obstructions [NFPA 54:10.15]:

- (1) Draft regulators and safety controls specifically listed for installation in venting systems and installed in accordance with the terms of their listing. [NFPA 54:10.15 (1)]
- (2) Approved draft regulators and safety controls designed and installed in accordance with approved engineering methods. [NFPA 54:10.15 (2)]
- (3) Listed heat reclaimers and automatically operated vent dampers installed in accordance with the terms of their listing. [NFPA 54:10.15 (3)]
- (4) Vent dampers serving listed appliances installed in accordance with this chapter or other approved engineering methods. [NFPA 54:10.15 (4)]
- (5) 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 414.3.1 and 414.3.2 is obtained. [NFPA 54:10.15(5)]

#### **415.0 Sizing of Category I Venting Systems.**

##### **415.1 Additional Requirements to Single Appliance Vent Tables (4.9 Through 4.13)**

###### **415.1.1 Obstructions and Vent Dampers.**

These venting tables shall not be used where obstructions (see Section 414.15) 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 [NFPA 54:13.1.1]:

- (1) The maximum capacity of the vent system shall be determined using the NAT MAX column. [NFPA 54:13.1.1 (1)]
- (2) The maximum capacity shall be determined as if the appliance were a fan-assisted appliance, using the FAN MIN column to determine the minimum capacity of the vent system. Where the corresponding FAN MIN is NA, the vent configuration shall not be permitted and an alternative venting configuration shall be utilized. [NFPA 54:13.1.1 (2)]

**415.1.2 Vent Downsizing.** Where the vent size determined from the tables is smaller than the appliance draft hood outlet or flue collar, the use of the smaller size shall be permitted, provided that the installation complies with all of the following requirements [NFPA 54:13.1.2]:

- (1) The total vent height (H) is at least ten 10 feet (3 m). [NFPA 54:13.1.2 (1)]
- (2) Vents for appliance draft hood outlets or flue collars twelve (12) inches (300 mm) in

diameter or smaller are not reduced more than one table size. [NFPA 54:13.1.2 (2)]

- (3) Vents for appliance draft hood outlets or flue collars larger than twelve (12) inches (300 mm) in diameter are not reduced more than two table sizes. [NFPA 54:13.1.2 (3)]
- (4) The maximum capacity listed in the tables for a fan-assisted appliance is reduced by 10 percent (0.90 maximum table capacity). [NFPA 54:13.1.2 (4)]
- (5) The draft hood outlet is greater than four (4) inches (100 mm) in diameter. Do not connect a three (3) inches (80mm) diameter vent to a four (4) inches (100mm) diameter draft hood outlet. This provision shall not apply to fan-assisted appliances. [NFPA 54:13.1.2 (5)]

**415.1.3 Elbows.** Single-appliance venting configurations with zero (0) lateral lengths in Tables 4-9, 4-10, and 4-13 shall have no elbows in the venting system. For vent configurations with lateral lengths, the venting tables include allowance for two ninety (90) degree turns. For each additional elbow up to and including forty-five (45) degrees, the maximum capacity listed in the venting tables shall be reduced by 5 percent. For each elbow greater than forty-five (45) degrees up to and including ninety (90) degrees, the maximum capacity listed in the venting tables shall be reduced by 10 percent. [NFPA 54:13.1.3]

**415.1.4 Zero Lateral.** Zero (0) lateral (L) shall apply only to a straight vertical vent attached to a top outlet draft hood or flue collar. [NFPA 54:13.1.4]

**415.1.5 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. [NFPA 54:13.1.5]

**415.1.6 Two Stage/Modulating 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. [NFPA 54:13.1.6]

**415.1.7 Corrugated Chimney Liners.** Listed corrugated metallic chimney liner systems in masonry chimneys shall be sized by using Table 4-9 or 4-10 for Type B vents, with the maximum capacity reduced by 20 percent (0.80 maximum capacity) and the minimum capacity as shown in Table 4-9 or 4-10. Corrugated metallic liner systems installed with bends or offsets shall have their maximum capacity further reduced in accordance with 415.1.3. The 20 percent reduction for corrugated metallic chimney liner systems includes an allowance for one long radius ninety (90) degree turn at the bottom of the liner. [NFPA 54:13.1.7]

**415.1.8 Vertical Vent Upsizing/7x Rule.**

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 (7) times the flow area of the listed appliance categorized vent area, flue collar area, or draft hood outlet area unless designed in accordance with approved engineering methods. [NFPA 54:13.1.8]

**415.1.9 Exterior Chimneys and Vents.**

Tables 4-9 through 4-13 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 4-11 in combination with Table 4-19 shall be used for clay-tile-lined exterior masonry chimneys, provided all of the following are met [NFPA 54:13.1.9]:

- (1) The vent connector is Type B double wall. [NFPA 54:13.1.9 (1)]
- (2) The vent connector length is limited to 1-1/2 feet for each inch (180 mm/mm) of vent connector diameter. [NFPA 54:13.1.9 (2)]
- (3) The appliance is draft-hood-equipped. [NFPA 54:13.1.9 (3)]
- (4) The input rating is less than the maximum capacity given in Table 4-11. [NFPA 54:13.1.9 (4)]



- (5) For a water heater, the outdoor design temperature shall not be less than 5°F (15°C).

**Exception:** Vents serving listed appliances installed in accordance with the appliance instructions and the terms of the listing. [NFPA 54:13.1.9 (5)]

**415.1.10 Corrugated Vent Connector Size.**

Corrugated vent connectors shall not be smaller than the listed appliance categorized vent diameter, flue collar diameter, or draft hood outlet diameter. [NFPA 54:13.1.10]

**415.1.11 Upsizing.** Vent connectors shall not be upsized more than two sizes greater than the listed appliance categorized vent diameter, flue collar diameter, or draft hood outlet diameter. [NFPA 54:13.1.11]

**415.1.12 Multiple Vertical Vent Sizes.** In a single run of vent or vent connector, more than one diameter and type shall be permitted to be used, provided that all the sizes and types are permitted by the tables. [NFPA 54:13.1.12]

**415.1.13 Interpolation.** Interpolation shall be permitted in calculating capacities for vent dimensions that fall between table entries. [NFPA 54:13.1.13]

**415.1.14 Extrapolation.** Extrapolation beyond the table entries shall not be permitted. [NFPA 54:13.1.14]

**415.1.15 Sizing Vents Not Covered by Tables.** For vent heights lower than six (6) feet and higher than shown in the tables, engineering methods shall be used to calculate vent capacities. [NFPA 54:13.1.15]

**415.2 Additional Requirements to Multiple Appliance Vent Table 4-14 Through Table 4-21(a) and Table 4-21(b).** [NFPA 54:13.2]

**415.2.1 Obstructions and Vent Dampers.**

These venting tables shall not be used where obstructions (see Section 414.15) are installed in the venting system. The installation of vents serving listed appliances with vent dampers shall be in accordance with the appliance manufacturers' instructions or in accordance with the following [NFPA 54:13.2.1]:

- (1) The maximum capacity of the vent connector shall be determined using the NAT Max column. [NFPA 54:13.2.1 (1)]
- (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. [NFPA 54:13.2.1 (2)]

- (3) The minimum capacity shall be determined as if the appliance were a fan-assisted appliance. [NFPA 54:13.2.1 (3)]

- (a) The minimum capacity of the vent connector shall be determined using the FAN Min column. [NFPA 54:13.2.1 (3)(a)]

- (b) The FAN + FAN column shall be used when the second appliance is a fan-assisted appliance, and the FAN + NAT column shall be used when 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. [NFPA 54:13.2.1 (3)(b)]

**415.2.2 Vent Connector Maximum Length.**

The maximum vent connector horizontal length shall be eighteen (18) in./in. (180 mm/mm) of connector diameter as shown in Table 4-8 [NFPA 54:13.2.2]

**415.2.3 Vent Connector Exceeding Maximum Length.**

The vent connector shall be routed to the vent utilizing the shortest possible route. Connectors with longer horizontal lengths than those listed in Table 4-8 are permitted under the following conditions [NFPA 54:13.2.3]:

- (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 in Table 4-8. For example, the maximum length listed for a four (4) inches (100 mm) connector is six (6) feet (1.8 m). With a connector length greater than six (6) feet (1.8 m) but not exceeding twelve (12) feet (3.7 m), the maximum capacity must be reduced by 10 percent (0.90 maximum vent connector

capacity). With a connector length greater than twelve (12) feet (3.7 m) but not exceeding eighteen (18) feet (5.5 m), the maximum capacity must be reduced by 20 percent (0.80 maximum vent capacity). [NFPA 54:13.2.3 (1)]

- (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 4-9 shall be used. For single-wall connectors, Table 4-10 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. [NFPA 54:13.2.3 (2)]

**TABLE 4-8**  
**Vent Connector Maximum Length**

Connector Diameter Maximum (in.)	Connector Horizontal Length (ft.)
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 units, 1 in. = 25.4 mm; 1 ft = 0.305 m.

[NFPA 54 Table 13.2.2]

**415.2.4 Vent Connector Manifolds.** Where the vent connectors are combined prior to entering the vertical portion of the common vent to form a common vent manifold, the size of the common vent manifold and the

common vent shall be determined by applying a 10 percent reduction (.90 x maximum common vent capacity) to the Common Vent Capacity part of the common vent tables. The length of the common vent connector manifold (LM) shall not exceed eighteen (18) in./in. (180 mm/mm) of common vent connector manifold diameter (D). [NFPA 54:13.2.4]

**415.2.5 Vent Offsets.** Where the common vertical vent is offset, the maximum capacity of the common vent shall be reduced in accordance with 415.2.6 and the horizontal length of the common vent offset shall not exceed eighteen (18) in./in. (180 mm/mm) of common vent diameter. [NFPA 54:13.2.5]

**415.2.6 Elbows in Vents.** For each elbow up to and including forty-five (45) degrees in the common vent, the maximum common vent capacity listed in the venting tables shall be reduced by 5 percent. For each elbow greater than forty-five (45) degrees up to and including ninety (90) degrees, the maximum common vent capacity listed in the venting tables shall be reduced by 10 percent. [NFPA 54:13.2.6]

**415.2.7 Elbows in Connectors.** The vent connector capacities listed in the common vent sizing tables include allowance for two ninety (90) degree elbows. For each additional elbow up to and including forty-five (45) degrees, the maximum vent connector capacity listed in the venting tables shall be reduced by 5 percent. For each elbow greater than forty-five (45) degrees up to and including ninety (90) degrees, the maximum vent connector capacity listed in the venting tables shall be reduced by 10 percent. [NFPA 54:13.2.7]

**415.2.8 Tee and Wye Sizing.** At the point where tee or wye fittings connect to a common vent, the opening size of the fitting shall be equal to the size of the common vent. Such fittings shall not be prohibited from having reduced size openings at the point of connection of appliance vent connectors. [NFPA 54:13.2.9]

**415.2.9 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. [NFPA 54:13.2.10]

**415.2.10 Connector Rise.** The 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. [NFPA 54:13.2.11]

**415.2.11 Vent Heights.** For multiple units of gas utilization 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. [NFPA 54:13.2.12]

**415.2.12 Vertical Vent Size Limitation.** 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 (7) times the smallest listed appliance categorized vent areas, flue collar area, or draft hood outlet area unless designed in accordance with approved engineering methods. [NFPA 54:13.2.17]

**415.2.13 Two Stage/Modulating 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 table shall be greater than the highest appliance input rating. [NFPA 54:13.2.18]

**415.2.14 Corrugated Chimney Liners.** Listed corrugated metallic chimney liner systems in masonry chimneys shall be sized by using Table 4-14 or 4-15 for Type B vents, with the maximum capacity reduced by 20 percent (0.80 maximum capacity) and the minimum capacity as shown in Table 4-14 or 4-15. Corrugated metallic liner systems installed with bends or offsets shall have their maximum capacity further reduced in accordance with 415.2.5 and 415.2.6. The 20 percent reduction for corrugated metallic chimney liner systems includes an allowance for one long radius ninety (90) degree turn at the bottom of the liner. [NFPA 54:13.2.19]

**415.2.15 Exterior Chimneys and Vents.** Tables 4-14 through 4-18 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 4-20 and 4-21 shall be used for clay-tile-lined exterior masonry chimneys, provided all of the following

**TABLE G.2.3**  
**Masonry Chimney Liner Dimensions with Circular Equivalents**

Nominal Liner Size (in.)	Inside Dimensions of Liner (in.)	Inside Diameter or Equivalent Diameter (in.)	Equivalent Area (in. <sup>2</sup> )
4 x 8	2-1/2 x 6-1/2	4.0	12.2
		5.0	19.6
		6.0	28.3
		7.0	38.3
8 x 8	6-3/4 x 6-3/4	7.4	42.7
		8.0	50.3
8 x 12	6-1/2 x 10-1/2	9.0	63.6
		10.0	78.5
12 x 12	9-3/4 x 9-3/4	10.4	83.3
		11.0	95.0
12 x 16	9-1/2 x 13-1/2	11.8	107.5
		12.0	113.0
		14.0	153.9
		14.5	162.9
16 x 16	13-1/4 x 13-1/4	15.0	176.7
		16.2	206.1
16 x 20	13 x 17	18.0	254.4
		18.2	260.2
20 x 20	16-1/2 x 16-3/4	20.0	314.1
		20.1	314.2
20 x 24	16-1/2 x 20-1/2	22.0	308.1
		22.1	308.1
24 x 24	20-1/4 x 20-1/4	24.0	452.3
		24.1	456.2
24 x 28	20-1/4 x 24-1/4	26.4	543.3
		27.0	572.5
28 x 28	24-1/4 x 24-1/4	27.9	607.0
		30.9	749.9
30 x 30	25-1/2 x 25-1/2	33.0	855.3
		34.4	929.4
30 x 36	25-1/2 x 31-1/2	36.0	1017.9
36 x 36	31-1/2 x 31-1/2		

For SI units, 1 in. = 25.4 mm, 1 in.<sup>2</sup> = 645 mm<sup>2</sup>.

Note: When liner sizes differ dimensionally from those shown in this table, equivalent diameters can be determined from published tables for square and rectangular ducts of equivalent carrying capacity or by other engineering methods.

conditions are met [NFPA 54:13.2.20]:

- (1) Vent connector is Type B double-wall. [NFPA 54:13.2.20 (1)]
- (2) At least one appliance is draft-hood-equipped. [NFPA 54:13.2.20 (2)]
- (3) The combined appliance input rating is less than the maximum capacity given by Table 4-20(a) (for NAT + NAT) or Table 4-21(a) (for FAN + NAT). [NFPA 54:13.2.20 (3)]
- (4) The input rating of each space-heating appliance is greater than the minimum input rating given by Table 4-20(b) (for NAT + NAT) or Table 4-21(a) (for FAN + NAT). [NFPA 54:13.2.20 (4)]
- (5) The vent connector sizing is in accordance

with Table 4-16. Where these conditions cannot be met, an alternative venting design shall be used, such as a listed chimney lining system.

**Exception:** Vents serving listed appliances installed in accordance with the appliance manufacturers' instructions and the terms of the listing. [NFPA 54:13.2.20 (5)]

**415.2.16 Vent Connector Upsizing.** Vent connectors shall not be increased 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 vent connector sizes determined from the tables for fan-assisted appliances are smaller than the flue collar diameter, the use of the smaller sizes shall be permitted provided that the installation complies with all of the following conditions [NFPA 54:13.2.21]:

- (1) Vent connectors for fan-assisted appliance flue collars twelve (12) inches (300 mm) in diameter or smaller are not reduced by more than one table size [e.g., twelve (12) inches to ten (10) inches (300 mm to 250 mm) is a one-size reduction] and those larger than twelve (12) inches (300 mm) in diameter are not reduced more than two table sizes [e.g., twenty-four (24) inches to twenty (20) inches (610 mm to 510 mm) is a two-size reduction]. [NFPA 54:13.2.21 (1)]
- (2) Fan-assisted appliances are common vented with a draft-hood-equipped appliance. [NFPA 54:13.2.21 (2)]
- (3) The vent connector has a smooth interior wall. [NFPA 54:13.2.21 (3)]

**415.2.17 Multiple Vent and Connector Sizes.** All combinations of pipe sizes, single-wall, metal pipe, and double-wall metal pipe shall be allowed within any connector runs or within the common vent, provided ALL of the appropriate tables permit ALL of the desired sizes and types of pipe, as if they were used for the entire length of the subject connector or vent. Where single-wall and Type B double-wall metal pipes are used for vent connectors within the same venting system, the common

vent must be sized using Table 4-15 or Table 4-17 as appropriate. [NFPA 54:13.2.22]

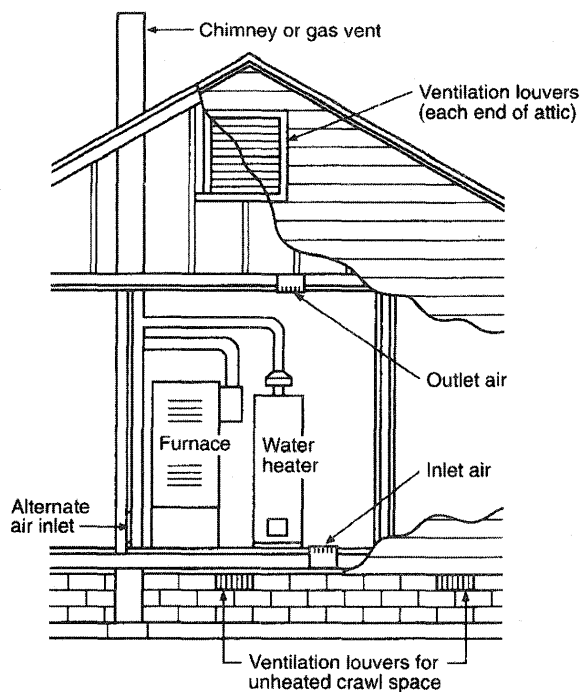
**415.2.18 Multiple Vent and Connector Sizes Permitted.** Where a table permits more than one diameter of pipe to be used for a connector or vent, all the permitted sizes shall be permitted to be used. [NFPA 54:13.2.23]

**415.2.19 Interpolation.** Interpolation shall be permitted in calculating capacities for vent dimensions that fall between table entries. (See Part II Figure G.1(a) – 6.1(d)) [NFPA 54:13.2.24]

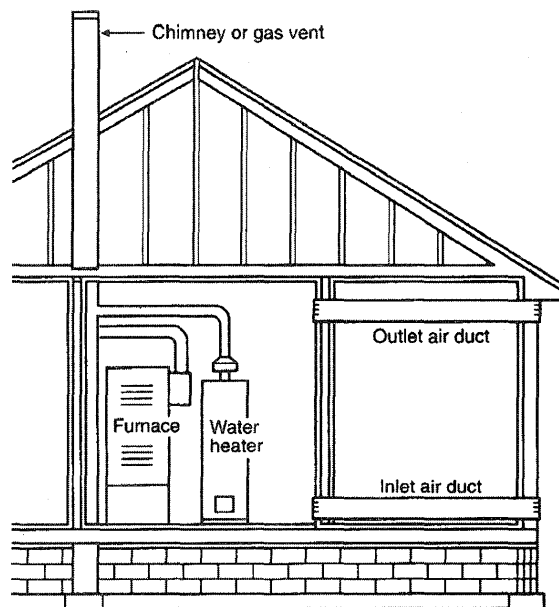
**415.2.20 Extrapolation.** Extrapolation beyond the table entries shall not be permitted. [NFPA 54:13.2.25]

**415.2.21 Sizing Vents Not Covered by Tables.** For vent heights lower than six (6) feet and higher than shown in the tables, engineering methods shall be used to calculate vent capacities. [NFPA 54:13.2.26]

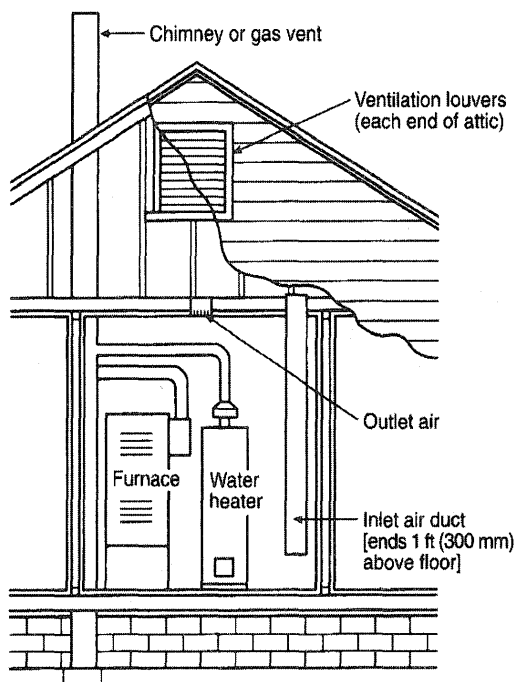
**416.0 Direct-Vent Equipment.** Listed direct-vent gas utilization equipment shall be considered properly vented where installed in accordance with the terms of its listing, the manufacturers' instructions, and Section 414.8.3. [NFPA 54:10.2.5]



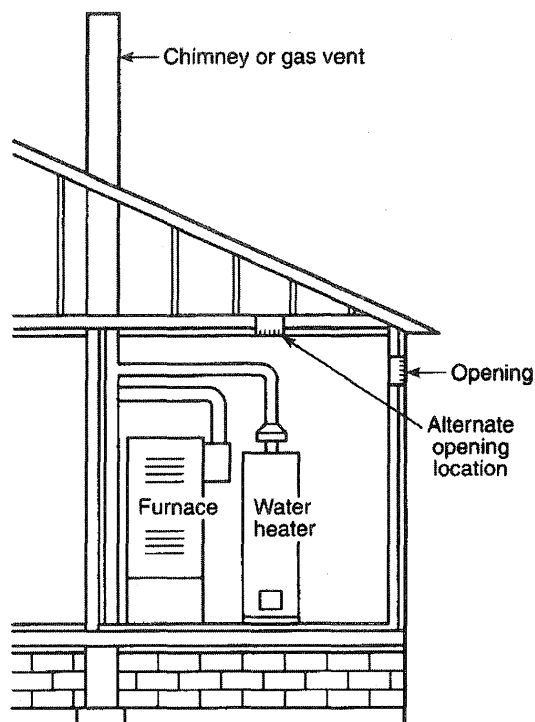
**FIGURE 4-9 All Combustion Air From Outdoors - Inlet Air From Ventilated Crawl Space and Outlet Air to Ventilated Attic.**



**FIGURE 4-11 All Combustion Air From Outdoors Through Horizontal Ducts.**



**FIGURE 4-10 All Combustion Air From Outdoors Through Ventilated Attic.**



**FIGURE 4-12 All Combustion Air From Outdoors Through Single Combustion Air Opening.**

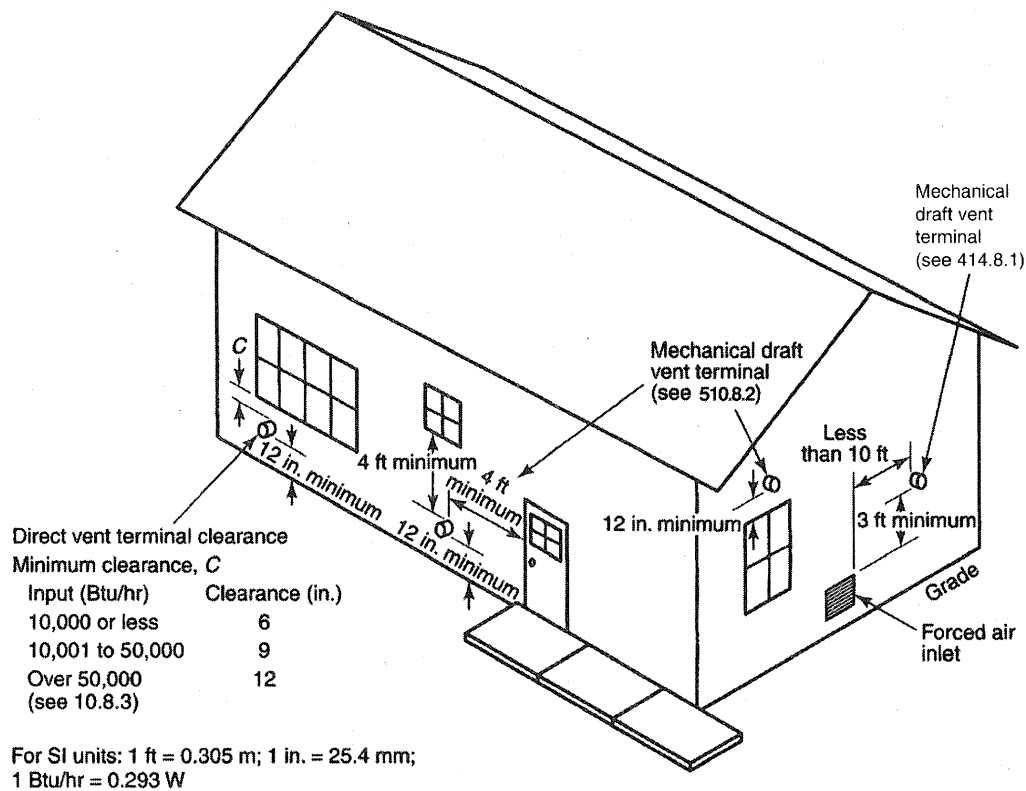


FIGURE 4-13 Exit Terminals of Mechanical Draft and Direct-Vent Venting Systems.



**99% Winter Design Temperatures for the Contiguous United States**

This map is a necessarily generalized guide to temperatures in the contiguous United States. Temperatures shown for areas such as mountainous regions and large urban centers may not be accurate. The data used to develop this map are from the 1993 ASHRAE Handbook — Fundamentals (Chapter 24, Table 1: Climate Conditions for the United States).

For 99% winter design temperatures in Alaska, consult the ASHRAE Handbook — Fundamentals.

99% winter design temperatures for Hawaii are greater than 37°F.

FIGURE 4-14 Range of Winter Design Temperatures Used in Analyzing Exterior Masonry Chimneys in the United States.

Table 4-9 Type B Double-Wall Gas Vent [NFPA 54:Table 13.1]

												Number of Appliances:						Single						
												Appliance Type:						Category I						
												Appliance Vent Connection:						Connected Directly to Vent						
Vent Diameter — D (in.)																								
Height H (ft.)		Lateral L (ft.)		Appliance Input Rating in Thousands of Btu per Hour																				
				3			4			5			6			7			8			9		
				FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max	FAN Min	FAN Max	NAT Max
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	1006	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	1096	585		
	2	12	61	42	17	118	81	23	194	129	26	289	195	40	402	273	48	533	355	57	684	457		
	5	23	57	40	32	113	77	41	187	124	52	280	188	68	392	263	81	522	346	95	671	446		
	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	1263	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	1057	575	0	1384	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	1173	650	0	1548	855		
	2	9	81	56	13	166	112	14	283	185	18	432	280	27	613	394	33	826	535	42	1072	700		
	5	21	77	54	28	160	108	36	275	176	45	421	273	58	600	385	69	811	524	82	1055	688		
	10	27	70	50	37	150	102	48	262	171	59	405	261	77	580	371	91	788	507	107	1028	668		
	15	33	64	NA	44	141	96	57	249	163	70	389	249	90	560	357	105	765	490	124	1002	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	1297	708	0	1730	952		
	2	8	86	61	11	183	122	14	320	206	15	497	314	22	715	445	26	975	615	33	1276	813		
	5	20	82	NA	27	177	119	35	312	200	43	487	308	55	702	438	65	960	605	77	1259	798		
	10	26	76	NA	35	168	114	45	299	190	56	471	298	73	681	426	86	935	589	101	1230	773		
	15	59	70	NA	42	158	NA	54	287	180	66	455	288	85	662	413	100	911	572	117	1203	747		
	20	NA	NA	NA	50	149	NA	63	275	169	76	440	278	97	642	401	113	888	556	131	1176	722		
	30	NA	NA	NA	69	131	NA	84	250	NA	99	410	259	123	605	376	141	844	522	161	1125	670		
100	0	NA	NA	NA	0	218	NA	0	407	NA	0	665	400	0	997	560	0	1411	770	0	1908	1040		
	2	NA	NA	NA	10	194	NA	12	354	NA	13	566	375	18	831	510	21	1155	700	25	1536	935		
	5	NA	NA	NA	26	189	NA	33	347	NA	40	557	369	52	820	504	60	1141	692	71	1519	926		
	10	NA	NA	NA	33	182	NA	43	335	NA	53	542	361	68	801	493	80	1118	679	94	1492	910		
	15	NA	NA	NA	40	174	NA	50	321	NA	62	528	353	80	782	482	93	1095	666	109	1465	895		
	20	NA	NA	NA	47	166	NA	59	311	NA	71	513	344	90	763	471	105	1073	653	122	1438	880		
	30	NA	NA	NA	NA	NA	NA	78	290	NA	92	483	NA	115	726	449	131	1029	627	149	1387	849		
	50	NA	NA	NA	NA	NA	NA	NA	NA	NA	147	428	NA	180	651	405	197	944	575	217	1288	787		

Table 4-9 [NFPA 54:Table 13.1] Continued

				Number of Appliances:										Single											
				Appliance Type:										Category I											
				Appliance Vent Connection:										Connected Directly to Vent											
Vent Diameter — D (in.)																									
		10		12		14		16		18		20		22		24									
Height Lateral H L (ft.) (ft.)	Appliance Input Rating in Thousands of Btu per Hour																								
	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	1121	570	0	1645	850	0	2267	1170	0	2983	1530	0	3802	1960	0	4721	2430	0	5737	2950	0	6853	3520
	2	75	675	455	103	982	650	138	1346	890	178	1769	1170	225	2250	1480	296	2782	1850	360	3377	2220	426	4030	2670
	4	110	668	445	147	975	640	191	1338	880	242	1761	1160	300	2242	1475	390	2774	1835	469	3370	2215	555	4023	2660
	6	128	661	435	171	967	630	219	1330	870	276	1753	1150	341	2235	1470	437	2767	1820	523	3363	2210	618	4017	2650
8	0	0	1261	660	0	1858	970	0	2571	1320	0	3399	1740	0	4333	2220	0	5387	2750	0	6555	3360	0	7838	4010
	2	71	770	515	98	1124	745	130	1543	1020	168	2030	1340	212	2584	1700	278	3196	2110	336	3882	2560	401	4634	3050
	5	115	758	503	154	1110	733	199	1528	1010	251	2013	1330	311	2563	1685	398	3180	2090	476	3863	2545	562	4612	3040
	8	137	746	490	180	1097	720	231	1514	1000	289	2000	1320	354	2552	1670	450	3163	2070	537	3850	2530	630	4602	3030
10	0	0	1377	720	0	2036	1060	0	2825	1450	0	3742	1925	0	4782	2450	0	5955	3050	0	7254	3710	0	8682	4450
	2	68	852	560	93	1244	850	124	1713	1130	161	2256	1480	202	2868	1890	264	3556	2340	319	4322	2840	378	5153	3390
	5	112	839	547	149	1229	829	192	1696	1105	243	2238	1461	300	2849	1871	382	3536	2318	458	4301	2818	540	5132	3371
	10	142	817	525	187	1204	795	238	1669	1080	298	2209	1430	364	2818	1840	459	3504	2280	546	4268	2780	641	5099	3340
15	0	0	1596	840	0	2380	1240	0	3323	1720	0	4423	2270	0	5678	2900	0	7099	3620	0	8665	4410	0	10393	5300
	2	63	1019	675	86	1495	985	114	2062	1350	147	2719	1770	186	3467	2260	239	4304	2800	290	5232	3410	346	6251	4080
	5	105	1003	660	140	1476	967	182	2041	1327	229	2696	1748	283	3442	2235	355	4278	2777	426	5204	3385	501	6222	4057
	10	135	977	635	177	1446	936	227	2009	1289	283	2659	1712	346	3402	2193	432	4234	2739	510	5159	3343	599	6175	4019
15	155	953	610	202	1418	905	257	1976	1250	318	2623	1675	385	3363	2150	479	4192	2700	564	5115	3300	665	6129	3980	
20	0	0	1756	930	0	2637	1350	0	3701	1900	0	4948	2520	0	6376	3250	0	7988	4060	0	9785	4980	0	11753	6000
	2	59	1150	755	81	1694	1100	107	2343	1520	139	3097	2000	175	3955	2570	220	4916	3200	269	5983	3910	321	7154	4700
	5	101	1133	738	135	1674	1079	174	2320	1498	219	3071	1978	270	3926	2544	337	4885	3174	403	5950	3880	475	7119	4662
	10	130	1105	710	172	1641	1045	220	2282	1460	273	3029	1940	334	3880	2500	413	4835	3130	489	5896	3830	573	7063	4600
15	150	1078	688	195	1609	1018	248	2245	1425	306	2988	1910	372	3835	2465	459	4786	3090	541	5844	3795	631	7007	4575	
20	167	1052	665	217	1578	990	273	2210	1390	335	2948	1880	404	3791	2430	495	4737	3050	585	5792	3760	689	6953	4550	
30	0	0	1977	1060	0	3004	1550	0	4252	2170	0	5725	2920	0	7420	3770	0	9341	4750	0	11483	5850	0	13848	7060
	2	54	1351	865	74	2004	1310	98	2786	1800	127	3696	2380	159	4734	3050	199	5900	3810	241	7194	4650	285	8617	5600
	5	96	1332	851	127	1981	1289	164	2759	1775	206	3666	2350	252	4701	3020	312	5863	3783	373	7155	4622	439	8574	5555
	10	125	1301	829	164	1944	1254	209	2716	1733	259	3617	2300	316	4647	2970	386	5803	3739	456	7090	4574	535	8505	5471
15	143	1272	807	187	1908	1220	237	2674	1692	292	3570	2250	354	4594	2920	431	5744	3695	507	7026	4527	590	8437	5391	
20	160	1243	784	207	1873	1185	260	2633	1650	319	3523	2200	384	4542	2870	467	5686	3650	548	6964	4480	639	8370	5310	
30	195	1189	745	246	1807	1130	305	2555	1585	369	3433	2130	440	4442	2785	540	5574	3565	635	6842	4375	739	8239	5225	
50	0	0	2231	1195	0	3441	1825	0	4934	2550	0	6711	3440	0	8774	4460	0	11129	5635	0	13767	6940	0	16694	8430
	2	41	1620	1010	66	2431	1513	86	3409	2125	113	4554	2840	141	5864	3670	171	7339	4630	209	8980	5695	251	10788	6860
	5	90	1600	996	118	2406	1495	151	3380	2102	191	4520	2813	234	5826	3639	283	7295	4597	336	8933	5654	394	10737	6818
	10	118	1567	972	154	2366	1466	196	3332	2064	243	4464	2767	295	5763	3585	355	7224	4542	419	8855	5585	491	10652	6749
15	136	1536	948	177	2327	1437	222	3285	2026	274	4409	2721	330	5701	3534	396	7155	4511	465	8779	5546	542	10570	6710	
20	151	1505	924	195	2288	1408	244	3239	1987	300	4356	2675	361	5641	3481	433	7086	4479	506	8704	5506	586	10488	6670	
30	183	1446	876	232	2214	1349	287	3150	1910	347	4253	2631	412	5523	3431	494	6953	4421	577	8557	5444	672	10328	6603	
100	0	0	2491	1310	0	3925	2050	0	5729	2950	0	7914	4050	0	10485	5300	0	13454	6700	0	16817	8600	0	20578	10300
	2	30	1975	1170	44	3027	1820	72	4313	2550	95	5834	3500	120	7591	4600	138	9577	5800	169	11803	7200	204	14264	8800
	5	82	1955	1159	107	3002	1803	136	4282	2531	172	5797	3475	208	7548	4566	245	9528	5769	293	11748	7162	341	14204	8756
	10	108	1923	1142	142	2961	1775	180	4231	2500	223	5737	3434	268	7478	4509	318	9447	5717	374	11658	7100	436	14105	8683
15	126	1892	1124	163	2920	1747	206	4182	2469	252	5678	3392	304	7409	4451	358	9367	5665	418	11569	7037	487	14007	8610	
20	141	1861	1107	181	2880	1719	226	4133	2438	277	5619	3351	330	7341	4394	387	9289	5613	452	11482	6975	523	13910	8537	
30	170	1802	1071	215	2803	1663	265	4037	2375	319	5505	3267	378	7209	4279	446	9136	5509	514	11310	6850	592	13720	8391	
50	241	1688	1000	292	2657	1550	350	3856	2250	415	5289	3100	486	6956	4050	572	8841	5300	659	10979	6600	752	13354	8100	



Table 4-10 Type B Double-Wall Vent [NFPA 54:Table 13.2]

		Number of Appliances:												Single							
		Appliance Type:												Category I							
		Appliance Vent Connection:												Single-Wall Metal Connector							
Vent Diameter — D (in.)																					
Height Lateral H L (ft) (ft)		Appliance Input Rating in Thousands of Btu per Hour																			
		3		4		5		6		7		8		9		10		12			
		FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT	FAN	NAT		
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
6	0	38	77	45	59	151	85	85	249	140	126	373	204	165	522	284	211	695	369	267	894
	2	39	51	36	60	96	66	85	156	104	123	231	156	159	320	213	201	423	284	251	541
	4	NANA	33	74	92	63	102	152	102	146	225	152	187	313	208	237	416	277	295	533	
	6	NANA	31	83	89	60	114	147	99	163	220	148	207	307	203	263	409	271	327	526	
8	0	37	83	50	58	164	93	83	273	154	123	412	234	161	580	319	206	777	414	258	1002
	2	39	56	39	59	108	75	83	176	119	121	261	179	155	363	246	197	482	321	246	617
	5	NANA	37	77	102	69	107	168	114	151	252	171	193	352	235	245	470	311	305	604	
	8	NANA	33	90	95	64	122	161	107	175	243	163	223	342	225	280	458	300	344	591	
10	0	37	87	53	57	174	99	82	293	165	120	444	254	158	628	344	202	844	449	253	1093
	2	39	61	41	59	117	80	82	193	128	119	287	194	153	400	272	193	531	354	242	681
	5	52	56	39	76	111	76	105	185	122	148	277	186	190	388	261	241	518	344	299	667
	10	NANA	34	97	100	68	132	171	112	188	261	171	237	369	241	296	497	325	363	643	
15	0	36	93	57	56	190	111	80	325	186	116	499	283	153	713	388	195	966	523	244	1259
	2	38	69	47	57	136	93	80	225	149	115	337	224	148	473	314	187	631	413	232	812
	5	51	63	44	75	128	86	102	216	140	144	326	217	182	459	298	231	616	400	287	795
	10	NANA	39	95	116	79	128	201	131	182	308	203	228	438	284	284	592	381	349	768	
20	0	35	96	60	54	200	118	78	346	201	114	537	306	149	772	428	190	1053	573	238	1379
	2	37	74	50	56	148	99	78	248	165	113	375	248	144	528	344	182	708	468	227	914
	5	50	68	47	73	140	94	100	239	158	141	363	239	178	514	334	224	692	457	279	896
	10	NANA	41	93	129	86	125	223	146	177	344	224	222	491	316	277	666	437	339	866	
30	0	34	99	63	53	211	127	76	372	219	110	584	334	144	849	472	184	1168	647	229	1542
	2	37	80	56	55	164	111	76	281	183	109	429	279	139	610	392	175	823	533	219	1069
	5	49	74	52	72	157	106	98	271	173	136	417	271	171	595	382	215	806	521	269	1049
	10	NANA	NA	91	144	98	122	255	168	171	397	257	213	570	367	265	777	501	327	1017	
50	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515	176	1292	704	220	1724
	2	36	84	61	53	181	121	73	318	205	104	495	312	133	712	443	168	971	613	209	1273
	5	48	80	NA	70	174	117	94	308	198	131	482	305	164	696	435	204	953	602	257	1252
	10	NANA	NA	89	160	NA	118	292	186	162	461	292	203	671	420	253	923	583	313	1217	
100	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515	176	1292	704	220	1724
	2	36	84	61	53	181	121	73	318	205	104	495	312	133	712	443	168	971	613	209	1273
	5	48	80	NA	70	174	117	94	308	198	131	482	305	164	696	435	204	953	602	257	1252
	10	NANA	NA	89	160	NA	118	292	186	162	461	292	203	671	420	253	923	583	313	1217	
200	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515	176	1292	704	220	1724
	2	36	84	61	53	181	121	73	318	205	104	495	312	133	712	443	168	971	613	209	1273
	5	48	80	NA	70	174	117	94	308	198	131	482	305	164	696	435	204	953	602	257	1252
	10	NANA	NA	89	160	NA	118	292	186	162	461	292	203	671	420	253	923	583	313	1217	
300	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515	176	1292	704	220	1724
	2	36	84	61	53	181	121	73	318	205	104	495	312	133	712	443	168	971	613	209	1273
	5	48	80	NA	70	174	117	94	308	198	131	482	305	164	696	435	204	953	602	257	1252
	10	NANA	NA	89	160	NA	118	292	186	162	461	292	203	671	420	253	923	583	313	1217	
500	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515	176	1292	704	220	1724
	2	36	84	61	53	181	121	73	318	205	104	495	312	133	712	443	168	971	613	209	1273
	5	48	80	NA	70	174	117	94	308	198	131	482	305	164	696	435	204	953	602	257	1252
	10	NANA	NA	89	160	NA	118	292	186	162	461	292	203	671	420	253	923	583	313	1217	
800	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515	176	1292	704	220	1724
	2	36	84	61	53	181	121	73	318	205	104	495	312	133	712	443	168	971	613	209	1273
	5	48	80	NA	70	174	117	94	308	198	131	482	305	164	696	435	204	953	602	257	1252
	10	NANA	NA	89	160	NA	118	292	186	162	461	292	203	671	420	253	923	583	313	1217	
1000	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515	176	1292	704	220	1724
	2	36	84	61	53	181	121	73	318	205	104	495	312	133	712	443	168	971	613	209	1273
	5	48	80	NA	70	174	117	94	308	198	131	482	305	164	696	435	204	953	602	257	1252
	10	NANA	NA	89	160	NA	118	292	186	162	461	292	203	671	420	253	923	583	313	1217	
1200	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515	176	1292	704	220	1724
	2	36	84	61	53	181	121	73	318	205	104	495	312	133	712	443	168	971	613	209	1273
	5	48	80	NA	70	174	117	94	308	198	131	482	305	164	696	435	204	953	602	257	1252
	10	NANA	NA	89	160	NA	118	292	186	162	461	292	203	671	420	253	923	583	313	1217	
1500	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515	176	1292	704	220	1724
	2	36	84	61	53	181	121	73	318	205	104	495	312	133	712	443	168	971	613	209	1273
	5	48	80	NA	70	174	117	94	308	198	131	482	305	164	696	435	204	953	602	257	1252
	10	NANA	NA	89	160	NA	118	292	186	162	461	292	203	671	420	253	923	583	313	1217	
2000	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515	176	1292	704	220	1724
	2	36	84	61	53	181	121	73	318	205	104	495	312	133	712	443	168	971	613	209	1273
	5	48	80	NA	70	174	117	94	308	198	131	482	305	164	696	435	204	953	602	257	1252
	10	NANA	NA	89	160	NA	118	292	186	162	461	292	203	671	420	253	923	583	313	1217	
3000	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515	176	1292	704	220	1724
	2	36	84	61	53	181	121	73	318	205	104	495	312	133	712	443	168	971	613	209	1273
	5	48	80	NA	70	174	117	94	308	198	131	482	305	164	696	435	204	953	602	257	1252
	10	NANA	NA	89	160	NA	118	292	186	162	461	292	203	671	420	253	923	583	313	1217	
4000	0	33	99	66	51	213	133	73	394	230	105	629	361	138	928	515					

Table 4-11 Masonry Chimney [NFPA 54:Table 13.3]

				Number of Appliances:												Single																						
				Appliance Type:												Category I																						
				Appliance Vent Connection:												Type B Double-Wall Connector																						
				Type B Double-Wall Connector Diameter — D (in.)																																		
				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 per Hour																																		
Height	Lateral	H	L	FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT								
				Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max					
(ft)	(ft)	(ft)	(ft)	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max							
				Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max					
6	2	5	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	
			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	1024	651		
		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	1007	640		
		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	1144	724		
		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	1124	712		
		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	1093	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	1376	841		
		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	1352	828		
		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	1315	777		
		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	1280	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	1083	627		121	1548	953		
		NA	NA	36		NA	NA	68		NA	NA	116		NA	NA	184		80	503	254		95	658	350		113	845	463		133	1059	597		179	1523	933		
		NA	NA	NA		NA	NA	60		NA	NA	107		NA	NA	172		NA	NA	237		122	627	332		143	811	440		167	1022	566		221	1482	879		
		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	1443	840		
		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	1406	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	1240	717		111	1793	1112		
		NA	NA	NA		NA	NA	76		NA	NA	128		NA	NA	198		75	561	281		90	741	393		106	962	526		125	1216	683		169	1766	1094		
		NA	NA	NA		NA	NA	67		NA	NA	115		NA	NA	184		NA	NA	263		115	709	373		135	927	500		158	1176	648		210	1721	1025		
		NA	NA	NA		NA	NA	NA		NA	NA	107		NA	NA	171		NA	NA	243		NA	NA	353		156	893	476		181	1139	621		239	1679	981		
		NA	NA	NA		NA	NA	NA		NA	NA	91		NA	NA	159		NA	NA	227		NA	NA	332		176	860	450		203	1103	592		264	1638	940		
		NA	NA	NA		NA	NA	NA		NA	NA	NA		NA	NA	188		NA	NA	288		NA	NA	416		NA	NA	416		249	1035	555		318	1560	877		
50	2	NA	NA	NA		NA	NA	92		NA	NA	161		NA	NA	251		NA	NA	351		51	840	477		61	1106	633		72	1413	812		99	2080	1243		
		NA	NA	NA		NA	NA	NA		NA	NA	151		NA	NA	230		NA	NA	323		83	819	445		98	1083	596		116	1387	774		155	2052	1225		
		NA	NA	NA		NA	NA	NA		NA	NA	138		NA	NA	215		NA	NA	304		NA	NA	424		126	1047	567		147	1347	733		195	2006	1147		
		NA	NA	NA		NA	NA	NA		NA	NA	127		NA	NA	199		NA	NA	282		NA	NA	400		146	1010	539		170	1307	702		222	1961	1099		
		NA	NA	NA		NA	NA	NA		NA	NA	NA		NA	NA	185		NA	NA	264		NA	NA	376		165	977	511		190	1269	669		246	1916	1050		
Minimum Internal Area of Chimney Square Inches				12		19		28		38		50		63		78		95		132																		
				49		88		137		198		269		352		445		550		792																		

Table 4-12 Masonry Chimney [NFPA 54:Table 13.4]

			Number of Appliances:												Single														
			Appliance Type:												Category I														
			Appliance Vent Connection:												Single-Wall Metal Connector														
			Single-Wall Metal Connector Diameter — D (in.) 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 per Hour																										
Height	Lateral		FAN	NAT		FAN	NAT		FAN	NAT		FAN	NAT		FAN	NAT		FAN	NAT		FAN	NAT		FAN	NAT		FAN	NAT	
H	L		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
(ft.)	(ft.)		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	1021	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	1003	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	1142	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	1121	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	1088	665
15	2		NA	NA	35	NA	NA	67	NA	NA	113	NA	NA	178	166	473	249	211	611	335	264	776	440	362	965	560	520	1373	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	1348	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	1309	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	1272	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	1079	625	508	1544	950
	5		NA	NA	35	NA	NA	67	NA	NA	115	NA	NA	183	NA	NA	252	255	655	348	317	842	461	433	1055	594	623	1518	930
	10		NA	NA	NA	NA	NA	59	NA	NA	105	NA	NA	170	NA	NA	235	312	622	330	382	806	437	517	1016	562	733	1475	875
	15		NA	NA	NA	NA	NA	95	NA	NA	156	NA	NA	217	NA	NA	311	442	773	414	442	773	414	591	979	539	823	1434	835
	20		NA	NA	NA	NA	NA	80	NA	NA	144	NA	NA	202	NA	NA	292	NA	NA	392	663	944	510	911	1394	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	1237	715	489	1789	1110
	5		NA	NA	NA	NA	NA	75	NA	NA	127	NA	NA	196	NA	NA	279	245	737	391	306	958	524	417	1210	680	600	1760	1090
	10		NA	NA	NA	NA	NA	66	NA	NA	113	NA	NA	182	NA	NA	260	300	703	370	370	920	496	500	1168	644	708	1713	1020
	15		NA	NA	NA	NA	NA	NA	NA	NA	105	NA	NA	168	NA	NA	240	NA	NA	349	428	884	471	572	1128	615	798	1668	975
	20		NA	NA	NA	NA	NA	NA	88	NA	NA	155	NA	NA	223	NA	NA	327	NA	NA	445	643	1089	585	883	1624	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	1539	865
50	2		NA	NA	NA	NA	NA	91	NA	NA	160	NA	NA	250	NA	NA	350	191	837	475	238	1103	631	323	1408	810	463	2076	1240
	5		NA	NA	NA	NA	NA	NA	NA	NA	149	NA	NA	228	NA	NA	321	NA	NA	442	293	1078	593	398	1381	770	571	2044	1220
	10		NA	NA	NA	NA	NA	NA	NA	NA	136	NA	NA	212	NA	NA	301	NA	NA	420	355	1038	562	447	1337	728	674	1994	1140
	15		NA	NA	NA	NA	NA	NA	NA	NA	124	NA	NA	195	NA	NA	278	NA	NA	395	NA	NA	533	546	1294	695	761	1945	1090
	20		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	180	NA	NA	258	NA	NA	370	NA	NA	504	616	1251	660	844	1898	1040
	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	1009	1805	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		

Table 4-13 Single-Wall Metal Pipe or Type B Asbestos Cement Vent [NFPA 54:Table 13.5]

				Number of Appliances:			Single		
				Appliance Type:			Category I		
				Appliance Vent Connection:			Connected Directly to Vent		
Single-Wall Metal Connector Diameter - D (in.) To be used with chimney area within the size limits at bottom									
Height H (ft.)	Lateral L (ft.)	3	4	5	6	7	8	10	12
		Appliance Input Rating in Thousands of Btu per Hour							
		Maximum Appliance Input Rating in Thousands of Btu per Hour							
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	1040
	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	1190
	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	1370
	2	44	84	148	230	320	441	730	1140
	5	NA	78	137	210	296	410	694	1080
	10	NA	68	125	196	274	388	656	1050
	15	NA	NA	113	177	258	366	625	1000
	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	1550
	2	NA	95	171	260	370	492	820	1290
	5	NA	NA	159	234	342	474	780	1230
	10	NA	NA	146	221	318	456	730	1190
	15	NA	NA	NA	200	292	407	705	1130
	20	NA	NA	NA	185	276	384	670	1080
	30	NA	NA	NA	NA	222	330	605	1010

Table 4-14 Type B Double-Wall Vent [NFPA 54:Table 13.6]

										Number of Appliances:						Two or More															
										Appliance Type:						Category I															
										Appliance Vent Connection:						Type B Double-Wall Connector															
Type B Double-Wall Vent and Connector Diameter — D (in.)																															
		3			4			5			6			7			8			9			10								
Height H (ft.)	Rise R (ft.)	Appliance Input Rating in Thousands of Btu per Hour																													
		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	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	1014	478						
	3	22	75	48	33	141	86	46	229	134	61	366	194	83	502	263	103	661	343	126	842	441	151	1043	538						
100	1	18	82	37	28	158	66	40	262	104	53	442	150	73	611	204	91	810	266	112	1038	341	135	1285	417						
	2	19	83	44	30	161	79	42	267	123	55	447	178	75	619	242	94	822	316	115	1054	405	139	1306	494						
	3	20	84	50	31	163	89	44	272	138	57	452	200	78	627	272	97	834	355	118	1069	455	142	1327	555						

## Common Vent Capacity

		Type B Double-Wall Common Vent Diameter — D (in.)																				
Vent Height		4			5			6			7			8			9			10		
		Combined Appliance Input Rating in Thousands of Btu per Hour																				
		FAN (ft.)	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT
		+FAN	+FAN	+NAT	+FAN	+FAN	+NAT	+FAN	+FAN	+NAT	+FAN	+FAN	+NAT	+FAN	+FAN	+NAT	+FAN	+FAN	+NAT	+FAN	+FAN	+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	1035	826	640
30		152	138	118	244	210	185	361	297	266	547	459	360	720	585	470	979	808	605	1209	975	740
50		167	153	134	279	244	214	421	353	310	641	547	423	854	706	550	1164	977	705	1451	1188	860
100		175	163	NA	311	277	NA	489	421	NA	751	658	479	1025	873	625	1408	1215	800	1784	1502	975

Table 4-14 Continued[NFPA 54:Table 13.6]

							Number of Appliances:						Two or More									
							Appliance Type:						Category I									
							Appliance Vent Connection:						Type B Double-Wall Vent Connector									
Type B Double-Wall Vent Connector Diameter – D (in.)																						
		12		14		16		18		20		22		24								
Vent Height H (ft.)	Connector Rise R (ft.)	Appliance Input Rating Limits in Thousands of Btu per Hour																				
		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			
6	2	174	764	496	223	1046	653	281	1371	853	346	1772	1080	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	180	897	616	230	1231	827	287	1617	1081	352	2069	1370	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	1126	696	298	1478	910	365	1920	1150	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	192	952	644	244	1307	884	305	1719	1150	372	2211	1460	471	2737	1800	560	3319	2180	662	3957	2590
	6	198	1050	772	252	1445	1072	313	1902	1390	380	2434	1770	478	3018	2180	568	3665	2640	669	4373	3130
10	2	196	870	536	249	1195	730	311	1570	955	379	2049	1205	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	201	997	664	256	1371	924	318	1804	1205	387	2332	1535	486	2887	1890	581	3502	2280	686	4175	2710
	6	207	1095	792	263	1509	1118	325	1989	1455	395	2556	1865	494	3169	2290	589	3849	2760	694	4593	3270
15	2	214	967	568	272	1334	790	336	1760	1030	408	2317	1305	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	221	1085	712	279	1499	1006	344	1978	1320	416	2579	1665	523	3197	2060	624	3881	2490	734	4631	2960
	6	228	1181	856	286	1632	1222	351	2157	1610	424	2796	2025	533	3470	2510	634	4216	3030	743	5035	3600
20	2	223	1051	596	291	1443	840	357	1911	1095	430	2533	1385	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	230	1162	748	298	1597	1064	365	2116	1395	438	2778	1765	554	3447	2180	661	4190	2630	772	5005	3130
	6	237	1253	900	307	1726	1288	373	2287	1695	450	2984	2145	567	3708	2650	671	4511	3190	785	5392	3790
30	2	216	1217	632	286	1664	910	367	2183	1190	461	2891	1540	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	223	1316	792	294	1802	1160	376	2366	1510	474	3110	1920	619	3840	2365	728	4861	2860	847	5606	3410
	6	231	1400	952	303	1920	1410	384	2524	1830	485	3299	2340	632	4080	2875	741	4976	3480	860	5961	4150
50	2	206	1479	689	273	2023	1007	350	2659	1315	435	3548	1665	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	213	1561	860	281	2139	1291	359	2814	1685	447	3730	2135	580	4601	2633	709	5569	3185	851	6633	3790
	6	221	1631	1031	290	2242	1575	369	2951	2055	461	3893	2605	594	4808	3208	724	5826	3885	867	6943	4620
100	2	192	1923	712	254	2644	1050	326	3490	1370	402	4707	1740	NA	NA	NA	NA	NA	NA	NA	NA	NA
	4	200	1984	888	263	2731	1346	336	3606	1760	414	4842	2220	523	5982	2750	639	7254	3330	769	8650	3950
	6	208	2035	1064	272	2811	1642	346	3714	2150	426	4968	2700	539	6143	3350	654	7453	4070	786	8892	4810

## Common Vent Capacity

Vent Height H (ft.)		Type B Double-Wall Common Vent Diameter — D (in.)																				
		12		14		16		18		20		22		24								
		Combined Appliance Input Rating in Thousands of Btu per Hour																				
		FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT			
		+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT			
6		900	696	588	1284	990	815	1735	1336	1065	2253	1732	1345	2838	2180	1660	3488	2677	1970	4206	3226	2390
8		994	773	652	1423	1103	912	1927	1491	1190	2507	1936	1510	3162	2439	1860	3890	2998	2200	4695	3616	2680
10		1076	841	712	1542	1200	995	2093	1625	1300	2727	2113	1645	3444	2665	2030	4241	3278	2400	5123	3957	2920
15		1247	986	825	1794	1410	1158	2440	1910	1510	3184	2484	1910	4026	3133	2360	4971	3862	2790	6016	4670	3400
20		1405	1116	916	2006	1588	1290	2722	2147	1690	3561	2798	2140	4548	3552	2640	5573	4352	3120	6749	5261	3800
30		1658	1327	1025	2373	1892	1525	3220	2558	1990	4197	3326	2520	5303	4193	3110	6539	5157	3680	7940	6247	4480
50		2024	1640	1280	2911	2347	1863	3964	3183	2430	5184	4149	3075	6567	5240	3800	8116	6458	4500	9837	7813	5475
100		2569	2131	1670	3732	3076	2450	5125	4202	3200	6749	5509	4050	8597	6986	5000	10681	8648	5920	13004	10499	7200



Table 4-15 Type B Double-Wall Vent [NFPA 54:Table 13.7]

			Number of Appliances:												Two or More													
			Appliance Type:												Category I													
			Appliance Vent Connection:												Single-Wall Metal Connector													
Vent Connector Capacity																												
		Single-Wall Metal Vent Connector Diameter — D (in.)																										
		3			4			5			6			7			8			9			10					
Vent Connector Height Rise		Appliance Input Rating Limits in Thousands of Btu per Hour																										
H (ft)	R (ft)	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	1	NA	NA	26	NA	NA	46	NA	NA	71	NA	NA	102	207	223	140	262	293	183	325	373	234	447	463	286			
	2	NA	NA	31	NA	NA	55	NA	NA	85	168	182	123	215	251	167	271	331	219	334	422	281	458	524	344			
	3	NA	NA	34	NA	NA	62	121	131	95	175	198	138	222	273	188	279	361	247	344	462	316	468	574	385			
8	1	NA	NA	27	NA	NA	48	NA	NA	75	NA	NA	106	226	240	145	285	316	191	352	403	244	481	502	299			
	2	NA	NA	32	NA	NA	57	125	126	89	184	193	127	234	266	173	293	353	228	360	450	292	492	560	355			
	3	NA	NA	35	NA	NA	64	130	138	100	191	208	144	241	287	197	302	381	256	370	489	328	501	609	400			
10	1	NA	NA	28	NA	NA	50	119	121	77	182	186	110	240	253	150	302	335	196	372	429	252	506	534	308			
	2	NA	NA	33	84	85	59	124	134	91	189	203	132	248	278	183	311	369	235	381	473	302	517	589	368			
	3	NA	NA	36	89	91	67	129	144	102	197	217	148	257	299	203	320	398	265	391	511	339	528	637	413			
15	1	NA	NA	29	79	87	52	116	138	81	177	214	116	238	291	158	312	380	208	397	482	266	556	596	324			
	2	NA	NA	34	83	94	62	121	150	97	185	230	138	246	314	189	321	411	248	407	522	317	568	646	387			
	3	NA	NA	39	87	100	70	127	160	109	193	243	157	255	333	215	331	438	281	418	557	360	579	690	437			
20	1	49	56	30	78	97	54	115	152	84	175	238	120	233	325	165	306	425	217	390	538	276	546	664	336			
	2	52	59	36	82	103	64	120	163	101	182	252	144	243	346	197	317	453	259	400	574	331	558	709	403			
	3	55	62	40	87	107	72	125	172	113	190	264	164	252	363	223	326	476	294	412	607	375	570	750	457			
30	1	47	60	31	77	110	57	112	175	89	169	278	129	226	380	175	296	497	230	378	630	294	528	779	358			
	2	51	62	37	81	115	67	117	185	106	177	290	152	236	397	208	307	521	274	389	662	349	541	819	425			
	3	54	64	42	85	119	76	122	193	120	185	300	172	244	412	235	316	542	309	400	690	394	555	855	482			
50	1	46	69	34	75	128	60	109	207	96	162	336	137	217	460	188	284	604	245	364	768	314	507	951	384			
	2	49	71	40	79	132	72	114	215	113	170	345	164	226	473	223	294	623	293	376	793	375	520	983	458			
	3	52	72	45	83	136	82	119	221	123	178	353	186	235	486	252	304	640	331	387	816	423	535	1013	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	1236	393			
	2	48	80	41	75	153	73	110	255	115	160	428	167	212	593	228	279	788	299	358	1011	383	490	1259	469			
	3	51	81	46	79	157	85	114	260	129	168	433	190	222	603	256	289	801	339	368	1027	431	506	1280	527			

## Common Vent Capacity

Vent Height		Type B Double-Wall Vent Diameter — D (in.)																				
		4			5			6			7			8			9			10		
		Combined Appliance Input Rating in Thousands of Btu per Hour																				
		H (ft)	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
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	1013	808	626	
30	145	132	113	236	202	180	350	286	257	533	446	349	703	570	459	958	790	593	1183	952	723	
50	159	145	128	268	233	208	406	337	296	622	529	410	833	686	535	1139	954	689	1418	1157	838	
100	166	153	NA	297	263	NA	469	398	NA	726	633	464	999	846	606	1378	1185	780	1741	1459	948	

Table 4-16 Masonry Chimney [NFPA 54:Table 13.8]

										Number of Appliances:						Two or More													
										Appliance Type:						Category I													
										Appliance Vent Connection:						Type B Double-Wall Connector													
Vent Connector Capacity																													
Vent Connector Height Rise		Type B Double-Wall Vent Connector Diameter — D (in.)																											
		3			4			5			6			7			8			9			10						
		Appliance Input Rating Limits in Thousands of Btu per Hour																											
H	R	FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT		FAN		NAT	
(ft.)	(ft.)	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	Min	Max	Max	
6	1	24	33	21	39	62	40	52	106	67	65	194	101	87	274	141	104	370	201	124	479	253	145	599	319				
	2	26	43	28	41	79	52	53	133	85	67	230	124	89	324	173	107	436	232	127	562	300	148	694	378				
	3	27	49	34	42	92	61	55	155	97	69	262	143	91	369	203	109	491	270	129	633	349	151	795	439				
8	1	24	39	22	39	72	41	55	117	69	71	213	105	94	304	148	113	414	210	134	539	267	156	682	335				
	2	26	47	29	40	87	53	57	140	86	73	246	127	97	350	179	116	473	240	137	615	311	160	776	394				
	3	27	52	34	42	97	62	59	159	98	75	269	145	99	383	206	119	517	276	139	672	358	163	848	452				
10	1	24	42	22	38	80	42	55	130	71	74	232	108	101	324	153	120	444	216	142	582	277	165	739	348				
	2	26	50	29	40	93	54	57	153	87	76	261	129	103	366	184	123	498	247	145	652	321	168	825	407				
	3	27	55	35	41	105	63	58	170	100	78	284	148	106	397	209	126	540	281	147	705	366	171	893	463				
15	1	24	48	23	38	93	44	54	154	74	72	277	114	100	384	164	125	511	229	153	658	297	184	824	375				
	2	25	55	31	39	105	55	56	174	89	74	299	134	103	419	192	128	558	260	156	718	339	187	900	432				
	3	26	59	35	41	115	64	57	189	102	76	319	153	105	448	215	131	597	292	159	760	382	190	960	486				
20	1	24	52	24	37	102	46	53	172	77	71	313	119	98	437	173	123	584	239	150	752	312	180	943	397				
	2	25	58	31	39	114	56	55	190	91	73	335	138	101	467	199	126	625	270	153	805	354	184	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	1115	432				
	2	25	60	32	38	122	58	54	208	95	72	376	145	99	531	209	122	715	287	149	928	378	179	1171	484				
	3	26	64	36	40	131	66	56	221	107	74	392	163	101	554	233	125	746	317	152	968	418	182	1220	535				
50	1	23	51	25	36	116	51	51	209	89	67	405	143	92	582	213	115	798	294	140	1049	392	168	1334	506				
	2	24	59	32	37	127	61	53	225	102	70	421	161	95	604	235	118	827	326	143	1085	433	172	1379	558				
	3	26	64	36	39	135	69	55	237	115	72	435	180	98	624	260	121	854	357	147	1118	474	176	1421	611				
100	1	23	46	24	35	108	50	49	208	92	65	428	155	88	640	237	109	907	334	134	1222	454	161	1589	596				
	2	24	53	31	37	120	60	51	224	105	67	444	174	92	660	260	113	933	368	138	1253	497	165	1626	651				
	3	25	59	35	38	130	68	53	237	118	69	458	193	94	679	285	116	956	399	141	1282	540	169	1661	705				

## Common Vent Capacity

		Minimum Internal Area of Masonry Chimney Flue (in. <sup>2</sup> )																							
		12			19			28			38			50			63			78			113		
Vent Height		Combined Appliance Input Rating in Thousands of Btu per Hour																							
H (ft.)	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	FAN +FAN	FAN +NAT	NAT +NAT	
6	NA	74	25	NA	119	46	NA	178	71	NA	257	103	NA	351	143	NA	458	188	NA	582	246	1041	853	NA	
8	NA	80	28	NA	130	53	NA	193	82	NA	279	119	NA	384	163	NA	501	218	724	636	278	1144	937	408	
10	NA	84	31	NA	138	56	NA	207	90	NA	299	131	NA	409	177	606	538	236	776	686	302	1226	1010	454	
15	NA	NA	36	NA	152	67	NA	233	106	NA	334	132	523	467	212	682	611	283	874	781	365	1374	1156	546	
20	NA	NA	41	NA	NA	75	NA	250	122	NA	368	172	565	508	243	742	668	325	955	858	419	1513	1286	648	
30	NA	NA	NA	NA	NA	NA	NA	270	137	NA	404	198	615	564	278	816	747	381	10062	969	496	1702	1473	749	
50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	620	328	879	831	461	1165	1089	606	1905	1692	922	
100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	348	NA	NA	499	NA	NA	669	2053	1921	1058	



Table 4-17 Masonry Chimney [NFPA 54:Table 13.9]

										Number of Appliances:						Two or More					
										Appliance Type:						Category I					
										Appliance Vent Connection:						Single-Wall Metal Connector					

Vent Connector Capacity																																	
Vent Connector Height Rise H R (ft.) (ft.)		Single-Wall Metal Vent Connector Diameter — D (in.)																															
		Appliance Input Rating Limits in Thousands of Btu per Hour																															
		3		4		5		6		7		8		9		10																	
		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	1	NA	NA	21	NA	NA	39	NA	NA	66	179	191	100	231	271	140	292	366	200	362	474	252	499	594	316								
	2	NA	NA	28	NA	NA	52	NA	NA	84	186	227	123	239	321	172	301	432	231	373	557	299	509	696	376								
	3	NA	NA	34	NA	NA	61	134	153	97	193	258	142	247	365	202	309	491	269	381	634	348	519	793	437								
8	1	NA	NA	21	NA	NA	40	NA	NA	68	195	208	103	250	298	146	313	407	207	387	530	263	529	672	331								
	2	NA	NA	28	NA	NA	52	137	139	85	202	240	125	258	343	177	323	465	238	397	607	309	540	766	391								
	3	NA	NA	34	NA	NA	62	143	156	98	210	264	145	266	376	205	332	509	274	407	663	356	551	838	450								
10	1	NA	NA	22	NA	NA	41	130	151	70	202	225	106	267	316	151	333	434	213	410	571	273	558	727	343								
	2	NA	NA	29	NA	NA	53	136	150	86	210	255	128	276	358	181	343	489	244	420	640	317	569	813	403								
	3	NA	NA	34	97	102	62	143	166	99	217	277	147	284	389	207	352	530	279	430	694	363	580	880	459								
15	1	NA	NA	23	NA	NA	43	129	151	73	199	271	112	268	376	161	349	502	225	445	646	291	623	808	366								
	2	NA	NA	30	92	103	54	135	170	88	207	295	132	277	411	189	359	548	256	456	706	334	634	884	424								
	3	NA	NA	34	96	112	63	141	185	101	215	315	151	286	439	213	368	586	289	466	755	378	646	945	479								
20	1	NA	NA	23	87	99	45	128	167	76	197	303	117	265	425	169	345	569	235	439	734	306	614	921	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	1042	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	1089	421								
	2	NA	NA	31	91	119	57	132	203	93	201	366	142	269	518	205	348	699	282	442	908	372	613	1145	473								
	3	NA	NA	35	95	127	65	138	216	105	209	381	160	277	540	229	358	729	312	452	946	412	626	1193	524								
50	1	NA	NA	24	85	113	50	124	204	87	188	392	139	252	567	208	328	778	287	417	1022	383	582	1302	492								
	2	NA	NA	31	89	123	60	130	218	100	196	408	158	262	588	230	339	806	320	429	1058	425	596	1346	545								
	3	NA	NA	35	94	131	68	136	231	112	205	422	176	271	607	255	349	831	351	440	1090	466	610	1386	597								
100	1	NA	NA	23	84	104	49	122	200	89	182	410	151	243	617	232	315	875	328	402	1181	444	560	1537	580								
	2	NA	NA	30	88	115	59	127	215	102	190	425	169	253	636	254	326	899	361	415	1210	488	575	1570	634								
	3	NA	NA	34	93	124	67	133	228	115	199	438	188	262	654	279	337	921	392	427	1238	529	589	1604	687								

## Common Vent Capacity

		Minimum Internal Area of Masonry Chimney Flue (in. <sup>2</sup> )																							
		12		19		28		38		50		63		78		113									
Vent Height H (ft.)	Combined Appliance Input Rating in Thousands of Btu per Hour																								
	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	FAN	FAN	NAT	
	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+NAT	+NAT	+FAN	+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	1136	928	405	
10	NA	NA	31	NA	136	56	NA	205	89	NA	295	129	NA	405	175	NA	532	234	771	680	300	1216	1000	450	
15	NA	NA	36	NA	NA	66	NA	230	105	NA	335	150	NA	400	210	677	602	280	866	772	360	1359	1139	540	
20	NA	NA	NA	NA	NA	74	NA	247	120	NA	362	170	NA	503	240	765	661	321	947	849	415	1495	1264	640	
30	NA	NA	NA	NA	NA	NA	NA	NA	135	NA	398	195	NA	558	275	808	739	377	1052	957	490	1682	1447	740	
50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	612	325	NA	821	456	1152	1076	600	1879	1672	910	
100	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	494	NA	NA	663	2006	1885	1046	

Table 4-18 Single-Wall Metal Pipe or Type B Asbestos Cement Vent [NFPA 54:Table 13.10]

Number of Appliances:	Two or More
Appliance Type:	Draft-Hood-Equipped
Appliance Vent Connection:	Direct to Pipe or Vent

**Vent Connector Capacity**

Total Vent Height (ft.)	Connector Rise (ft.)	Vent Connector Diameter – D (in.)					
		3	4	5	6	7	8
		Maximum Appliance Input Rating in Thousands of Btu per Hour					
6 - 8	1	21	40	68	102	146	205
	2	28	53	86	124	178	235
15	3	34	61	98	147	204	275
	1	23	44	77	117	179	240
	2	30	56	92	134	194	265
30 and up	3	35	64	102	155	216	298
	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	Common Vent Diameter – D (in.)						
	4	5	6	7	8	10	12
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	1190

Table 4-19 Exterior Masonry Chimney [NFPA 54:Table 13.11]

Special Use:		Minimum Allowable Input Rating of Space-Heating Appliance in Thousands of Btu per Hour						
Number of Appliances:		Single						
Appliance Type:		NAT						
Appliance Vent Connection:		Type B Double-Wall Connector						
Vent Height (ft.)		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°F to 36°F	Local 99% Winter Design Temperature: 27°F 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°F to 26°F	Local 99% Winter Design Temperature: 17°F 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°F to 16°F	Local 99% Winter Design Temperature: 5°F 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°F to 4°F	Local 99% Winter Design Temperature: -10°F 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	1003
-11°F or Lower	Local 99% Winter Design Temperature: -11°F or Lower Not recommended for any vent configurations							

Table 4-20(a) Exterior Masonry Chimney [NFPA 54:Table 13.12(a)]

Special Use: Combined Appliance Maximum Input Rating in Thousands of Btu per Hour								
Number of Applications:				Two or More				
Appliance Type:				NAT + NAT				
Appliance Vent Connection:				Type B Double-Wall Connector				
Vent Height (ft)	Internal Area of Chimney (Square Inches)							
	12	19	28	38	50	63	78	113
6	25	46	71	103	143	188	246	NA
8	28	53	82	119	163	218	278	408
10	31	56	90	131	177	236	302	454
15	NA	67	106	152	212	283	365	546
20	NA	NA	NA	NA	NA	325	419	648
30	NA	NA	NA	NA	NA	NA	496	749
50	NA	NA	NA	NA	NA	NA	NA	922
100	NA	NA	NA	NA	NA	NA	NA	NA

Table 4-20(b) Exterior Masonry Chimney [NFPA 54:Table 13.12(b)]

Special Use: Combined Appliance Maximum Input Rating in Thousands of Btu per Hour								
Number of Applications:			Two or More					
Appliance Type:			NAT + NAT					
Appliance Vent Connection:			Type B Double-Wall Connector					
Vent Height (ft)	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°F to 36°F	Local 99% Winter Design Temperature: 27°F 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

Table 4-20(b) Continued [NFPA 54:Table 13.12(b)]

17°F 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 configuration					

Table 4-21(a) Exterior Masonry Chimney [NFPA 54:Table 13.13(a)]

Special Use:		Combined Appliance Maximum Input Rating in Thousand of Btu per Hour						
Number of Applications:		Two or More						
Appliance Type:		FAN + NAT						
Vent Height H (ft.)	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	1010
15	NA	152	233	334	467	611	781	1156
20	NA	NA	250	368	508	668	858	1286
30	NA	NA	NA	404	564	747	969	1473
50	NA	NA	NA	NA	NA	831	1089	1692
100	NA	NA	NA	NA	NA	NA	NA	1921

Table 4-21(b) Exterior Masonry Chimney

Special Use:		Minimum Allowable Input Rating of Space-Heating Appliance in Thousands of Btu per Hour						
Number of Applications:		Two or More						
Appliance Type:		NAT + NAT						
Appliance Vent Connection:		Type B Double-Wall Connector						
Vent Height (ft.)	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	1600
27°F to 36°F	Local 99% Winter Design Temperature: 27°F 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	1554
17°F TO 26°F	Local 99% Winter Design Temperature: 17°F 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	1669
5°F TO 16°F	Local 99% Winter Design Temperature: 5°F 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	682
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	1833
-10°F to 4°F	Local 99% Winter Design Temperature -10°F 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	1003
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							

## PART II

This is originally from NFPA 54,  
which contains additional references.

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

**G.1 Examples Using Single Appliance Venting Tables.** See Figure G.1(a) through Figure G.1(n).

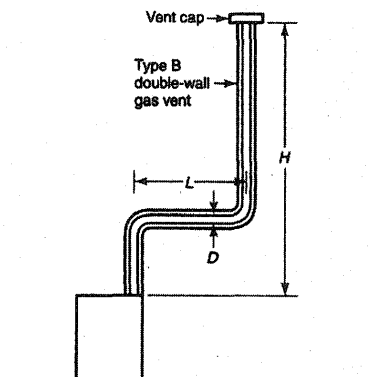


Table 4-9 is used when sizing Type B double-wall gas vent connected directly to the appliance.

Note: The appliance can be either Category I draft-hood-equipped or fan-assisted type.

**FIGURE G.1(a) Type B Double-Wall Vent System Serving a Single Appliance with a Type B Double-Wall Vent**

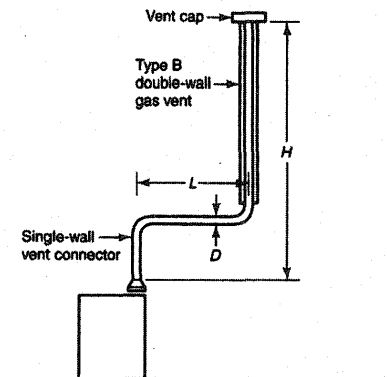


Table 4-10 is used when sizing a single-wall metal vent connector attached to a Type B double-wall gas vent.

Note: The appliance can be either Category I draft-hood-equipped or fan-assisted type.

**FIGURE G.1 (d) Type B Double-Wall Vent System Serving a Single Appliance with a Single-Wall Metal Vent Connector.**

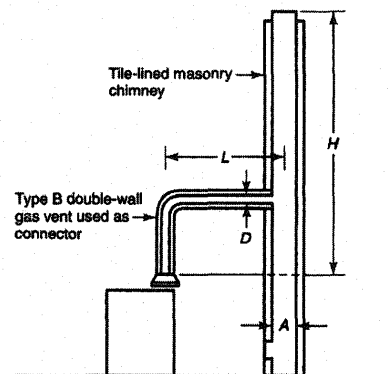


Table 4.11 is used when sizing Type B double-wall gas vent connector attached to a tile-lined masonry chimney.

Note:

1. A is the equivalent cross-section area of the tile liner.
2. The appliance can be either Category I draft-hood-equipped or fan-assisted type.

**FIGURE G.1 (c) Vent System Serving a Single Appliance with a Masonry Chimney and a Type B Double-Wall Vent Connector**

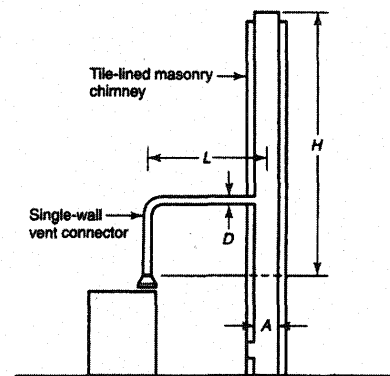
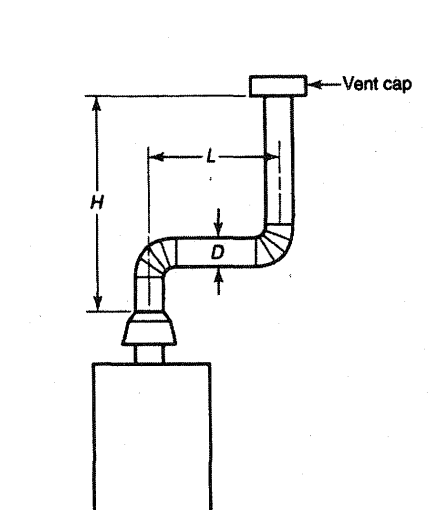


Table 4-12 is used when sizing a single-wall vent connector attached to a tile-lined masonry chimney.

Note:

1. A is the equivalent cross-section area of the tile liner.
2. The appliance can be either Category I draft-hood-equipped or fan-assisted type.

**FIGURE G.1 (d) Vent System Serving a Single Appliance Using a Masonry Chimney and a Single-Wall Metal Vent Connector.**



Asbestos cement Type B or single-wall metal vent serving a single Draft-Hood-Equipped appliance. (See Table 4-13)

**FIGURE G.1(e) Asbestos Cement Type B or Single-Wall Metal Vent System Serving a Single Draft-Hood-Equipped Appliance.**

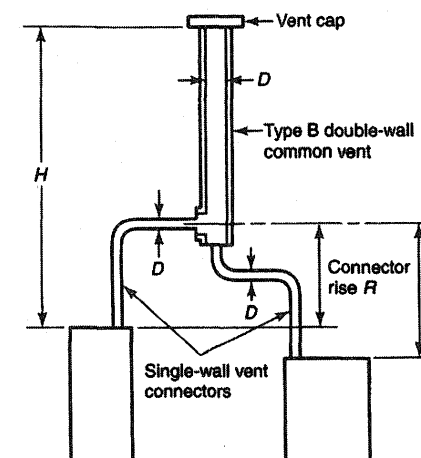


Table 4-15 is used when sizing single-wall vent connectors attached to a Type B double-wall common vent.

Note: Each appliance can be either Category I draft-hood-equipped or fan-assisted type.

**FIGURE G.1(g) Vent System Serving Two or More Appliances With Type B Double-Wall Vent and Single-Wall Metal Vent Connectors.**

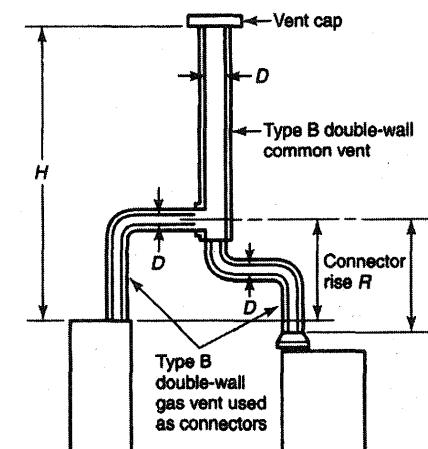


Table 4-14 is used when sizing Type B double-wall gas vent connectors attached to a Type B double-wall common vent.

Note: Each appliance can be either Category I draft-hood-equipped or fan-assisted type.

**FIGURE G.1(f) Vent System Serving Two or More Appliances With Type B Double-Wall Vent and Type B Double-Wall Vent Connectors.**

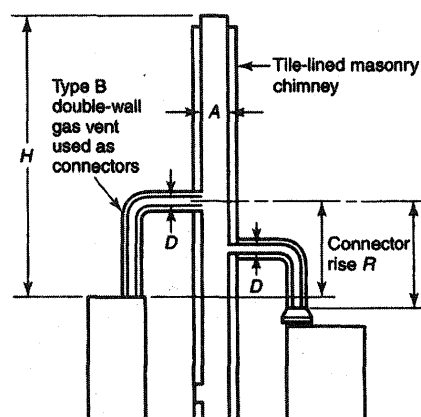


Table 4-16 is used when sizing Type B double-wall vent connectors attached to a tile-lined masonry chimney.

Notes:

1.  $A$  is the equivalent cross-sectional area of the tile liner.
2. Each appliance can be either Category I draft-hood-equipped or fan-assisted type.

**FIGURE G.1(h) Masonry Chimney Serving Two or More Appliances With Type B Double-Wall Vent Connectors**



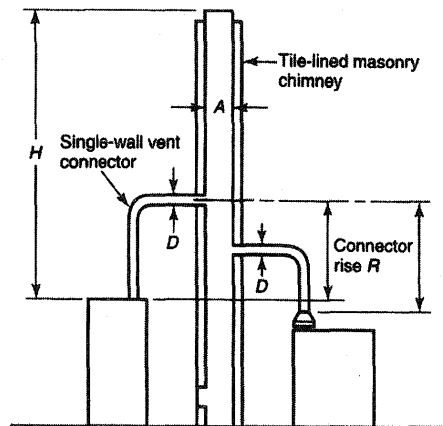
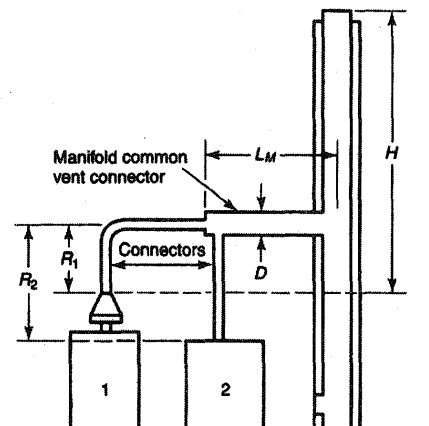


Table 4-17 is used when sizing single-wall metal vent connectors attached to a tile-lined masonry chimney.

Notes:

1. A is the equivalent cross-sectional area of the tile liner.
2. Each appliance can be either Category I draft-hood-equipped or fan-assisted type.

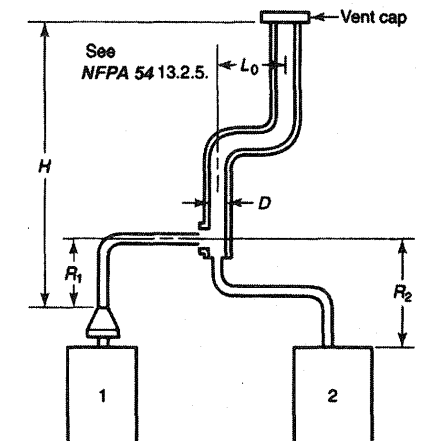
**FIGURE G.1(i) Masonry Chimney Serving Two or More Appliances With Single-Wall Metal Vent Connectors.**



Example: Manifolded common vent connector  $L_M$  can be no greater than 18 times the common vent connector manifold inside diameter; that is, a 4 in. (100 mm) inside diameter common vent connector manifold should not exceed 72 in. (1800 mm) in length.

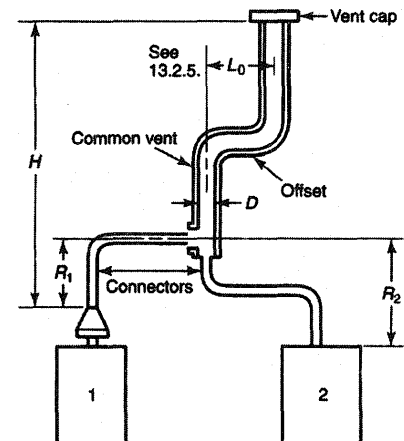
Note: This is an illustration of a typical manifolded vent connector. Different appliance, vent connector, or common vent types are possible.

**FIGURE G.1(k) Used of Manifolded Common Vent Connector.**



Asbestos cement Type B or single-wall metal pipe vent serving two or more draft-hood-equipped appliances. (See Table 4-18)

**FIGURE G.1(j) Asbestos Cement Type B or Single-Wall Metal Vent System Serving Two or More Draft-Hood-Equipped Appliances.**



Example: Offset common vent

Note: This is an illustration of a typical offset vent. Different appliance, vent connector, or vent types are possible.

**FIGURE G.1(l) Use of Offset Common Vent.**

**TABLE A.8.3.2.1**  
**Standard Method Volume, All Appliances**

Appliance Input (Btu/h)	Required Volume (ft. <sup>3</sup> )
5,000	250
10,000	500
15,000	750
20,000	1,000
25,000	1,250
30,000	1,500
35,000	1,750
40,000	2,000
45,000	2,250
50,000	2,500
55,000	2,750
60,000	3,000
65,000	3,250
70,000	3,500
75,000	3,750
80,000	4,000
85,000	4,250
90,000	4,500
95,000	4,750
100,000	5,000
105,000	5,250
110,000	5,500
115,000	5,750
120,000	6,000
125,000	6,250
130,000	6,500
135,000	6,750
140,000	7,000
145,000	7,250
150,000	7,500
160,000	8,000
170,000	8,500
180,000	9,000
190,000	9,500
200,000	10,000
210,000	10,500
220,000	11,000
230,000	11,500
240,000	12,000
250,000	12,500
260,000	13,000
270,000	13,500
280,000	14,000
290,000	14,500
300,000	15,000

409.4.1 See Figure 4-8 • 409.4.1(1) See Figure 4-9 and Figure 4-10 • 409.4.1(2) See Figure 4-11 • 409.4.2 See Figure 4-12 • For information on gas convenience outlets, see AGA 7-90, *Requirements for Gas Convenience Outlets*.

## CHAPTER 5

### FUEL GAS PIPING

#### 501.0 General.

The regulations of this chapter shall govern the installation of all fuel gas piping in or in connection with swimming pools, spas, or hot tubs or within the property lines of any premises up to 5 psi, other than service pipe. Fuel oil piping systems shall be installed in accordance with NFPA 31.

#### 502.0 Definitions.

For the purposes of this code, these definitions shall apply to this chapter. Certain terms, phrases, words, and their derivatives shall be interpreted as set forth in this section, provided, however, that whenever the words "gas meters" appear, they shall be construed to also mean valves and those devices required for the regulation of pressure and the measurement of natural gas being dispensed for any building, structure, or premises. [UPC 1203.0]

**502.1 Appliance Fuel Connector** – An assembly of listed semi-rigid or flexible tubing and fittings to carry fuel between a fuel piping outlet and a fuel-burning-appliance. [UPC 1203.1]

**502.2 Approved** – As to materials, workmanship, and types of construction, means approval by the Authority Having Jurisdiction as the result of investigation, inspection or test conducted by it or by reason of accepted principles or tests by other recognized testing or listing agencies.

**502.3 Fuel Gas** – Natural, manufactured, liquefied petroleum or a mixture of these. [UPC 1203.2]

**502.4 Gas Piping** – Any installation of pipe, valves, or fittings that is used to convey fuel gas, installed on any premises or in any building, but shall not include:

- (1) Any portion of the service piping.
- (2) Any approved piping connection six (6) feet (1,829 mm) or less in length between an existing gas outlet and a gas appliance in the same room with the outlet.

**502.4.1 Gas-Piping System** – Any arrangement of gas piping supplied by one (1) meter and each arrangement of gas piping serving a building, structure, or premises, whether individually metered or not. [UPC 1203.4]

**502.5 Gas Utility** – The duly enfranchised public utility supplying the gas from its street mains.

**502.6 Liquefied Petroleum Gas (LPG) Facilities** – Tanks, containers, container valves, regulating equipment, meters, and/or appurtenances for the storage and supply of liquefied petroleum gas for any building structure or premises. [UPC 1203.5]

**502.6.1 Provision for Location of Point of Delivery** – The location of the point of delivery shall be acceptable to the serving gas supplier. [NFPA 54:5.2]

**502.6.2 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. [UPC 1203.7]

**502.7 Service Piping** – The piping and equipment between the street gas main and the gas piping system inlet, which is installed by and is under the control and maintenance of the serving gas supplier. [UPC 1203.8]

**502.8 Transition Gas Riser** – Any listed or approved section or sections of pipe and fittings used to convey fuel gas and installed in a gas-piping system for the purpose of providing a transition from belowground to aboveground. [UPC 1203.9]

#### 503.0 Plans Required.

The Authority Having Jurisdiction may require the submission of plans, specifications, drawings and such other information as it may deem necessary, prior to the commencement of, and at any time during the progress of any work regulated by this code. [UPC 101.3]

#### 504.0 Workmanship and Defects.

**504.1** No gas piping shall be strained or bent and no appliance shall be supported by or develop any strain or stress on its supply piping.

**504.2** Gas pipe or tubing and fittings shall be clear and free from cutting burrs and defects in structure or threading and shall be thoroughly brushed, and chip and scale blown. Defects in pipe, tubing, and fittings shall not be repaired. Defective pipe, tubing, and fittings shall be replaced. [UPC 1209.5.5]

**504.3 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. [UPC 1209.5.6]

### **505.0 Inspections.**

**505.1** Upon completion of the installation of any gas piping, and prior to the use of thereof, the Authority Having Jurisdiction shall be notified that such gas piping is ready for inspection. [UPC 1204.1]

**505.2** All excavations required for the installation of underground piping shall be kept open until such time as the piping has been inspected and approved. If any such piping is covered or concealed before such approval, it shall be exposed upon the direction of the Authority Having Jurisdiction. [UPC 1204.2]

**505.3** The Authority Having Jurisdiction shall make the following inspections and shall either approve that portion of the work as completed or shall notify the permit holder wherein the same fails to comply with this code. [UPC 1204.3]

**505.3.1 Rough Piping Inspection.** This inspection shall be made after all gas piping authorized by the permit has been installed, and before any such piping has been covered or concealed, or any appliance has been attached thereto. This inspection shall include a determination that the gas piping size, material, and installation meet the requirements of this code. [UPC 1204.3.1]

**505.3.2 Final Piping Inspection.** This inspection shall be made after all piping authorized by the permit has been installed and after all portions thereof that are to be covered or concealed are so concealed and before any fixtures, appliance, or shutoff valve has been attached thereto. This inspection shall be in accordance with Section 514.0. Test gauges used in conducting tests shall comply with Section 319.0, Test Gauges. [UPC 1204.3.2]

**505.3.3** In cases where the work authorized by the permit consists of a minor installation of additional piping to piping already connected to a gas meter, the foregoing inspections may be waived at the discretion of the Authority Having Jurisdiction. In this event, the Authority Having Jurisdiction shall make such inspection as he deems advisable in order to assure himself that the work has been performed in accordance with the intent of this code. [UPC 1204.4]

### **506.0 Certificate of Inspection.**

**506.1** If, upon final piping inspection the installation is found to comply with the provisions of this code, a certificate of inspection may be issued by the Authority Having Jurisdiction. [UPC 1205.1]

**506.2** It shall be unlawful for any serving gas supplier, or person furnishing gas, to turn on or cause to be turned on, any fuel gas or any gas meter or meters, until such certificate of final inspection, as herein provided, has been issued. [UPC 1205.3]

### **507.0 Authority to Render Gas Service.**

**507.1** It shall be unlawful for any person, firm, or corporation, excepting an authorized agent or employee of a person, firm, or corporation engaged in the business of furnishing or supplying gas and whose service pipes supply or connect with the particular premises, to turn on or reconnect gas service in or on any premises where and when gas service is, at the time, not being rendered. [UPC 1206.1]

**507.2** It shall be unlawful to turn on or connect gas in or on any premises unless all outlets are properly and securely connected to gas appliances or capped or plugged with screw joint fittings. [UPC 1206.2]

### **508.0 Authority to Disconnect.**

**508.1** The Authority Having Jurisdiction or the serving gas supplier is hereby authorized to disconnect any gas piping or appliance or both that shall be found not to conform to the requirements of this code or that may be found defective and in such condition as to endanger life or property. [UPC 1207.1]

**508.2** Where such disconnection has been made, a notice shall be attached to such gas piping or appliance or both that shall state the same has been disconnected, together with the reasons therefor. [UPC 1207.2]

**508.3** It shall be unlawful to remove or disconnect any gas piping or gas appliance without capping or plugging with a screw joint fitting the outlet from which said pipe or appliance was removed. All outlets to which gas appliances are not connected shall be left capped gastight on any piping system that has been installed, altered, or repaired. [UPC 1207.3]

**Exception:** When an approved listed quick-disconnect device is used.

### **509.0 Temporary Use of Gas.**

Where temporary use of gas is desired and the Authority Having Jurisdiction deems the use nec-

essary, a permit may be issued for such use for a period of time not to exceed that designated by the Authority Having Jurisdiction, provided that such gas-piping system otherwise conforms to the requirements of this code regarding material, sizing, and safety. [UPC 1208.0]

## **510.0 Gas-Piping System Design, Materials, and Components.**

### **510.1 Piping Plan.**

**510.1.1 Installation of Piping System.** Where required by the Authority Having Jurisdiction, a piping sketch or plan shall be prepared before proceeding with the installation. This plan shall show the proposed location of piping, the size of different branches, the various load demands, and the location of the point of delivery. [UPC 1209.1.1]

**510.1.2 Addition to Existing System.** When additional gas utilization equipment is being connected to a gas-piping system, the existing piping shall be checked to determine whether it has adequate capacity (see section 510.4.3). If inadequate, the existing system shall be enlarged as required, or separate gas piping of adequate capacity shall be provided. [UPC 1209.1.2]

**510.2 Provision for Location of Point of Delivery.** The location of the point of delivery shall be acceptable to the serving gas supplier. [UPC 1209.2]

### **510.3 Interconnections Between Gas-Piping Systems.**

**510.3.1 Interconnections Supplying Separate Users.** Where two or more meters, or two or more service regulators where meters are not provided, are located on the same premises and supply separate users, the gas-piping systems shall not be interconnected on the outlet side of the meters or service regulators. [UPC 1209.3.1]

**510.3.2 Interconnections for Standby Fuels.** Where a supplementary gas for standby use is connected downstream from a meter or a service regulator where a meter is not provided, a device to prevent backflow shall be installed. A three-way valve installed to admit the standby supply and at the same time shut off the regular supply shall be permitted to be used for this purpose. [UPC 1209.3.2]

## **510.4 Sizing of Gas-Piping Systems.**

**510.4.1 General Considerations.** Gas-piping systems shall be of such size and so installed as to provide a supply of gas sufficient to meet the maximum demand without undue loss of pressure between the point of delivery and the gas utilization equipment. [UPC 1209.4.1]

**510.4.2 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 the input rating is not indicated, the gas supplier, equipment manufacturer, or a qualified agency shall be contacted. The total connected hourly load shall be used as the basis for piping sizing, assuming all equipment is operating at full capacity simultaneously. [UPC 1209.4.2]

**Exception:** Sizing shall be permitted to be based upon established load diversity factors.

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

- (1) Pipe sizing tables or sizing equations in this chapter.
- (2) Other approved engineering methods acceptable to the Authority Having Jurisdiction.
- (3) Sizing tables included in a listed piping system manufacturer's installation instructions. [UPC 1209.4.3]

**510.4.4 Allowable Pressure Drop.** The design pressure loss in any piping system under maximum probable flow conditions, from the point of delivery to the inlet connection of the gas utilization equipment, shall be such that the supply pressure at the equipment is greater than the minimum pressure required for proper equipment operation. [UPC 1209.4.4]

**510.4.5 Maximum Design Operating Pressure.** The maximum design operating pressure for piping systems located inside buildings shall not exceed 5 psi (34 kPa) unless one or more of the following conditions are met [NFPA 54:5.5.1]:

- (1) The piping system is welded [NFPA 54:5.5.1(1)].
- (2) The piping is located in a ventilated chase or otherwise enclosed for protection against accidental gas accumulation. [NFPA 54:5.5.1(2)]
- (3) The piping is located inside buildings or

separate areas of buildings used exclusively for one of the following [NFPA 54:5.5.1(3)]:

- (a) Industrial processing or heating
  - (b) Research
  - (c) Warehousing
  - (d) Boiler or mechanical equipment rooms
- (4) The piping is a temporary installation for buildings under construction [NFPA 54:5.5.1(4)].

## **510.5 Acceptable Piping Materials and Joining Methods.**

### **510.5.1 General.**

**510.5.1.1 Materials.** Materials used for piping systems shall comply with the requirements of this chapter or shall be acceptable to the Authority Having Jurisdiction. [NFPA 54:5.6.1.1]

**510.5.1.2 Used Materials.** Pipe, fittings, valves, or other materials shall not be used again unless they are free of foreign materials and have been ascertained to be adequate for the service intended. [NFPA 54:5.6.1.2]

**510.5.1.3 Other Materials.** Material not covered by the standards specifications listed herein shall be investigated and tested to determine that it is safe and suitable for the proposed service and, in addition, shall be recommended for that service by the manufacturer and shall be acceptable to the Authority Having Jurisdiction. [NFPA 54:5.6.1.3]

### **510.5.2 Metallic Pipe.**

**510.5.2.1 Cast Iron.** Cast-iron pipe shall not be used. [NFPA 54:5.6.2.1]

**510.5.2.2 Steel and Wrought Iron.** Steel and wrought-iron pipe shall be at least of standard weight (Schedule 40) and shall comply with one of the following standards [NFPA 54:5.6.2.2]:

- (1) ANSI/ASME B36.10, *Welded and Seamless Wrought-Steel Pipe*
- (2) ASTM A 53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless*
- (3) ASTM A 106, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service* [UPC 1209.5.2.2]

**510.5.2.3 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 scf of gas (0.7 mg/100 L). [NFPA 54:5.6.2.3]

**510.5.2.4 Threaded Copper, Brass and Aluminum.** Threaded copper, brass, or aluminum alloy pipe shall not be used with gases corrosive to such material. [NFPA 54:5.6.2.4]

**510.5.2.5 Aluminum Alloy.** Aluminum alloy pipe shall comply with ASTM B 241, *Specification for Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube* (except that the use of alloy 5456 is prohibited) and shall be marked at each end of each length indicating compliance. Aluminum alloy pipe shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation or is subject to repeated wettings by such liquids as water, detergents, or sewage. [NFPA 54:5.6.2.5]

**510.5.2.6 Aluminum Installation.** Aluminum alloy pipe shall not be used in exterior locations or underground. [NFPA 54:5.6.2.6]

**510.5.3 Metallic Tubing.** Seamless copper, aluminum alloy, or steel tubing shall not be used with gases corrosive to such material. [NFPA 54:5.6.3]

**510.5.3.1 Steel.** Steel tubing shall comply with ASTM A 539, *Standard Specification for Electric Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines*, or ASTM A 254, *Standard Specification for Copper Brazed Steel Tubing*. [NFPA 54:5.6.3.1]

**510.5.3.2 Copper and Brass.** Copper and brass tubing shall not be used if the gas contains more than an average of 0.3 g of hydrogen sulfide per 100 scf of gas (0.7 mg/100 L). Copper tubing shall comply with standard Type K or L of ASTM B 88, *Specification for Seamless Copper Water Tube*, or ASTM B 280, *Specification for Seamless Copper Tube for Air-Conditioning and Refrigeration Field Service*. [NFPA 54:5.6.3.2]

**510.5.3.3 Aluminum.** Aluminum alloy tubing shall comply with ASTM B 210, *Specification for Aluminum-Alloy Drawn Seamless Tubes*, or ASTM B 241, *Specification for Aluminum Alloy Seamless Pipe and*

*Seamless Extruded Tube.* Aluminum alloy tubing shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation or is subject to repeated wettings by liquids such as water, detergent, or sewage. Aluminum alloy tubing shall not be used in exterior locations or underground. [NFPA 54:5.6.3.3]

#### 510.5.3.4 Corrugated Stainless Steel.

Corrugated stainless steel tubing shall be tested and listed in compliance with the construction, installation, and performance requirements of ANSI/IAS LC-1, *Standard for Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing*. [NFPA 54:5.6.3.4]

#### 510.5.4 Plastic Pipe, Tubing, and Fittings.

Plastic pipe, tubing, and fittings shall be used outside underground only and shall conform with ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings*. Pipe to be used shall be marked "gas" and "ASTM D 2513." [NFPA 54:5.6.4]

**510.5.5 Anodeless Risers.** Anodeless risers shall comply with the following: [NFPA 54:5.6.4.1]

**510.5.5.1** 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. [NFPA 54:5.6.4.1 (1)]

**510.5.5.2** 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 design-certified to meet the requirements of Category I of ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings*, and the code of Federal Regulations, Title 49, Part 192.281(e). The manufacturer shall provide the user with qualified installation instructions as prescribed by the code of Federal Regulations, Title 49, Part 192.283(b). [NFPA 54:5.6.4.1 (2)]

**510.5.5.3** The use of plastic pipe, tubing, and fittings in undiluted liquefied petroleum gas-piping systems shall be in accordance with NFPA 58, *Liquefied Petroleum Gas Code*. [NFPA 54:5.6.4.1 (3)]

#### 510.5.6 Metallic Pipe Threads. [NFPA 54:5.6.7]

**510.5.6.1 Specifications for Pipe Threads.** Metallic pipe and fitting threads

shall be taper pipe threads and shall comply with ANSI/ASME B1.20.1, *Standard for Pipe Threads, General Purpose (Inch)*. [NFPA 54:5.6.7.1]

**510.5.6.2 Damaged Threads.** Pipe with threads that are stripped, chipped, corroded, or otherwise damaged shall not be used. Where a weld opens during the operation of cutting or threading, that portion of the pipe shall not be used. [NFPA 54:5.6.7.2]

**510.5.6.3 Number of Threads.** Field threading of metallic pipe shall be in accordance with Table 5-2. [NFPA 54:5.6.7.3]

**510.5.6.4 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. [NFPA 54:5.6.7.4]

**TABLE 5-2**

[NFPA 54: Table 5.6.7.3]

#### Specifications for Threading Metallic Pipe

Iron Pipe Size (in.)	Approximate Length of Threaded Portion (in.)	Approximate No. 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 units, 1 in. = 25.4 mm.

#### 510.5.7 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. [NFPA 54:5.6.8]

**510.5.7.1 Pipe Joints.** Pipe joints shall be threaded, flanged, brazed, or welded. Where nonferrous pipe is brazed, the brazing materials shall have a melting point in excess of 1,000°F (538°C). Brazing alloys shall not contain more than 0.05 percent phosphorus. [NFPA 54:5.6.8.1]

**510.5.7.2 Tubing Joints.** Tubing joints shall either be made with approved gas tubing fittings or be brazed with a material having a melting point in excess of 1,000°F (538°C). Brazing alloys shall not contain more than 0.05 percent phosphorus. [NFPA 54:5.6.8.2]

**510.5.7.3 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. [NFPA 54:5.6.8.3]

**510.5.7.4 Metallic Fittings (Including Valves, Strainers, Filters).** Metallic fittings shall comply with the following [NFPA 54:5.6.8.4]:

- (1) Threaded fittings in sizes larger than four (4) inches (100 mm) shall not be used unless acceptable to the Authority Having Jurisdiction. [NFPA 54:5.6.8.4 (1)]
- (2) Fittings used with steel or wrought-iron pipe shall be steel, brass, bronze, malleable iron, or cast iron. [NFPA 54:5.6.8.4 (2)]
- (3) Fittings used with copper or brass pipe shall be copper, brass, or bronze. [NFPA 54:5.6.8.4 (3)]
- (4) Fittings used with aluminum alloy pipe shall be of aluminum alloy. [NFPA 54:5.6.8.4 (4)]
- (5) Cast-Iron Fittings. [NFPA 54:5.6.8.4 (5)]
  - (a) Flanges shall be permitted. [NFPA 54:5.6.8.4 (5)(a)]
  - (b) Bushings shall not be used. [UPC 1209.5.8.4 (5)(b)]
  - (c) Fittings shall not be used in systems containing flammable

gas-air mixtures. [NFPA 54:5.6.8.4 (5)(c)]

- (d) Fittings in sizes four (4) inches (100 mm) and larger shall not be used indoors unless approved by the Authority Having Jurisdiction. [NFPA 54:5.6.8.4 (5)(d)]
- (e) Fittings in sizes six (6) inches (150 mm) and larger shall not be used unless approved by the Authority Having Jurisdiction. [NFPA 54:5.6.8.4 (5)(e)]
- (6) Aluminum Alloy Fittings. Threads shall not form the joint seal. [NFPA 54:5.6.8.4 (6)]
- (7) Zinc-Aluminum Alloy Fittings. Fittings shall not be used in systems containing flammable gas-air mixtures. [NFPA 54:5.6.8.4 (7)]
- (8) Special Fittings. Fittings such as couplings; proprietary-type joints; saddle tees; gland-type compression fittings; and flared, flareless, or compression-type tubing fittings shall be (1) used within the fitting manufacturers' pressure-temperature recommendations; (2) used within the service conditions anticipated with respect to vibration, fatigue, thermal expansion, or contraction; (3) installed or braced to prevent separation of the joint by gas pressure or external physical damage; and (4) acceptable to the Authority Having Jurisdiction. [NFPA 54:5.6.8.4 (8)]

#### **510.5.8 Plastic Piping, Joints, and Fittings.**

Plastic pipe, tubing, and fittings shall be joined in accordance with the manufacturers' instructions. The following shall be observed when making such joints [NFPA 54:5.6.9]:

- (1) The joint shall be designed and installed so that the longitudinal pullout resistance of the joint will be at least equal to the tensile strength of the plastic piping material. [NFPA 54:5.6.9 (1)]
- (2) Heat-fusion joints shall be made in accordance with qualified procedures that have been established and proven by test to produce gastight joints at least as strong as the pipe or tubing being joined. Joints shall be made with the joining method recommended



by the pipe manufacturer. Heat-fusion fittings shall be marked "ASTM D 2513." [NFPA 54:5.6.9 (2)]

- (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 forced fit in the plastic. Split tubular stiffeners shall not be used. [NFPA 54:5.6.9 (3)]
- (4) Plastic piping joints and fittings for use in liquefied petroleum gas-piping systems shall be in accordance with *Liquefied Petroleum Gas Code*, NFPA 58. [NFPA 54:5.6.9 (4)]

**510.5.9 Flanges.** All flanges shall comply with ANSI/ASME B16.1, *Standard for Cast Iron Pipe Flanges and Flanged Fittings*; ANSI/ASME B16.20, *Standard for Ring-Joint Gaskets and Grooves for Steel Pipe Flanges*; or MSS SP-6, *Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings*. The pressure-temperature ratings shall equal or exceed that required by the application. [NFPA 54:5.6.10]

**510.5.9.1 Flange Facings.** Standard facings shall be permitted for use under this code. Where 150 psi (1,090 kPa) steel flanges are bolted to Class 125 cast-iron flanges, the raised face on the steel flange shall be removed. [NFPA 54:5.6.10.1]

**510.5.9.2 Lapped Flanges.** Lapped flanges shall be used only aboveground or in exposed locations accessible for inspection. [NFPA 54:5.6.10.2]

**510.5.10 Flange Gaskets.** The material for gaskets shall be capable of withstanding the design temperature and pressure of the piping system and the chemical constituents of the gas being conducted without change to its chemical and physical properties. The effects of fire exposure to the joint shall be considered in choosing the material. [NFPA 54:5.6.11]

**510.5.10.1** Acceptable materials include the following [NFPA 54:5.6.11.1]:

- (1) Metal or metal-jacketed asbestos (plain or corrugated) [NFPA 54:5.6.11.1 (1)]
- (2) Asbestos [NFPA 54:5.6.11.1 (2)]
- (3) Aluminum "O" rings and spiral-wound metal gaskets [NFPA 54:5.6.11.1 (3)]

**510.5.10.2** When a flanged joint is opened, the gasket shall be replaced. [NFPA 54:5.6.11.2]

**510.5.10.3** Full-face gaskets shall be used with all bronze and cast-iron flanges. [NFPA 54:5.6.11.3]

## 510.6 Gas Meters.

**510.6.1 Capacity.** Gas meters shall be selected for the maximum expected pressure and permissible pressure drop. [NFPA 54:5.7.1]

## 510.7 Gas Pressure Regulators.

**510.7.1 Where Required.** A line gas pressure regulator or gas equipment pressure regulator, as applicable, shall be installed where the gas supply pressure is higher than that at which the branch supply line or gas utilization equipment is designed to operate or varies beyond design pressure limits. [NFPA 54:5.8.1]

**510.7.2 Listing.** The line gas pressure regulator shall be listed in accordance with ANSI Z21.80, *Line Pressure Regulators*. [NFPA 54:5.8.2]

**510.7.3 Location.** The gas pressure regulator shall be accessible for servicing. [NFPA 54:5.8.3]

**510.7.4 Regulator Protection.** Pressure regulators shall be protected against physical damage. [NFPA 54:5.8.4]

**510.7.5 Venting.** [NFPA 54:5.8.5]

**510.7.5.1 Line Gas Pressure Regulators.** Line gas pressure regulators shall comply with the following [NFPA 54:5.8.5.1]:

- (1) An independent vent to the outside of the building, sized in accordance with the regulator manufacturer's instructions, shall be provided where the location of a regulator is such that a ruptured diaphragm will cause a hazard. Where there is more than one regulator at a location, each regulator shall have a separate vent to the outside, or if approved by the Authority Having Jurisdiction, the vent lines shall be permitted to be manifolded in accordance with accepted engineering practices to minimize back pressure in the event of

diaphragm failure. (See NFPA 54:5.9.7) for information on properly locating the vent.) Materials for vent piping shall be in accordance with Section 510.5. [NFPA 54:5.8.5.1 (1)]

**Exception:** A regulator and vent-limiting means combination listed as complying with ANSI Z21.80, *Standard for Line Pressure Regulators*, shall be permitted to be used without a vent to the outdoors.

- (2) The vent shall be designed to prevent the entry of water, insects, or other foreign materials that could cause blockage. [NFPA 54:5.8.5.1 (2)]
- (3) At locations where regulators might be submerged during floods, a special antiflood-type breather vent fitting shall be installed, or the vent line shall be extended above the height of the expected flood waters. [NFPA 54:5.8.5.1 (3)]
- (4) A regulator shall not be vented to the gas equipment flue or exhaust system. [NFPA 54:5.8.5.1 (4)]

#### **510.7.6 Vents. [NFPA 54:5.9.7]**

**510.7.6.1** The discharge stacks, vents or outlet parts of all pressure-relieving and pressure-limiting devices shall be located so that gas is safely discharged into the outside atmosphere. Discharge stacks or vents shall be designed to prevent the entry of water, insects, or any other foreign material that could cause blockage. [NFPA 54:5.9.7.1]

**510.7.6.2** The discharge stack or vent line shall be at least the same size as the outlet of the pressure-relieving device. [NFPA 54:5.9.7.2]

**510.8 Shutoff Valves.** Shutoff valves shall be approved and shall be selected giving consideration to pressure drop, service involved, emergency use, and reliability of operation. Shutoff valves of size one (1) inch National Pipe Thread and smaller shall be listed. [NFPA 54:5.12]

#### **510.9 Expansion and Flexibility.**

**510.9.1 Design.** Piping systems shall be designed to have sufficient flexibility to prevent thermal expansion or contraction from causing excessive stresses in the piping material, excessive bending or loads at joints, or

undesirable forces or moments at points of connections to equipment and at anchorage or guide points. Formal calculations or model tests shall be required only where reasonable doubt exists as to the adequate flexibility of the system. [NFPA 54:5.13.1]

**510.9.1.1** Flexibility shall be provided by the use of bends, loops, offsets, or couplings of the slip type. Provision shall be made to absorb thermal changes by the use of expansion joints of the bellows type, or by the use of "ball" or "swivel" joints. Expansion joints of the slip type shall not be used inside buildings or for thermal expansion. Where expansion joints are used, anchors or ties of sufficient strength and rigidity shall be installed to provide for end forces due to fluid pressure and other causes. [NFPA 54:5.13.1.1]

**510.9.1.2** Pipe alignment guides shall be used with expansion joints according to the recommended practice of the joint manufacturer. [NFPA 54:5.13.1.2]

**510.9.2 Special Local Conditions.** Where local conditions include earthquake, tornado, unstable ground, or flood hazards, special consideration shall be given to increased strength and flexibility of piping supports and connections. [NFPA 54:5.13.2]

#### **511.0 Gas Piping Installation.**

##### **511.1 Piping Underground.**

**511.1.1 Clearances.** Underground gas piping shall be installed with sufficient clearance from any other underground structure to avoid contact therewith, to allow maintenance, and to protect against damage from proximity to other structures. In addition, underground plastic piping shall be installed with sufficient clearance or shall be insulated from any source of heat so as to prevent the heat from impairing the serviceability of the pipe. [NFPA 54:6.1.2]

##### **511.1.2 Protection Against Damage.**

**511.1.2.1 Cover Requirements.** Underground piping systems shall be installed with a minimum of eighteen (18) inches (460 mm) of cover. Where external damage to the pipe is not likely to result, the minimum cover shall be twelve (12) inches (300 mm). Where a minimum of twelve (12) inches (300 mm) of cover cannot be provided,

ed, the pipe shall be installed in conduit or bridged (shielded). [NFPA 54:6.1.2.1]

**511.1.2.2 Trenches.** The trench shall be graded so that the pipe has a firm, substantially continuous bearing on the bottom of the trench. [NFPA 54:6.1.2.2]

**511.1.2.3 Backfilling.** Where flooding of the trench is done to consolidate the backfill, care shall be exercised to see that the pipe is not floated from its firm bearing on the trench bottom. [NFPA 54:6.1.2.3]

**511.1.3 Protection Against Corrosion.** Gas piping in contact with earth or other material that could corrode the piping shall be protected against corrosion in an approved manner. When dissimilar metals are joined underground, an insulating coupling or fitting shall be used. Piping shall not be laid in contact with cinders. Uncoated threaded or socket-welded joints shall not be used in piping in contact with soil or where internal or external crevice corrosion is known to occur. [NFPA 54:6.1.3]

**511.1.4 Protection Against Freezing.** Where the formation of hydrates or ice is known to occur, piping shall be protected against freezing. [NFPA 54:6.1.4]

**511.1.5 Piping Through Foundation Wall.** Underground piping, where installed through the outer foundation or basement wall of a building, shall be encased in a protective pipe. The space between the gas piping and the building shall be sealed to prevent entry of gas or water. [NFPA 54:6.1.5]

**511.1.6 Piping Underground Beneath Buildings.** Where the installation of gas piping underground beneath buildings is unavoidable, the piping shall be encased in an approved conduit designed to withstand the superimposed loads. The conduit shall extend into a normally usable and accessible portion of the building and, at the point where the conduit terminates in the building, the space between the conduit and the gas piping shall be sealed to prevent the possible entrance of any gas leakage. Where the end sealing is of a type that will retain the full pressure of the pipe, the conduit shall be designed for the same pressure as the pipe. The conduit shall extend at least four (4) inches (100 mm) outside the building, be vented above grade to the outside, and be installed so as to prevent the entrance of water and insects. [NFPA 54: 6.1.6]

### 511.1.7 Plastic Pipe.

#### 511.1.7.1 Connection of Plastic Piping.

Plastic pipe shall be installed outside, underground only. [NFPA 54:6.1.7.1]

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

**Exception No. 2:** Plastic pipe shall be permitted to terminate with a wall head adapter aboveground in buildings, including basements, where the plastic pipe is inserted in a piping material permitted for use in buildings.

**511.1.7.2 Connections Between Metallic and Plastic Piping.** Connections made outside and underground between metallic and plastic piping shall be made only with ASTM D 2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings*, Category I transition fittings. [NFPA 54:6.1.7.2]

**511.1.7.3 Tracer Wire.** An electrically continuous corrosion-resistant tracer wire (minimum AWG 14) or tape shall be buried with the plastic pipe to facilitate locating. One end shall be brought aboveground at a building wall or riser. [NFPA 54:6.1.7.3]

### 511.2 Installation of Piping.

**511.2.1** Piping installed aboveground shall be securely supported and located where it will be protected from physical damage (also see 511.1.4). Where passing through an outside wall, the piping shall also be protected against corrosion by coating or wrapping with an inert material approved for such applications. Where piping is encased in a protective pipe sleeve, the annular space between the gas piping and the sleeve shall be sealed at the wall to prevent the entry of water, insects, or rodents. [NFPA 54:6.2.1]

#### 511.2.2 Building Structure.

- (1) The installation of gas piping shall not cause structural stresses within building components to exceed allowable design limits. [NFPA 54:6.2.2.1]
- (2) Approval shall be obtained before any beams or joists are cut or notched. Permission shall be obtained from the Authority Having Jurisdiction. [NFPA 54:6.2.2.2]

**511.2.3 Other Than Dry Gas.** Drips, sloping, protection from freezing, and branch pipe con-

nections, as provided for in 511.1.4, 511.6.1, and Section 511.8, shall be provided when other than dry gas is distributed and climatic conditions make such provisions necessary. [NFPA 54:6.2.3]

**511.2.4 Gas Piping To Be Sloped.** Piping for other than dry gas conditions shall be sloped not less than one-quarter (1/4) inch in fifteen (15) feet (7 mm in 4.6 m) to prevent traps. [NFPA 54:6.2.4]

**511.2.4.1 Ceiling Locations.** Gas piping shall be permitted to be installed in accessible spaces between a fixed ceiling and a dropped ceiling, whether or not such spaces are used as a plenum. Valves shall not be located in such spaces. [UPC 1211.2.4.1]

**Exception:** Equipment shutoff valves required by this code shall be permitted to be installed in accessible spaces containing vented gas utilization equipment.

**511.2.5 Prohibited Locations.** Gas piping inside any building shall not be installed in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumb-waiter, or elevator shaft. This provision shall not apply to ducts used to provide combustion and ventilation air in accordance with Section 507.0 of the Uniform Plumbing Code or to above-ceiling spaces as covered in 511.2.4.1. [UPC 1211.2.5]

**511.2.6 Hangers, Supports, and Anchors.**

**511.2.6.1** Piping shall be supported with pipe hooks, metal pipe straps, bands, brackets, or hangers suitable for the size of piping; be 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 ANSI/MSS SP-58, *Pipe Hangers and Supports - Materials, Design and Manufacture*. [NFPA 54:6.2.6.1]

**511.2.6.2** Spacings of supports in gas-piping installations shall not be greater than shown in Table 5-3. Spacing of supports for CSST shall be in accordance with the CSST manufacturer's instruction. [NFPA 54:6.2.6.2]

**511.2.6.3** Supports, hangers, and anchors

shall be installed so as not to interfere with the free expansion and contraction of the piping between anchors. All parts of the supporting equipment shall be designed and installed so they will not be disengaged by movement of the supported piping. [NFPA 54:6.2.6.3]

**Table 5-3 Support of Piping**

[NFPA Table 6.2.6.2]

Steel Pipe Nominal Size of Pipe	Spacing of Supports (ft.)	Normal Size of Tubing Smooth-wall (In. O.D.)	Spacing of Supports (ft.)
1/2	6	1/2	4
3/4 or 1	8	5/8 or 3/4	6
1-1/4 or larger (horizontal)	10	7/8 or 1 (horizontal)	8
1-1/4 or larger (vertical)	every floor level	1 or larger (vertical)	every floor level

For SI units: 1 ft. = 0.305 m.

**511.2.7 Removal of Pipe.** Where piping containing gas is to be removed, the line shall be first disconnected from all sources of gas and then thoroughly purged with air, water, or inert gas before any cutting or welding is done. (See Section 514.6.) [NFPA 54:6.2.7]

**511.3 Concealed Piping in Buildings.**

**511.3.1 General.** Gas piping in concealed locations shall be installed in accordance with this section. [NFPA 54:6.3.1]

**511.3.2 Connections.** Where gas piping is to be concealed, unions, tubing fittings, right and left couplings, bushings, swing joints, and compression couplings made by combinations of fittings shall not be used. Connections shall be of the following type [NFPA 54:6.3.2]:

- (1) Pipe fittings such as elbows, tees, and couplings [NFPA 54:6.3.2 (1)]
- (2) Joining tubing by brazing (See 510.5.6.2.) [NFPA 54:6.3.2 (2)]
- (3) Fittings listed for use in concealed spaces that have been demonstrated to sustain, without leakage, any forces due to temperature expansion or contraction, vibration, or fatigue based on their geographic location, application, or operation. [NFPA 54:6.3.2 (3)]
- (4) Where necessary to insert fittings in gas pipe that has been installed in a concealed location, the pipe shall be reconnected by welding, flanges, or the use of a ground joint union

with the nut center-punched to prevent loosening by vibration. [NFPA 54:6.3.2 (4)]

**511.3.3 Piping in Partitions.** Concealed gas piping shall not be located in solid partitions. [NFPA 54:6.3.3]

**511.3.4 Tubing in Partitions.** This provision shall not apply to tubing that pierces walls, floors, or partitions or to tubing installed vertically and horizontally inside hollow walls or partitions without protection along its entire concealed length where both of the following requirements are met [NFPA 54:6.3.4]:

- (1) A steel striker barrier not less than 0.0508 inch (1.3 mm) thick, or equivalent, is installed between the tubing and the finished wall and extends at least four (4) inches (100 mm) beyond concealed penetrations of plates, fire stops, wall studs, and so on. [NFPA 54:6.3.4 (1)]
- (2) The tubing is installed in single runs and is not rigidly secured. [NFPA 54:6.3.4 (2)]

**511.3.5 Piping in Floors.** In other than industrial occupancies and where approved by the Authority Having Jurisdiction, gas piping embedded in concrete floor slabs constructed with portland cement shall be surrounded with a minimum of one and one-half (1-1/2) inches (38 mm) of concrete and shall not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. All piping, fittings, and risers shall be protected against corrosion in accordance with 504.3. Piping shall not be embedded in concrete slabs containing quickset additives or cinder aggregate. [NFPA 54:6.3.5.2]

**511.4 Piping in Vertical Chases.** Where gas piping exceeding five (5) psi (34 kPa) is located within vertical chases in accordance with 510.4.5, the requirements of 511.4.1 through 511.4.3 shall apply. [NFPA 54:6.4]

**511.4.1 Pressure Reduction.** Where pressure reduction is required in branch connections for compliance with Section 510.4.5, such reduction shall take place either inside the chase or immediately adjacent to the outside wall of the chase. Regulator venting and downstream overpressure protection shall comply with 510.7.4. The regulator shall be accessible for service and repair and vented in accordance with one of the following [NFPA 54:6.4.1]:

- (1) Where the fuel gas is lighter than air, regulators equipped with a vent-limiting

means shall be permitted to be vented into the chase. Regulators not equipped with a vent-limiting means shall be permitted to be vented either directly to the outdoors or to a point within the top one (1) foot (0.3m) of the chase. [NFPA 54:6.4.1 (1)]

- (2) Where the fuel gas is heavier than air, the regulator vent shall be vented only directly to the outdoors. [NFPA 54:6.4.1 (2)]

**511.4.2 Chase Construction.** Chase construction shall comply with local building codes with respect to fire resistance and protection of horizontal and vertical openings. [NFPA 54:6.4.2]

**511.4.3 Ventilation.** A chase shall be ventilated to the outdoors and only at the top. The openings shall have a minimum free area (in square inches) equal to the product of one-half of the maximum pressure in the piping (in psi) times the largest nominal diameter of that piping (in inches), or the cross-sectional area of the chase, whichever is smaller. Where more than one fuel gas piping system is present, the free area for each system shall be calculated and the largest area used. [NFPA 54:6.4.3]

**511.5 Gas Pipe Turns.** Changes in direction of gas pipe shall be made by the use of fittings, factory bends, or field bends. [NFPA 54:6.5]

**511.5.1 Metallic Pipe.** Metallic pipe bends shall comply with the following [NFPA 54:6.5.1]:

- (1) Bends shall be made only with bending equipment and procedures intended for that purpose. [NFPA 54:6.5.1 (1)]
- (2) All bends shall be smooth and free from buckling, cracks, or other evidence of mechanical damage. [NFPA 54:6.5.1 (2)]
- (3) The longitudinal weld of the pipe shall be near the neutral axis of the bend. [NFPA 54:6.5.1 (3)]
- (4) Pipe shall not be bent through an arc of more than ninety (90) degrees. [NFPA 54:6.5.1 (4)]
- (5) The inside radius of a bend shall be not less than six (6) times the outside diameter of the pipe. [NFPA 54:6.5.1 (5)]

**511.5.2 Plastic Pipe.** Plastic pipe bends shall comply with the following [NFPA 54:6.5.2]:

- (1) The pipe shall not be damaged, and the internal diameter of the pipe shall not be effectively reduced. [NFPA 54:6.5.2 (1)]
- (2) Joints shall not be located in pipe bends. [NFPA 54:6.5.2 (2)]

- (3) The radius of the inner curve of such bends shall not be less than 25 times the inside diameter of the pipe. [NFPA 54:6.5.2 (3)]
- (4) Where the piping manufacturer specifies the use of special bending equipment or procedures, such equipment or procedures shall be used. [NFPA 54:6.5.2 (4)]

#### **511.5.3 Mitered Bends.**

Mitered bends shall be permitted subject to the following limitations [NFPA 54:6.5.3]:

- (1) Miters shall not be used in systems having a design pressure greater than 50 psi (340 kPa). Deflections caused by mis-alignments up to three (3) degrees shall not be considered as miters. [NFPA 54:6.5.3 (1)]
- (2) The total deflection angle at each miter shall not exceed ninety (90) degrees. [NFPA 54:6.5.3 (2)]

**511.5.4 Elbows.** Factory-made welding elbows or transverse segments cut therefrom shall have an arc length measured along the crotch of at least one (1) inch (25 mm) for pipe sizes two (2) inches and larger. [NFPA 54:6.5.4]

#### **511.6 Drips and Sediment Traps.**

**511.6.1 Provide Drips Where Necessary.** For other than dry gas conditions, a drip shall be provided at any point in the line of pipe where condensate could collect. Where required by the Authority Having Jurisdiction or the serving gas supplier, a drip shall also be provided at the outlet of the meter. This drip shall be so installed as to constitute a trap wherein an accumulation of condensate will shut off the flow of gas before it will run back into the meter. [NFPA 54:6.6.1]

**511.6.2 Location of Drips.** All drips shall be installed only in such locations that they will be readily accessible to permit cleaning or emptying. A drip shall not be located where the condensate is likely to freeze. [NFPA 54:6.6.2]

#### **511.6.3 Sediment Traps. (See Section 512.5.)**

#### **511.7 Outlets.**

##### **511.7.1 Location and Installation.**

**511.7.1.1** The outlet fittings or piping shall be securely fastened in place. [NFPA 54:6.7.1.1]

**511.7.1.2** Outlets shall not be located behind doors. [NFPA 54:6.7.1.2]

**511.7.1.3** Outlets shall be located far enough from floors, walls, patios, slabs,

and ceilings to permit the use of wrenches without straining, bending, or damaging the piping. [NFPA 54:6.7.1.3]

**511.7.1.4** The unthreaded portion of gas piping outlets shall extend not less than one (1) inch (25 mm) through finished ceilings or indoor or outdoor walls. [NFPA 54:6.7.1.4]

**511.7.1.5** The unthreaded portion of gas-piping outlets shall extend not less than two (2) inches (50 mm) above the surface of floors or outdoor patios or slabs. [NFPA 54:6.7.1.5]

**511.7.1.6** The provisions of Sections 511.7.1.4 and 511.7.1.5 shall not apply to listed quick-disconnect devices of the flush-mounted type or listed gas convenience outlets. Such devices shall be installed in accordance with the manufacturers' installation instructions. [NFPA 54:6.7.1.6]

##### **511.7.2 Cap All Outlets.**

**511.7.2.1** Each outlet, including a valve, shall be closed gastight with a threaded plug or cap immediately after installation and shall be left closed until the gas utilization equipment is connected thereto. When equipment is disconnected from an outlet and the outlet is not to be used again immediately, it shall be closed gastight. [NFPA 54:6.7.2.1]

**Exception:** The use of a listed quick-disconnect device with integral shutoff or listed gas convenience outlet shall be permitted.

**511.8 Branch Pipe Connection.** When a branch outlet is placed on a main supply line before it is known what size pipe will be connected to it, the outlet shall be of the same size as the line that supplies it. [NFPA 54:6.8]

**511.9 Manual Gas Shutoff Valves.** (Also see Section 512.2.)

**511.9.1 Valves at Regulators.** An accessible gas shutoff valve shall be provided upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve shall not be required at the second regulator. [NFPA 54:6.9.1]

**511.10 Prohibited Devices.** No device shall be placed inside the gas piping or fittings that will reduce the cross-sectional area or otherwise obstruct the free flow of gas, except where proper

allowance in the piping system design has been made for such a device and where approved by the Authority Having Jurisdiction. [NFPA 54:6.10]

### 511.11 Electrical Bonding and Grounding

**511.11.1** Each aboveground portion of a gas piping system that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping shall be considered to be bonded when it is connected to gas utilization equipment that is connected to the equipment grounding conductor of the circuit supplying that equipment. [NFPA 54:6.13.1]

**511.11.2** Gas piping shall not be used as a grounding conductor or electrode. [NFPA 54:6.13.2]

**511.12 Electrical Circuits.** Electrical circuits shall not utilize gas piping or components as conductors. [NFPA 54:6.14]

**Exception:** Low-voltage (50 V or less) control circuits, ignition circuits, and electronic flame detection device circuits shall be permitted to make use of piping or components as a part of an electric circuit.

### 511.13 Electrical Connections.

**511.13.1** All electrical connections between wiring and electrically operated control devices in a piping system shall conform to the requirements of NFPA 70, *National Electrical Code*. (See Section 511.11.) [NFPA 54:6.15.1]

**511.13.2** Any essential safety control depending on electric current as the operating medium shall be of a type that will shut off (fail safe) the flow of gas in the event of current failure. [NFPA 54:6.15.2]

### 511.14 Pipe Sizing Methods.

**511.14.1** Where the pipe size is to be determined using any of the methods in Sections 511.14.1.1 through 511.14.1.3, the diameter of each pipe segment shall be obtained from the pipe-sizing tables in Section 511.14.2 or from the sizing equations in Section 511.14.3. [NFPA 54:12.1]

**511.14.1.1 Longest Length Method.** The pipe size of each section of gas piping shall be determined using the longest length of piping from the point of delivery to the most remote outlet and the load of the section. [NFPA 54:12.1.1]

**511.14.1.2 Branch Length Method.** Pipe shall be sized as follows [NFPA 54:12.1.2]:

- (1) Pipe size of each section of the longest pipe run from the point of delivery to the most remote outlet shall be determined using the longest run of piping and the load of the section. [NFPA 54:12.1.2 (1)]
- (2) The pipe size of each section of branch piping not previously sized shall be determined using the length of piping from the point of delivery to the most remote outlet in each branch and the load of the section. [NFPA 54:12.1.2 (2)]

**511.14.1.3 Hybrid Pressure.** The pipe size for each section of higher pressure gas piping shall be determined using the longest length of piping from the point of delivery to the most remote line pressure regulator. The pipe size from the line pressure regulator to each outlet shall be determined using the length of piping from the regulator to the most remote outlet served by the regulator. [NFPA 54:12.1.3]

**511.14.2 Tables for Sizing Gas-Piping Systems.** Tables 5-7 through 5-23 shall be used to size gas piping in conjunction with one of the methods described in Sections 511.14.1.1 through 511.14.1.3. [NFPA 54:12.2]

**Equation 5-1 Low-Pressure Gas Formula (Less than 1.5 psi [10.3 kPa]):**

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

where:

D = inside diameter of pipe, inches

Q = input rate appliance(s), cubic feet per hour at 60°F (16°C) and 30 inch (759 mm) mercury column

P<sub>1</sub> = upstream pressure, psia (P<sub>1</sub> + 14.7)

P<sub>2</sub> = downstream pressure, psia (P<sub>2</sub> + 14.7)

L = equivalent length of pipe, feet

ΔH = pressure drop, inches water column (27.7 in. H<sub>2</sub>O = 1 psi)

**Equation 5-2 High-Pressure Gas Formula (1.5 psi [10.3 kPa] and above):**

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

where:

D = inside diameter of pipe, inches

Q = input rate appliance(s), cubic feet per hour at 60°F (16°C) and 30 inch (759 mm) mercury column

P<sub>1</sub> = upstream pressure, psia (P<sub>1</sub> + 14.7)

P<sub>2</sub> = downstream pressure, psia (P<sub>2</sub> + 14.7)

L = equivalent length of pipe, ft.

ΔH = pressure drop, in. water column  
(27.7 in. H<sub>2</sub>O = 1 psi)

**511.14.3 Sizing Equations.** The inside diameter of smooth wall pipe or tubing shall be determined by the sizing equations 5-1 and 5-2, using the equivalent pipe length determined by methods 511.14.1.1 through 511.14.1.3. [NFPA 54:12.3]

## 512.0 Equipment Connections to Building Piping.

**512.1 Connecting Gas Equipment.** Gas utilization equipment shall be connected to the building piping in compliance with 512.2 and 512.3 by one of the following [UPC 1212.1]:

- (1) Rigid metallic pipe and fittings. [UPC 1212.1 (1)]
- (2) Semirigid metallic tubing and metallic fittings. Aluminum alloy tubing shall not be used in exterior locations. [UPC 1212.1 (2)]
- (3) Listed flexible gas connectors in compliance with ANSI Z21.24, *Standard for Connectors for Gas Appliances*. The connectors shall be used in accordance with the terms of their listing that are completely in the same room as the equipment. [UPC 1212.1 (3)]
- (4) CSST where installed in accordance with the manufacturer's instructions. [UPC 1212.1 (4)]
- (5) In 512.1(2) and (3), the connector or tubing shall be installed so as to be protected against physical and thermal damage. Aluminum alloy tubing and connectors shall be coated to protect against external corrosion where they are in contact with masonry,

plaster, or insulation or are subject to repeated wettings by such liquids as water (except rain water), detergents, or sewage. [UPC 1212.1 (7)]

**512.2 Equipment Shutoff Valves and Connections.** Gas utilization equipment connected to a piping system shall have an accessible, approved manual shutoff valve with a nondisplaceable valve member, or a listed gas convenience outlet, installed within six (6) feet (1.8 m) of the equipment it serves. Where a connector is used, the valve shall be installed upstream of the connector. A union or flanged connection shall be provided downstream from this valve to permit removal of controls. [UPC 1212.4]

**512.3 Quick-Disconnect Devices.** Quick-disconnect devices used to connect equipment to the building piping shall be listed. Where they are installed indoors, an approved manual shutoff valve with a nondisplaceable valve member shall be installed upstream of the quick-disconnect device. [UPC 1212.5]

**512.4 Support of Chimneys.** All portions of chimneys shall be supported for the design and weight of the materials employed. Listed factory-built chimneys shall be supported and spaced in accordance with their listings and the manufacturers' instructions. [UPC 1212.6]

**512.5 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 at the time of equipment installation. The sediment trap shall be either a tee fitting with a capped nipple in the bottom outlet as illustrated in Figure 5-1 or other device recognized as an effective sediment trap. [UPC 1212.7]

**512.6 Installation of Piping.** Piping shall be installed in a manner not to interfere with inspection, maintenance, or servicing of the gas utilization equipment. [UPC 1212.8]

## 513.0 Liquefied Petroleum Gas Facilities and Piping.

Liquefied petroleum gas facilities shall comply with NFPA 58, *Liquefied Petroleum Gas Code*. [UPC 1213.0]

## 514.0 Pressure Testing and Inspection.

### 514.1 General.

**514.1.1** Prior to acceptance and initial opera-



tion, 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. [NFPA 54:7.1.1.1]

**514.1.2** 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, and ultrasonic, shall not be required unless specifically listed herein or in the engineering design. [NFPA 54:7.1.1.2]

**514.1.3** Where repairs or additions are made following the pressure test, the affected piping shall be tested. Minor repairs and additions are not required to be pressure-tested, provided that the work is inspected and connections are tested with a noncorrosive leak-detecting fluid or other leak-detecting methods approved by the Authority Having Jurisdiction. [NFPA 54:7.1.1.3]

**514.1.4** Where new branches are installed from the point of delivery to new appliances, only the newly installed branches shall be required to be pressure-tested. Connections between the new piping and the existing piping shall be tested with a noncorrosive leak-detecting fluid or approved leak-detecting methods. [NFPA 54:7.1.1.4]

**514.1.5** A piping system shall be tested as a complete unit or in sections. Under no circumstances shall a valve in a line be used as a bulkhead between gas in one section of the piping system and test medium in an adjacent section, unless two valves are installed in series with a valved "telltale" located between these valves. A valve shall not be subjected to the test pressure unless it can be determined that the valve, including the valve-closing mechanism, is designed to safely withstand the pressure. [NFPA 54:7.1.1.5]

**514.1.6** 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. [NFPA 54:7.1.1.6]

**514.1.7 Test Medium.** The test medium shall be air, nitrogen, carbon dioxide, or an inert gas. OXYGEN SHALL NEVER BE USED. [NFPA 54:7.1.2]

## **514.2 Test Preparation.**

**514.2.1** Pipe joints, including welds, shall be left exposed for examination during the test. [NFPA 54:7.1.3.1]

**Exception:** Covered or concealed pipe end joints that have been previously tested in accordance with this code.

**514.2.2** Expansion joints shall be provided with temporary restraints, if required for the additional thrust load under test. [NFPA 54:7.1.3.2]

**514.2.3** Appliances and equipment that are 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. [NFPA 54:7.1.3.3]

**514.2.4** Where the piping system is connected to appliances, equipment, or equipment components designed for operating pressures of less than the test pressure, such appliances, equipment, or equipment components shall be isolated from the piping system by disconnecting them and capping the outlets. [NFPA 54:7.1.3.4]

**514.2.5** Where the piping system is connected to appliances, equipment, or equipment components designed for operating pressures equal to or greater than the test pressure, such appliances and equipment shall be isolated from the piping system by closing the individual equipment shutoff valves. [NFPA 54:7.1.3.5]

**514.2.6** 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. [NFPA 54:7.1.3.6]

## **514.3 Test Pressure.**

**514.3.1** 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. Mechanical gauges used to measure test pressures shall have a range such that the highest end of the scale is not greater than five times the test pressure. [NFPA 54:7.1.4.1]

**514.3.2** The test pressure to be used shall be no less than one and one-half (1-1/2) times the proposed maximum working pressure, but not less than three (3) psi (20 kPa), irrespective of design pressure. [NFPA 54:7.1.4.2]

**514.3.3** Test duration shall be not less than one-half (1/2) h for each 500 cubic feet (14 m<sup>3</sup>) of pipe volume or fraction thereof. When testing a system having a volume less than ten (10) cubic feet (0.28 m<sup>3</sup>) or a system in a single-family dwelling, the test duration shall be a minimum of ten (10) minutes. The duration of the test shall not be required to exceed 24 hours. [NFPA 54:7.1.4.3]

#### **514.4 Detection of Leaks and Defects.**

**514.4.1** The piping system shall withstand the test pressure specified without showing any evidence of leakage or other defects. Any reduction of test pressures as indicated by pressure gauges shall be deemed to indicate the presence of a leak, unless such reduction can be readily attributed to some other cause. [NFPA 54:7.1.5.1]

**514.4.2** The leakage shall be located by means of an approved gas detector, a noncorrosive leak detection fluid, or other approved leak detection methods. Matches, candles, open flames, or other methods that provide a source of ignition shall not be used. [NFPA 54:7.1.5.2]

**514.4.3** Where leakage or other defects are located, the affected portion of the piping system shall be repaired or replaced and retested. [See Section 514.1.3.] [NFPA 54:7.1.5.3]

#### **514.5 System and Equipment Leakage Test.**

**514.5.1 Test Gases.** Leak checks using fuel gas shall be permitted in piping systems that have been pressure-tested in accordance with Section 514.0. [NFPA 54:7.2.1]

**514.5.2 Before Turning Gas On.** Before gas is introduced into a system of new gas piping, the entire system shall be inspected to determine that there are no open fittings or ends and all valves at unused outlets are closed and plugged or capped. [NFPA 54:7.2.2]

**514.5.3 Test for Leakage.** Immediately after the gas is turned on into a new system or into a system that has been initially restored after an interruption of service, the piping system shall be tested for leakage. Where leakage is indicated, the gas supply shall be shut off until the necessary repairs have been made. [NFPA 54:7.2.3]

#### **514.5.4 Placing Equipment in Operation.**

Gas utilization equipment shall not be placed in

operation until after the piping system has been tested in accordance with 514.5.3 and purged in accordance with 514.6.2. [NFPA 54:7.2.4]

#### **514.6 Purging.**

**514.6.1 Removal From Service.** When gas piping is to be opened for servicing, addition, or modification, the section to be worked on shall be turned off from the gas supply at the nearest convenient point and the line pressure-vented to the outdoors or to ventilated areas of sufficient size to prevent accumulation of flammable mixtures. The remaining gas in this section of pipe shall be displaced with an inert gas as required by Table 5-5. [NFPA 54:7.3.1]

**TABLE 5-5**

[NFPA 54 Table 7.3.1]

**Length of Piping Requiring Purging with Inert Gas for Servicing or Modification**

Nominal Pipe Size (in.)	Length of Piping Requiring Purging (ft.)
2	> 50
3	> 30
4	> 15
6	> 10
8 or larger	Any length

For SI units: 1 ft = 0.305 m.

**514.6.2 Placing in Operation.** When piping full of air is placed in operation, the air in the piping shall be displaced with fuel gas, except where such piping is required by Table 5-6 to be purged with an inert gas prior to introduction of fuel gas. The air can be safely displaced with fuel gas, provided that a moderately rapid and continuous flow of fuel-gas is introduced at one end of the line and air is vented out at the other end. The fuel-gas flow shall be continued without interruption until the vented gas is free of air. The point of discharge shall not be left unattended during purging. After purging, the vent shall then be closed. Where required by Table 5-6, the air in the piping shall first be displaced with an inert gas, and the inert gas shall then be displaced with fuel gas. [NFPA 54:7.3.2]

**TABLE 5-6**  
[NFPA 54 Table 7.3.2]

**Length of Piping Requiring Purging with Inert Gas Before Placing in Operation**

Nominal Pipe Size (in.)	Length of Piping Requiring Purging (ft.)
3	>30
4	>15
6	>10
8 or larger	Any length

For SI units: 1 ft = 0.305 m.

**514.6.3 Discharge of Purged Gases.** The open end of piping systems being purged shall not discharge into confined spaces or areas where there are sources of ignition unless precautions are taken to perform this operation in a safe manner by ventilation of the space, control of purging rate, and elimination of all hazardous conditions. [NFPA 54:7.3.3]

**514.6.4 Placing Equipment in Operation.** After the piping has been placed in operation, all equipment shall be purged and then placed in operation, as necessary. [NFPA 54:7.3.4]

**515.0 Required Gas Supply.**

**515.1** The following regulations, as set forth in this section and in Section 516.0, Required Gas Piping Size, shall be the standard for the installation of gas piping. All natural gas regulations and tables are based on the use of gas having a specific gravity of sixty hundredths (0.60), supplied at six (6) to eight (8) inches (152–203 mm) water column pressure at the outlet of the meter. For undiluted liquefied petroleum gas, gas piping may be sized for 2,500 Btu per cubic foot (25.9 Watt-hours/L) at eleven (11) inches (279 mm) water column and specific gravity of one and fifty-two hundredths (1.52). [UPC 1216.1]

**Note:** Where gas of a different specific gravity is to be delivered, the serving gas supplier should be contacted for specific gravity conversion factors to use in sizing piping systems from the pipe sizing tables in this chapter.

**515.2** The hourly volume of gas required at each piping outlet shall be taken as not less than the maximum hourly rating as specified by the manu-

facturer of the appliance or appliances to be connected to each such outlet. [UPC 1216.2]

**515.3** To obtain the cubic feet per hour (L/sec.) of gas required, divide input of appliances by the average Btu (Watt-hour) heating value per cubic foot (L) of the gas. The average Btu (Watt-hour) per cubic foot (L) of the gas in the area of the installation may be obtained from the serving gas supplier. [UPC 1216.3]

**515.4** The size of the supply piping outlet for any gas appliance shall not be less than one-half (1/2) inch (15 mm).

The minimum size of any piping outlet for a mobile home shall be three-quarter (3/4) inch (20 mm). [UPC 1216.4]

**516.0 Required Gas Piping Size.**

**516.1** Where the maximum demand does not exceed 250 cubic feet per hour (2 L/sec.) and the maximum length of piping between the meter and the most distant outlet is not over 250 feet (76,200 mm), the size of each section and each outlet of any system of gas piping shall be determined by means of Table 5-7 for steel pipe, or Table 5-15 for copper tubing systems, or Table 5-19 for CSST systems. Other systems within the range of Table 5-7 or 5-15 or Table 5-19 may be sized from that table or by means of the methods set forth in Section 516.3. [UPC 1217.1]

**516.2** To determine the size of each section of pipe in any system within the range of Table 5-7, proceed as follows:

- (1) Measure the length of the pipe from the gas meter location to the most remote outlet on the system.
- (2) In Table 5-7 select the length in feet column and row showing that distance, or the next longer distance if the table does not give the exact length.
- (3) Starting at the most remote outlet, find in the row just selected the gas demand for that outlet. If the exact figure of demand is not shown, choose the next larger figure in the row.
- (4) At the top of this column will be found the correct size of pipe.
- (5) Using this same row, proceed in a similar manner for each section of pipe serving this outlet. For each section of pipe, determine the

total gas demand supplied by that section. Where gas piping sections serve both heating and cooling equipment and the installation prevents both units from operating simultaneously, only the larger of the two demand loads need be used in sizing these sections.

- (6) Size each section of branch piping not previously sized by measuring the distance from the gas meter location to the most remote outlet in that branch and follow the procedures of steps 2, 3, 4, and 5 above. [UPC 1217.2]

**Note:** Size branch piping in the order of its distance from the meter location, beginning with the most distant outlet not previously sized.

**516.3** For conditions other than those covered by Section 516.1, such as longer runs or greater gas demands, the size of each gas-piping system shall be determined by standard engineering methods acceptable to the Authority Having Jurisdiction, and each such system shall be so designed that the total pressure drop between the meter or other point of supply and any outlet when full demand is being supplied to all outlets will at no time exceed five-tenths (0.5) inches (12.7 mm) water column pressure. [UPC 1217.3]

**516.4** Where the gas pressure may be higher than fourteen (14) inches (356 mm) or lower than six (6) inches (152 mm) of water column, or when diversity demand factors are used, the design, pipe, sizing, materials, location, and use of such systems first shall be approved by the Authority Having Jurisdiction. Piping systems designed for pressures higher than the serving gas supplier's standard delivery pressure shall have prior verification from the gas supplier of the availability of the design pressure. Systems using undiluted liquefied petroleum gas may be sized using Table 5-11 for steel pipe and Table 5-23 for CSST for eleven (11) inches (279 mm) water column and in accordance with the provisions of Sections 516.1 and 516.2. For copper tubing systems using undiluted liquefied petroleum gas, the capacity of the tubing shall be determined by multiplying the values of Table 5-15 by the appropriate factor from Table 5-16. [UPC 1217.4]

Table 5-7 Sizing of IPS Gas Piping [UPC Table 12-7]

						Gas		Natural		
						Pressure Drop		0.5 in. w.c.		
						Specific Gravity		0.60		
Pipe Size, inches										
	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	3-1/2	4
Length feet	Maximum Capacity in Cubic Feet of Gas per Hour									
10	174	363	684	1,404	2,103	4,050	6,455	11,412	16,709	23,277
20	119	249	470	965	1,445	2,784	4,437	7,843	11,484	15,998
30	96	200	377	775	1,161	2,235	3,563	6,299	9,222	12,847
40	82	171	323	663	993	1,913	3,049	5,391	7,893	10,995
50	73	152	286	588	880	1,696	2,703	4,778	6,995	9,745
60	66	138	259	532	798	1,536	2,449	4,329	6,338	8,830
70	61	127	239	490	734	1,413	2,253	3,983	5,831	8,123
80	56	118	222	456	683	1,315	2,096	3,705	5,425	7,557
90	53	111	208	428	641	1,234	1,966	3,476	5,090	7,091
100	50	104	197	404	605	1,165	1,857	3,284	4,808	6,698
125	44	93	174	358	536	1,033	1,646	2,910	4,261	5,936
150	40	84	158	324	486	936	1,492	2,637	3,861	5,378
200	34	72	135	278	416	801	1,277	2,257	3,304	4,603
250	30	64	120	246	369	710	1,131	2,000	2,929	4,080
300	28	58	109	223	334	643	1,025	1,812	2,654	3,697
350	25	53	100	205	307	592	943	1,667	2,441	3,401
400	24	49	93	191	286	551	877	1,551	2,271	3,164
450	22	46	87	179	268	517	823	1,455	2,131	2,968
500	21	44	82	169	253	488	778	1,375	2,013	2,804
550	20	42	78	161	241	463	739	1,306	1,912	2,663
600	19	40	75	153	230	442	705	1,246	1,824	2,541

Table 5-7 (Metric) Sizing of IPS Gas Piping [UPC Table 12-7 (Metric)]

						Gas			Natural	
						Pressure Drop			12.7 mm w.c.	
						Specific Gravity			0.60	
Pipe Size, millimeters										
	15	20	25	32	40	50	65	80	90	100
Length meters	Maximum Delivery Capacity in Liters per Second									
	3.0	1.4	2.9	5.4	11.0	16.5	31.9	50.8	89.8	131.4
6.0	0.9	2.0	3.7	7.6	11.4	21.9	34.9	61.7	90.3	125.9
9.0	0.8	1.6	3.0	6.1	9.1	17.6	28.0	49.6	72.5	101.1
12.2	0.6	1.3	2.5	5.2	7.8	15.1	24.0	42.4	62.1	86.5
15.2	0.6	1.2	2.3	4.6	6.9	13.3	21.3	37.6	55.0	76.7
18.2	0.5	1.1	2.0	4.2	6.3	12.1	19.3	34.1	49.9	69.5
21.3	0.5	1.0	1.9	3.9	5.8	11.1	17.7	31.3	45.9	63.9
24.0	0.4	0.9	1.7	3.6	5.4	10.3	16.5	29.1	42.7	59.5
27.4	0.4	0.9	1.6	3.4	5.0	9.7	15.5	27.3	40.0	55.8
30.4	0.4	0.8	1.5	3.2	4.8	9.2	14.6	25.8	37.8	52.7
38.0	0.3	0.7	1.4	2.8	4.2	8.1	13.0	22.9	33.5	46.7
45.6	0.3	0.7	1.2	2.6	3.8	7.4	11.7	20.7	30.4	42.3
60.8	0.3	0.6	1.1	2.2	3.3	6.3	10.0	17.8	26.0	36.2
76.0	0.2	0.6	0.9	1.9	2.9	5.6	8.9	15.7	23.0	32.1
91.2	0.2	0.5	0.9	1.8	2.6	5.1	8.1	14.3	20.9	29.1
106.4	0.2	0.4	0.8	1.6	2.4	4.7	7.4	13.1	19.2	26.8
121.6	0.2	0.4	0.7	1.5	2.2	4.3	6.9	12.2	17.9	24.9
136.8	0.2	0.4	0.7	1.4	2.1	4.1	6.5	11.4	16.8	23.4
152.0	0.2	0.3	0.6	1.3	2.0	3.8	6.1	10.8	15.8	22.1
167.2	0.2	0.3	0.6	1.3	1.9	3.6	5.8	10.3	15.0	21.0
182.4	0.1	0.3	0.6	1.2	1.8	3.5	5.5	9.8	14.3	20.0

Table 5-8 Sizing of Medium Pressure Gas Piping [UPC Table 12-8]

						Gas		Natural			
						Inlet Pressure		2.0 psi			
						Pressure Drop		1.5 psi			
						Specific Gravity		0.6			
Pipe Size, inches											
	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	5	6
Length feet	Capacity in Cubic Feet of Gas per Hour										
50	466	974	1,834	3,766	5,642	10,867	17,320	30,618			
100	320	669	1,261	2,588	3,878	7,469	11,904	21,044			
150	257	537	1,012	2,078	3,114	5,998	9,559	16,899			
200	220	460	866	1,799	2,665	5,133	8,181	14,463			
250	195	408	768	1,577	2,362	4,549	7,251	12,818			
300	177	369	696	1,429	2,140	4,122	6,570	11,614			
350	163	340	640	1,314	1,969	3,792	6,044	10,685			
400	151	316	595	1,223	1,832	3,528	5,623	9,940			
450	142	297	559	1,147	1,719	3,310	5,276	9,327			
500	134	280	528	1,084	1,624	3,127	4,984	8,810			
550	127	266	501	1,029	1,542	2,970	4,733	8,367			
600	121	254	478	982	1,471	2,833	4,515	7,983			
650	116	243	458	940	1,409	2,713	4,324	7,644	15,592		
700	112	234	440	903	1,353	2,606	4,154	7,344	14,979		
750	108	225	424	870	1,304	2,511	4,002	7,075	14,430		
800	104	217	409	840	1,259	2,425	3,865	6,832	13,935		
850	101	210	396	813	1,218	2,347	3,740	6,612	13,486		
900	97	204	384	788	1,181	2,275	3,625	6,410	13,075		
950	95	198	373	766	1,147	2,209	3,522	6,225	12,698		
1000	92	193	363	745	1,116	2,149	3,425	6,055	12,351		
1100	87	183	345	707	1,060	2,041	3,253	5,751	11,730		
1200	83	174	329	675	1,011	1,947	3,103	5,486	11,190		
1300	80	167	315	646	968	1,865	2,972	5,254	10,716		
1400	77	161	302	621	930	1,791	2,855	5,047	10,295		
1500	74	155	291	598	896	1,726	2,751	4,862	9,918	17,943	29,054
1600	71	149	281	578	865	1,667	2,656	4,696	9,578	17,327	28,057
1700	69	145	272	559	837	1,613	2,570	4,544	9,269	16,768	27,151
1800	67	140	264	542	812	1,564	2,492	4,406	8,986	16,258	26,325
1900	65	136	256	526	788	1,519	2,420	4,279	8,727	15,789	25,566
2000	63	132	249	512	767	1,477	2,354	4,162	8,488	15,357	24,866
2100	62	129	243	499	747	1,439	2,293	4,053	8,267	14,957	24,218
2200	60	126	237	486	728	1,403	2,236	3,953	8,062	14,585	23,616
2300	59	123	231	475	711	1,369	2,183	3,859	7,870	14,238	23,055
2400	57	120	226	464	695	1,338	2,133	3,771	7,691	13,914	22,531
2500	56	117	221	454	680	1,309	2,086	3,688	7,523	13,610	22,038
2600	55	115	216	444	665	1,282	2,043	3,611	7,365	13,325	21,576

Table 5-8 (Metric) Sizing of Medium Pressure Gas Piping [UPC Table 12-8 (Metric)]

						Gas		Natural			
						Inlet Pressure		13.8 kPa			
						Pressure Drop		10.3 kPa			
						Specific Gravity		0.60			
Pipe Size, millimeters											
	15	20	25	32	40	50	65	80	100	125	150
Length meters	Capacity in Liters per Second										
15.2	3.7	7.7	14.4	29.6	44.4	85.5	136.3	240.9			
30.4	2.5	5.3	9.9	20.4	30.5	58.8	93.6	165.6			
45.6	2.0	4.2	8.0	16.4	24.5	47.2	75.2	132.9			
60.8	1.7	3.6	6.8	14.0	21.0	40.4	64.4	113.8			
76.0	1.5	3.2	6.0	12.4	18.6	35.8	57.0	100.8			
91.2	1.4	2.9	5.5	11.2	16.8	32.4	51.7	91.4			
106.4	1.3	2.7	5.0	10.3	15.5	29.8	47.6	84.1			
121.6	1.2	2.5	4.7	9.6	14.4	27.8	44.2	78.2			
136.8	1.1	2.3	4.4	9.0	13.5	26.0	41.5	73.4			
152.0	1.1	2.2	4.2	8.5	12.8	24.6	39.2	69.3			
167.2	1.0	2.1	3.9	8.1	12.1	23.4	37.2	65.8			
182.4	1.0	2.0	3.8	7.7	11.6	22.3	35.5	62.8			
197.6	0.9	1.9	3.6	7.4	11.1	21.3	34.0	60.1			
212.8	0.9	1.8	3.5	7.1	10.6	20.5	32.7	57.8	117.8		
228.0	0.8	1.8	3.3	6.8	10.3	19.8	31.5	55.7	113.5		
243.2	0.8	1.7	3.2	6.6	9.9	19.1	30.4	53.7	109.6		
258.4	0.8	1.7	3.1	6.4	9.6	18.5	29.4	52.0	106.1		
273.6	0.8	1.6	3.0	6.2	9.3	17.9	28.5	50.4	102.9		
288.8	0.7	1.6	2.9	6.0	9.0	17.4	27.7	49.0	99.9		
304.0	0.7	1.5	2.9	5.9	8.8	16.9	26.9	47.6	97.2		
334.4	0.7	1.4	2.7	5.6	8.3	16.1	25.6	45.2	92.3		
364.8	0.7	1.4	2.6	5.3	8.0	15.3	24.4	43.2	88.0		
395.2	0.6	1.3	2.5	5.1	7.6	14.7	23.4	41.3	84.3		
425.6	0.6	1.3	2.4	4.9	7.3	14.1	22.5	39.7	81.0		
456.0	0.6	1.2	2.3	4.7	7.0	13.6	21.6	38.3	78.0	141.2	228.6
486.4	0.6	1.2	2.2	4.5	6.8	13.1	20.9	36.9	75.3	136.3	220.7
516.8	0.5	1.1	2.1	4.4	6.6	12.7	20.2	35.7	72.9	131.9	213.6
547.2	0.5	1.1	2.1	4.3	6.4	12.3	19.6	34.7	70.7	127.9	207.1
577.6	0.5	1.1	2.0	4.1	6.2	11.9	19.0	33.7	68.7	124.2	201.1
608.0	0.5	1.0	2.0	4.0	6.0	11.6	18.5	32.7	66.8	120.8	195.6
638.4	0.5	1.0	1.9	3.9	5.9	11.3	18.0	31.9	65.0	117.7	190.5
668.8	0.5	1.0	1.9	3.8	5.7	11.0	17.6	31.1	63.4	114.7	185.8
669.2	0.5	1.0	1.8	3.7	5.6	10.8	17.2	30.4	61.9	112.0	181.4
729.6	0.5	0.9	1.8	3.6	5.5	10.5	16.8	29.7	60.5	109.5	177.2
760.0	0.4	0.9	1.7	3.6	5.3	10.3	16.4	29.0	59.2	107.1	173.4
790.4	0.4	0.9	1.7	3.5	5.2	10.1	16.1	28.4	57.9	104.8	169.7



Table 5-9 Sizing of Medium Pressure Gas Piping [UPC Table 12-9]

						Gas			Natural		
						Inlet Pressure			3.0 psi		
						Pressure Drop			1.5 psi		
						Specific Gravity			0.60		
Pipe Size, inches											
	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	5	6
Length feet	Capacity in Cubic Feet of Gas per Hour										
	50	857	1,793	3,377	6,934	10,389	20,008	31,890	56,376		
100	589	1,232	2,321	4,766	7,140	13,752	21,918	38,747			
150	473	990	1,864	3,827	5,734	11,043	17,601	31,115			
200	405	847	1,595	3,275	4,908	9,451	15,064	26,631			
250	359	751	1,414	2,903	4,349	8,377	13,351	23,602			
300	325	680	1,281	2,630	3,941	7,560	12,097	21,385			
350	299	626	1,179	2,420	3,626	6,983	11,129	19,674			
400	278	582	1,096	2,251	3,373	6,496	10,353	18,303			
450	261	546	1,029	2,112	3,165	6,095	9,714	17,173			
500	247	516	972	1,995	2,989	5,757	9,176	16,222			
550	234	490	923	1,895	2,839	5,468	8,715	15,406			
600	224	467	881	1,808	2,709	5,216	8,314	14,698			
650	214	448	843	1,731	2,594	4,995	7,962	14,075	28,709		
700	206	430	810	1,663	2,492	4,799	7,649	13,522	27,581		
750	198	414	780	1,602	2,401	4,623	7,369	13,027	26,570		
800	191	400	754	1,547	2,318	4,465	7,116	12,580	25,658		
850	185	387	729	1,497	2,243	4,321	6,886	12,174	24,831		
900	180	375	707	1,452	2,175	4,189	6,677	11,803	24,074		
950	174	365	687	1,410	2,112	4,068	6,484	11,463	23,380		
1000	170	355	668	1,371	2,055	3,957	6,307	11,149	22,741		
1100	161	337	634	1,302	1,951	3,758	5,990	10,589	21,598		
1200	154	321	605	1,242	1,862	3,585	5,714	10,102	20,605		
1300	147	308	580	1,190	1,783	3,433	5,472	9,674	19,731		
1400	141	296	557	1,143	1,713	3,298	5,257	9,294	18,956		
1500	136	285	536	1,101	1,650	3,178	5,064	8,953	18,262	33,038	53,496
1600	131	275	518	1,063	1,593	3,069	4,891	8,646	17,635	31,904	51,660
1700	127	266	501	1,029	1,542	2,970	4,733	8,367	17,066	30,875	49,993
1800	123	258	486	998	1,495	2,879	4,589	8,112	16,546	29,935	48,471
1900	120	251	472	969	1,452	2,796	4,457	7,878	16,069	29,072	47,074
2000	117	244	459	942	1,412	2,720	4,335	7,663	15,629	28,276	45,785
2100	114	237	447	918	1,375	2,649	4,222	7,463	15,222	27,539	44,593
2200	111	231	436	895	1,341	2,583	4,117	7,278	14,844	26,855	43,484
2300	108	226	426	874	1,309	2,522	4,019	7,105	14,491	26,217	42,451
2400	106	221	416	854	1,279	2,464	3,927	6,943	14,161	25,620	41,485
2500	103	216	407	835	1,252	2,410	3,842	6,791	13,852	25,060	40,579
2600	101	211	398	818	1,225	2,360	3,761	6,649	13,561	24,534	39,727

Table 5-9 (Metric) Sizing of Medium Pressure Gas Piping [UPC Table 12-9 (Metric)]

						Gas		Natural			
						Inlet Pressure		20.7 kPa			
						Pressure Drop		10.3 kPa			
						Specific Gravity		0.60			
Pipe Size, millimeters											
	15	20	25	32	40	50	65	80	100	125	150
Length meters	Capacity in Liters per Second										
	15.2	6.7	14.1	26.6	54.5	81.7	157.4	250.9	443.5		
30.4	4.6	9.7	18.3	37.5	56.2	108.2	172.4	304.8			
45.6	3.7	7.8	14.7	30.1	45.1	86.9	138.5	244.8			
60.8	3.2	6.7	12.6	25.8	38.6	74.4	118.5	209.5			
76.0	2.8	5.9	11.1	22.8	34.2	65.9	105.0	185.7			
91.2	2.6	5.4	10.1	20.7	31.0	59.7	95.2	168.2			
106.4	2.4	4.9	9.3	19.0	28.5	54.9	87.6	154.8			
121.6	2.2	4.6	8.6	17.7	26.5	51.1	81.5	144.0			
136.8	2.1	4.3	8.1	16.6	24.9	47.9	76.4	135.1			
152.0	1.9	4.1	7.6	15.7	23.5	45.3	72.2	127.6			
167.2	1.8	3.9	7.3	14.9	22.3	43.0	68.6	121.2			
183.4	1.8	3.7	6.9	14.2	21.3	41.0	65.4	115.6			
197.6	1.7	3.5	6.6	13.6	20.4	39.3	62.6	110.7	225.9		
212.8	1.6	3.4	6.4	13.1	19.6	37.8	60.2	106.4	217.0		
228.0	1.6	3.3	6.1	12.6	18.9	36.4	58.0	102.5	209.0		
243.2	1.5	3.1	5.9	12.2	18.2	35.1	56.0	99.0	201.9		
258.4	1.5	3.0	5.7	11.8	17.6	34.0	54.2	95.8	195.3		
273.6	1.4	3.0	5.6	11.4	17.1	33.0	52.5	92.9	189.4		
288.8	1.4	2.9	5.4	11.1	16.6	32.0	51.0	90.2	183.9		
304.0	1.3	2.8	5.3	10.8	16.2	31.1	49.6	87.7	178.9		
334.4	1.3	2.6	5.0	10.2	15.4	29.6	47.1	83.3	169.9		
364.8	1.2	2.5	4.8	9.8	14.6	28.2	45.0	79.5	162.1		
395.2	1.2	2.4	4.6	9.4	14.0	27.0	43.0	76.1	155.2		
425.6	1.1	2.3	4.4	9.0	13.5	25.9	41.4	73.1	149.1		
456.0	1.1	2.2	4.2	8.7	13.0	25.0	39.8	70.4	143.7		
486.4	1.0	2.2	4.1	8.4	12.5	24.1	38.5	68.0	138.7	251.0	406.4
516.8	1.0	2.1	3.9	8.1	12.1	23.4	37.2	65.8	134.3	242.9	393.3
547.2	1.0	2.0	3.8	7.8	11.8	22.6	36.1	63.8	130.2	235.5	381.3
577.6	0.9	2.0	3.7	7.6	11.4	22.0	35.1	62.0	126.4	228.7	370.3
608.0	0.9	1.9	3.6	7.4	11.1	21.4	34.1	60.3	123.0	222.4	360.2
638.4	0.9	1.9	3.5	7.2	10.8	20.8	33.2	58.7	119.8	216.7	350.8
668.8	0.9	1.8	3.4	7.0	10.6	20.3	32.4	57.3	116.8	211.3	342.1
669.2	0.9	1.8	3.3	6.9	10.3	19.8	31.6	55.9	114.0	206.2	334.0
729.6	0.8	1.7	3.3	6.7	10.1	19.4	30.9	54.6	111.4	201.6	326.4
760.0	0.8	1.7	3.2	6.6	9.8	19.0	30.2	53.4	109.0	197.2	319.2
790.4	0.8	1.7	3.1	6.4	9.6	18.6	29.6	52.3	106.7	193.0	312.5

Table 5-10 Sizing of Medium Pressure Gas Piping [UPC Table 12-10]

						Gas		Natural			
						Inlet Pressure		5.0 psi			
						Pressure Drop		1.5 psi			
						Specific Gravity		0.60			
Pipe Size, inches											
	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	5	6
Length feet	Capacity in Cubic Feet of Gas per Hour										
	50	1,399	2,925	5,509	11,311	16,947	32,638	52,020	91,962		
100	961	2,010	3,786	7,774	11,648	22,432	35,753	63,205			
150	772	1,614	3,041	6,243	9,353	18,014	28,711	50,756			
200	661	1,381	2,602	5,343	8,005	15,417	24,573	43,441			
250	586	1,224	2,306	4,735	7,095	13,664	21,779	38,501			
300	531	1,109	2,090	4,291	6,429	12,381	19,733	34,884			
350	488	1,021	1,923	3,947	5,914	11,390	18,154	32,093			
400	454	949	1,789	3,672	5,502	10,596	16,889	29,865			
450	426	891	1,678	3,445	5,162	9,942	15,846	28,013			
500	402	842	1,585	3,255	4,876	9,391	14,968	26,461			
550	382	799	1,506	3,091	4,631	8,919	14,216	25,131			
600	365	762	1,436	2,949	4,418	8,509	13,562	23,976			
650	349	730	1,375	2,824	4,231	8,149	12,988	22,960	46,830		
700	335	701	1,321	2,713	4,065	7,828	12,477	22,057	44,990		
750	323	676	1,273	2,614	3,916	7,542	12,020	21,249	43,342		
800	312	653	1,229	2,524	3,781	7,283	11,608	20,520	41,855		
850	302	632	1,190	2,442	3,659	7,048	11,233	19,858	40,504		
900	293	612	1,153	2,368	3,548	6,833	10,891	19,253	39,271		
950	284	595	1,120	2,300	3,446	6,636	10,577	18,698	38,139		
1000	277	578	1,089	2,237	3,351	6,455	10,288	18,187	37,095		
1100	263	549	1,035	2,124	3,183	6,130	9,771	17,273	35,231		
1200	251	524	987	2,027	3,037	5,848	9,321	16,478	33,611		
1300	240	502	945	1,941	2,908	5,600	8,926	15,780	32,186		
1400	231	482	908	1,865	2,794	5,380	8,575	15,160	30,921		
1500	222	464	875	1,796	2,691	5,183	8,261	14,605	29,789	53,892	87,263
1600	214	449	845	1,735	2,599	5,005	7,978	14,103	28,766	52,043	84,269
1700	208	434	818	1,679	2,515	4,844	7,720	13,648	27,838	50,363	81,550
1800	201	421	798	1,628	2,439	4,696	7,485	13,233	26,991	48,830	79,067
1900	195	409	770	1,581	2,368	4,561	7,270	12,851	26,213	47,422	76,787
2000	190	398	749	1,537	2,303	4,436	7,071	12,500	25,495	46,124	74,686
2100	185	387	729	1,497	2,243	4,321	6,886	12,174	24,831	44,923	72,740
2200	181	378	711	1,460	2,188	4,213	6,715	11,871	24,214	43,806	70,932
2300	176	369	694	1,425	2,136	4,113	6,556	11,589	23,639	42,765	69,247
2400	172	360	678	1,393	2,087	4,020	6,406	11,326	23,100	41,792	67,671
2500	168	352	664	1,363	2,042	3,932	6,267	11,078	22,596	40,879	66,193
2600	165	345	650	1,334	1,999	3,849	6,135	10,846	22,121	40,021	64,803

Table 5-10 (Metric) Sizing of Medium Pressure Gas Piping [UPC Table 12-10 (Metric)]

						Gas			Natural		
						Inlet Pressure			34.5 kPa		
						Pressure Drop			10.3 kPa		
						Specific Gravity			0.60		
Pipe Size, millimeters											
	15	20	25	32	40	50	65	80	100	125	150
Length meters	Capacity in Liters per Second										
	15.2	11.0	23.0	46.3	89.0	133.3	256.8	409.2	723.5		
30.4	7.6	15.8	29.8	61.2	91.6	176.5	281.3	497.2			
45.6	6.1	12.7	23.9	49.1	73.6	141.7	225.9	399.3			
60.8	5.2	10.9	20.5	42.0	63.0	121.3	193.3	341.7			
76.0	4.6	9.6	18.1	37.3	55.8	107.5	171.3	302.9			
91.2	4.2	8.7	16.4	33.8	50.6	97.4	155.2	274.4			
106.4	3.8	8.0	15.1	31.1	46.5	89.6	142.8	252.5			
121.6	3.6	7.5	14.1	28.9	43.3	83.4	132.9	234.9			
136.8	3.4	7.0	13.0	27.1	40.6	78.2	124.7	220.4			
152.0	3.2	6.6	12.5	25.6	38.4	73.9	117.8	208.2			
167.2	3.0	6.3	11.8	24.3	36.4	70.2	111.8	197.7			
182.4	2.9	6.0	11.3	23.2	34.8	66.9	106.7	188.6			
197.6	2.7	5.7	10.8	22.2	33.3	64.1	102.2	180.6	368.4		
212.8	2.6	5.5	10.4	21.3	32.0	61.6	98.2	173.5	353.9		
228.0	2.5	5.3	10.0	20.6	30.8	59.3	94.6	167.2	341.0		
243.2	2.5	5.1	9.7	19.9	29.7	57.3	91.3	161.4	329.3		
258.4	2.4	5.0	9.4	19.2	28.8	55.4	88.4	156.2	318.6		
273.6	2.3	4.8	9.1	18.6	27.9	53.8	85.7	151.5	308.9		
288.0	2.2	4.7	8.8	18.1	27.1	52.2	83.2	147.1	300.0		
304.0	2.2	4.6	8.6	17.6	26.4	50.8	80.9	143.1	291.8		
334.4	2.1	4.3	8.1	16.7	25.0	48.2	76.9	135.9	277.2		
364.8	2.0	4.1	7.8	15.9	23.9	46.0	73.3	129.6	264.4		
395.2	1.9	3.9	7.4	15.3	22.9	44.1	70.2	124.1	253.2		
425.6	1.8	3.8	7.1	14.7	22.0	42.3	67.5	119.3	243.3		
456.0	1.7	3.7	6.9	14.1	21.2	40.8	65.0	114.9	234.3	424.0	686.5
486.4	1.7	3.5	6.6	13.6	20.4	39.4	62.8	111.0	226.3	409.4	662.9
516.8	1.6	3.4	6.4	13.2	19.8	38.1	60.7	107.4	219.0	396.2	641.6
547.2	1.6	3.3	6.2	12.8	19.2	36.9	58.9	104.1	212.3	384.1	622.0
577.6	1.5	3.2	6.1	12.4	18.6	35.9	57.2	101.1	206.2	373.1	604.1
608.0	1.5	3.1	5.9	12.1	18.1	34.9	55.6	98.3	200.6	362.9	587.6
638.4	1.5	3.0	5.7	11.8	17.6	34.0	54.2	95.8	195.3	353.4	572.2
668.8	1.4	3.0	5.6	11.5	17.2	33.1	52.8	93.4	190.5	344.6	558.0
699.2	1.4	2.9	5.5	11.2	16.8	32.4	51.6	91.2	186.0	336.4	544.8
729.6	1.4	2.8	5.3	11.0	16.4	31.6	50.4	89.1	181.7	328.8	532.4
760.0	1.3	2.8	5.2	10.7	16.1	30.9	49.3	87.2	177.8	321.6	520.7
790.4	1.3	2.7	5.1	10.5	15.7	30.3	48.3	85.3	174.0	314.8	509.8

Table 5-11 Low-Pressure LPG Pipe Sizing [UPC Table 12-11]

				Gas	Undiluted LPG	
				Inlet Pressure	11 in. w.c.	
				Pressure Drop	0.5 in. w.c.	
Pipe Size, inches						
	1/2	3/4	1	1-1/4	1-1/2	2
Length feet	Maximum Capacity in Thousands of Btu per Hour					
10	275	567	1071	2205	3307	6221
20	189	393	732	1496	2299	4331
30	152	315	590	1212	1858	3465
40	129	267	504	1039	1559	2992
50	114	237	448	913	1417	2646
60	103	217	409	834	1275	2394
70	96	196	378	771	1181	2205
80	89	185	346	724	1086	2047
90	83	173	322	677	1023	1921
100	78	162	307	630	976	1811
125	69	146	275	567	866	1606
150	63	132	252	511	787	1496
200	55	112	213	440	675	1280

Table 5-11 (Metric) Low-Pressure LPG Pipe Sizing [UPC Table 12-11 (Metric)]

				Gas	Undiluted LPG		
				Inlet Pressure	279 mm w.c.		
				Pressure Drop	12.7 mm w.c.		
Pipe Size, millimeters							
	15	20	25	32	40	50	
Length meters	Maximum Capacity in Thousands of Watts						
	3.0	80.6	166.1	313.8	646.1	969.0	1822.8
	6.1	55.4	115.2	214.5	438.3	673.6	1269.0
	9.1	44.5	92.3	172.9	355.1	544.4	1015.2
	12.2	37.8	78.2	147.7	304.4	456.8	876.7
	15.2	33.4	69.4	131.3	267.5	415.2	775.3
	18.2	30.2	63.6	119.8	244.4	373.6	701.4
	21.3	28.1	57.4	110.8	225.9	346.0	646.1
	24.3	26.1	54.2	101.4	212.1	318.2	600.0
	27.4	24.3	50.7	94.4	198.4	299.7	562.9
	30.4	22.9	47.5	90.0	184.6	286.0	530.6
	38.0	20.2	42.8	80.6	166.1	253.7	470.6
	45.6	18.5	38.7	73.8	149.7	230.6	438.3
	60.8	16.1	32.8	62.4	128.9	197.8	369.2

Table 5-12 Sizing of IPS Pipe for Undiluted LPG [UPC Table 12-12]

						Gas		Undiluted LPG			
						Inlet Pressure		10.0 psi			
						Pressure Drop		3.0 psi			
						Specific Gravity		1.52			
Pipe Size, inches											
	1/2	3/4	1	1-1/4	1-1/2	2	2-1/2	3	4	5	6
Length feet	Maximum Delivery Capacity in Cubic Feet per Hour										
50	1,000	2,070	3,899	8,005	11,994	23,100	36,818	65,088			
100	690	1,423	2,680	5,502	8,244	15,877	25,305	44,734			
150	550	1,142	2,152	4,418	6,620	12,750	20,321	35,923			
200	470	978	1,842	3,782	5,666	10,912	17,392	30,746			
250	420	867	1,632	3,351	5,022	9,671	15,414	27,243			
300	390	785	1,479	3,037	4,550	8,763	13,966	24,690			
350	350	722	1,361	2,794	4,186	8,062	12,849	22,714			
400	325	672	1,266	2,599	3,894	7,500	11,953	21,131			
450	300	631	1,188	2,439	3,654	7,037	11,215	19,827			
500	285	596	1,122	2,303	3,451	6,647	10,594	18,728			
550	272	566	1,066	2,188	3,278	6,313	10,062	17,787			
600	260	540	1,017	2,087	3,127	6,023	9,599	16,969			
650	250	517	973	1,999	2,995	5,767	9,192	16,250	33,145		
700	240	496	935	1,920	2,877	5,541	8,311	15,611	31,842		
750	230	478	901	1,850	2,772	5,338	8,507	15,040	30,676		
800	222	462	870	1,786	2,676	5,155	8,215	14,523	29,623		
850	215	447	842	1,729	2,590	4,988	7,950	14,055	28,667		
900	208	433	816	1,676	2,511	4,836	7,708	13,627	27,795		
950	202	421	793	1,628	2,439	4,697	7,486	13,234	26,993		
1,000	198	409	771	1,583	2,372	4,568	7,281	12,872	26,255		
1,100	188	389	732	1,504	2,253	4,339	6,915	12,225	24,935		
1,200	180	371	699	1,434	2,149	4,139	6,597	11,663	23,789		
1,300	171	355	669	1,374	2,058	3,964	6,318	11,169	22,780		
1,400	164	341	643	1,320	1,977	3,808	6,069	10,730	21,885		
1,500	158	329	619	1,271	1,905	3,669	5,847	10,337	21,083	38,143	61,762
1,600	152	317	598	1,228	1,839	3,543	5,646	9,982	20,360	36,834	59,643
1,700	148	307	579	1,138	1,780	3,428	5,464	9,660	19,705	35,645	57,718
1,800	143	298	561	1,152	1,726	3,324	5,298	9,366	19,103	34,560	55,961
1,900	139	289	545	1,119	1,676	3,228	5,145	9,096	18,552	33,564	54,348
2,000	136	281	530	1,088	1,630	3,140	5,004	8,847	18,045	32,645	52,860
2,100	133	274	516	1,060	1,588	3,058	4,874	8,616	17,575	31,795	51,483
2,200	130	267	503	1,033	1,548	2,982	4,753	8,402	17,138	31,005	50,204
2,300	127	261	491	1,009	1,512	2,911	4,640	8,203	16,731	30,268	49,011
2,400	124	255	480	986	1,477	2,845	4,534	8,016	16,350	29,579	47,895
2,500	121	249	470	964	1,445	2,783	4,435	7,841	15,993	28,933	46,849
2,600	118	244	460	944	1,415	2,724	4,342	7,676	15,657	28,325	45,865

Table 5-12 (Metric) Sizing of IPS Pipe for Undiluted LPG [UPC Table 12-12 (Metric)]

						Gas		Undiluted LPG			
						Inlet Pressure		68.9 kPa			
						Pressure Drop		20.7 kPa			
						Specific Gravity		1.52			
Pipe Size, millimeters											
	15	20	25	32	40	50	65	80	100	125	150
Length meters	Maximum Delivery Capacity in Liters per Second										
	15.2	8.0	16.6	31.2	64.0	96.0	184.8	294.5	520.7		
30.4	5.5	11.4	21.4	44.0	66.0	127.0	202.4	357.9			
45.6	4.4	9.1	17.2	35.3	53.0	102.0	162.6	287.4			
60.8	3.8	7.8	14.7	30.3	45.3	87.3	139.1	246.0			
76.0	3.4	6.9	13.1	26.8	40.2	77.4	123.3	218.0			
91.2	3.0	6.3	11.8	24.3	36.4	70.1	111.7	197.5			
106.4	2.8	5.8	10.9	22.4	33.5	64.5	102.8	181.7			
121.6	2.6	5.4	10.1	20.8	31.2	60.0	95.6	169.1			
136.8	2.4	5.1	9.5	19.5	29.2	56.3	89.7	158.6			
152.0	2.3	4.8	9.0	18.4	27.6	53.2	84.8	149.8			
167.2	2.2	4.5	8.5	17.5	26.2	50.5	80.5	142.3			
182.4	2.1	4.3	8.1	16.7	25.0	48.2	76.8	135.8			
197.6	2.0	4.1	7.8	16.0	24.0	46.1	73.5	130.0	265.2		
212.8	1.9	4.0	7.5	15.4	23.0	44.3	70.7	124.9	254.7		
228.0	1.8	3.8	7.2	14.8	22.2	42.7	68.1	120.3	245.4		
243.2	1.8	3.7	7.0	14.3	21.4	41.2	65.7	116.2	237.0		
258.4	1.7	3.6	6.7	13.8	20.7	39.9	63.6	112.4	229.3		
273.6	1.7	3.5	6.5	13.4	20.1	38.7	61.7	109.0	222.4		
288.8	1.6	3.4	6.3	13.0	19.5	37.6	60.0	105.9	215.9		
304.0	1.6	3.3	6.2	12.7	19.0	36.5	58.2	103.0	210.0		
334.4	1.5	3.1	5.9	12.0	18.0	34.7	55.3	97.8	199.5		
364.8	1.4	3.0	5.6	11.5	17.2	33.1	52.8	93.3	190.3		
395.2	1.4	2.8	5.4	11.0	16.5	31.7	50.5	89.4	182.2		
425.6	1.3	2.7	5.1	10.6	15.8	30.5	48.6	85.8	175.1		
456.0	1.3	2.6	5.0	10.2	15.2	29.4	46.8	82.7	168.7	305.1	494.1
486.4	1.2	2.5	4.8	9.8	14.7	28.3	45.2	79.9	162.9	294.7	477.1
516.8	1.2	2.5	4.6	9.1	14.2	27.4	43.7	77.3	157.6	285.2	461.7
547.2	1.1	2.4	4.5	9.2	13.8	26.6	42.4	74.9	152.8	276.5	447.7
577.6	1.1	2.3	4.4	9.0	13.4	25.8	41.2	72.8	148.4	268.5	434.8
608.0	1.1	2.2	4.2	8.7	13.0	25.1	40.0	70.8	144.4	261.2	422.9
638.4	1.1	2.2	4.1	8.5	12.7	24.5	39.0	68.9	140.6	254.4	411.9
668.8	1.0	2.1	4.0	8.3	12.4	23.9	38.0	67.2	137.1	248.1	401.6
699.2	1.0	2.1	3.9	8.1	12.1	23.3	37.1	65.6	133.8	242.1	392.1
729.6	1.0	2.0	3.8	7.9	11.8	22.8	36.3	64.1	130.8	236.6	383.2
760.0	1.0	2.0	3.8	7.7	11.6	22.3	35.5	62.7	127.9	231.5	374.8
790.4	0.9	2.0	3.7	7.6	11.3	21.8	34.7	61.4	125.3	226.6	366.9

**TABLE 5-13 [UPC Table 12-13]**  
**Capacities of Listed Metal Appliance Connectors for Use With Gas Pressures Less Than an 8 Inch Water Column**

Semi-rigid Connector O.D. Inches	Flexible Connector Nominal I.D., Inches	Capacities for Various Lengths, in Thousands Btu/h (Based on Pressure Drop of 0.2 in. Water Column Natural Gas of 1,100 Btu/cu. ft.)							
		1 foot	1-1/2 feet	2 feet	2-1/2 feet	3 feet	4 feet	5 feet	6 feet
All Gas Appliances						Ranges and Dryers Only			
3/8	1/4	28	23	20	19	17			
1/2	3/8	66	54	47	44	41			
5/8	1/2	134	110	95	88	82	72	63	57
—	3/4	285	233	202	188	174			
—	1	567	467	405	378	353			

## Notes:

1. Flexible connector listings are based on the nominal internal diameter.
2. Semi-rigid connector listings are based on the outside diameter.
3. Gas connectors are certified by the testing agency as complete assemblies, including the fittings and valves. Capacities shown are based on the use of fittings and valves supplied with the connector.
4. Capacities for LPG are 1.6 times the natural gas capacities shown.

Example: Capacity of a 1/4 inch flexible connector 1 foot long is  $28,000 \times 1.6 = 44,800$  Btu/h.

**TABLE 5-13 (Metric) [UPC Table 12-13 (Metric)]**  
**Capacities of Listed Metal Appliance Connectors for Use With Gas Pressures Less Than a 203 mm Water Column**

Semi-rigid Connector O.D. mm	Flexible Connector Nominal I.D., mm	Capacities for Various Lengths, in Thousands Watts (Based on Pressure Drop of 50 Pa Water Column Natural Gas of 11.4 Watt-hours/L)							
		305 mm	457 mm	610 mm	762 mm	914 mm	1219 mm	1524 mm	1829 mm
		All Gas Appliances					Ranges and Dryers Only		
10	6.4	8.2	6.7	5.9	5.6	5			
15	9.5	19.3	15.8	13.8	12.9	12			
18	12.7	39.3	32.2	27.8	25.8	24	21.1	18.5	16.7
	19.1	83.5	68.3	59.2	55.1	51			
	25.9	166.1	136.8	118.7	110.8	103.4			

Notes: See Table 5-13 (English units).

Example: Capacity of a 6.4 mm flexible connector 305 mm long is  $8204 \times 1.6 = 13,126.4$  W.



**TABLE 5-14 [UPC Table 12-14]**  
**Capacities of Listed Metal Appliance Connectors for Use With Gas Pressures**  
**Not Less Than an 8 Inch Water Column**

Semi-rigid Connector O.D. Inches	Flexible Connector Nominal I.D., Inches	Capacities for Various Lengths, in Thousands Btu/h (Based on Pressure Drop of 0.2" Water Column Natural Gas of 1100 Btu/cu. ft.)							
		1 foot	1-1/2 feet	2 feet	2-1/2 feet	3 feet	4 feet	5 feet	6 feet
All Gas Appliances						Ranges and Dryers Only			
3/8	1/4	40	33	29	27	25			
1/2	3/8	93	76	66	62	58			
5/8	1/2	189	155	134	125	116	101	90	80
	3/4	404	330	287	266	244			
	1	803	661	573	534	500			

## Notes:

1. Flexible connector listings are based on the nominal internal diameter.
2. Semi-rigid connector listings are based on the outside diameter.
3. Gas connectors are certified by the testing agency as complete assemblies, including the fittings and valves. Capacities shown are based on the use of fittings and valves supplied with the connector.
4. Capacities for LPG are 1.6 times the natural gas capacities shown.

Example: Capacity of a 1/4 inch flexible connector 1 foot long is  $40,000 \times 1.6 = 64,000$  Btu/h.

**TABLE 5-14 (Metric) [UPC Table 12-14 (Metric)]**  
**Capacities of Listed Metal Appliance Connectors for Use With Gas Pressures**  
**Not Less Than a 203 mm Water Column**

Semi-rigid Connector O.D. mm	Flexible Connector Nominal I.D., mm	Capacities for Various Lengths, in Thousands Watts (Based on Pressure Drop of 50 Pa mm Water Column Natural Gas of 11.4 Watt-hours/L)							
		305 mm	457 mm	610 mm	762 mm	914 mm	1,219 mm	1,524 mm	1,829 mm
		All Gas Appliances						Ranges and Dryers Only	
10	6.4	11.7	9.7	8.5	7.9	7.3			
15	9.5	27.3	22.3	19.3	18.2	17.0			
18	12.7	55.4	45.4	39.3	36.6	34.0	29.6	26.4	23.4
	19.1	118.4	96.7	84.1	77.9	71.5			
	25.4	235.3	193.7	167.9	156.5	146.5			

Notes: See Table 5-14 (English units).

Example: Capacity of a 6.4 mm flexible connector 0.3 m long is  $11,720W \times 1.6 = 18,752$  W.

Table 5-15 [UPC Table 12-15]

## Copper Tube – Low Pressure

Maximum Delivery Capacity\* of Cubic Feet of Gas Per Hour of Copper Tube Carrying Natural Gas of 0.60\*\* Specific Gravity at Low Pressure (Less than 14 inches Water Column) Based on Pressure Drop of 0.50 Inch Water Column

Length of Tube, feet	Outside Diameter of Tube, inches						
	3/8 (10 mm)	1/2 (15 mm)	5/8 (18 mm)	3/4 (20 mm)	7/8 (22 mm)	1-1/8 (28 mm)	1-3/8 (34 mm)
10	24	50	101	176	250	535	963
20	17	34	69	121	172	368	662
30	13	27	56	97	138	295	531
40	11	23	48	83	118	253	455
50	10	21	42	74	105	224	403
60	9.1	19	38	67	95	203	365
70	8.4	17	35	62	84	197	336
80	7.8	16	33	57	81	174	313
90	7.3	15	31	54	76	163	293
100	6.9	14	29	51	72	154	277
125	6.1	13	26	45	64	136	245
150	5.6	11	23	41	58	124	222
175	5.1	11	21	38	53	114	205
200	4.8	10	20	35	50	106	190
250	4.2	8.7	18	31	44	94	169

\*Includes 20% factor for fittings.

\*\*For other pressure drop values see Table 5-16.

Table 5-16 [UPC Table 12-16]

## Specific Gravity

Multipliers to Be Used with Copper Tube When Specific Gravity of 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	.59
.70	.93	1.70	.58
.75	.90	1.80	.56
.80	.87	1.90	.56
.85	.84	2.00	.55
.90	.82	2.10	.54

Adjustment for a gas with an average specific gravity (relative density) other than 0.60 is achieved by multiplying the CFH values of Tables 5-15, 5-17, or 5-18 by the appropriate multiplier.

Table 5-17 [UPC Table 12-17]

## Copper Tube – Medium Pressure

Maximum Delivery Capacity\* of Cubic Feet of Gas Per Hour of Copper Tube Carrying Natural Gas of 0.60\*\* Specific Gravity at Medium Pressure (2.0 psig) Based on Pressure Drop of 1.0 psig:

Length of Tube, feet	Outside Diameter of Tube, inches						
	3/8 (10 mm)	1/2 (15 mm)	5/8 (18 mm)	3/4 (20 mm)	7/8 (22 mm)	1-1/8 (28 mm)	1-3/8 (34 mm)
10	222	458	932	1629	2,311	4,937	8,889
20	153	315	641	1120	1,589	3,393	6,109
30	123	253	515	899	1,276	2,725	4,906
40	105	216	440	770	1,092	2,332	4,199
50	93	192	390	682	968	2,067	3,721
60	84	174	354	618	877	1,873	3,372
70	78	160	325	569	807	1,723	3,102
80	72	149	303	529	750	1,603	2,886
90	68	140	254	496	704	1,504	2,708
100	64	132	268	469	665	1,421	2,558
125	57	117	238	415	589	1,259	2,267
150	51	106	215	376	534	1,141	2,054
175	47	97	198	346	491	1,050	1,890
200	44	91	184	322	457	976	1,758
250	39	80	163	286	405	865	1,558

\*Includes 20% factor for fittings.

\*\*For other pressure drop values see Table 5-16.

Table 5-18 [UPC Table 12-18]

## Copper Tube – High Pressure

Maximum Delivery Capacity\* of Cubic Feet of Gas Per Hour of Copper Tube Carrying Natural Gas of 0.60\*\* Specific Gravity at High Pressure (5.0 psig) Based on Pressure Drop of 3.50 psig:

Length of Tube, feet	Outside Diameter of Tube, inches						
	3/8 (10 mm)	1/2 (15 mm)	5/8 (18 mm)	3/4 (20 mm)	7/8 (22 mm)	1-1/8 (28 mm)	1-3/8 (34 mm)
10	462	954	1,941	3,392	4,812	10,279	18,504
20	318	656	1,334	2,331	3,307	7,064	12,718
30	255	527	1,071	1,872	2,656	5,673	10,213
40	218	451	917	1,602	2,273	4,855	8,741
50	194	399	812	1,420	2,015	4,303	7,747
60	175	362	736	1,287	1,825	3,899	7,019
70	161	333	677	1,184	1,679	3,587	6,458
80	150	310	630	1,101	1,562	3,337	6,008
90	141	291	591	1,033	1,466	3,131	5,637
100	133	274	558	976	1,385	2,958	5,324
125	118	243	495	865	1,227	2,621	4,719
150	107	220	448	784	1,112	2,375	4,276
175	98	203	413	721	1,023	2,185	3,934
200	91	189	384	671	952	2,033	3,659
250	81	167	340	594	843	1,802	3,243

\*Includes 20% factor for fittings.

\*\*For other pressure drop values see Table 5-16.

Table 5-19 Corrugated Stainless Steel Tubing (CSST) [UPC Table 12-19]

						Gas		Natural			
						Inlet Pressure		0.5 psi or less			
						Pressure Drop		0.5 in.w.c.			
						Specific Gravity		0.60			
Tube Size (EHD)*											
Flow Designation	13	15	18	19	23	25	30	31	37	46	62
Length feet	Maximum Capacity in Cubic Feet of Gas per Hour										
5	46	63	115	134	225	270	471	546	895	1,790	4,142
10	32	44	82	95	161	192	330	383	639	1,261	2,934
15	25	35	66	77	132	157	267	310	524	1,027	2,398
20	22	31	58	67	116	137	231	269	456	888	2,078
25	19	27	52	60	104	122	206	240	409	793	1,860
30	18	25	47	55	96	112	188	218	374	723	1,698
40	15	21	41	47	83	97	162	188	325	625	1,472
50	13	19	37	42	75	87	144	168	292	559	1,317
60	12	17	34	38	68	80	131	153	267	509	1,203
70	11	16	31	36	63	74	121	141	248	471	1,114
80	10	15	29	33	60	69	113	132	232	440	1,042
90	10	14	28	32	57	65	107	125	219	415	983
100	9	13	26	30	54	62	101	118	208	393	933
150	7	10	20	23	42	48	78	91	171	320	762
200	6	9	18	21	38	44	71	82	148	277	661
250	5	8	16	19	34	39	63	74	133	247	591
300	5	7	15	17	32	36	57	67	95	226	540

## Note:

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

\*EHD = Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Table 5-20 Corrugated Stainless Steel Tubing (CSST) [UPC Table 12-20]

						Gas		Natural			
						Inlet Pressure		0.5 psi or less			
						Pressure Drop		3.0 in. w.c.			
						Specific Gravity		0.60			
Tube Size (EHD)*											
Flow Designation	13	15	18	19	23	25	30	31	37	46	62
Length feet	Maximum Capacity in Cubic Feet of Gas per Hour										
5	120	160	277	327	529	649	1,182	1,365	2,141	4,428	10,103
10	83	112	197	231	380	462	828	958	1,528	3,199	7,156
15	67	90	161	189	313	379	673	778	1,254	2,541	5,848
20	57	78	140	164	273	329	580	672	1,090	2,197	5,069
25	51	69	125	147	245	295	518	599	978	1,963	4,536
30	46	63	115	134	225	270	471	546	895	1,790	4,142
40	39	54	100	116	196	234	407	471	778	1,548	3,590
50	35	48	89	104	176	210	363	421	698	1,383	3,213
60	32	44	82	95	161	192	330	383	639	1,261	2,934
70	29	41	76	88	150	178	306	365	593	1,166	2,717
80	27	38	71	82	141	167	285	331	555	1,090	2,543
90	26	36	67	77	133	157	268	311	524	1,027	2,398
100	24	34	63	73	126	149	254	295	498	974	2,276
150	19	27	52	60	104	122	206	240	409	793	1,860
200	17	23	45	52	91	106	178	207	355	686	1,612
250	15	21	40	46	82	95	159	184	319	613	1,442
300	13	19	37	42	75	87	144	168	234	559	1,317

## Note:

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

\*EHD = Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Table 5-21 Corrugated Stainless Steel Tubing (CSST) [UPC Table 12-21]

						Gas		Natural			
						Inlet Pressure		0.5 psi or less			
						Pressure Drop		6.0 in. w.c.			
						Specific Gravity		0.60			
Tube Size (EHD)*											
Flow Designation	13	15	18	19	23	25	30	31	37	46	62
Length feet	Maximum Capacity in Cubic Feet of Gas per Hour										
5	173	229	389	461	737	911	1,687	1,946	3,000	6,282	14,263
10	120	160	277	327	529	649	1,182	1,365	2,141	4,428	10,103
15	96	130	227	267	436	532	960	1,110	1,758	3,607	8,257
20	83	112	197	231	380	462	828	958	1,528	3,119	7,156
25	74	99	176	207	342	414	739	855	1,371	2,786	6,404
30	67	90	161	189	313	379	673	778	1,254	2,541	5,848
40	57	78	140	164	273	329	580	672	1,090	2,197	5,069
50	51	69	125	147	245	295	518	599	978	1,963	4,536
60	46	63	115	134	225	270	471	546	895	1,790	4,142
70	42	58	106	124	209	250	435	505	830	1,656	3,837
80	39	54	100	116	196	234	407	471	778	1,548	3,590
90	37	51	94	109	185	221	383	444	735	1,458	3,386
100	35	48	89	104	176	210	363	421	698	1,383	3,213
150	28	39	73	85	145	172	294	342	573	1,126	2,626
200	24	34	63	73	126	149	254	295	498	974	2,276
250	21	30	57	66	114	134	226	263	447	870	2,036
300	19	27	52	60	104	122	206	240	409	793	1,860

## Note:

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

\*EHD = Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Table 5-22 Corrugated Stainless Steel Tubing (CSST) [UPC Table 12-22]

						Gas		Natural			
						Inlet Pressure		2.0 psi			
						Pressure Drop		1.0 in. w.c.			
						Specific Gravity		0.60			
Tube Size (EHD)*											
Flow Designation	13	15	18	19	23	25	30	31	37	46	62
Length feet	Maximum Capacity in Cubic Feet of Gas per Hour										
10	270	353	587	700	1,098	1,372	2,592	2,986	4,509	9,599	21,637
25	166	220	374	444	709	876	1,620	1,869	2,887	6,041	13,715
30	151	200	342	405	650	801	1,475	1,703	2,642	5,509	12,526
40	129	172	297	351	567	696	1,273	1,470	2,297	4,763	10,855
50	115	154	266	314	510	624	1,135	1,311	2,061	4,255	9,715
75	93	124	218	257	420	512	922	1,066	1,692	3,467	7,940
80	89	120	211	249	407	496	892	1,031	1,639	3,355	7,689
100	79	107	189	222	366	445	795	920	1,471	2,997	6,881
150	64	87	155	182	302	364	646	748	1,207	2,442	5,624
200	55	75	135	157	263	317	557	645	1,049	2,111	4,874
250	49	67	121	141	236	284	497	576	941	1,886	4,362
300	44	61	110	129	217	260	453	525	862	1,720	3,983
400	38	52	96	111	189	225	390	453	749	1,487	3,452
500	34	46	86	100	170	202	348	404	552	1,329	3,089

## Notes:

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

\*EHD = Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.

Table 5-23 Corrugated Stainless Steel Tubing (CSST) [UPC Table 12-23]

						Gas		Natural			
						Inlet Pressure		5.0 psi			
						Pressure Drop		3.5 in. w.c.			
						Specific Gravity		0.60			
Tube Size (EHD)*											
Flow Designation	13	15	18	19	23	25	30	31	37	46	62
Length feet	Maximum Capacity in Cubic Feet of Gas per Hour										
10	523	674	1,084	1,304	1,995	2,530	4,923	5,659	8,295	18,080	40,353
25	322	420	691	827	1,289	1,616	3,077	3,543	5,311	11,378	25,580
30	292	382	632	755	1,181	1,478	2,803	3,228	4,860	10,377	23,361
40	251	329	549	654	1,031	1,284	2,418	2,786	4,225	8,972	20,246
50	223	293	492	586	926	1,151	2,157	2,486	3,791	8,015	18,119
75	180	238	403	479	763	944	1,752	2,021	3,112	6,530	14,809
80	174	230	391	463	740	915	1,694	1,955	3,016	6,320	14,341
100	154	205	350	415	665	820	1,511	1,744	2,705	5,646	12,834
150	124	166	287	339	548	672	1,228	1,418	2,221	4,600	10,489
200	107	143	249	294	478	584	1,060	1,224	1,931	3,977	9,090
250	95	128	223	263	430	524	945	1,092	1,732	3,553	8,135
300	86	116	204	240	394	479	860	995	1,585	3,240	7,430
400	74	100	177	208	343	416	742	858	1,378	2,802	6,439
500	66	89	159	186	309	373	662	766	1,035	2,503	5,762

## Notes:

- Table does not include effect of pressure drop across line regulator. Where regulator loss exceeds 1 psi, do not use this table. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drop across regulator may vary with the flow rate.
- CAUTION: Capacities shown in table may exceed maximum capacity of selected regulator. Consult with tubing manufacturer for guidance.
- Table includes losses for four 90-degree bends and two end fittings. Tubing runs with larger numbers of bends and/or fittings shall be increased by an equivalent length of tubing to the following equation:  $L = 1.3n$ , where  $L$  is additional length (ft.) of tubing and  $n$  is the number of additional fittings and/or bends.

\*EHD = Equivalent Hydraulic Diameter, which is a measure of the relative hydraulic efficiency between different tubing sizes. The greater the value of EHD, the greater the gas capacity of the tubing.





## CHAPTER 6

### PRODUCT AND MATERIALS STANDARDS

#### STANDARDS AND WRITING AGENCIES

Abbreviations used in Table 6-1 refer to standards or specifications issued by the organizations identified below:

All standards and specifications for materials are subject to change. Designations indicating the year of issue may thus become obsolete.

ANSI	American National Standards Institute, Inc., 25 W. 42nd Street, 4th floor, New York, NY 10036.
ASME	The American Society of Mechanical Engineering, 3 Park Avenue, New York, NY 10016
ASSE	American Society of Sanitary Engineering, 901 Canterbay, Suite A, Westlake, Ohio 44145
ASTM	American Society of Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.
AWWA	American Water Works Association, 6666 W. Quincy Avenue, Denver, CO 80235.
CISPI	Cast Iron Soil Pipe Institute, 5959 Shallowford Road, Suite 419, Chattanooga, TN 37421.
(D) or [D]	Discontinued.
e1	An editorial change since the last revision or reapproval.
FS	Federal Specifications, Federal Supply Service, Standards Division, General Services Administration, 7th and D Streets, Washington, DC 20407.
IAPMO	International Association of Plumbing and Mechanical Officials, 5001 E. Philadelphia Street., Ontario, CA 91761
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry, 127 Park Street, N.E., Vienna, VA 22180.
NFPA	National Fire Protection Association P.O.Box 9101, 1 Batterymarch Park, Quincy, MA 02269-9101
NSPI	National Spa and Pool Institute, 2111 Eisenhower Avenue, Alexandria, VA 22314
UL	Underwriters' Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062.

TABLE 6-1 Material Standards		
Standard Number	Standard Title	Application
ANSI Z21.10.1-98	Gas Water Heaters - Volume I –Storage Water Heaters with Input Ratings of 75,000 BTU per Hour or Less (22 kW)	Appliances
ANSI Z21.10.3-01	Gas Water Heaters - Volume III – Storage, with Input Ratings Above 75,000 Btu per Hour, Circulating and Instantaneous Water Heaters	Appliances
ANSI Z21.12-90	Draft Hoods	Appliances
ANSI Z21.13-00	Gas-Fired Low-Pressure Steam and Hot Water Boilers	Appliances
ANSI Z21.15-97	Manually Operated Gas Valves for Appliances, Appliance Connector, Valves and Hose End Valves	Valves
ANSI Z21.22-99	Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems	Valves
ANSI Z21.24-01	Connectors for Gas Appliances	Appliances
ANSI Z21.41-98 CSA 6.9-M98	Quick-Disconnect Devices for Use with Gas Fuel Appliances	Joints
ANSI Z21.56-98 CSA 4.7-2001	Gas Fired Pool Heaters	Swimming Pools and Spas
ANSI Z21.80-97, CSA 6.22-M97	Line Pressure Regulators	Fuel Gas
ANSI Z34.1-93	Certification - Third Party Certification Programs for Products, Processes, and Services	Certification
ANSI Z124.1-95	Plastic Bathtub Units	Fixtures
ANSI Z124.7-97	Prefabricated Plastic Spa Shells	Fixtures
ANSI Z124.8-90	Plastic Bathtub Liners	Fixtures
ANSI Z223.1-99	National Fuel Gas Code (same as NFPA 54)	Fuel Gas
ASCE 25-99	Earthquake Actuated Automatic Gas Shutoff Devices	Fuel Gas
ASME A112.1.2-96	Air Gaps in Plumbing Systems	Piping
ASME A112.6.3--01	Floor and Trench Drains	DWV Components
ASME A112.14.1-03	Backwater Valves	Valves

## MANDATORY REFERENCED STANDARDS

Table 6-1

Standard Number	Standard Title	Application
ASME A112.18.1-00	Plumbing Fixture Fittings	Piping
ASME A112.18.2-02	Plumbing Fixture Waste Fittings	Piping
ASME A112.19.1M-94(R99)	Enameled Cast Iron Plumbing Fixtures (Supplement 1-1998)	Fixtures
ASME A112.19.4M-94(R99)	Porcelain Enameled Formed Steel Plumbing Fixtures (Supplement 1-1998)	Fixtures
ASME A112.19.7M-95	Whirlpool Bathtub Appliances	Fixtures
ASME A112.19.8M-87(R96)	Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, Hot Tubs, and Whirlpool Bathtub Appliances	Swimming Pools and Spas
ASME A112.19.17-02	Manufactured Safety Vacuum Relief System (SVRS) for Residential and Commercial Swimming Pool, Spa, Hot Tub, and Wading Pool Systems	Swimming Pools and Spas
ASME A112.36.2M-91(R98)	Cleanouts (Note 1)	DWV Components
ASME B1.20.1-83 (R92)	Pipe Threads, General Purpose (Inch)	Joints
ASME B16.3- 99	Malleable-Iron Threaded Fittings	Piping, Ferrous
ASME B16.4- 98	Gray Iron Threaded Fittings	Piping, Ferrous
ASME B16.12- 98	Iron Threaded Drainage Fittings (Note 1)	Piping, Ferrous
ASME B16.15-85 (R94)	Cast Bronze Threaded Fittings, Classes 125 and 250	Piping, Copper Alloy
ASME B16.18- 84	Cast Copper Alloy Solder Joint Pressure Fittings (Note 1)	Piping, Copper Alloy
ASME B16.22- 95	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings Alloy	Piping, Copper Alloy
ASME B16.23- 92	Cast Copper Alloy Solder Joint Drainage Fittings - DWV Alloy	Piping, Copper Alloy
ASME B16.24- 02	Cast Copper Alloy Pipe Flanges and Flanged Fittings Alloy	Piping, Copper Alloy
ASME B16.26-88	Cast Copper Alloy Fittings for Flared Copper Tubes Alloy	Piping, Copper Alloy
ASME B16.29- 02	Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings-DWV Alloy (Note 1)	Piping, Copper Alloy
ASME B16.33- 90	Manually Operated Metallic Gas Valves for Use in Gas Piping Systems up to 125 psig.	Valves
ASME B16.34-96	Valves - Flanged, Threaded, and Welding End	Valves

Standard Number	Standard Title	Application
ASME B16.38-85	Large Metallic Valves for Gas Distribution (Manually Operated, NPS 2-1/2 to 12, 125 psig Maximum)	Valves
ASME B16.39-98	Pipe Unions, Malleable Iron Threaded	Piping, Ferrous
ASME B16.47-96	Large Diameter Steel Flanges	Piping, Ferrous
ASME B16.50-01	Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings	Piping, Copper Alloy
ASME B36.10M-00	Welded and Seamless Wrought Steel Pipe	Piping, Ferrous
ASME Section IV	Rules for Construction of Heating Boilers	Miscellaneous
ASME Section IX	Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators	Certification
ASSE 1001- 90	Pipe Applied Atmospheric-Type Vacuum Breakers	Backflow Protection
ASSE 1003- 01	Water Pressure Reducing Valves	Valves
ASSE 1011- 95	Hose-Connection Vacuum Breakers	Backflow Protection
ASSE 1012-02	Backflow Prevention with Intermediate Atmospheric Vent	Backflow Protection
ASSE 1013-99	Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Proventers	Backflow Protection
ASSE 1014- 90	Hand-Held Showers	Fixtures
ASSE 1015-99	Double-Check Backflow Prevention Assembly	Backflow Protection
ASSE 1016-96	Individual, Thermostatic Pressure Balancing and Combination Pressure Balancing and Thermostatic Control Valves for Individual Fixture Fittings	Valves
ASSE 1017- 98	Temperature Actuated Mixing Valves for Hot Water Distribution Systems	Valves
ASSE 1018- R01	Trap Seal Primer Valves Water Supply Fed	Valves
ASSE 1019- 97	Vacuum Breaker Wall Hydrant, Freeze-Resistant Automatic Draining Type	Backflow Protection
ASSE 1020- 98	Pressure Vacuum Breaker Assembly	Backflow Protection
ASSE 1024-03	Dual Check Valve Backflow Preventers	Backflow Protection
ASSE 1044- 01	Trap Seal Primer Devices-Drainage Types and Electronic Design Types	DWV Components

## MANDATORY REFERENCED STANDARDS

Table 6-1

Standard Number	Standard Title	Application
ASSE 1052-94	Hose Connection Backflow Preventers	Backflow Protection
ASSE 1055-97	Chemical Dispensing Systems	Backflow Protection
ASSE 1057-01	Freeze Resistant Sanitary Yard Hydrants with Backflow Protection	Backflow Protection
ASSE 1060-96	Outdoor Enclosures for Backflow Prevention Assemblies	Backflow Protection
ASTM A 53- 01	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded, and Seamless	Piping, Ferrous
ASTM A 74- 98	Cast Iron Soil Pipe and Fittings (Note 1)	Piping, Ferrous
ASTM A 126-95 (R01)	Gray Iron Castings for Valves, Flanges, and Pipe Fittings	Piping, Ferrous
ASTM A 377- 99	Ductile-Iron Pressure Pipe	Piping, Ferrous
ASTM A 518-99	Corrosion-Resistant High-Silicon Iron Castings	Piping, Ferrous
ASTM A 653- 01a	Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process	Piping, Ferrous
ASTM A 733- 01	Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples	Piping, Ferrous
ASTM A 861- 01a	High-Silicon Iron Pipe and Fittings (Note 1)	Piping, Ferrous
ASTM A888-98 <sup>o1</sup>	Hubless Cast-Iron Soil Pipe and Fittings for Sanitary and Storm Drain Waste and Vent Piping Applications	Piping, Ferrous
ASTM B 32- 96	Solder Metal (Note 2)	Joints
ASTM B 42- 98	Seamless Copper Pipe, Standard Sizes	Piping, Copper Alloy
ASTM B 43- 98	Seamless Red Brass Pipe, Standard Sizes	Piping, Copper Alloy
ASTM B 75- 99	Seamless Copper Tube	Piping, Copper Alloy
ASTM B 88- 99 <sup>o1</sup>	Seamless Copper Water Tube	Piping, Copper Alloy
ASTM B 135- 00	Seamless Brass Tube	Piping, Copper Alloy
ASTM B 152- 00	Copper Sheet, Strip, Plate, and Rolled Bar	Miscellaneous
ASTM B 302- 00	Threadless Copper Pipe, Standard Sizes	Piping, Copper Alloy
ASTM B 306- 99	Copper Drainage Tube (DWV)	Piping, Copper Alloy

Standard Number	Standard Title	Application
ASTM B 447- 00	Welded Copper Tube	Piping, Copper Alloy
ASTM B 584- 00	Copper Alloy Sand Casting for General Applications (Note 3)	Piping, Copper Alloy
ASTM B 587- 97 <sup>e1</sup>	Welded Brass Tube	Piping, Copper Alloy
ASTM B 687- 99	Brass, Copper, and Chromium-Plated Pipe Nipples	Piping, Copper Alloy
ASTM B 813- 00 <sup>e1</sup>	Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube	Joints
ASTM B 828-00	Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings	Joints
ASTM C 14- 99	Concrete Sewer, Storm Drain and Culvert Pipe	Piping, Non-Metallic
ASTM C 296- 00	Asbestos-Cement Pressure Pipe	Piping, Non-Metallic
ASTM C 425- 02	Compression Joints for Vitrified Clay Pipe and Fittings	Joints
ASTM C 428- 97 (R02)	Asbestos-Cement Nonpressure Sewer Pipe (Notes 4 & 5)	Piping, Non-Metallic
ASTM C 443- 01	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets	Joints
ASTM C 564- 97	Rubber Gaskets for Cast Iron Soil Pipe and Fittings (Note 1)	Joints
ASTM C 700- 2002	Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated	Piping, Non-Metallic
ASTM C 1053- 00	Borosilicate Glass Pipe and Fittings for Drain, Waste and Vent (DWV) Applications (Note 1)	Piping, Non-Metallic
ASTM C 1173- 97	Flexible Transition Couplings for Underground Piping Systems	Joints
ASTM C 1277- 97	Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings	Piping, Ferrous
ASTM C 1440-99 <sup>e1</sup>	Thermoplastic Elastomeric (TPE) Gasket Materials for Drain Waste, and Vent (DWV), Sewer, Sanitary and Storm Plumbing Systems	Piping, Plastic
ASTM C 1460-00	Shielded Transition Couplings for Use with Dissimilar DWV Pipe and Fittings Above Ground	Piping, Plastic
ASTM C 1461-00	Mechanical Couplings Using Thermoplastic Elastomeric (TPE) Gaskets for Joining Drain, Waste, and Vent (DWV); Sewer; Sanitary; and Storm Plumbing Systems for Above and Below Ground	Piping, Plastic

Standard Number	Standard Title	Application
ASTM C 1540-02	Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings	Joints
ASTM D 1785-99	Poly (Vinyl Chloride) (PVC) Plastic Pipe Sch. 40, 80 and 120	Piping, Plastic
ASTM D 1869-95(R00)	Rubber O-Rings for Asbestos-Cement Pipe	Joints
ASTM D 2104-01	Polyethylene (PE) Plastic Pipe, Sch. 40	Piping, Plastic
ASTM D 2235- 01	Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings	Joints
ASTM D 2239- 01	Polyethylene (PE) Plastic Pipe, (SDR-PR) Based on Controlled Inside Diameter	Piping, Plastic
ASTM D 2241- 00	Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)	Piping, Plastic
ASTM D 2447-01	Polyethylene (PE) Plastic Pipe, Sch. 40 and 80 (Based on Controlled Outside Diameter)	Piping, Plastic
ASTM D 2464- 99	Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Sch. 80 (Note 1)	Piping, Plastic
ASTM D 2466- 01	Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Sch, 40 (Note 1)	Piping, Plastic
ASTM D 2467- 01	Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Sch, 80 (Note 1)	Piping, Plastic
ASTM D 2468-96a	Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings (Sch. 40)	Piping, Plastic
ASTM D 2513- 01a	Thermoplastic Gas Pressure Pipe Tubing, and Fittings (Note 1)	Piping, Plastic
ASTM D 2564- 96a	Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems	Joints
ASTM D 2609- 00	Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe (Note 1)	Piping, Plastic
ASTM D 2661- 01	Acrylonitrile-Butadiene-Styrene (ABS) Sch. 40 Plastic Drain, Waste and Vent Pipe and Fittings (Note 1)	Piping, Plastic
ASTM D 2665- 01	Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings	Piping, Plastic
ASTM D 2672-96a	Joints for IPS PVC Pipe Using Solvent Cement	Joints
ASTM D 2751-96a	Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings (Note 1)	Piping, Plastic

Table 6-1

USPSHTC

Standard Number	Standard Title	Application
ASTM D 2846- 99	Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems	Piping, Plastic
ASTM D 2855-96	Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings	Joints
ASTM D 3034- 01	Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings	Piping, Plastic
ASTM D 3035-01	Polyethylene (PE) Plastic Pipe (DR-PR) (Based on Controlled Outside Diameter)	Piping, Plastic
ASTM D 3311- 94	Drain, Waste, and Vent (DWV) Plastic Fittings Patterns (Note 1)	Piping, Plastic
ASTM F 402-98	Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings	Joints
ASTM F 405-98	Corrugated Polyethylene (PE) Tubing and Fittings	Piping, Plastic
ASTM F 409- 99a	Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings (Note 1)	Piping, Plastic
ASTM F 438- 01	Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Sch. 40	Piping, Plastic
ASTM F 439- 01	Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Sch. 80	Piping, Plastic
ASTM F 441- 99	Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Sch. 40 and 80	Piping, Plastic
ASTM F 442-99	Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)	Piping, Plastic
ASTM F 493-97	Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings	Joints
ASTM F 628- 01	Acrylonitrile-Butadiene-Styrene (ABS) Sch. 40 Plastic Drain, Waste and Vent Pipe with a Foam Core (Note 1)	Piping, Plastic
ASTM F 656- 96a	Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings	Joints
ASTM F 714-01	Polyethylene (PE) Plastic Pipe (SDR-PR) (Based on Outside Diameter)	Piping, Plastic
ASTM F 789-95a	Type PS-46 and Type PS-115 Poly(Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings (Note 1)	Piping, Plastic



Standard Number	Standard Title	Application
ASTM F 810- 01	Smoothwall Polyethylene (PE) Pipe for Use in Drainage and Waste Disposal Absorption Fields	Piping, Plastic
ASTM F 876- 01 <sup>e1</sup>	Crosslinked Polyethylene (PEX) Tubing	Piping, Plastic
ASTM F 877- 01 <sup>e1</sup>	Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems	Piping, Plastic
ASTM F 891- 00	Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core	Piping, Plastic
ASTM F 949- 01a	Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings	Piping, Plastic
ASTM F 1476-01	Gasketed Mechanical Couplings for Use in Piping Application	Joints
ASTM F1673-95	Polyvinylidene Fluoride (PVDF) Corrosive Waste Drainage Systems	Piping, Plastic
ASTM F 1807-99	Metal Insert Fittings with Copper Ring for SDR 9 Crosslinked Polyethylene (PEX) Tubing	Piping, Plastic
ASTM F 1924-01	Plastic Mechanical Fitting for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing	Piping, Plastic
ASTM F 1948-99a	Metallic Mechanical Fittings for Use on Outside Diameter Controlled Thermoplastic Gas Distribution Pipe and Tubing	Piping, Plastic
ASTM F 1960-00e1	Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-Linked Polyethylene (PEX) Tubing	Piping, Plastic
ASTM F 1961-99	Metal Cold Flare Compression Fittings with Disc Springs for Crosslinked Polyethylene (PEX) Tubing	Piping, Plastic
ASTM F 1973-99 <sup>e1</sup>	Factory Assembled Anodeless Riser and Transition Fitting in Polyethylene (PE) Fuel Gas Distribution Systems	Piping, Plastic
ASTM F 2080-01	Cold-Expansion Fittings With Metal Compression Sleeves for Cross-Linked Polyethylene (PEX) Pipe	Piping, Plastic
ASTM F 2098-01	Stainless Steel Clamps for Securing SDR9 Cross-linked Polyethylene (PEX) Tubing to Metal Insert Fittings	Joints
ASTM F 2159-03	Plastic Insert Fittings Utilizing a Copper Ring for SDR 9 Cross-Linked Polyethylene (PEX) Tubing	Joints
ASTM F 2165-02	Flexible Pre-Insulated Piping	Piping, Plastic

Table 6-1

USPSHTC

Standard Number	Standard Title	Application
AWS A5.8-92	Filler Metals for Brazing and Braze Welding	Joints
AWS B2.2-91	Brazing Procedure and Performance Qualification	Certification
AWWA C203-91a	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enameled and Tape - Hot Applied	Piping
AWWA C213- 01	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines	Piping, Ferrous
AWWA C400- 93	Asbestos-Cement Distribution Pipe, 4 in. Through 16 in. (100 mm through 400 mm) for Water Distribution Systems	Piping, Non-Metallic
AWWA C500- 93	Gate Valves for Water Supply Service and Sewerage System Valves	Valves
AWWA C507- 99	Ball Valves, 6 in. Through 48 in. (150 mm through 1200 mm)	Valves
CISPI 301-00	Hubless Cast-Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications (Note 1)	Piping, Ferrous
FS WW-P-541-E-80	Plumbing fixtures, General Specification	Fixtures
FS WW-V 58b	Valves, Gate, Cast Iron (125 and 250) lb, Screwed and Flanged (for Land Use)	Valves
IAPMO IS 1-03	Non-Metallic Building Sewers	Piping, Non-Metallic
IAPMO IS 2-93	Tile-Lined Roman Bathtubs	Fixtures
IAPMO IS 3-00	Copper Plumbing Tube, Pipe and Fittings	Piping, Copper Alloy
IAPMO IS 5-92	ABS Building Drain, Waste, and Vent Pipe and Fittings	Piping, Plastic
IAPMO IS 6-00	Hubless Cast Iron Sanitary and Rainwater Systems	Piping, Ferrous
IAPMO IS 7-90	Polyethylene (PE) Cold Water Building Supply and Yard Piping	Piping, Plastic
IAPMO IS 8-95 <sup>91</sup>	PVC Cold Water Building Supply and Yard Piping	Piping, Plastic
IAPMO IS 9-95	PVC Building Drain, Waste and Vent Pipe Fittings	Piping, Plastic
IAPMO IS 11-87	ABS Sewer Pipe and Fittings	Piping, Plastic
IAPMO IS 12-93	Polyethylene (PE) for Gas Yard Piping	Piping, Plastic
IAPMO IS 13-00	Protectively Coated Pipe	Piping
IAPMO IS 15-82	Asbestos Cement Pressure Pipe for Water Service and Yard Piping	Piping, Non-Metallic

Standard Number	Standard Title	Application
IAPMO IS 18-85	Extra Strength Vitrified Clay Pipe in Building Drains	Piping, Non-Metallic
IAPMO IS 20-00	CPVC Solvent Cemented Hot and Cold Water Distribution Systems	Piping, Plastic
IAPMO IS 21-89	Welded Copper and Copper Alloy Water Tube	Piping, Copper Alloy
IAPMO SIS 1-03	Flexible PVC Hose	Piping, Plastic
IAPMO PS 25-84	Fittings for Joining Polyethylene Pipe for Water Service and Yard Piping	Joints
IAPMO PS 31-95	Backflow Prevention Assemblies	Backflow Protection
IAPMO PS 33-00a	Flexible PVC Hose for Pools, Hot Tubs, Spas and Jetted Bathtubs	Piping, Plastic
IAPMO PS 34-96	Polyethylene Encasement Sleeve for Potable Water Pipe and Tubing	Piping
IAPMO PS 36-90	Lead-Free Sealing Compounds for Threaded Joints	Joints
IAPMO PS 37-90	Black Plastic PVC or PE Pressure-Sensitive Corrosion Preventive Tape	Joints
IAPMO PS 38-99	ABS and PVC Backwater Valves	Valves
IIAPMO PS 40-01	Anodeless Transition Riser for Use with PVC Gas Yard Piping	Fuel Gas
IAPMO PS 42-96	Pipe Alignment and Secondary Support Systems	Piping
IAPMO PS 43-91	Cushioned Bathtubs And Whirlpool Bathtub Appliances	Fixtures
IAPMO PS 51-98	Plastic and Metallic Expansion Joints	Joints
IAPMO PS 53-92	Grooved Mechanical Pipe Couplings and Grooved End Fittings	Joints
IAPMO PS 55-92	Bathwaste Strainer Drains	Fixtures
IAPMO PS 66-00	Dielectric Waterway Fittings	Piping
PS69-01	Plastic Bathtubs and Overflow Assemblies	Fixtures
IAPMO SPS 3-93	Skimmers (Spas, Hot Tubs and Swimming Pools)	Swimming Pools and Spas
IAPMO SPS 4-00	Special Use Suction Fittings for Swimming Pools, Spas and Hot Tubs (For Suction Side Automatic Swimming Pool Cleaners)	Swimming Pools and Spas

Standard Number	Standard Title	Application
MSS SP-25-98	Standard Marking System for Valves, Fittings, Flanges,	Piping and Unions
MSS SP-58-93	Pipe Hangers And Supports – Materials, Design and Manufacture	Piping
MSS SP-67-95	Butterfly Valves	Valves
NFPA 54-02	National Fuel Gas Code (same as ANSI Z223.1)	Fuel Gas
NFPA 85-01	Boiler and Combustion Systems Hazard Code	Appliances
NSPI 1-91	Public Swimming Pools	Swimming Pools and Spas
NSPI 2-99	Public Spas	Swimming Pools and Spas
NSPI 3-99	Permanently Installed Residential Spas	Swimming Pools and Spas
NSPI 4-99	Aboveground/Onground Residential Swimming Pools	Swimming Pools and Spas
NSPI 5-03	Residential Inground Swimming Pools	Swimming Pools and Spas
NSPI 6-99	Portable Spas	Swimming Pools and Spas
NSPI 8-96	Swimming Pools, Spas and Hot Tubs	Swimming Pools and Spas
UL 125-97	Valves for Anhydrous Ammonia and LP-Gas (Other than Safety Relief)	Valves
UL 132-97	Safety Relief Valves for Anhydrous Ammonia and LPG	Valves
UL 144-99	LPG Regulators	Valves
UL 174-96	Household Electric Storage Tank Water Heaters	Appliances
UL 296-03	Oil Burners	Appliances
UL 343-97	Pumps for Oil-Burning Appliances	Pumps
UL 378-93	Draft Equipment	Miscellaneous
UL 441-96	Gas Vents	Miscellaneous

Standard Number	Standard Title	Application
UL 569-95	Pigtails and Flexible Hose Connectors for LP-Gas	Fuel Gas
UL 726-95	Oil-Fired Boiler Assemblies	Appliances
UL 732-95	Oil-Fired Storage Tank Water Heaters	Appliances
UL 778-96	Motor-Operated Water Pumps	Pumps
UL 834-95	Heating, Water Supply, and Power Boilers - Electric	Appliances
UL 1453-95	Electric Booster and Commercial Storage Tank Water Heaters	Appliances

## Notes

- 1 Although this standard is referenced in Table 6-1, some of the pipe, tubing, fittings, valves, or fixtures included in the standard are not acceptable for use under the provisions of the Uniform Plumbing Code.
- 2 See Section 316.1.3 for restriction.
- 3 Alloy C85200 for cleanout plugs.
- 4 Limited to domestic sewage.
- 5 Type II only.

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**APPENDIX A CONVERSION TABLE**

<b>MULTIPLY</b>	<b>BY</b>	<b>TO OBTAIN</b>
Acres .....	43,560	Square feet
Acre-feet .....	43,560	Cubic feet
Acre-feet .....	325,851	Gallons
Atmospheres .....	76.0	Cms of mercury
Atmospheres .....	29.92	Inches of mercury
Atmospheres .....	33.90	Feet of water
Atmospheres .....	14.70	Pounds/square inch
Btu/minute .....	12.96	Foot-Pounds/second
Btu/minute .....	0.02356	Horse-power
Centimeters .....	0.3937	Inches
Centimeters of mercury .....	0.01316	Atmospheres
Centimeters of mercury .....	0.4461	Feet of water
Centimeters of mercury .....	27.85	Pounds/square foot
Centimeters of mercury .....	0.1934	Pounds/square inch
Cubic feet .....	1728	Cubic inches
Cubic feet .....	0.03704	Cubic yards
Cubic feet .....	7.48052	Gallons
Cubic feet .....	29.92	Quarts (liquid)
Cubic feet/minute.....	472.0	Cubic cms/second
Cubic feet/minute.....	0.1247	Gallons/second
Cubic feet/minute.....	62.43	Pounds of water/minute
Cubic feet/second.....	0.0646317	Million gallons/day
Cubic feet/second.....	448.831	Gallons/minute
Cubic yards.....	27	Cubic feet
Cubic yards.....	202.0	Gallons
Feet .....	304.8	Millimeters
Feet of water.....	0.02950	Atmospheres
Feet of water.....	0.8826	Inches of mercury
Feet of water.....	62.43	Pounds/square foot
Feet of water.....	0.4335	Pounds/square inch
Feet/minute.....	0.01667	Feet/second
Feet/minute.....	0.01136	Miles/hour
Feet/second.....	0.6818	Miles/hour
Feet/second.....	0.01136	Miles/minute
Gallons .....	3785	Cubic centimeters
Gallons .....	0.1337	Cubic feet
Gallons .....	231	Cubic inches
Gallons .....	4	Quarts (liquid)
Gallons water.....	8.3453	Pounds of water
Gallons/minute.....	0.002228	Cubic feet/second
Gallons/minute.....	8.0208	Cubic feet/hour
Gallons water/minute.....	6.0086	Tons of water/24 hours
Inches .....	25.4	Millimeters
Inches of mercury .....	0.03342	Atmospheres
Inches of mercury .....	1.133	Feet of water
Inches of mercury .....	0.4912	Pounds/square foot

MULTIPLY	BY	TO OBTAIN
Inches of water .....	0.002458	Atmospheres
Inches of water .....	0.07355	Inches of mercury
Inches of water .....	5.202	Pounds/square feet
Inches of water .....	0.03613	Pounds/square inch
Liters .....	1000	Cubic centimeters
Liters .....	61.02	Cubic inches
Liters .....	0.2642	Gallons
Miles .....	5280	Feet
Miles/hour .....	88	Feet/minute
Miles/hour .....	1.467	Feet/second
Millimeters .....	0.1	Centimeters
Millimeters .....	0.03937	Inches
Million gallon/day .....	1.54723	Cubic feet/second
Pounds of water.....	0.01602	Cubic feet
Pounds of water.....	27.68	Cubic inches
Pounds of water.....	0.1198	Gallons
Pounds/cubic inch .....	1728	Pounds/cubic feet
Pounds/square foot .....	0.01602	Feet of water
Pounds/square inch.....	0.06804	Atmospheres
Pounds/square inch.....	2.307	Feet of water
Pounds/square inch.....	2.036	Inches of mercury
Quarts (dry) .....	67.20	Cubic inches
Quarts (liquid) .....	57.75	Cubic inches
Square feet .....	144	Square inches
Square miles.....	640	Acres
Square yards .....	9	Square feet
Temperature (°C) + 273.....	1	Abs. temperature (°C)
Temperature (°C) + 17.28.....	1.8	Temperature (°F)
Temperature (°F) + 460 .....	1	Abs. temperature (°F)
Temperature (°F) - 32.....	5/9	Temperature (°C)
Tons (short) .....	2000	Pounds
Tons of water/24 hours.....	83.333	Pounds water/hour
Tons of water/24 hours.....	0.16643	Gallons/minute
Tons of water/24 hours.....	1.3349	Cubic feet/hour

## APPENDIX B METRIC SYSTEM

### (INTERNATIONAL SYSTEM OF UNITS – SI)

For the users of this Code, we are including a short explanation and some conversion tables to aid in the conversion of our familiar English units to the forthcoming SI units.

This is written with the Code users in mind, and will detail only those measurements used in everyday work and calculations. For the scientific units, we recommend the use of ANSI Z210.1 entitled "Metric Practice Guide."

#### GENERAL COMMENTS

Our present system of measuring involves the three dimensions of Force, Length and Time. The SI units involve Mass, Length and Time. The change of Force to Mass has meaning in scientific and engineering work, but for practical use, in ordinary construction, we will show kilogram to pounds conversion values although an exact conversion would be pounds force divided by the acceleration due to gravity to mass units.

In the same manner, the SI units for temperature expressed in Kelvins and based on absolute zero will be given as degrees Celsius which is the more familiar and practical Centigrade degrees.

The SI system measures angles in radians where there are two pi radians in a circle, but using a 1.5708 bend to change from a vertical stack to a horizontal house drain is not as easy as calling out a 1/4 bend or an ell for water piping.

The foregoing notes are intended to show that in making conversions from one unit system to another, a little common sense must be used and the degree of accuracy needed to do the job, in hand, must be kept in mind.

The following tables are set up using this approach and using the preferred SI units.

TO CONVERT	INTO	MULTIPLY BY
Atmospheres	Cms of mercury	76.0
Btu	Joules	1,054.8
Btu/hour	Watts	0.2931
Btu/minute	Kilowatts	0.01757
Btu/minute	Watts	17.57
Celsius	Fahrenheit	$(^{\circ}\text{C} \times 9/5) + 32^{\circ}$
Circumference	Radians	6.283
Cubic centimeters	Cubic inches	0.06102
Cubic feet	Cubic meters	0.02832
Cubic feet	Liters	28.32
Cubic feet/minute	Cubic cms/second	472.0
Cubic inches	Cubic cms	16.39
Cubic inches	Liters	0.01639
Cubic meters	Gallons (U.S. liquid)	264.2
Feet	Centimeters	30.48
Feet	Meters	0.3048
Feet	Millimeters	304.8
Feet of water	Kgs/square cm	0.03048
Foot-Pounds	Joules	1.356
Foot-pounds/minute	Kilowatts	$2.260 \times 10^{-5}$
Foot-pounds/second	Kilowatts	$1.356 \times 10^{-3}$
Gallons	Liters	3.785
Horsepower	Watts	745.7
Horsepower-hours	Joules	$2.684 \times 10^6$
Horsepower-hours	Kilowatt-hours	0.7457
Inches	Millimeters	25.4
Joules	Btu	$9.480 \times 10^{-4}$
Joules	Foot-pounds	0.7376

TO CONVERT	INTO	MULTIPLY BY
Joules	Watt-hours	$2.778 \times 10^{-4}$
Kilograms	Pounds	2.205
Kilograms	Tons (short)	$1.102 \times 10^{-3}$
Kilometers	Miles	0.6214
Kilometers/hour	Miles/hour	0.6214
Kilowatts	Horsepower	1.341
Kilowatt-hours	Btu	3,413
Kilowatt-hours	Foot-pounds	$2.655 \times 10^6$
Kilowatt-hours	Joules	$3.6 \times 10^6$
Liters	Cubic feet	0.03531
Liters	Gallons (U.S. liquid)	0.2642
Meters	Feet	3.281
Meters	Inches	39.37
Meters	Yards	1.094
Meters/second	Feet/second	3.281
Meters/second	Miles/hr	2.237
Miles (statute)	Kilometers	1.609
Miles/hour	Meters/minute	26.82
Millimeters	Inches	0.03937
Ounces (fluid)	Liters	0.02957
Pints (liquid)	Cubic centimeters	473.2
Pounds	Kilograms	0.4536
PSI	Pascals	6,895
Quarts (liquid)	Liters	0.9463
Radians	Degrees	57.30
Square inches	Square millimeters	645.2
Square meters	Square inches	1,550
Square millimeters	Square inches	$1.550 \times 10^{-3}$
Watts	Btu/hour	3.4129
Watts	Btu/minute	0.05688
Watts	Foot-pounds/second	0.7378
Watts	Horsepower	$1.341 \times 10^{-3}$

These basic conversion factors are mathematically correct as far as we can determine, but when the plumbing industry, including plumbers, suppliers and manufacturers, actually begins the conversion program, it will undoubtedly follow the guidelines of committees selected from all phases of the construction industries as set up under the American National Metric Council.

The final preferred units used will be those that apply to our industry and will be of the magnitude to simplify and ease job calculations and avoid confusion and ambiguity.

The conversion looks complex and confusing, but when the metric system was first proposed in France, an attempt was made to include a 10 hour day, a 10 day week and 10 months to the year, but cooler heads prevailed and our time still follows the sun and seasons. Likewise, assigning new units or numbers to the quantities we must work with cannot change the basic hydraulic principles that plumbers have worked with throughout history.

Information on conversion factors provided by ANSI, American National Metric Council and Division of Designatronics, Inc.

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# **2006 Uniform Swimming Pool, Spa and Hot Tub Code**



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