File No. 130840 Committee Item No. 9
Board Item No. 40

# COMMITTEE/BOARD OF SUPERVISORS

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**Committee:** Land Use and Economic Development **Date** October 21, 2013

**Board of Supervisors Meeting** **Date** October 29, 2013

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**Completed by:** Alisa Miller **Date** October 18, 2013
**Completed by:** Alisa Miller **Date** October 24, 2013

FILE NO. 130840 ORDINANCE NO.

[Plumbing Code - Repeal of Existing 2010 Code and Enactment of 2013 Edition]

**Ordinance repealing the 2010 Plumbing Code in its entirety and enacting a 2013 Plumbing Code consisting of the new model code, as amended by the State of California and as further amended by San Francisco; adopting environmental findings and findings of local conditions under the California Health and Safety Code; providing for an operative date of January 1, 2014; and directing the Clerk of the Board to forward the legislation to the State Building Standards Commission as required by State law.**

NOTE: **Unchanged Code text and uncodified text** are in plain Arial font.
**Additions to Codes** are in *single-underline italics Times New Roman font*.
**Deletions to Codes** are in ~~*strikethrough italics Times New Roman font*~~.
**Board amendment additions** are in double-underlined Arial font.
**Board amendment deletions** are in ~~strikethrough Arial font~~.
**Asterisks (* * * *)** indicate the omission of unchanged Code subsections or parts of tables.

Be it ordained by the People of the City and County of San Francisco:

Section 1. Environmental Findings. The Planning Department has determined that the actions contemplated in this ordinance comply with the California Environmental Quality Act (California Public Resources Code Sections 21000 et seq.). Said determination is on file with the Clerk of the Board of Supervisors in File No. 130840 and is incorporated herein by reference.

Section 2. General Findings.

A. The State of California adopts a new California Building Standards Code every three years that goes into effect throughout the State 180 days after publication. The California Building Standards Code is contained in Title 24 of the California Code of

Regulations, and consists of several parts that are based upon model codes with amendments made by various State agencies. The California Plumbing Code is Part 5 of Title 24 of the California Code of Regulations. The 2013 California Plumbing Code will go into effect throughout California on January 1, 2014.

B. Local jurisdictions are required to enforce the California Plumbing Code but they may also enact more stringent standards when reasonably necessary because of local conditions caused by climate, geology or topography.

C. As in past State code adoption cycles, in this ordinance San Francisco repeals its existing Plumbing Code in its entirety and enacts a new Plumbing Code consisting of the new model code, as amended by the California Plumbing Code, and as further amended by San Francisco.

D. On August 21, 2013, at a duly noticed public hearing, the Building Inspection Commission considered this legislation.

Section 3. Findings regarding Local Conditions.

A. California Health & Safety Code Section 17958.7 provides that before making any changes or modifications to the California Plumbing Code and any other applicable provisions published by the State Building Standards Commission, the governing body must make an express finding that each such change or modification is reasonably necessary because of specified local conditions, and the findings must be filed with the State Building Standards Commission before the local changes or modifications can go into effect.

B. The City and County of San Francisco is unique among California communities with respect to local climatic, geological, topographical, and other conditions. A specific list of findings that support San Francisco's modifications to the 2013 California Plumbing Code and a section-by-section correlation of each modification with a specific numbered finding are contained in Exhibit A entitled "Standard Findings for San Francisco Amendments," on file

with the Clerk of the Board of Supervisors in File No. 130840, which is hereby declared to be part of this ordinance as if set forth fully therein.

C. Pursuant to California Health and Safety Code Section 17958.7, the Board of Supervisors finds and determines that the local conditions described in Exhibit A constitute a general summary of the most significant local conditions giving rise to the need for modification of the 2013 California Plumbing Code provisions published by the State Building Standards Commission. The Board of Supervisors further finds and determines that the proposed modifications are reasonably necessary based upon the local conditions set forth in Exhibit A.

Section 4. The 2010 San Francisco Plumbing Code is hereby repealed in its entirety. The San Francisco Plumbing Code being repealed consists of Ordinance 272-10, which is available on the website of the Board of Supervisors. There have been no subsequent amendments.

Section 5. The 2013 San Francisco Plumbing Code is hereby enacted. The Plumbing Code being enacted consists of the new model code, as amended by the 2013 California Plumbing Code, and as further amended by the San Francisco amendments. A copy of the new model code, as amended by the 2013 California Plumbing Code, together with the San Francisco amendments, is on file with the Clerk of the Board of Supervisors in File No. 130840 all of which is hereby declared to be part of this ordinance as if set forth fully therein. Additions to the 2013 California Plumbing Code are shown in bold underlined type; deletions are shown with strikethrough.

Section 6. Continuance of Actions Under Prior Code. Nothing contained in this ordinance shall be construed as abating any action now pending under or by virtue of any ordinance of the City and County of San Francisco hereby repealed, nor shall this ordinance

be construed as discontinuing, abating, modifying or altering any penalties accruing, or to accrue, or as waiving any right of the City under any such ordinance.

Section 7. Severability. If any section, subsection, sentence, clause, or phrase of this ordinance is, for any reason, held to be unconstitutional, such decision shall not affect the validity of the remaining portions of this ordinance. The Board of Supervisors hereby declares that it would have passed this ordinance, and each section, subsection, sentence, clause, or phrase of this Ordinance, irrespective of the fact that any one or more sections, subsections, sentences, clauses, or phrases be declared unconstitutional.

Section 8. Effective and Operative Dates. This ordinance shall become effective 30 days after enactment. Enactment occurs when the Mayor signs the ordinance, the Mayor returns the ordinance unsigned or does not sign the ordinance within ten days of receiving it, or the Board of Supervisors overrides the Mayor's veto of the ordinance. This ordinance shall take effect and be in full force on and after either January 1, 2014 or its effective date if the effective date is later.

Section 9. Directions to Clerk. Upon final passage of this ordinance, the Clerk of the Board of Supervisors is hereby directed to transmit this ordinance with the Exhibit A attachment and the San Francisco modifications to the 2013 California Plumbing Code to the State Building Standards Commission pursuant to the applicable provisions of State law.

APPROVED AS TO FORM:
DENNIS J. HERRERA, City Attorney

By: Judith A. Boyajian
JUDITH A. BOYAJIAN
Deputy City Attorney

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FILE NO. 130840

# LEGISLATIVE DIGEST

[Plumbing Code - Repeal of Existing 2010 Code and Enactment of 2013 Edition]

**Ordinance repealing the 2010 Plumbing Code in its entirety and enacting a 2013 Plumbing Code consisting of the new model code, as amended by the State of California and as further amended by San Francisco; adopting environmental findings and findings of local conditions under the California Health and Safety Code; providing for an operative date of January 1, 2014; and directing the Clerk of the Board to forward the legislation to the State Building Standards Commission as required by State law.**

## Existing Law

The San Francisco Plumbing Code regulates the installation and maintenance of plumbing systems and fixtures, water heaters, water supply and distribution, sanitation and ventilation systems, drainage, fuel piping, and medical and gas vacuum systems. The current Code consists of the 2009 Uniform Plumbing Code, as amended by the 2010 California Plumbing Code, and as further amended by San Francisco.

## Amendments to Current Law

On January 1, 2014, a new California Plumbing Code will go into effect throughout the State. San Francisco's local amendments to the 2010 California Plumbing Code will not be carried forward unless re-enacted and made applicable to the 2013 California Plumbing Code. Therefore, as in past State code adoption cycles, San Francisco will repeal its existing Plumbing Code in its entirety and adopt a new Plumbing Code that consists of the new model code, as amended by the State of California, and as further amended by San Francisco. San Francisco's local amendments to the 2010 California Plumbing Code will be carried forward and made applicable to the 2013 California Plumbing Code with only minor technical changes.

The San Francisco amendments are not integrated into the text of the California Plumbing Code but rather are separately printed in a stand-alone document. Therefore, the user must consult both texts in order to determine the complete code requirement. In the San Francisco amendments, additions to the 2013 California Plumbing Code are shown in bold type; deletions are shown with strikethrough.

## Background Information

Generally, the State of California adopts a new California Building Standards Code every three years that goes into effect throughout the State 180 days after publication. In this Code cycle, the California Building Standards Code will go into effect on January 1, 2014. The California Building Standards Code is contained in Title 24 of the California Code of

Regulations, and consists of several parts that are based upon model codes with amendments made by various State agencies. The California Plumbing Code is Part 5 of Title 24 of the California Code of Regulations.

Local jurisdictions are required to enforce the California Plumbing Code. Local jurisdictions may also enact more stringent requirements than those contained in the State Code where more stringent requirements are reasonably necessary because of local conditions caused by climate, geology, or topography. The local amendments are not effective until findings supporting any amendments, additions, or deletions to the State Code are adopted and sent to the State Building Standards Commission.

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# EXHIBIT A

## STANDARD FINDINGS FOR SAN FRANCISCO BUILDING STANDARDS CODE AMENDMENTS:

1. Certain buildings/occupancies in San Francisco are at increased risk for earthquake-induced failure and consequent fire due to local hazardous microzones, slide areas, and local liquefaction hazards. (Geology)

2. Certain buildings/occupancies in San Francisco are at increased risk of fire due to high density of buildings on very small lots, with many buildings built up to the property lines. (Topography)

3. Topography of San Francisco has let to development of a high density of buildings on small lots, necessitating special provisions for exiting, fire separation, or fire-resistive construction. (Topography)

4. Many buildings are built on steep hills and narrow streets, requiring special safety consideration. (Topography)

5. Additional fire, structural and other protection is required due to high building density and crowded occupancy. (Topography)

6. San Francisco has narrow, crowded sidewalks due to building and population density and unusual topography. (Topography)

7. All rain water in San Francisco drains to the building drains and sewer; unusual geology, occasional extremely high local rainfall amounts, and the configuration of the City as a peninsula restrict the installation of separate storm water and sewer systems. (Topography, Climate, Geology)

8. Moist, corrosive atmosphere of salt-laden fog in San Francisco necessitates additional requirements. (Climate)

9. Not a building standard; no local findings required.

10. Soil conditions in this region induce adverse reactions with some materials, leading to premature failures and subsequent unsanitary conditions. (Climate)

11. The region is subject to fluctuating rainfall due to changes in climatic conditions. (Climate)

12. San Francisco is a peninsula surrounded on three sides by water at sea level;

mitigation of climate change impacts, including sea level rise, is critical to the long term protection of the local built environment and local infrastructure. (Topography)

13. Climate and potential climate change impacts San Francisco's water resources, including reservoirs and distribution facilities. (Climate)

14. Organic material in San Francisco's waste breaks down into methane gas which is a significant contributor to climate change. (Climate)

15. San Francisco is topographically constrained and its built environment occupies most available land, requiring minimization of debris and solid waste. (Topography)

16. Prevailing winds, coastal mountain ranges, and periodic seasonal high temperatures contribute to photochemical reactions that produce smog and ozone; limiting the emission of smog's chemical precursors - volatile organic chemicals and oxides of nitrogen - is necessary to health and safety. (Climate, Topography)

17. The aquifers underlying San Francisco are small relative to local population, necessitating ongoing water imports and special provisions to ensure efficient use of water in local buildings. (Geology)

# 2013 San Francisco Plumbing Code Findings

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| CHAPTER 15<br>No San Francisco Amendments | | CHAPTER 16 & 16A<br>No San Francisco Amendments | |
| Appendix A, B, D, G, H, I, J<br>No San Francisco Amendments | | | |

# PROPOSED SAN FRANCISCO PLUMBING CODE AMENDMENTS 2013 Edition

# CHAPTER 1 ADMINISTRATION

## DIVISION I CALIFORNIA ADMINISTRATION

*No San Francisco Plumbing Code Amendments.*

## DIVISION II ADMINISTRATION

### SECTION 101.0 – GENERAL

*101.1 Revise this section as follows:*

**101.1 Title.** This document shall be known as the "~~Uniform~~ **2013 San Francisco** Plumbing Code," may be cited as such, and will be referred to herein as "this code."

### SECTION 102.0 – ORGANIZATION AND ENFORCEMENT

*102.2 Add the following to the end of this section:*

**The Authority Having Jurisdiction, when necessary, may call upon the Police Department and other City and County of San Francisco agencies for aid or assistance in carrying out or enforcing any of the provisions of this code.**

*102.2.1 Revise the first paragraph of this section as follows:*

**102.2.1 Right of Entry.** Where it is necessary to make an inspection to enforce the provisions of this code **or other codes or ordinances**, or where the Authority Having Jurisdiction has reasonable cause to believe that there exists in a building or upon a premises a condition or violation of this code **or other codes or ordinances** that makes the building or premises unsafe, insanitary, dangerous or hazardous, the Authority Having Jurisdiction shall be permitted to enter the building or premises at reasonable times to

inspect or to perform the duties imposed upon the Authority Having Jurisdiction by this code **or other codes or ordinances**, provided that where such building or premises is occupied, the Authority Having Jurisdiction shall present credentials to the occupant and request entry. Where such building or premises is unoccupied, the Authority Having Jurisdiction shall first make a reasonable effort to locate the owner or other person having charge or control of the building or premises and request entry. Where entry is refused, the Authority Having Jurisdiction has recourse to every remedy provided by law to secure entry.

*102.2.3 Revise this section as follows:*

**102.2.3 Authority to Disconnect Utilities in Emergencies.** The Authority Having Jurisdiction shall have the authority to disconnect a 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. **For notification procedures, see Section 102A.16 of the Building Code.**

*102.2.6 Add the following section:*

**102.2.6 Rules and Regulations. The Authority Having Jurisdiction shall have the power to render interpretations of this code and to adopt and enforce rules and supplemental regulations to clarify the application of its provisions. Such interpretations, rules and regulations shall be in conformance with the intent and purpose of this code. Such rules and regulations, commonly referred to as "Code Rulings" and "Administrative Bulletins" supplemental to this code, shall not take effect until approved by the Building Inspection Commission and signed by the Authority Having Jurisdiction except in unusual circumstances where the Authority Having Jurisdiction has determined that there is an immediate need to protect the public health and safety. When the Authority Having Jurisdiction finds that such circumstances exist, the Authority Having Jurisdiction may order immediate enforcement of a particular rule or regulation. The Authority Having Jurisdiction shall arrange for a subscription service to such rules and regulations, the entire cost of which is to be borne by the subscribers.**

*102.2.7 Add the following section:*

**102.2.7 Code Revisions. The Authority Having Jurisdiction shall transmit to the Building Inspection Commission, at intervals not exceeding three years, recommendations for changes to this code, based on studies of the following:**

**1. Requests of the Board of Examiners for variances from this code, and for approvals of alternate materials, alternate designs and methods of construction.**

**2. Code changes recommended by the Board of Examiners.**

**3. Code changes recommended by the Code Advisory Committee or other bodies subordinate to the Building Inspection Commission.**

**4. Results obtained and problems encountered in legal actions taken to correct code violations.**

**5. Changes or improvements in materials, methods of construction or design, and changes proposed by interested persons.**

**6. Investigations of fire and structural damage to buildings, and of determination of**

**unsatisfactory building performance.**

**7. Periodic changes to the California Plumbing Code and other State regulations which may affect this code.**

**8. Administrative Bulletins and Code Rulings currently in effect.**

**9. Violations of the code found on inspections or investigations.**

*102.2.8 Add the following section:*

**102.2.8 Modifications. When there are practical difficulties involved in carrying out the provisions of this code, the Authority Having Jurisdiction may grant modifications for individual cases. The Authority Having Jurisdiction shall first find that a special individual reason makes the strict letter of this code impractical and that the modification is in conformance with the intent and purpose of this code and that such modification does not lessen the standard of this code to safeguard life or limb, health, property, or public welfare. The details of any action granting modifications shall be recorded and entered in the files of the Department of Building Inspection.**

*102.5 Replace this section as follows:*

**102.5 Penalties. Any person, the owner or the owner's authorized agent, who violates, disobeys, omits, neglects or refuses to comply with, or resists or opposes the execution of any of the provisions of this code, shall be liable for a civil penalty, not to exceed $500 for each day such violation is committed or permitted to continue, which penalty shall be assessed and recovered in a civil action brought in the name of the people of the City and County of San Francisco by the City Attorney in any court of competent jurisdiction. Any penalty assessed and recovered in an action brought pursuant to this paragraph shall be paid to the City Treasurer and credited to the Department of Building Inspection's Special Fund.**

**Any person, the owner or the owner's authorized agent, who violates, disobeys, omits, neglects or refuses to comply with, or who resists or opposes the execution of any of the provisions of this code, shall be guilty of a misdemeanor, and upon conviction thereof shall be punished by a fine not exceeding $500 or by imprisonment not exceeding six months, or by both such fine and imprisonment, unless otherwise provided in this code, and shall be deemed guilty of a separate offense for every day such violation, disobedience, omission, neglect or refusal shall continue. Any person who shall do any work in violation of any of the provisions of this code, and any person having charge of such work who shall permit it to be done, shall be liable for the penalty provided.**

**It shall be unlawful for any person to interfere with the posting of any notice provided for in this code or to tear down or mutilate any such notice posted by the Department of Building Inspection.**

## SECTION 103.0 – PERMITS AND INSPECTIONS

*103.1 Add the following second paragraph of this section:*

**Emergency work for the protection of life or limb, health, property and public welfare shall**

**have a permit obtained within one day of commencing such work, excluding Saturdays, Sundays and legal holidays.**

*103.1.1 Replace Section 103.1.1(1) and the first paragraph of Section 103.1.1(2) as follows:*

**103.1.1 Exempt Work.** A permit shall not be required for the following:

**(1) Repair of leaks not requiring cutting into or removing piping.**

**(2) Unstopping of traps, sewers, vents or waste pipes not requiring cutting into or removal of traps or piping.**

**(3) Replacement, repair or maintenance of faucets, valves, hose bibbs or roof drain not requiring cutting into or removal of piping.**

**(4) Replacement of toilets ~~with 1.6 gallon (6.06 liter) per flush toilet fixtures~~ except in structures with alternate water piping.**

**(5) Replacement of furnace filters.**

**(6) Removal of drainage, water or gas piping from a building when the water supply, gas and drainage lines have been disconnected in an approved manner under a permit.**

**(7) Work involved in setting up for display of plumbing fixtures or appliances, when not connected to any supply or drainage lines, in a sales establishment.**

**~~(8) Installation of plumbing systems installed by a utility in the operation of their utility business.~~**

**~~(9)~~ (8) Replacement of water conservation devices not requiring cutting into or removal of piping.**

**~~(10)~~ (9) Work performed in buildings or structures owned and occupied by the State and Federal governments.**

*103.1.3 Add the following section:*

**103.1.3 Homeowner's Permit. A permit for plumbing work in, on or about a single-family dwelling may be issued by the Authority Having Jurisdiction, provided said work is done by the owner or a family member who has demonstrated, to the satisfaction of the administrative authority, his or her qualifications to satisfactorily perform the plumbing work in the dwelling which is, or is intended to be, occupied by the owner. If the plumbing work performed under the homeowner's permit does not comply with the requirements of this code and if the corrections are not made as required by the Department of Building Inspection, then the work shall be corrected by a State-licensed plumbing contractor under a separate permit.**

**Such State-licensed plumbing contractor shall be required to pay only the permit issuance fee as set forth in Section 110A, Table 1A-C – Plumbing/Mechanical Permit Issuance and Inspection Fees - of the Building Code. If additional inspection is required, the appropriate fees as set forth in**

**Section 110A, Table 1A-C - Plumbing/Mechanical Permit Issuance and Inspection Fees and Table 1A-G - Inspection, Surveys and Reports - of the Building Code shall apply.**

*103.1.4 Add the following section:*

**103.1.4 Amending Applications. After a permit has been issued and an inspection of the work has been made, the scope of the permit may be altered by filing an amended permit application and paying fees for any additional work as set forth in Table 1A-C - Plumbing/Mechanical Permit Issuance and Inspection Fees and Table 1A-G - Inspections, Survey, and Reports of Section 110A of the Building Code.**

*103.2 Replace this section as follows:*

**103.2 Application. Permit applicants shall file with the Department of Building Inspection an application on a form furnished for that purpose.**

**A permit for inspection of the proposed plumbing work set forth in the application will be issued to State-licensed contractors or to homeowners subject to the requirements of Section 103.1.3 A separate permit shall be obtained for each separate building, structure or property.**

*103.3 Replace this section as follows:*

**103.3 Permit Issuance. An issued permit entitles the permittee to proceed with the work described therein. The issuance of a permit does not constitute approval of any work done under that permit. Permits shall not be transferable.**

*103.3.3 Replace this section as follows:*

**103.3.3 Permit Expiration. Plumbing permits expire per Section 106A.4.4 of the San Francisco Building Code. Permit fees may be partially refunded if a written cancellation request is made to the Building Official prior to commencement of the permitted work and within 90 days of the date of permit issuance. See Section 110A, Table 1A-R - Refunds - of the Building Code for refunds.**

*103.3.3.1 Add the following section:*

**103.3.3.1 Commencement of Work on Permit Expired Due to Work Not Started. A new permit shall be obtained to undertake the work described on an expired permit on which no work was performed. If not more than one year has elapsed since the expiration of the original permit, the applicant is eligible for reduced fees. See Section 110A, Table 1A- B – Other Building Permit and Plan Review Fees - of the Building Code for applicable fees.**

**If a refund has been granted per Section 103.3.3, the applicant shall not be eligible for the reduced fees as set forth in Section 110A, Table 1A-B - Other Building Permit and Plan Review Fees - of the Building Code.**

*103.3.3.2 Add the following section:*

**103.3.3.2 Recommencement of Work on Permit Expired Due to Work Not Completed. The applicant shall obtain a new permit for the work not completed. The permit fee shall be based on**

work remaining to be done. Fees shall be as set forth in Section 110A, Table 1A-C – Plumbing/Mechanical Permit Issuance and Inspection Fees - of the Building Code.

*103.4 Replace this section as follows:*

**103.4 Permit Fees.** Before any permit is issued, the applicant shall pay to the Central Permit Bureau the fees as set forth in Section 110A, Table 1A-C – Plumbing/Mechanical Permit Issuance and Inspection Fees - of the Building Code. The replacement of a plumbing fixture or a gas appliance without a change in drainage, piping or venting shall not require the payment of permit issuance fee. A separate permit issuance fee shall be paid for each class of work, i.e., sewers and drainage, gas and water.

Final inspection will not be made unless all outstanding fees related to the permit work have been paid.

*103.4.1 Replace the following section:*

**103.4.1 Inspections Not Covered by Permit Fees.**

103.4.1.1 Off Hours of Inspection. Off-hour inspection may be performed outside normal inspection hours by prior arrangement and prepayment of fees as set forth in Section 110A, Table 1A-G - Inspections, Surveys and Reports - of the Building Code.

103.4.1.2 Reinspections. A reinspection fee shall be assessed for each inspection or reinspection made necessary by any of the following conditions:

(1) When the portion of the work for which the inspection is requested is not complete or code complying.

(2) When previously identified deficiencies in the work are not properly corrected.

(3) When the approved construction documents are not available to the inspector.

(4) When access is not provided on the date and time of the inspection appointment.

(5) When work deviates from the approved construction documents.

The first reinspection for failure to comply with code requirements shall not be assessed a reinspection fee. All subsequent reinspections for the same or subsequent errors or omissions shall be charged a reinspection fee.

Subsequent to inspector determination of reinspection fee requirements, no required or requested inspections shall be made nor shall the job be given a certificate of final completion and occupancy or final approval until the required reinspection fees are paid. See Section 110A, Table 1A-G - Inspections, Surveys and Reports - of the Building Code for applicable fees.

103.4.1.3 Survey. A plumbing survey may be requested when a plumbing inspector's assistance is desired to establish code compliance of existing or proposed plumbing system requirements. See Section 110A, Table 1A-G - Inspections, Surveys and Reports - of the Building Code for applicable

**fees.**

*103.4.3.1 Revise this section as follows:*

**103.4.3.1 Fees.** An investigation fee, in addition to the permit fee, shall be collected whether or not a permit is then or subsequently issued. **See Section 110A, Table 1A-C – Plumbing/Mechanical Permit Issuance and Inspection Fees, and Table 1A-K - Penalties, Hearings, Code Enforcement Assessments- of the Building Code for applicable fees.** ~~The investigation fee shall be equal to the amount of the permit fee that is required by this code if a permit were to be issued.~~ The payment of such investigation fee shall not exempt a person from compliance with other provisions of this code, nor from a penalty prescribed by law.

**The Director may reduce the investigation fee to two times the amount of the permit fee as called for in Section 110A, Table 1A-C - Plumbing/Mechanical Permit Issuance and Inspection Fees - of the Building Code for work that was constructed prior to the current building ownership or for work without permit which was done prior to January 1, 1967, if the owner files with the Director a notarized affidavit together with documents substantiating such dates of work.**

**Appeals of investigation fees may be filed with the Board of Appeals in the manner provided in Part III of the San Francisco Municipal Code. Such filing shall be subject to the fees and rules of the Board of Appeals. The Board of Appeals, in reviewing the appeal, may reduce the appealed amount to not less than two times the permit fee as set forth in Section 110A, Table 1A-C- Plumbing/Mechanical Permit Issuance and Inspection Fees - of the Building Code.**

*103.4.4 Replace this section as follows:*

103.4.4 Fee Refunds. ~~The Authority Having Jurisdiction shall be permitted to authorize the refunding of a fee paid hereunder that was erroneously paid or collected.~~ **For fee refunds, see Section 107A.6 of the Building Code.**

*103.5.9 Revise the fourth paragraph as follows:*

To obtain reinspection, the applicant shall file an application therefore in writing upon a form furnished for that purpose and pay the reinspection fee in accordance with ~~Table 103.4~~ **Section 110A, Table 1A-G - Inspections, Surveys and Reports - of the Building Code.**

## SECTION 104.0 – ABATEMENT OF PUBLIC NUISANCE

*104.0 Add the following section:*

**104.0 Abatement of Public Nuisance**

**In order to abate a nuisance as defined in Section 216.0 of this code, the inspection and abatement procedures as set forth in Section 102A of the Building Code shall apply.**

## SECTION 105.0 – BOARD OF EXAMINERS

*105.0 Add the following section:*

**105.0 Board of Examiners**

**Application may be made to the Board of Examiners for approval of alternate materials, methods and types of construction and for variances from the provisions of this code. See Building Code, Section 105A.1.**

## SECTION 106.0 – REPAIRS TO DEFECTIVE BUILDING SEWERS

*106.0 Add the following section:*

**106.0 Repairs to Defective Building Sewers**

**106.1 General. Any defective building sewer found to be a nuisance or hazardous to the public shall be repaired at the owner's expense by a licensed plumbing contractor in accordance with this code. In the event the owner fails to repair the defective building sewer after written notice has been sent the owner by the Authority Having Jurisdiction, the Authority Having Jurisdiction shall abate the condition in accordance with Section 102A of the Building Code.**

**106.2 Cost of Repairs by City and County of San Francisco. Whenever the Authority Having Jurisdiction, pursuant to the authority conferred by this code and the Building Code, shall cause a building sewer to be repaired or replaced, the cost thereof shall be paid from the "Plumbing Building Sewer Revolving Fund" and assessed against the property served by said building sewer.**

**106.3 Plumbing Building Sewer Revolving Fund. A special revolving fund, to be known as the "Plumbing Building Sewer Revolving Fund," is hereby created for the purpose of defraying the costs and expenses which may be incurred by the Department of Building Inspection in carrying out the authority conferred by this code to repair or replace defective building sewers.**

**The Board of Supervisors shall transfer one half of the funds appropriated to the "Side Sewer Repair" fund of the Department of Building Inspection or shall appropriate, establish or increase the special revolving fund with such funds as it may deem necessary in order to expedite performance of the work of repairing or replacing defective building sewers. The special revolving fund shall be replenished with all funds collected under the proceeding hereinafter provided for, either upon voluntary payments or as a result of the sale of the property after delinquency, or otherwise. Balances remaining in the Plumbing Building Sewer Revolving Fund at the close of any fiscal year shall be carried forward in such fund.**

**106.4 Assessment for Costs. The Authority Having Jurisdiction shall take action to have the costs of all work done or caused to be done pursuant to this section assessed against the parcel or parcels of land upon which said building is served by the building sewer per Section 102A of the Building Code. Such costs shall include, in addition to all costs related to repairing or replacing the building sewer or demolishing and clearing the site, the City and County of San Francisco's costs in administering the required work. See Section 110A, Table 1A-K - Penalties, Hearings, Code Enforcement Assessments - of the Building Code for the applicable fee.**

# CHAPTER 2
# DEFINITIONS

## SECTION 201.0 – GENERAL

*201.1 Add the following to the end of the first sentence:*

**Where words, terms and phrases are not defined, they shall have their ordinary accepted meaning within the context with which they are used.**

## SECTION 204.0 – B

*204.0 Add the following definition:*

**Boiler - A closed vessel used for heating water or liquid, or for generating steam or vapor by direct application of heat from combustible fuels or electricity.**

## SECTION 208.0 – F

*208.0 Add the following definition:*

**Foot Vent - See "Relief Vent," Section 220.0.**

## SECTION 216.0 – N

*216.0 Add the following items after Item (3) under definition of "Nuisance":*

**(4) Open, unsecured, leaking, plugged or otherwise defective sewer, gas or water lines.**

**(5) Inadequate plumbing system maintenance, dilapidation, obsolescence, or damage.**

**(6) Plumbing or plumbing fixtures, gas appliances or piping installed in violation of this code or without permit.**

**(7) Where a change in occupancy classification is made without complying with the applicable provisions of this code and the Building Code.**

## SECTION 218.0 – P

*218.0 Revise this definition as follows:*

**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**, and fire sprinkler systems. Plumbing systems shall include all plumbing appliances, plumbing appurtenances and plumbing fixtures.**

## SECTION 221.0 – S

*221.0 Add the following definition:*

**Story - That portion of a building included between the upper surface of any floor and the upper surface of the floor next above. For the purposes of this code, balcony, loft and mezzanine levels that contain plumbing outlets are also to be considered as stories.**

# CHAPTER 3
# GENERAL REGULATIONS

## SECTION 313.0 – HANGERS AND SUPPORTS

*313.8 Add the following section:*

**313.8 Materials**

**313.8.1 Plumber's tape hanger iron may be used to secure pipe not greater than 2 inches (50.8 mm) in diameter.**

**313.8.2 Hanger iron shall be galvanized and not thinner than 22 gauge, 1/32-inch thick (0.8 mm) and 3/4-inch (19.05 mm) wide, securely nailed or screwed to the structure. When the strap-iron is formed around the pipe, it shall be secured with a 1/4-inch (6.35 mm) stove bolt.**

# CHAPTER 4
# PLUMBING FIXTURES AND FIXTURE FITTINGS

## SECTION 403.3 – URINALS

*403.3.1 Revise this section as follows:*

403.3.1 Nonwater Urinals. Nonwater urinals shall be listed and comply with the applicable standards referenced in Table 1401.1. Nonwater urinals shall have a barrier liquid sealant to maintain a trap seal. Nonwater urinals shall permit the uninhibited flow of waste through the urinal to the sanitary drainage system. Nonwater urinals shall permit the uninhibited flow of waste through the urinal to the sanitary drainage system. Nonwater urinals shall be cleaned and maintained in accordance with the manufacturer's instructions after installation. **Where nonwater urinals are installed, not less than one water supplied fixture rated at not less than 1 water supply fixture unit (WSFU) shall be installed upstream on the same drain line to facilitate drain line flow and rinsing.** Where nonwater urinals are installed they shall have a water distribution line rough-in to the urinal location to allow for the

installation of an approved backflow prevention device in the event of a retrofit.

## SECTION 406.0 – PROHIBITED FIXTURES

*406.0 Add the following section:*

**406.4 Watercloset-Sink Combinations. Watercloset-Sink combinations are not allowed in structures with treated alternate water piping.**

## SECTION 422.0 – MINIMUM NUMBER OF REQUIRED FIXTURES

*422.1 Replace this section as follows:*

422.1 **Fixture Count.** Plumbing fixtures shall be provided ~~for the type of building occupancy and in the minimum number shown in table 422.1. The total occupant load and occupancy classification shall be determined in accordance with the building code. Occupancy classification not shown in table 422.1 shall be considered separately by the Authority Having Jurisdiction.~~ **in accordance with Section 2902 of the Building Code.**

*Table 422.1 Add a note under the title as follows:*

**TABLE 422.1**

**Minimum Plumbing Facilities**

**NOTE : This Table is not applicable in San Francisco.**

**Refer to Table 2902.1 of the Building code.**

**EXCERPT FROM THE 2013 SAN FRANCISCO BUILDING CODE**

**Table 2902.1 of the San Francisco Building code has been inserted below for your convenience.**

**TABLE 2902.1 – MINIMUM PLUMBING FIXTURES [1, 2, 3]**

| TYPE OF BUILDING OR OCCUPANCY[4] | WATER CLOSETS[5] (Fixtures per person) | | LAVATORIES[5] (Fixtures per person) | | BATHTUB OR SHOWER (Fixtures per person) |
|---|---|---|---|---|---|
| | Male | Female | Male | Female | |
| For the occupancies listed below, use 30 square feet (2.78 $m^2$) per occupant for the minimum number of plumbing fixtures. | | | | | |
| Group A | | | | | |

| TYPE OF BUILDING OR OCCUPANCY[4] | WATER CLOSETS[5] (Fixtures per person) | | LAVATORIES[5] (Fixtures per person) | | BATHTUB OR SHOWER (Fixtures per person) |
|---|---|---|---|---|---|
| | Male | Female | Male | Female | |
| Conference rooms, dining rooms, drinking establishments, exhibit rooms, gymnasiums, lounges, stages and similar uses including restaurants classified as Group B occupancies | 1:1-25 | 1:1-25 | one for each water closet up to four; then one for each two additional water closets | | |
| | 2:26-75 | 2:26-75 | | | |
| | 3:76-125 | 3:76-125 | | | |
| | 4:126-200 | 4:126-200 | | | |
| | 5:201-300 | 5:201-300 | | | |
| | 6:301-400 | 6:301-400 | | | |
| Over 400, add one fixture for each additional 200 males or 150 females. | | | | | |
| For the assembly occupancies listed below, use the number of fixed seating or, where no fixed seating is provided, use 15 square feet (1.39 m2) per occupant for the minimum number of plumbing fixtures. | | | | | |
| Assembly places– Auditoriums, convention halls, dance floors, lodge rooms, stadiums and casinos | 1:1-50 | 3:1-50 | 1:1-200 | 1:1-200 | |
| | 2:51-100 | 4:51-100 | 2:201-400 | 2:201-400 | |
| | 3:101-150 | 6:101-200 | 3:401-750 | 3:401-750 | |
| | 4:151-300 | 8:201-400 | Over 750, add one fixture for each additional 500 persons | | |
| | Over 300 males, add one fixture for each additional 200, and over 400 females add one for each 125. | | | | |
| For the assembly occupancies listed below, use the number of fixed seating or, where no fixed seating is provided, use 30 square feet (2.29 m2) per occupant for the minimum number of plumbing fixtures. | | | | | |
| Worship places | | | | | |
| Principal assembly area | one per 150 | one per 75 | one per two water closets | | |
| Worship places | | | | | |
| Educational and activity unit | one per 125 | one per 75 | one per two water closets | | |

| TYPE OF BUILDING OR OCCUPANCY[4] | WATER CLOSETS[5] (Fixtures per person) | | LAVATORIES[5] (Fixtures per person) | | BATHTUB OR SHOWER (Fixtures per person) |
|---|---|---|---|---|---|
| | Male | Female | Male | Female | |
| For the occupancies listed below, use 200 square feet (18.58 $m^2$) per occupant for the minimum number of plumbing fixtures. | | | | | |
| Group B | | | | | |
| Offices or public buildings | 1:1-15 | 1:1-15 | one per two water closets | | |
| | 2:16-35 | 2:16-35 | | | |
| | 3:36-55 | 3:36-55 | | | |
| | Over 55, add one for each 50 persons. | | | | |
| For the occupancies listed below, use 50 square feet (4.65 $m^2$) per occupant for the minimum number of plumbing fixtures. | | | | | |
| Group E | 1:1-15 | 1:1-15 | one per 40 | one per 40 | |
| Schools–for staff use | 2:16-35 | 2:16-35 | | | |
| All schools | 3:36-55 | 3:36-55 | | | |
| | Over 55, add one fixture for each additional 40 persons. | | | | |
| Schools–for student use | 1:1-20 | 1:1-20 | 1:1-25 | 1:1-25 | |
| Day care | 2:21-50 | 2:21-50 | 2:26-50 | 2:26-50 | |
| | Over 50, add one fixture for each additional 50 persons. | | Over 50, add one fixture for each additional 50 persons. | | |
| Elementary | one per 30 | one per 25 | one per 35 | one per 35 | |
| Secondary | one per 40 | one per 30 | one per 40 | one per 40 | |

*(Continued)*

| TYPE OF BUILDING OR OCCUPANCY[4] | WATER CLOSETS[5] (Fixtures per person) | | LAVATORIES[5] (Fixtures per person) | | BATHTUB OR SHOWER (Fixtures per person) |
|---|---|---|---|---|---|
| | Male | Female | Male | Female | |
| For the occupancies listed below, use 50 square feet (4.65 $m^2$) per occupant for the minimum number of plumbing fixtures. | | | | | |
| Education Facilities other than Group E | | | | | |
| Others (colleges, universities, adult centers, etc.) | one per 40 | one per 30 | one per 40 | one per 40 | |
| For the occupancies listed below, use 2,000 square feet (185.8 $m^2$) per occupant for the minimum number of plumbing fixtures. | | | | | |
| Group F | 1:1-10 | 1:1-10 | one for each two water closets | | one shower for each 15 persons exposed to excessive heat or to skin contamination with irritating materials |
| Workshop, foundries and similar establishments, and Group H Occupancies | 2:11-25 | 2:11-25 | | | |
| | 3:26-50 | 3:26-50 | | | |
| | 4:51-75 | 4:51-75 | | | |
| | 5:76-100 | 5:76-100 | | | |
| | Over 100, add one fixture for each additional 300 persons. | | | | |
| For the occupancies listed below, use the designated application and 200 square feet (18.58 $m^2$) per occupant of the general use area for the minimum number of plumbing fixtures. | | | | | |
| Group I | | | | | |
| Hospital waiting rooms | one per room (usable by either sex) | | one per room | | |
| Hospital general use areas | 1:1-15 | 1:1-15 | one per each two water closets | | |
| | 2:16-35 | 3:16-35 | | | |
| | 3:36-55 | 4:36-55 | | | |
| | Over 55, add one fixture | | | | |

| TYPE OF BUILDING OR OCCUPANCY[4] | WATER CLOSETS[5] (Fixtures per person) | | LAVATORIES[5] (Fixtures per person) | | BATHTUB OR SHOWER (Fixtures per person) |
|---|---|---|---|---|---|
| | Male | Female | Male | Female | |
| | for each additional 40 persons. | | | | |
| Hospital patient room | one per room | | one per room | | one per room |
| Hospital ward room | one per eight patients | | one per 10 patients | | one per 20 patients |
| Jails and reformatories | | | | | |
| Cell | one per cell | | one per cell | | |
| Exercise room | one per exercise room | | one per exercise room | | |
| Other institutions (on each occupied floor) | one per 25 | one per 25 | one per 10 | one per 10 | one per eight |
| For the occupancies listed below, use 200 square feet (18.58 $m^2$) per occupant for the minimum number of plumbing fixtures. | | | | | |
| Group M | | | | | |
| Retail or wholesale stores | 1:1-50 | 1:1-50 | one for each two water closets | | |
| | 2:51-~~200~~100 | 2:51-100 | | | |
| | 3:101-400 | ~~2~~3:101-200 | | | |
| | | 4:201-300 | | | |
| | | 5:301-400 | | | |
| | Over 400, add one fixture for each additional 500 males and one for each 150 females. | | | | |
| For Group R Occupancies, dwelling units and hotel guest rooms, use the chart. For congregate residences, use 200 square feet (18.58 $m^2$) for Group R, Division I Occupancies and 300 square feet (27.87 $m^2$) for Group R, Division 3 Occupancies for the minimum plumbing fixtures. | | | | | |
| Group R | | | | | |

| TYPE OF BUILDING OR OCCUPANCY[4] | WATER CLOSETS[5] (Fixtures per person) | | LAVATORIES[5] (Fixtures per person) | | BATHTUB OR SHOWER (Fixtures per person) |
|---|---|---|---|---|---|
| | Male | Female | Male | Female | |
| Dwelling units | one per dwelling unit | | one per dwelling unit | | one per dwelling unit |
| Hotel guest rooms | one per guest room | | one per guest room | | one per guest room |
| Congregate residences | one per 10 | one per 8 | one per 12 | one per 12 | one per eight |
| | Add one fixture for each additional 25 males and one for each additional 20 females. | | Over 12, add one fixture for each additional 20 males and one for each additional 15 females. | | For females, add one bathtub per 30. Over 150, add one per 20. |

*(Continued)*

| TYPE OF BUILDING OR OCCUPANCY[4] | WATER CLOSETS[5] (Fixtures per person) | | LAVATORIES[5] (Fixtures per person) | |
|---|---|---|---|---|
| | Male | Female | Male | Female |
| For the occupancies listed below, use 5,000 square feet (464.5 m2) per occupant for the minimum number of plumbing fixtures. | | | | |
| Group S Warehouses | 1:1-10 | 1:1-10 | one per 40 occupants of each sex | one shower for each 15 persons exposed to excessive heat or to skin contamination with poisonous, infectious or irritating materials |
| | 2:11-25 | 2:11-25 | | |
| | 3:26-50 | 3:26-50 | | |
| | 4:51-75 | 4:51-75 | | |
| | 5:76-100 | 5:76-100 | | |
| | Over 100, add one for each 300 males and females. | | | |

NOTE: Occupant loads over 30 shall have one drinking fountain for each 150 occupants.

1 The figures shown are based on one fixture being the minimum required for the number of persons indicated or any fraction thereof.

| TYPE OF BUILDING OR OCCUPANCY[4] | WATER CLOSETS[5] (Fixtures per person) | | LAVATORIES[5] (Fixtures per person) | |
|---|---|---|---|---|
| | Male | Female | Male | Female |

2 Drinking fountains shall not be installed in toilet rooms.

3 When the design occupant load is less than 10 persons, a facility usable by either sex may be approved by the building official.

4 Any category not mentioned specifically or about which there are any questions shall be classified by the building official and included in the category which it most nearly resembles, based on the expected use of the plumbing facilities.

5 Where urinals are provided, one water closet less than the number specified may be provided for each urinal installed, except the number of water closets in such cases shall not be reduced to less than one half of the minimum specified.

6 Twenty-four inches (610 mm) of wash sink or 18 inches (457 mm) of a circular basin, when provided with water outlets for such space, shall be considered equivalent to one lavatory.

# CHAPTER 5
# WATER HEATERS

## SECTION 604.0 – WATER HEATER REQUIREMENTS

*504.1 Add the first paragraph to the section:*

**504.1 Location.** Water Heaters mounted on the exterior of a building and located 7' or more above grade shall require an approved means for service or replacement.

# CHAPTER 6
# WATER SUPPLY AND DISTRIBUTION

## SECTION 603.0 – CROSS-CONNECTION CONTROL

*603.1 Add a new third paragraph to this section as follows:*

Structures with alternate water piping shall have an Reduced-Pressure Principle Backflow

**Prevention Assembly installed on the domestic supply as close as practical to the meter.**

*603.5.6.4 Add the following section:*

**603.5.6.4 All such installations shall be approved in writing by the San Francisco Water Department prior to installation.**

## SECTION 604.0 – MATERIALS

*604.1 Add the following sentence to the end of the second paragraph:*

**Connections between copper water piping and ferrous materials shall be made with dielectric or insulated fittings or brass nipples of 6 inches (152.4 mm) minimum length.**

## SECTION 606.0 – VALVES

*606.8 Add the following section:*

**606.8 All buildings four stories or more in height or water supply greater than 40 feet above the water meter shall have an approved backflow assembly installed as near as possible to the water meter and before the first fitting or branch line. The backflow assembly installed shall be in accordance to the degree of hazard within the building, but in no case less than an approved double check assembly. See Table 603.2.**

## SECTION 609.0 – INSTALLATION, TESTING, UNIONS AND LOCATION

*609.10.2 Add the following section:*

**609.10.2 Air Chambers. Air chambers shall be installed on all hot and cold water outlets supplying quick-acting valves to provide water hammer relief. The size of each air chamber shall be 24 times the diameter of the fixture supply.**

*609.10.3 Add the following section:*

**609.10.3 Quick-Acting Valves. The following valves shall be considered quick-acting: flushometers, single-handle faucets, single- handle tub and tub/shower combination control valves, single-handle shower control valves, rapid response electric solenoid valves (such as used on ice-makers, clothes washers, etc.) and any other appliance or fixture that dispenses water in a quick open and close method in its operation.**

# CHAPTER 7
# SANITARY DRAINAGE

## SECTION 701.0 – MATERIALS

*701.1(2) (A) Revise this section as follows:*

*(A) ~~[HCD1 & HCD 2]~~* ABS and PVC installations are limited to not more than two stories of **Commercial or private** ~~areas of~~ residential accommodations.

*701.1(3) Revise this section as follows:*

701.1(3) No vitrified clay pipe or fittings shall be used above-ground or where pressurized by a pump or ejector **or underground within the foundation line of the building.** They shall be kept not less than 12 inches (305 mm) belowground.

*701.1(7) Add the following section:*

**701.1(7) Copper tubing shall not be used for urinal drainage or applications which are detrimental to the integrity of copper tubing.**

## SECTION 706.0 – CHANGES IN DIRECTION OF DRAINAGE FLOW

*706.4 Revise this section as follows:*

706.4 Vertical drainage lines connecting with horizontal drainage lines shall enter through 45 degree (0.79 rad) wye branches, combination wye and one-eighth bend branches, or other approved fittings of equivalent sweep. Branches or offsets of 60 degrees (1.05 rad) shall be permitted to be used where installed in a true vertical position. **In buildings more than three stories in height, any fixture within 10 feet (304 mm) of the connection of the vertical to horizontal change shall enter the horizontal drainage line at least 10 feet (304 mm) downstream from the change or may connect into the next vertical downstream line.**

## SECTION 710.0 – DRAINAGE OF FIXTURES LOCATED BELOW THE NEXT UPSTREAM MANHOLE OR BELOW THE MAIN SEWER LEVEL

*710.1.1 Add the following section:*

**710.1.1 Drainage of Fixtures Located Below the Fresh Air Inlet. Where a fixture is installed with the flood rim level equal to or lower than the elevation of the fresh air inlet serving the house trap, the piping serving the fixture shall be protected by installing an approved type of backwater valve. Where a fixture is installed with the flood rim level higher than the elevation of the fresh air inlet serving the house trap, the fixture shall not discharge through such backwater valve.**

# CHAPTER 8
# INDIRECT WASTES

*No San Francisco Plumbing Code Amendments.*

# CHAPTER 9
# VENTS

## SECTION 901.0 – GENERAL

*901.1. Add second paragraph to this section as follows:*

**No mechanical device shall be installed in any venting system. Such venting system shall remain unobstructed to an approved termination.**

## SECTION 907.0 – VENT STACKS AND RELIEF VENTS

*907.1 Revise this section as follows:*

907.1 Drainage Stack. Each drainage stack that extends ~~10~~ **six (6)** or more stories above the building drain or other horizontal drain, shall be served by a parallel vent stack, which shall extend undiminished in size from its upper terminal and connect to the drainage stack at or immediately below the lowest fixture drain. Each such vent stack shall also be connected to the drainage stack at each fifth floor, counting down from the uppermost fixture drain, by means of a yoke vent, the size of which shall be not less in diameter than either the drainage or the vent stack, whichever is smaller.

*907.3 Add the following section:*

**907.3 Vent Stacks and Relief Vents. Every building in which plumbing is installed shall have at least one main stack which shall run undiminished in size and as directly as possible from each building drain serving said building through to the open air above the roof.**

**For the purposes of this section, the main stack shall be defined as the largest size stack that is connected to a building drain or sewer.**

**A vent stack shall be installed with a soil or waste stack whenever relief vents or other branch vents are required in two or more branch intervals. A vent stack shall be installed in accordance with Section 706.1.**

**The size of the soil stack shall be determined by the total fixture units on that stack as per Table 703.2.**

# CHAPTER 10
# TRAPS AND INTERCEPTORS

## SECTION 1008.0 – BUILDING TRAPS

*1008.1 Revise this section as follows:*

**1008.1 General**

Building traps shall not be installed except where required by the Authority Having Jurisdiction. Each building trap where installed shall be provided with a cleanout and with a relieving vent or fresh-air intake on the inlet side of the trap~~, which need not be larger than one-half the diameter of the drain to which it connects. Such relieving vent or fresh-air intake shall be carried above grade and terminate in a screened outlet located outside the building~~. **Such trap shall have a fresh air inlet of not less than 4 inch (101.6 mm) diameter pipe. The inlet shall be covered by an approved perforated plate not less than 16 square inches (102323.mm$^2$). Perforations shall be not more than 3/8 inch (9.6 mm) diameter and provide an aggregate open area of not less than one-half the cross-sectional area of the sewer trap. The air inlet shall be connected to the building side of the trap and shall lead to the open air, terminating at a point not less than 10 feet (304 mm) from any window or door.**

## SECTION 1016.0 – SAND INTERCEPTORS

*1016.3 Add the following section:*

**1016.3.1 When drains are provided for planter boxes, such drains shall enter into the sanitary or storm drainage plumbing system by discharging into an approved sump, receiving tank or sand settling tank. No trap shall be installed between the planter box and any approved receptor. Sizes of drains shall conform to Table 703.2.**

**Catch basins or sumps to drain surface water or collect subsoil drainage shall meet the following requirements:**

**(1) The catch basin or sump shall be poured in place, and all sides and bottom shall be watertight.**

**(2) A removable metal grill approved for applied design loads shall be placed on top.**

**(3) Each catch basin shall be served with its own trap and cleanout, and shall connect to the storm or sanitary system independently.**

**(4) If inlet is located below the building sewer or drain, a sump pump minimum of 1-1/2" (38.1 mm) outlet may be used. The bottom of sump shall maintain a 1'- 0" (25.4 mm) distance from the inlet, creating a 1' - 0" (25.4 mm) sand trap.**

**(5) If the depth of the sump is over 5' - 0" (1.52 m) a larger catch basin shall be required with a permanent ladder securely bolted to the interior to provide access for maintenance. A minimum clear space of 30" × 30" (762 mm × 762 mm) shall be provided.**

**(6) A listed and approved plastic catch basin may be installed in areas of residential buildings that are not subjected to any vehicular traffic and shall be installed on a concrete base to prevent settling, provided all other code requirements of this section and the listing and installation requirements of such catch basin are met.**

# CHAPTER 11
# STORM DRAINAGE

## SECTION 1101.0 – GENERAL

*1101.1.1 Add the following section:*

**1101.1.1 Leaders, Connection to Drain. All storm water or casual water from roof areas, balconies, lightwells, courtyards or similar areas which total more than 200 square feet (18.4 square meters) aggregate shall drain or be conveyed directly to the building drain, or building sewer, or to an approved alternate location based on approved geotechnical and engineering designs. Such drainage shall not be directed to flow onto adjacent property or over public way, including sidewalks. The opening of the leader shall meet the same requirements as Section 1106.0 of the California Plumbing Code.**

*1101.1.2 Add the following section:*

**1101.1.2 Temporary Provisions. When the stormwater sewer is not yet installed, the building stormwater drainage system may discharge into the sewer on the street side of the main trap as near to the curbline as possible.**

*1101.1.3 Add the following section:*

**1101.1.3 Temporary Provisions Drain Trap. When, under the provisions of Section 1101.1.2 the building stormwater drainage system discharges to the sewer, a trap shall be placed in that drain at a point near where it branches into the sewer. The trap shall be supplied with clean water by an approved means such as a hose bibb or trap primer.**

# CHAPTER 12
# FUEL GAS PIPING

## SECTION 1208.0 – GAS PIPING SYSTEM DESIGN, MATERIALS, AND COMPONENTS

*1208.5.1.1 Add a second paragraph as follows:*

**Gas piping in exterior locations, except as otherwise regulated by this code, shall be of galvanized iron or steel, with galvanized fittings.**

# CHAPTER 13
# HEALTH CARE FACILITIES AND MEDICAL GAS AND VACUUM SYSTEMS

*No San Francisco Plumbing Code Amendments.*

# CHAPTER 14
# REFERENCED STANDARDS

*No San Francisco Plumbing Code Amendments.*

# CHAPTER 15
# FIRESTOP PROTECTION

*No San Francisco Plumbing Code Amendments.*

# CHAPTER 16
# ALTERNATE WATER SOURCES FOR NONPOTABLE APPLICATIONS

*No San Francisco Plumbing Code Amendments.*

# CHAPTER 17
# NONPOTABLE RAINWATER CATCHMENT SYSTEMS

*No San Francisco Plumbing Code Amendments.*

# Appendix A
# RECOMMENDED RULES FOR SIZING THE WATER SUPPLY SYSTEM

*No San Francisco Plumbing Code Amendments.*

# Appendix B
# EXPLANATORY NOTES ON COMBINATION WASTE AND VENT SYSTEMS

*No San Francisco Plumbing Code Amendments.*

# Appendix D
# SIZING STORMWATER DRAINAGE SYSTEMS

*No San Francisco Plumbing Code Amendments.*

# Appendix G
# SIZING OF VENTING SYSTEMS SERVING APPLIANCES EQUIPPED WITH DRAFT HOODS, CATEGORY 1 APPLIANCES, AND APPLIANCES LISTED FOR USE WITH TYPE B VENTS

*No San Francisco Plumbing Code Amendments.*

# Appendix H
# PRIVATE SEWAGE DISPOSAL SYSTEMS

*No San Francisco Plumbing Code Amendments.*

# Appendix I
# INSTALLATION STANDARDS

*No San Francisco Plumbing Code Amendments.*

# Appendix J
# COMBINATION OF INDOOR AND OUTDOOR COMBUSTION AND VENTILATION OPENING DESIGN

*No San Francisco Plumbing Code Amendments.*

# SAN FRANCISCO
# PLANNING DEPARTMENT

1650 Mission St.
Suite 400
San Francisco,
CA 94103-2479

Reception:
**415.558.6378**

Fax:
**415.558.6409**

Planning
Information:
**415.558.6377**

## Certificate of Determination
## Exemption from Environmental Review

| | |
|---|---|
| *Case No.:* | **2013.1157E** |
| *Project Title:* | **2013 San Francisco Building Codes - Proposed Amendments** |
| *Location:* | Citywide |
| *Project Sponsor:* | Kirk Means, Building Inspector, Department of Building Inspection |
| *Staff Contact:* | Christopher Espiritu – (415) 575-9022<br>Christopher.Espiritu@sfgov.org |

### PROJECT DESCRIPTION:

The proposed project would include updates to the current San Francisco Building, Residential, Electrical, Plumbing, and Mechanical Codes and the adoption of local amendments to the 2013 California Building Standard Codes. Elements of the proposed 2013 San Francisco Building Code would reflect a similar structure to the previously-adopted 2010 San Francisco Building Code and would retain discrete code sections for Building, Residential, Electrical, Plumbing, and Mechanical. An addition of a new individual section for the San Francisco Green Building Code, which was formerly Section 13C of the 2010 San Francisco Building Code, would be added to the proposed 2013 San Francisco Building Code. The California Green Building Code is part 11 of Title 24 of the California Code of Regulations and will go into effect throughout California at the same time as the 2013 California Building Standards Code; thus a Green Building Code section would be added to the proposed 2013 San Francisco Building Code.
(Continued on next page)

### EXEMPT STATUS:

General Rule Exclusion [State Guidelines, Section 15061(b)(3)].

### DETERMINATION:

I do hereby certify that the above determination has been made pursuant to State and Local requirements.

Catherine Wise for
Sarah Jones
Environmental Review Officer

October 16, 2013
Date

cc: Kirk Means, Building Inspector, DBI
Judy Boyajian, Deputy City Attorney
Virna Byrd, M.D.F.
Bulletin Board

## PROJECT DESCRIPTION (continued):

The San Francisco Building Code regulates and controls the design, construction, quality of materials, use and occupancy, location, maintenance and demolition of all buildings and structures, quarrying, grading, excavation and filling of land, in the City and County of San Francisco. In addition, the Code provides safety to life and property from fire and other hazards attributed to the built environment and to provide safety to fire fighters and emergency responders during emergency operations. (The full text of proposed amendments is available for review at the Department of Building Inspection (DBI)).

The proposed project is subject to review and adoption by the San Francisco Board of Supervisors. Approval action for the proposed project is the adoption of the proposed project (ordinance) by the Board of Supervisors. Following introduction of the proposed ordinance to the Board of Supervisors, a 30-day review and comment period would be required prior to a Land Use Committee hearing on the proposed changes to the Code. When approved, the Land Use Committee will send the proposed ordinance to the full Board. The Board of Supervisors will review and approve the proposed project (ordinance) and upon approval by the Board of Supervisors, the proposed ordinance will be forwarded to the Mayor for signature. Following mayoral signature of the proposed ordinance, there is a 30-day waiting period before the approved ordinances can become effective.

## REMARKS:

Every three years, the State of California adopts new California Building Code Standards, which go into effect throughout the State within 180 days after publication. The 2013 California Building Code will go into effect throughout California on January 1, 2014. The City and County of San Francisco is required, by State law, to enforce the California Building, Electrical, Plumbing, Mechanical, Housing, and Fire Codes.

Additional discretionary actions for local jurisdictions include the ability to enact more stringent standards, or local amendments, to the California Building Code Standards. Local amendments proposed for adoption by the City of San Francisco primarily deal with administrative, procedural, informational, and non-physical aspects of the various Code sections. To the extent that the local amendments relate to physical building conditions, they are intended to improve building safety and regulate building features such as wood decks, balconies, earthquake recording instruments, and sidewalks. The physical effects of such modifications are related to building design features which are very minor, localized in terms of visibility and impact, and intended to improve building safety. In addition, these local amendments provide guidance on specific conditions that are unique to the City of San Francisco such as topography, geology, and climate.

CEQA Guidelines Section 15061(b)(3) provides an exemption from environmental review where it can be seen with certainty that the proposed project would not have a significant effect on the environment. Since the proposed code amendments would have no significant environmental effects, it is appropriately

exempt from environmental review under the General Rule Exclusion (CEQA Guidelines Section 15061(b)(3)).

CEQA State Guidelines Section 15300.2 states that a categorical exemption shall not be used for an activity where there is a reasonable possibility that the activity will have a significant effect on the environment due to unusual circumstances. There are no unusual circumstances surrounding the current proposal that would suggest a reasonable possibility of a significant environmental effect. The proposed would have no significant environmental effects. The project would be exempt under the above-cited classification. For the above reasons, the proposed project is appropriately exempt from environmental review.

**BUILDING INSPECTION COMMISSION (BIC)**

**Department of Building Inspection** **Voice (415) 558-6164 - Fax (415) 558-6509**
**1660 Mission Street, San Francisco, California 94103-2414**

August 22, 2013

Edwin M. Lee
Mayor

COMMISSION

Angus McCarthy
President

Warren Mar
Vice-President

Kevin Clinch
Frank Lee
Dr. James McCray, Jr.
Myrna Melgar
Debra Walker

Sonya Harris
Secretary

Tom Hui
Acting Director

Ms. Angela Calvillo
Clerk of the Board
Board of Supervisors, City Hall
1 Dr. Carlton B. Goodlett Place, Room 244
San Francisco, CA 94102-4694

**RE: Code amendments to the 2013 California Building, Mechanical, Electrical, Plumbing, Residential & Green Building Codes and recommend approval to the Board of Supervisors.**

Dear Ms. Calvillo:

On August 22, 2013 the Building Inspection Commission held a public hearing on the proposed Code amendments referenced above.

The Commission voted unanimously (6-0) to recommend that the Board of Supervisors approve the amendments.

The Commissioners voted as follows:

| | | | |
|---|---|---|---|
| President McCarthy | Aye | Vice-President Mar | Aye |
| Commissioner Clinch | Aye | Commissioner Lee | Aye |
| Commissioner McCray, Jr. | Aye | Commissioner Melgar | Aye |
| Commissioner Walker, excused | | | |

Enclosed please find the Code Advisory Committee's recommendation to the BIC. Under separate cover, copies of the proposed amendments will follow from the Technical Services Division of the Department of Building Inspection.

Should you have any questions, please do not hesitate to call me at 558-6164.

Sincerely,

Sonya Harris
Commission Secretary

cc: Tom Hui, S.E., Acting Director
Mayor Edwin M. Lee
Supervisor David Chiu
Supervisor Scott Wiener
Supervisor Norman Yee
Supervisor Mark Farrell
Supervisor London Breed
Supervisor Eric Mar
Supervisor Malia Cohen
Deputy City Attorney John Malamut

City and County of San Francisco
Department of Building Inspection

Edwin M. Lee, Mayor
Tom C. Hui, S.E., C.B.O., Acting Director

August 16, 2013

Building Inspection Commission
1660 Mission Street
San Francisco, CA 94103

RE: Proposed 2013 amendments to the California Building Standards Code, CCR Title 24

Honorable Members of the Commission:

At the regular meeting of August 14, 2013, the full Code Advisory Committee (CAC) deliberated on and unanimously voted to approve, and transmit to the Building Inspection Commission, all of the 2013 San Francisco amendments to the 2013 California Title 24 building standards codes. This Committee has labored long and arduous hours over the past five months and feels that the work product before you represents the basis for a continuing safe and healthy building environment in San Francisco.

The San Francisco building standards codes approved and recommended by this Committee are:

1. 2013 San Francisco Building Code
   (which includes the amendments to the California Building and Residential Codes)
2. 2013 San Francisco Mechanical Code
3. 2013 San Francisco Electrical Code
4. 2013 San Francisco Plumbing Code
5. 2013 San Francisco Green Building Code

These documents are transmitted to you for your further action and a final approval to send them on to the Board of Supervisors. If you have any questions, please call me at (415) 575-6832.

Respectfully submitted,

Kirk Means
DBI Technical Services Division
Secretary to the Code Advisory Committee

cc: Tom C. Hui, S.E., C.B.O., Acting Director
Edward Sweeney, Acting Deputy Director
David Leung, Manager, Permit Submittal and Issuance
Ned Fennie, Jr., Chair, Code Advisory Committee
Bill Strawn, Communications Manager

City and County of San Francisco
Department of Building Inspection

Edwin M. Lee, Mayor
Tom C. Hui, S.E., C.B.O., Acting Director

August 29, 2013

RECEIVED
BOARD OF SUPERVISORS
SAN FRANCISCO
2013 AUG 29 PM 3:30

Angela Calvillo, Clerk of the Board
Board of Supervisors
#1 Dr. Carlton B. Goodlett Place, Room 244
San Francisco, CA 94102-4689

Dear Ms. Calvillo:

Attached please find an original and two electronic (CD's) copies of six proposed ordinances (approved by the Building Inspection Commission on August 21, 2013) for the Board of Supervisors approval, which repeal the San Francisco amendments to the 2010 California Building Standards codes and adopt replacement amendments to the new 2013 California Building Standards Codes effective January 1, 2014. (Two copies of these 2013 California Building Standards Codes are hereby provided for your reference in the form of each California adopted model code and their associated California amendments to them.)

The following is a list of accompanying documents (three sets):

1) Environmental Findings (to follow)
2) Exhibit A
3) San Francisco Building Code Ordinance, Legislative Digest, Findings, proposed amendment text (Building)
4) San Francisco Building Code; Residential Building Requirements Ordinance, Legislative Digest, Findings, proposed amendment text. (Residential)
5) San Francisco Electrical Code Ordinance, Legislative Digest, Findings, proposed amendment text (Electrical)
6) San Francisco Mechanical Code Ordinance, Legislative Digest, Findings, proposed amendment text (Mechanical)
7) San Francisco Plumbing Code Ordinance, Legislative Digest, Findings, proposed amendment text (Plumbing)
8) San Francisco Green Building Code Ordinance, Legislative Digest, Findings, proposed amendment text (Green)

In order for the San Francisco code amendments to coordinate with the California codes, which have an effective date of January 1, 2014, the timeline for approval and adoption requires that the codes be submitted to the Board of Supervisors on or before August 30, 2013 for introduction and assignment to the Land Use Committee (on September 10, 2013), a thirty day review and comment period follows prior to hearing at the Land Use Committee on October 21, 2013. When approved, it is proposed that the Board of Supervisors agendize

1660 Mission Street – San Francisco CA 94103
Office (415) 558-6088 – FAX (415) 558-6401
Website: www.sfdbi.org

Readings on October 29, 2013 and November 5, 2013. Upon their approval, the ordinances will be forwarded to the Mayor for signature within 10 days, followed by a 30 day wait period (ending approximately December 15, 2013) before filing with the California Building Standards Commission to become effective for an implementation date of January 1, 2014.

The following person may be contacted regarding this matter:

Kirk Means, Building Inspector
Technical Services Division
Department of Building Inspection
Phone: (415) 575-6832
Fax: (415) 558-6401

Attachments: As stated

BOARD of SUPERVISORS

City Hall
Dr. Carlton B. Goodlett Place, Room 244
San Francisco 94102-4689
Tel. No. 554-5184
Fax No. 554-5163
TDD/TTY No. 554-5227

September 16, 2013

**File Nos. 130836-130841**

Sarah Jones
Environmental Review Officer
Planning Department
1650 Mission Street, 4th Floor
San Francisco, CA 94103

Dear Ms. Jones:

On September 10, 2013, the Building Inspection Commission introduced the following proposed legislation:

**130836 Building Code - Repeal of Existing 2010 Code and Enactment of 2013 Edition**

Ordinance repealing the 2010 Building Code in its entirety and enacting a 2013 Building Code consisting of the new model code, as amended by the State of California and as further amended by San Francisco; adopting environmental findings and findings of local conditions under the California Health and Safety Code; providing for an operative date of January 1, 2014; and directing the Clerk of the Board to forward the legislation to the State Building Standards Commission as required by State law.

**130837 Building Code - Residential Building Requirements**

Ordinance incorporating the provisions of the 2013 California Residential Code into various chapters of the Building Code with local amendments, and adding Chapter 36 to serve as a directory of where such provisions may be found in the Building Code; adopting environmental findings and findings of local conditions under the California Health and Safety Code; providing for an operative date of January 1, 2014; and directing the Clerk of the Board to forward the legislation to the State Building Standards Commission as required by State law.

**130838 Electrical Code - Repeal of Existing 2010 Code and Enactment of 2013 Edition**

Ordinance repealing the 2010 Electrical Code in its entirety and enacting a 2013 Electrical Code consisting of the new model code, as amended by the State of California and as further amended by San Francisco; adopting environmental findings and findings of local conditions under the California Health and Safety Code; providing for an operative date of January 1, 2014; and directing the Clerk of the Board to forward the legislation to the State Building Standards Commission as required by State law.

**130839** **Mechanical Code - Repeal of Existing 2010 Code and Enactment of 2013 Edition**

Ordinance repealing the 2010 Mechanical Code in its entirety and enacting a 2013 Mechanical Code consisting of the new model code, as amended by the State of California and as further amended by San Francisco; adopting environmental findings and findings of local conditions under the California Health and Safety Code; providing for an operative date of January 1, 2014; and directing the Clerk of the Board to forward the legislation to the State Building Standards Commission as required by State law.

**130840** **Plumbing Code - Repeal of Existing 2010 Code and Enactment of 2013 Edition**

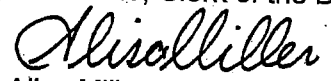
Ordinance repealing the 2010 Plumbing Code in its entirety and enacting a 2013 Plumbing Code consisting of the new model code, as amended by the State of California and as further amended by San Francisco; adopting environmental findings and findings of local conditions under the California Health and Safety Code; providing for an operative date of January 1, 2014; and directing the Clerk of the Board to forward the legislation to the State Building Standards Commission as required by State law.

**130841** **Green Building Code - Enactment of New Code**

Ordinance enacting a 2013 San Francisco Green Building Code consisting of the 2013 California Green Building Standards Code, as amended by San Francisco; adopting environmental findings and findings required by the California Health and Safety Code, California Public Resources Code, and Title 24 of the California Code of Regulations; providing for an operative date of January 1, 2014; and directing the Clerk of the Board to forward the legislation to the State Building Standards Commission as required by State law.

This legislation is being transmitted to you for environmental review.

Angela Calvillo, Clerk of the Board



By: Alisa Miller, Committee Clerk
Land Use & Economic Development Committee

Attachment

c: Monica Pereira, Environmental Planning
Joy Navarrete, Environmental Planning

# 2013 California Plumbing Code

## California Code of Regulations Title 24, Part 5

## California Building Standards Commission

## Based on 2012 Uniform Plumbing Code®

EFFECTIVE
January 1, 2014
(For Errata and Supplements, See History Note Appendix)

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INTERNATIONAL ASSOCIATION OF PLUMBING AND MECHANICAL OFFICIALS
4755 East Philadelphia Street
Ontario, California 91761-2816

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Held By

CALIFORNIA BUILDING STANDARDS COMMISSION
2525 Natomas Park Drive, Suite 130
Sacramento, CA 95833-2936

First Printing, July 1, 2013
Printed in The United States

185

# PREFACE

This document is the 5th of 12 Parts of the official triennial compilation and publication of the adoptions, amendments and repeal of administrative regulations to *California Code of Regulations, Title 24,* also referred to as the *California Building Standards Code.* Part 5 is known as the *California Plumbing Code* and incorporates, by adoption, the 2012 edition of the *Uniform Plumbing Code* of the International Association of Plumbing and Mechanical Officials with the California amendments.

The *California Building Standards Code* is published in its entirety every three years by order of the California legislature, with supplements published in intervening years. The California legislature delegated authority to various State agencies, boards, commissions and departments to create building regulations to implement the State's statutes. These building regulations or standards, have the same force of law, and take effect 180 days after their publication unless otherwise stipulated. The *California Building Standards Code* applies to occupancies in the State of California as annotated.

A city, county or city and county may establish more restrictive building standards reasonably necessary because of local climatic, geological or topographical conditions. Findings of the local condition(s) and the adopted local building standard(s) must be filed with the California Building Standards Commission to become effective and may not be effective sooner than the effective date of this edition of *California Building Standards Code.* Local building standards that were adopted and applicable to previous editions of the *California Building Standards Code* do not apply to this edition without appropriate adoption and the required filing.

To familiarize yourself with the format of this code, it is suggested that users review the following contents:

- How To Distinguish Model Code Language From California Amendments; and
- Matrix Adoption Tables

Should you find publication (e.g., typographical) errors or inconsistencies in this code or wish to offer comments toward improving its format, please address your comments to:

**California Building Standards Commission**
2525 Natomas Park Drive, Suite 130
Sacramento, CA 95833-2936

Phone: (916) 263-0916
FAX: (916) 263-0959

Web Page: www.bsc.ca.gov

# ACKNOWLEDGEMENTS

The 2013 California Building Standards Code (Code) was developed through the outstanding collaborative efforts of the Department of Housing and Community Development, the Division of State Architect, the Office of the State Fire Marshal, the Office of Statewide Health Planning and Development, the California Energy Commission, the California Department of Public Health, the California State Lands Commission, the Board of State and Community Corrections, and the California Building Standards Commission (Commission).

This collaborative effort included the assistance of the Commission's Code Advisory Committees and many other volunteers who worked tirelessly to assist the Commission in the production of this Code.

*Governor Edmund G. Brown Jr.*

*Members of the Building Standards Commission*

*Secretary Anna Caballaro – Chair*
*James Barthman – Vice-Chair*

*Stephen Jensen*
*Randy Twist*
*Richard Sawhill*
*Kent Sasaki*
*Rose Conroy*
*Sheila Lee*
*Richard Sierra*
*Steven Winkel*

*Erick Mikiten*

*Jim McGowan – Executive Director*
*Michael L. Nearman – Deputy Executive Director*

For questions on California state agency amendments, please refer to the contact list on the following page.

# California Code of Regulations Title 24

## California Agency Information Contact List

***Board of State and Community Corrections***
*www.bscc.ca.gov.....(916) 445-5073*
*Local Adult Jail Standards*
*Local Juvenile Facility Standards*

***California Building Standards Commission***
*www.bsc.ca.gov .....(916) 263-0916*

***California Energy Commission***
*www.energy.ca.gov .....**Energy Hotline** (800) 772-3300*
*Building Efficiency Standards*
*Appliance Efficiency Standards*
*Compliance Manual/Forms*

***California State Lands Commission***
*www.slc.ca.gov .....(562) 499-6312*
*Marine Oil Terminals*

***California State Library***
*www.library.ca.gov.....(916) 654-0266*

***Department of Consumer Affairs:***

***Acupuncture Board***
*www.acupuncture.ca.gov.....(916) 515-5200*
*Office Standards*

***Board of Pharmacy***
*www.pharmacy.ca.gov.....(916) 574-7900*
*Pharmacy Standards*

***Bureau of Barbering and Cosmetology***
*www.barbercosmo.ca.gov .....(916) 952-5210*
*Barber and Beauty Shop,*
*and College Standards*

***Bureau of Electronic and Appliance Repair,***
***Home Furnishings and Thermal Insulation***
*www.bearhfti.ca.gov.....(916) 999-2041*
*Insulation Testing Standards*

***Structural Pest Control Board***
*www.pestboard.ca.gov.....(800) 737-8188*
*Structural Standards*

***Veterinary Medical Board***
*www.vmb.ca.gov.....(916) 263-2610*
*Veterinary Hospital Standards*

***Department of Food and Agriculture***
*www.cdfa.ca.gov*

*Meat & Poultry Packing Plant Standards (916) 654-0509*
*Dairy Standards (916) 654-0773*

***Department of Housing and Community Development***
*www.hcd.ca.gov.....(916) 445-9471*
*Residential - Hotels, Motels, Apartments,*
*Single-Family Dwellings; and*
*Permanent Structures in Mobilehome &*
*Special Occupancy Parks*

*(916) 445-3338*
*Factory-Built Housing, Manufactured Housing &*
*Commercial Modular*

*Mobilehome - Permits & Inspections*
*Northern Region - (916) 255-2501*
*Southern Region - (951) 782-4420*

*(916) 445-9471*
*Employee Housing Standards*

***Department of Public Health***
*www.dph.ca.gov.....(916) 449-5661*
*Organized Camps Standards*
*Public Swimming Pools Standards*

***Division of the State Architect***
*www.dgs.ca.gov/dsa .....(916) 445-8100*

***Access Compliance***
***Structural Safety***
*Public Schools Standards*
*Essential Services Building Standards*
*Community College Standards*

***State Historical Building Safety Board***
*Alternative Building Standards*

***Office of Statewide Health Planning and Development***
*www.oshpd.ca.gov .....(916) 440-8356*
*Hospital Standards*
*Skilled Nursing Facility Standards &*
*Clinic Standards*
*Permits*

***Office of the State Fire Marshal***
*osfm.fire.ca.gov .....(916) 445-8200*
*Code Development and Analysis*
*Fire Safety Standards*

# UPC FOREWORD

***Not Adopted by The State of California***

The advantages of a uniform plumbing code adopted by various local jurisdictions has long been recognized. Disorder in the industry as a result of widely divergent plumbing practices and the use of many different, often conflicting, plumbing codes by local jurisdictions influenced the Western Plumbing Officials Association (now the International Association of Plumbing and Mechanical Officials [IAPMO]) to form a committee of plumbing inspectors, master and journeyman plumbers, and sanitary and mechanical engineers, assisted by public utility companies and the plumbing industry to create a basic plumbing document for general use. The product of this effort, the first edition of the *Uniform Plumbing Code®* (UPC®) was officially adopted by IAPMO in 1945. The widespread use of this code over the past five decades by jurisdictions throughout the United States and internationally is testament to its merit.

With the publication of the 2003 Edition of the *Uniform Plumbing Code®*, another significant milestone was reached. For the first time in the history of the United States, a plumbing code was developed through a true consensus process. The 2012 edition represents the most current approaches in the plumbing field and is the fourth edition developed under the ANSI consensus process. Contributions to the content of the code were made by every segment of the built industry, including such diverse interests as consumers, enforcing authorities, installers/maintainers, insurance, labor, manufacturers, research/standards/testing laboratories, special experts, and users.

The UPC is designed to provide consumers with safe and sanitary plumbing systems while, at the same time, allowing latitude for innovation and new technologies. The public at large is encouraged and invited to participate in IAPMO's open consensus code development process. This code is updated every three years. A code development timeline and other relevant information is available at IAPMO's website at www.iapmo.org.

The *Uniform Plumbing Code®* is dedicated to all those who, in working to achieve "the ultimate plumbing code," have unselfishly devoted their time, effort, and personal funds to create and maintain this, the finest plumbing code in existence today.

The 2012 *Uniform Plumbing Code®* is supported by the American Society of Sanitary Engineering (ASSE), the Mechanical Contractors Association of America (MCAA), the Plumbing-Heating-Cooling Contractors National Association (PHCC-NA), the United Association (UA), and the World Plumbing Council (WPC). The presence of these logos, while reflecting support, does not imply any ownership of the copyright to the UPC, which is held exclusively by IAPMO. Further, the logos of these associations indicates the support of IAPMO's open, consensus process being used to develop IAPMO's codes and standards.

The addresses of the organizations are as follows:

ASSE – 901 Canterbury Road, Suite A • Westlake, OH 44145-7201 • (440) 835-3040

MCAA – 1385 Piccard Drive • Rockville, MD 20850 • (301) 869-5800

PHCC-NA – PO Box 6808 • Falls Church, VA 22046 • (800) 533-7694

UA – Three Park Place • Annapolis, MD 21401 • (410) 269-2000

WPC – World Plumbing Council Secretariat – P.O. Box 810 • Lafayette, IN 47902 USA

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## HOW TO DISTINGUISH MODEL CODE LANGUAGE FROM CALIFORNIA AMENDMENTS

To distinguish between model code language and incorporated California Amendments, including exclusive California standards, California amendments will appear in italics.

Symbols in the margins indicate the status of code changes as follows:

***[BSC]*** This symbol identifies which State agency(s) by its "acronym" that has amended a section of the model code. For a complete listing of State agency acronyms, see the Application Section within Chapter 1, Division I.

‖ This symbol indicates that a change has been made to a California amendment.

| This symbol indicates that a section, paragraph, or table has been revised or relocated within IAPMO model code language.

> This symbol indicates deletion of California language.

→ This symbol indicates where an entire section, paragraph, or table has been deleted from IAPMO model code language.

# RELATED PUBLICATIONS AND SERVICES

***The Documents Listed are Not by this Reference Adopted by The State of California.***

IAPMO provides a variety of other products which are useful for inspectors, building officials, architects, engineers, manufacturers, contractors, plumbers, and apprentices.

**IAPMO Headquarters Directory**
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**Uniform Plumbing Code – 2012 Edition:**

The Uniform Plumbing Code is the most widely adopted plumbing code in the world. The 2012 edition contains complete "turnkey" requirements for the installation and maintenance of plumbing systems, all in one easy to use book.

**Uniform Plumbing Code Illustrated Training Manual:**

The UPC Illustrated Training Manual is an excellent reference for anyone involved in the plumbing industry. It contains an extensive definitions section and several hundred comprehensive technical diagrams and illustrations. It serves as a textbook, and it also is useful as a valuable tool for explaining the intent and use of the Code.

**Uniform Plumbing Code Study Guide:**

This book is the perfect complement to the UPC Illustrated Training Manual. Alone, it constitutes a complete self-study course for learning the UPC. It has hundreds of questions, general practice exams, and plumbing math, pipe sizing exercises and fitting identification. A big help in getting you ready for a certification exam!

**Uniform Plumbing Code Answers & Analysis Manual:**

This increasing popular manual is the result of ongoing work by IAPMO's Answers & Analysis Committee. Updated annually, it contains hundreds of questions and answers. Many of these questions arise in the daily administration of the code.

**Guide to Important Code Questions to the Uniform Plumbing Code:**

An excellent reference for learning and understanding plumbing code changes and identifies code changes between editions. It is a useful tool for preparing code change proposals.

**Uniform Mechanical Code – 2012 Edition:**

The Uniform Mechanical Code contains complete requirements for the installation and maintenance of heating, ventilating, cooking and refrigeration systems.

**Uniform Mechanical Code Illustrated Training Manual:**

Contains technical diagrams and illustrations that demonstrate the intent and use of the UMC. A great reference for everyone involved in Mechanical HVACR design and installation.

**Uniform Mechanical Code Study Guide:**

The Study Guide is a complete self-study course for learning the UMC. A big help in getting ready for a certification exam! This book is the perfect complement to the UMC Illustrated Training Manual.

# RELATED PUBLICATIONS AND SERVICES

*The Documents Listed are Not by this Reference Adopted by The State of California.*

**Uniform Mechanical Code Answer & Analysis Manual:**

This increasing popular manual is the result of ongoing work by IAPMO's Answers & Analysis Committee. It contains hundreds of questions and answers that encompass three editions of the UMC. Many of these questions arise in the daily administration of the code.

**Guide to Important Code Questions to the Uniform Mechanical Code:**

An excellent reference for learning and understanding mechanical code changes and identifies code changes between editions. It is a useful tool for preparing code change proposals.

**Uniform Swimming Pool, Spa, and Hot Tub Code – 2012 Edition:**

The Uniform Swimming Pool, Spa and Hot Tub Code contains complete and current requirements for the erection, installation, alteration, repair, relocation, replacement, addition to and use or maintenance of these systems.

**Uniform Solar Energy Code – 2012 Edition:**

The Uniform Solar Energy Code is a unique document that provides a complete set of regulations and guidelines that cover both plumbing and mechanical systems in one "turnkey" package. The code is ideal for use by inspectors, jurisdictions and the installation industry.

**Drain Waste and Vent Calculator:**

A slide-rule style calculator provides quick and simple access to the fixture unit and sizing tables of Chapter 7 of the UPC.

**Water Sizing Calculator:**

Sizing water systems becomes a much simpler task with the use of this handy slide-rule style calculator.

**Natural Gas Pipe Sizing Calculator:**

This Natural Gas Pipe Sizing Calculator is presented in an easy to use and read slide-rule format. Designed for systems with a supply pressure of six to eight inches of water column, all pipe capacities are given in cubic feet per hour.

**Trailer Standards:**

IAPMO has developed a number of standards for specialty products used in manufactured homes and recreational vehicles. These standards are available individually, or they may be purchased as a set.

**Directory of Listed Plumbing Products:**

The IAPMO Listing Program was primarily created to benefit the building and plumbing officials that the products installed meet the appropriate standards and code. For a product to continue to be listed, unannounced inspections of the manufacturing facilities verify continued compliance. This directory contains information on several thousand IAPMO-listed plumbing products and is updated annually.

**Education and Training Seminars:**

IAPMO specializes in conducting training and education, including fulfilling continuing education requirements, on the UPC and UMC as well as all of the most commonly utilized codes in the Construction Trades. Special seminars on industry or code subjects are expeditiously created and delivered upon request. Please call to obtain the seminar schedule or to arrange for a custom special seminar.

**Backflow Prevention Institute – IAPMO**

The IAPMO Backflow Prevention Institute provides professional education and training for the control of hazards to our water supply and is dedicated to water-system safety worldwide. The Institute provides training in backflow prevention and cross-connection control. This program includes backflow preventers, testers, repairers, and cross-connection control surveyors. Each of these courses provides compliance certification to American National Standards Institute standards.

# RELATED PUBLICATIONS AND SERVICES

*The Documents Listed are Not by this Reference Adopted by The State of California.*

**Backflow Prevention Reference Manual:**

This unique 300-page manual contains full-color illustrations and sections relating to real-world installations, backflow prevention, testing cross-connection control, repair and inspections. The manual is an excellent textbook and a reference the inspectors in every jurisdiction should have access too. It is also an important resource for system designers, urban planners and utility companies – professionals on both sides of the water meter.

**Drinking Water & Backflow Prevention Magazine:**

A monthly subscription to Drinking Water & Backflow Prevention Magazine provides current and valuable information regarding this critical public health topic. Subjects range from actual incident reporting, application of the newest technology, and general interest articles including fire systems, irrigation systems, and security as well as installation, inspection and repair tips.

**Backflow Prevention Tech-Wheel:**

Find quick answers to your backflow questions! The Backflow Tech-Wheel contains a wealth of information in a graphic, quick reference format. One side delivers solutions to device application questions; the other a troubleshooting guide offering solutions to backflow problems.

**ANSI Z 124 Standards:**

These standards are written to specifically address a variety of plastic plumbing fixtures and components. They are available individually, or may be grouped for quantity discounts.

**IAPMO Installation Standards:**

IAPMO standards committees have formulated installation standards for a wide variety of commonly used plumbing materials and systems. The IAPMO installation standards are included after the text of the Uniform Plumbing Code, or can be purchased separately.

**Material and Property Standards:**

IAPMO does not generally develop material and property standards, but when a need exists the Association will take a leadership role by filling the void. They are available, are subject to amendments and are withdrawn when recognized consensus standards are formulated.

**OFFICIAL Magazine:**

IAPMO's bimonthly publication features informative articles related to Plumbing and Mechanical HVACR installations, award winning general interest features, technical columns and industry updates. Subscriptions are available and all IAPMO members receive a free copy of every issue!

**Membership in IAPMO:**

IAPMO membership is open to all interested persons. Membership categories include Student, Individual, Senior, Organizational and Governmental. Member benefits include discounted prices on IAPMO publications, a subscription to Official magazine, and numerous educational and training opportunities.

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**Main Number:** 909-472-4100 • **Publication Orders:** 800-85-IAPMO • **Publication Fax:** 877-85-CODES
**Website:** www.iapmo.org • **Office Hours:** Monday – Friday, 8am – 5pm Pacific Time

# CALIFORNIA MATRIX ADOPTION TABLES

**Format of the Matrix Adoption Tables**

The matrix adoption tables, examples of which follow, are non-regulatory aids intended to show the user which state agencies have adopted and/or amended given sections of model code. An agency's statutory authority for certain occupancies or building applications determines which chapter or section may be adopted, repealed, amended or added. See Chapter 1, Division I, Sections 1.2.0 through 1.14.0, for agency authority, building application and enforcement responsibilities.

The side headings identify the scope of the state agencies' adoption as follows:

**Adopt the entire UPC chapter without state amendments.**

If there is an "X" under a particular state agency's acronym in this row, it means that particular state agency has adopted the entire model code chapter without any state amendments.

**Example:**

**CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE**
**CHAPTER 1 - ADMINISTRATION**

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | X | | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | S | A | M | P | L | E | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | |

**Adopt the entire UPC chapter as amended, state-amended sections are listed below:**

If there is an "X" under a particular state agency's acronym in this row, it means that a particular state agency has adopted the entire model code chapter, with state amendments.

Each state-amended section that the agency has added to that particular chapter is listed. There will be an "X" in the column, by that particular section, under the agency's acronym, as well as an "X" by each section that the agency has adopted.

**Example:**

**CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE**
**CHAPTER 1 - ADMINISTRATION**

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | X | | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | S | A | M | P | L | E | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| 101 | X | | | | | | | | | | | | | | | | | | |
| 102 | X | | | | | | | | | | | | | | | | | | |

**Adopt only those sections which are listed below:**

If there is an "X" under a particular state agency's acronym in this row, it means that particular state agency is adoption only specific model code or state-amended sections within this chapter. There will be an "X" in the column under the agency's acronym, as well as an "X" by each section that the agency has adopted.

**Example:**

**CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE**
**CHAPTER 1 - ADMINISTRATION**

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | X | | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | S | A | M | P | L | E | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| 101 | X | | | | | | | | | | | | | | | | | | |
| 102 | X | | | | | | | | | | | | | | | | | | |

**Legend of Acronyms of Adopting State Agencies**

| | |
|---|---|
| BSC | California Building Standards Commission (see Section 1.2.0) |
| SFM | Office of the State Fire Marshal (see Section 1.11.0) |
| HCD 1 | Department of Housing and Community Development (see Section 1.8.2.1.1) |
| HCD 2 | Department of Housing and Community Development (see Section 1.8.2.1.3) |
| HCD 1/AC | Department of Housing and Community Development (see Section 1.8.2.1.2) |
| DSA-AC | Division of the State Architect-Access Compliance (see Section 1.9.1) |
| DSA-SS | Division of the State Architect-Structural Safety (see Section 1.9.2) |
| DSA-SS/CC | Division of the State Architect-Structural Safety/Community Colleges (see Section 1.9.2.2) |
| OSHPD 1 | Office of Statewide Health Planning and Development (see Section 1.10.1) |
| OSHPD 2 | Office of Statewide Health Planning and Development (see Section 1.10.2) |
| OSHPD 3 | Office of Statewide Health Planning and Development (see Section 1.10.3) |
| OSHPD 4 | Office of Statewide Health Planning and Development (see Section 1.10.4) |
| BSCC | Board of State and Community Corrections (see Section 1.3.0) |
| DPH | Department of Public Health (see Section 1.7.0) |
| AGR | Department of Food and Agriculture (see Section 1.6.0) |
| CEC | California Energy Commission (see Section 100 in Part 2, the California Energy Code) |
| CA | Department of Consumer Affairs (see Section 1.4.0):<br>Board of Barbering and Cosmetology<br>Board of Examiners in Veterinary Medicine<br>Board of Pharmacy<br>Acupuncture Board<br>Bureau of Home Furnishings<br>Structural Pest Control Board |
| SL | State Library (see Section 1.12.0) |
| SLC | State Lands Commission (see Section 1.14.0) |
| DWR | Department of Water Resources (see Section 1.13.0 of Chapter 1 of the California Plumbing Code in Part 2 of Title 24) |

The state agencies are available to answer questions about their adoptions. Contact information is provided on page v of this code.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 1 - ADMINISTRATION

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| *Division I – California Administration* | | | | | | | | | | | | | | | | | | | |
| 1.1.1 | X | X | X | X | X | | X | X | | | | | | | | | | | |
| 1.1.2 | X | X | X | X | X | | X | X | | | | | | | | | | | |
| 1.1.3 | X | X | X | X | X | | X | X | | | | | | | | | | | |
| 1.1.4 | X | X | X | X | X | | X | X | | | | | | | | | | | |
| 1.1.5 | X | X | X | X | X | | X | X | | | | | | | | | | | |
| 1.1.6 | X | X | X | X | X | | X | X | | | | | | | | | | | |
| 1.1.7 | X | X | X | X | X | | X | X | | | | | | | | | | | |
| 1.1.8 | X | X | X | X | X | | X | X | | | | | | | | | | | |
| 1.1.9 | X | X | X | X | X | | X | X | | | | | | | | | | | |
| 1.1.10 | X | X | X | X | X | | X | X | | | | | | | | | | | |
| 1.1.11 | X | X | X | X | X | | X | X | | | | | | | | | | | |
| 1.1.12 | X | X | X | X | X | | X | X | | | | | | | | | | | |
| 1.2.0 | X | | | | | | | | | | | | | | | | | | |
| 1.3.0 | | | | | | | | | | | | | X | | | | | | |
| 1.4.0 | | | | | | | | | | | | | | | | | X | | |
| 1.6.0 | | | | | | | | | | | | | | | X | | | | |
| 1.7.0 | | | | | | | | | | | | | | X | | | | | |
| 1.8.0 | | | X | X | X | | | | | | | | | | | | | | |
| 1.9.0 | | | | | | X | | | | | | | | | | | | | |
| 1.9.1 | | | | | | X | | | | | | | | | | | | | |
| 1.9.2 | | | | | | | X | | | | | | | | | | | | |
| 1.9.2.1 | | | | | | | X | | | | | | | | | | | | |
| 1.9.2.2 | | | | | | | | X | | | | | | | | | | | |
| 1.10.1 | | | | | | | | | X | | | | | | | | | | |
| 1.10.2 | | | | | | | | | | X | | | | | | | | | |
| 1.10.3 | | | | | | | | | | | X | | | | | | | | |
| 1.10.4 | | | | | | | | | | | | X | | | | | | | |
| 1.11.0 | | X | | | | | | | | | | | | | | | | | |
| 1.13.0 | | | | | | | | | | | | | | | | X | | | |
| Division II - Administration | | | | | | | | | | | | | | | | | | | |
| 101.0 - 103.1.1 | | | | | | | | | X | X | X | X | | | | | | | |
| 103.1.2 and subsections | | | X | X | | | | | X | X | X | X | | | | | | | |
| 103.1.1 - 103.8 | | | | | | | | | X | X | X | X | | | | | | | |

# CHAPTER 1
## ADMINISTRATION
## DIVISION I
## CALIFORNIA ADMINISTRATION

*1.1.0 General.*

***1.1.1 Title.*** *These regulations shall be known as the California Plumbing Code, may be cited as such and will be referred to herein as "this code." The California Plumbing Code is Part 5 of twelve parts of the official compilation and publication of the adoption, amendment, and repeal of plumbing regulations to the California Code of Regulations, Title 24, also referred to as the California Building Standards Code. This part incorporates by adoption the 2012 Uniform Plumbing Code of the International Association of Plumbing and Mechanical Officials with necessary California amendments.*

***1.1.2 Purpose.*** *The purpose of this code is to establish the minimum requirements to safeguard the public health, safety and general welfare through structural strength, means of egress facilities, stability, access to persons with disabilities, sanitation, adequate lighting and ventilation, and energy conservation; safety to life and property from fire and other hazards attributed to the built environment; and to provide safety to fire fighters and emergency responders during emergency operations.*

***1.1.3 Scope.*** *The provisions of this code shall apply to the construction, alteration, movement, enlargement, replacement, repair, equipment, use and occupancy, location, maintenance, removal, and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures throughout the State of California.*

***1.1.3.1 Non-State-Regulated Buildings, Structures, and Applications.*** *Except as modified by local ordinance pursuant to Section 1.1.8, the following standards in the California Code of Regulations, Title 24, Parts 2, 2.5, 3, 4, 5, 6, 9, 10 and 11 shall apply to all occupancies and applications not regulated by a state agency.*

***1.1.3.2 State-Regulated Buildings, Structures, and Applications.*** *The model code, state amendments to the model code, and/or state amendments where there are no relevant model code provisions shall apply to the following buildings, structures, and applications regulated by state agencies as specified in Section 1.2.0 through 1.14.0, except where modified by local ordinance pursuant to Section 1.1.8. When adopted by a state agency, the provisions of this code shall be enforced by the appropriate enforcing agency, but only to the extent of authority granted to such agency by the state Legislature.*

***Note:*** *See Preface to distinguish the model code provisions from the California provisions.*

1. *State-owned buildings, including buildings constructed by the Trustees of the California State University, and to the extent permitted by California laws, buildings designed and constructed by the Regents of the University of California, and regulated by the Building Standards Commission. See Section 1.2.0 for additional scope provisions.*
2. *Local detention facilities regulated by the Corrections Standards Authority. See Section 1.3.0 for additional scope provisions.*
3. *Barbering, cosmetology or electrolysis establishments, acupuncture offices, pharmacies, veterinary facilities, and structural pest control locations regulated by the Department of Consumer Affairs. See Section 1.4.0 for additional scope provisions.*
4. *Reserved for the California Energy Commission. See Section 1.5.0 for additional scope provisions.*
5. *Dairies and places of meat inspection regulated by the Department of Food and Agriculture. See Section 1.6.0 for additional scope provisions.*
6. *Organized camps, laboratory animal quarters, public swimming pools, radiation protection, commissaries serving mobile food preparation vehicles, and wild animal quarantine facilities regulated by the Department of Public Health. See Section 1.7.0 for additional scope provisions.*
7. *Hotel, motels, lodging houses, apartment houses, dwellings, dormitories, condominiums, shelters for homeless persons, congregate residences, employee housing, factory-built housing, and other types of dwellings containing sleeping accommodations with or without common toilets or cooking facilities. See Section 1.8.2.1.1 for additional scope provisions.*
8. *Accommodations for persons with disabilities in buildings containing newly constructed covered multifamily dwellings, new common use spaces serving existing covered multifamily dwellings, additions to existing buildings where the addition alone meets the definition of "COVERED MULTIFAMILY DWELLINGS," and common use spaces serving covered multifamily dwellings which are regulated by the Department of Housing and Community Development. See Section 1.8.2.1.2 for additional scope provisions.*
9. *Permanent buildings and permanent accessory buildings or structures constructed within mobilehome parks and special occupancy parks regulated by the Department of Housing and Community Development. See Section 1.8.2.1.3 for additional scope provisions.*
10. *Accommodations for persons with disabilities regulated by the Division of the State Architect. See Section 1.9.1 for additional scope provisions.*

11. *Public elementary and secondary schools, community college buildings, and state-owned or state-leased essential service buildings regulated by the Division of the State Architect. See Section 1.9.2 for additional scope provisions.*
12. *Reserved for the State Historical Building Safety Board with the Division of the State Architect.*
13. *General acute care hospitals, acute psychiatric hospitals, skilled nursing and/or intermediate care facilities, clinics licensed by the Department of Public Health, and correctional treatment centers regulated by the Office of Statewide Health Planning and Development. See Section 1.10.0 for additional scope provisions.*
14. *Applications regulated by the Office of State Fire Marshal include but are not limited to following in accordance with Section 1.11.0:*
    1. *Buildings or structures used or intended for use as an:*

       *1.1 Asylum, jail, prison.*

       *1.2 Mental hospital, hospital, home for the elderly, children's nursery, children's home or institution, school or any similar occupancy of any capacity.*

       *1.3. Theater, dancehall, skating rink, auditorium, assembly hall, meeting hall, nightclub, fair building, or similar place of assemblage where 50 or more persons may gather together in a building, room or structure for the purpose of amusement, entertainment, instruction, deliberation, worship, drinking or dining, awaiting transportation, or education.*

       *1.4. Small family day care homes, large family day-care homes, residential facilities and residential facilities for the elderly, residential care facilities.*

       *1.5. State institutions or other state-owned or state-occupied buildings.*

       *1.6. High rise structures.*

       *1.7. Motion picture production studios.*

       *1.8. Organized camps.*

       *1.9. Residential structures.*
    2. *Tents, awnings or other fabric enclosures used in connection with any occupancy.*
    3. *Fire alarm devices, equipment and systems in connection with any occupancy.*
    4. *Hazardous materials, flammable and combustible liquids.*
    5. *Public school automatic fire detection, alarm and sprinkler systems.*
    6. *Wildland-urban interface fire areas.*
15. *Public libraries constructed and renovated using funds from the California Library Construction and Renovation Bond Act of 1988 and regulated by the State Librarian. See Section 1.12.0 for additional scope provisions.*
16. *Graywater systems regulated by the Department of Water Resources. See Section 1.13.0 for additional scope provisions.*
17. *For applications listed in Section 1.9.1 regulated by the Division of the State Architect – Access Compliance, outdoor environments and uses shall be classified according to accessibility uses described in Chapter 11A, 11B, and 11C.*
18. *Marine Oil Terminals regulated by the California State Lands Commission. See Section 1.14.0 for additional scope provisions.*

***1.1.4 Appendices.*** *Provisions contained in the appendices of this code shall not apply unless specifically adopted by a state agency or adopted by a local enforcing agency in compliance with Health and Safety Code Section 18901 et seq. for Building Standards Law, Health and Safety Code Section 17950 for State Housing Law and Health and Safety Code Section 13869.7 for Fire Protection Districts. See Section 1.1.8 of this code.*

***1.1.5 Referenced Codes.*** *The codes, standards and publications adopted and set forth in this code, including other codes, standards and publications referred to therein are, by title and date of publication, hereby adopted as standard reference documents of this code. When this code does not specifically cover any subject related to building design and construction, recognized architectural or engineering practices shall be employed. The National Fire Codes, standards, and the Fire Protection Handbook of the National Fire Protection Association are permitted to be used as authoritative guides in determining recognized fire prevention engineering practices.*

***1.1.6 Non-Building Standards, Orders, and Regulations.***

*Requirements contained in the Uniform Plumbing Code, or in any other referenced standard, code or document, which are not building standards as defined in Health and Safety Code Section 18909 shall not be construed as part of the provisions of this code. For nonbuilding standards, orders, and regulations, see other titles of the California Code of Regulations.*

***1.1.7 Order of Precedence and Use.***

***1.1.7.1 Differences.*** *In the event of any differences between these building standards and the standard reference documents, the text of these building standards shall govern.*

***1.1.7.2 Specific Provisions.*** *Where a specific provision varies from a general provision, the specific provision shall apply.*

***1.1.7.3 Conflicts.*** *When the requirements of this code conflict with the requirements of any other part of the California Building Standards Code, Title 24, the most restrictive requirements shall prevail.*

***1.1.8 City, County, or City and County Amendments, Additions or Deletions.*** *The provisions of this code do not limit the authority of city, county, or city and county governments to establish more restrictive and reasonably necessary dif-*

*ferences to the provisions contained in this code pursuant to complying with Section 1.1.8.1. The effective date of amendments, additions, or deletions to this code by city, county, or city and county filed pursuant to Section 1.1.8.1 shall be the date filed. However, in no case shall the amendments, additions or deletions to this code be effective any sooner than the effective date of this code.*

*Local modifications shall comply with Health and Safety Code Section 18941.5 for Building Standards Law, Health and Safety Code Section 17958 for State Housing Law or Health and Safety Code Section 13869.7 for Fire Protection Districts.*

***1.1.8.1 Findings and Filings.***

1. *The city, county, or city and county shall make express findings for each amendment, addition or deletion based upon climatic, topographical, or geological conditions.*

   ***Exception:** Hazardous building ordinances and programs mitigating unreinforced masonry buildings.*

2. *The city, county, or city and county shall file the amendments, additions or deletions expressly marked and identified as to the applicable findings. Cities, counties, cities and counties, and fire departments shall file the amendments, additions or deletions, and the findings with the California Building Standards Commission at 2525 Natomas Park Drive, Suite 130, Sacramento, CA 95833.*

3. *Findings prepared by fire protection districts shall be ratified by the local city, county, or city and county and filed with the California Department of Housing and Community Development, Division of Codes and Standards, P.O. Box 1407, Sacramento, CA 95812-1407 or 1800 3rd Street, Room 260, Sacramento, CA 95811.*

***1.1.9 Effective Date of this Code.** Only those standards approved by the California Building Standards Commission that are effective at the time an application for building permit is submitted shall apply to the plans and specifications for, and to the construction performed under, that permit. For the effective dates of the provisions contained in this code, see the History Note page of this code.*

***1.1.10 Availability of Codes.** At least one complete copy each of Titles 8, 19, 20, 24, and 25 with all revisions shall be maintained in the office of the building official responsible for the administration and enforcement of this code. Each state department concerned and each city, county, or city and county shall have an up-to-date copy of the code available for public inspection. See Health and Safety Code Section 18942 (d)(1) and (2).*

***1.1.11 Format.** This part fundamentally adopts the Uniform Plumbing Code by reference on a chapter-by-chapter basis. When a specific chapter of the Uniform Plumbing Code is not printed in the code and is marked "Reserved", such chapter of the Uniform Plumbing Code is not adopted as a portion of this code. When a specific chapter of the Uniform Plumbing Code is marked "Not Adopted by the State of California" but appears in the code, it may be available for adoption by local ordinance.*

***Note:** Matrix Adoption Tables at the front of each chapter may aid the code user in determining which chapter or sections within a chapter are applicable to buildings under the authority of a specific state agency, but they are not to be considered regulatory.*

***1.1.12 Validity.** If any chapter, section, subsection, sentence, clause or phrase of this code is for any reason held to be unconstitutional, contrary to statute, exceeding the authority of the state as stipulated by statutes or otherwise inoperative, such decision shall not affect the validity of the remaining portion of this code.*

***1.2.0 Building Standards Commission.***

***1.2.1** Specific scope of application of the agency responsible for enforcement, the enforcement agency, and the specific authority to adopt and enforce such provisions of this code, unless otherwise stated.*

1. ***State Buildings for All Occupancies.***

   ***Application** – State buildings (all occupancies), including buildings constructed by the Trustees of the California State University and the Regents of the University of California where no state agency has the authority to adopt building standards applicable to such buildings.*

   ***Enforcing Agency** – State or local agency specified by the applicable provisions of law.*

   ***Authority Cited** – Health and Safety Code Section 18934.5.*

   ***Reference** – Health and Safety Code, Division 13, Part 2.5, commencing with Section 18901.*

2. ***University of California, California State Universities, and California Community Colleges.***

   ***Application** – Standards for lighting for parking lots and primary campus walkways at the University of California, California State Universities, and California Community Colleges.*

   ***Enforcing Agency** – State or local agency specified by the applicable provisions of law.*

   ***Authority Cited** – Government Code Section 14617.*

   ***Reference** – Government Code Section 14617.*

3. ***Existing State-Owned Buildings, including those owned by the University of California and by the California State University** – Building seismic retrofit standards including abating falling hazards of structural and nonstructural components and strengthening of building structures. See also Division of the State Architect.*

   ***Enforcing Agency** – State or local agency specified by the applicable provisions of law.*

   ***Authority Cited** – Government Code Section 16600.*

   ***References** – Government Code Sections 16600 through 16604.*

4. ***Unreinforced Masonry Bearing Wall Buildings.***

***Application*** *– Minimum seismic strengthening standards for buildings specified in Appendix Chapter 1 of the California Code for Building Conservation, except for buildings subject to building standards adopted pursuant to Part 1.5 (commencing with Section 17910).*

***Enforcing Agency*** *– State or local agency specified by the applicable provisions of law.*

***Authority Cited*** *– Health and Safety Code Section 18934.6.*

***References*** *– Health and Safety Code Sections 18901 through 18949.*

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

***1.2.2.1 Research Reports.*** *Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from approved sources.*

***1.2.2.2 Tests.*** *Whenever there is insufficient evidence of compliance with the provisions of this code, or evidence that a material or method does not conform to the requirements of this code, or in order to substantiate claims for alternative materials or methods, the building official shall have the authority to require tests as evidence of compliance to be made at no expense to the jurisdiction. Test methods shall be as specified in this code or by other recognized test standards. In the absence of recognized and accepted test methods, the building official shall approve the testing procedures. Tests shall be performed by an approved agency. Reports of such tests shall be retained by the building official for the period required for retention of public records.*

***1.2.3 Adopting Agency Identification.*** *The provisions of this code applicable to buildings identified in this section will be identified in the Matrix Adoption Tables under the acronym BSC.*

***1.3.0 Board of State and Community Corrections.***

*1.3.1 Specific scope of application of the agency responsible for enforcement, the enforcement agency, and the specific authority to adopt and enforce such provisions of this code, unless otherwise stated.*

***Application*** *– Local detention facilities.*

***Enforcing Agency*** *– Board of State and Community Corrections.*

***Authority Cited*** *– Penal Code Section 6030; Welfare and Institutions Code Sections 210 and 885.*

***References*** *– Penal Code Section 6030; Welfare and Institutions Code Sections 210 and 885.*

***1.3.2 Adopting Agency Identification.*** *The provisions of this code applicable to buildings identified in this section will be identified in the Matrix Adoption Tables under the acronym BSCC.*

***1.4.0 Department of Consumer Affairs.***

*1.4.1 Specific scope of application of the agency responsible for enforcement, the enforcement agency, and the specific authority to adopt and enforce such provisions of this code, unless otherwise stated.*

***Board of Barbering and Cosmetology.***

***Application*** *– Any establishment or mobile unit where barbering, cosmetology, or electrolysis is being performed.*

***Enforcing Agency*** *– State or local agency specified by applicable provisions of law.*

***Authority Cited*** *– Business and Professions Code Section 7312.*

***References*** *– Business and Professions Code Sections 7303, 7303.1, 7312, and 7313.*

***1.4.2 Adopting Agency Identification.*** *The provisions of this code applicable to buildings identified in this section will be identified in the Matrix Adoption Tables under the acronym CA.*

***1.5.0 Reserved for California Energy Commission.***

***1.6.0 Department of Food and Agriculture.***

*1.6.1 Specific scope of application of the agency responsible for enforcement, the enforcement agency, and the specific authority to adopt and enforce such provisions of this code, unless otherwise stated.*

***Application*** *– Dairies and places of meat and poultry inspection.*

***Enforcing Agency*** *– Department of Food and Agriculture.*

***Authority Cited*** *– Food and Agricultural Code Sections 18735, 18960, 19384, 33481, and 33731.*

***References*** *– Food and Agricultural Code Sections 18735, 18960, 19384, 33481, and 33731.*

***1.6.2 Adopting Agency Identification.*** *The provisions of this code applicable to buildings identified in this section will be identified in the Matrix Adoption Tables under the acronym AGR.*

***1.7.0 Department of Public Health.***

*1.7.1 Specific scope of application of the agency responsible for enforcement, the enforcement agency, and the specific authority to adopt and enforce such provisions of this code, unless otherwise stated.*

***Department of Public Health.***

***Application*** *– Commissaries serving mobile food preparation units, food establishments, and organized camps.*
***Enforcing Agency*** *– Department of Health Services and local health agency.*

***Authority Cited*** *– Health and Safety Code Sections 18897.2, 110065, 113710, and 131200.*

***References*** *– Health and Safety Code Sections 18897.2, 18897.4, 18897.7, 110065, 113705, 113710, and 131200.*

***1.7.2 Adopting Agency Identification.***

*The provisions of this code applicable to buildings identified in this section will be identified in the Matrix Adoption Tables under the acronym DPH.*

***1.8.0 Department of Housing and Community Development. [HCD]***

***1.8.1 Purpose.*** *The purpose of this code is to establish minimum requirements to protect the health, safety, and general welfare of the occupants and the public by governing the erection, construction, reconstruction, enlargement, conversion, alteration, repair, moving, removal, demolition, sanitation, ventilation, and maintenance or use of plumbing equipment or systems.*

***1.8.2 Authority and Abbreviations.***

***1.8.2.1 General.*** *The Department of Housing and Community Development is authorized by law to promulgate and adopt building standards and regulations for several types of building applications. The applications under the authority of the Department of Housing and Community Development are listed in Sections 1.8.2.1.1 through 1.8.2.1.3.*

***1.8.2.1.1 Housing Construction.***

***Application*** *– Hotels, motels, lodging houses, apartment houses, dwellings, dormitories, condominiums, shelters for homeless persons, congregate residences, employee housing, factory built housing, and other types of dwellings containing sleeping accommodations with or without common toilet or cooking facilities including accessory buildings, facilities, and uses thereto. Sections of this code which pertain to applications listed in this section are identified using the abbreviation "HCD 1".*

***Enforcing Agency*** *– Local building department or the Department of Housing and Community Development.*

***Authority Cited*** *– Health and Safety Code Sections 17040, 17050, 17920.9, 17921, 17921.3, 17921.6, 17921.10, 17922, 17922.6, 17922.12, 17927, 17928, 17959.6, 18300, 18552, 18554, 18620, 18630, 18640, 18670, 18690, 18691, 18865, 18871.3, 18871.4, 18873, 18873.1, 18873.2, 18873.3, 18873.4, 18873.5, 18938.3, 18944.11, and 19990; and Government Code Section 12955.1.*

***References*** *– Health and Safety Code Sections 17000 through 17062.5, 17910 through 17995.5, 18200 through 18700, 18860 through 18874, and 19960 through 19997; and Government Code Sections 12955.1 and 12955.1.1.*

***1.8.2.1.2 Housing Accessibility.***

***Application*** *– "COVERED MULTIFAMILY DWELLINGS" as defined in Chapter 11A of the California Code of Regulations, Title 24, Part 2, also known as the California Building Code (CBC) including but not limited to lodging houses, dormitories, timeshares, condominiums, shelters for homeless persons, congregate residences, apartment houses, dwellings, employee housing, factory-built housing, and other types of dwellings containing sleeping accommodations with or without common toilet or cooking facilities.*

*Sections of this code identified by the abbreviation "HCD 1-AC" require specific accommodations for "PERSONS WITH DISABILITIES" as defined in Chapter 11A of the CBC. The application of such provisions shall be in conjunction with other requirements of this code and apply only to newly constructed "COVERED MULTIFAMILY DWELLINGS" as defined in Chapter 11A of the CBC. "HCD 1-AC" applications include, but are not limited to, the following:*

1. *All newly-constructed "COVERED MULTIFAMILY DWELLINGS" as defined in Chapter 11A of the CBC.*
2. *New "COMMON USE AREAS" as defined in Chapter 11A of the CBC serving existing covered multifamily dwellings.*
3. *Additions to existing buildings, where the addition alone meets the definition of "COVERED MULTIFAMILY DWELLINGS" as defined in Chapter 11A of the CBC.*
4. *Common use areas serving covered multifamily dwellings.*
5. *Where any portion of a building's exterior is preserved, but the interior of the building is removed, including all structural portions of floors and ceilings, the building is considered a new building for determining the application of CBC, Chapter 11A.*

*HCD 1-AC building standards generally do not apply to public use areas or public accommodations such as hotels and motels. Public use areas, public accommodations and housing which is publicly funded as defined in Chapter 2 of the CBC are subject to the Division of the State Architect (DSA-AC) and are referenced in Section 1.9.1.*

***Enforcing Agency*** *– Local building department or the Department of Housing and Community Development.*

***Authority Cited*** *– Health and Safety Code Sections 17040, 17050, 17920.9, 17921, 17921.3, 17921.6, 17921.10, 17922, 17922.6, 17922.12, 17927, 17928, 17959.6, 18300, 18552, 18554, 18620, 18630, 18640, 18670, 18690, 18691, 18865, 18871.3, 18871.4, 18873, 18873.1, 18873.2, 18873.3, 18873.4, 18873.5, 18938.3, 18944.11, and 19990; and Government Code Section 12955.1.*

*References – Health and Safety Code Sections 17000 through 17062.5, 17910 through 17995.5, 18200 through 18700, 18860 through 18874, and 19960 through 19997; and Government Code Sections 12955.1 and 12955.1.1.*

***1.8.2.1.3 Permanent Buildings in Mobilehome Parks and Special Occupancy Parks.***

***Application** – Permanent buildings, and permanent accessory buildings or structures, constructed within mobilehome parks and special occupancy parks that are under the control and ownership of the park operator. Sections of this code which pertain to applications listed in this section are identified using the abbreviation "HCD 2".*

***Enforcing Agency** – Local building department or other local agency responsible for the enforcement of Health and Safety Code Division 13, Part 2.1, commencing with Section 18200 for mobilehome parks and Health and Safety Code, Division 13, Part 2.3, commencing with Section 18860 for special occupancy parks; or the Department of Housing and Community Development.*

***Authority Cited** – Health and Safety Code Sections 17040, 17050, 17920.9, 17921, 17921.3, 17921.6, 17921.10, 17922, 17922.6, 17922.12, 17927, 17928, 17959.6, 18300, 18552, 18554, 18620, 18630, 18640, 18670, 18690, 18691, 18865, 18871.3, 18871.4, 18873, 18873.1, 18873.2, 18873.3, 18873.4, 18873.5, 18938.3, 18944.11, and 19990; and Government Code Section 12955.1.*

***References** – Health and Safety Code Sections 17000 through 17062.5, 17910 through 17995.5, 18200 through 18700, 18860 through 18874, and 19960 through 19997; and Government Code Sections 12955.1 and 12955.1.1.*

***1.8.3 Local Enforcing Agency.***

***1.8.3.1 Duties and Powers.** The building department of every city, county, or city and county shall enforce all the provisions of law, this code, and the other rules and regulations promulgated by the Department of Housing and Community Development pertaining to the installation, erection, construction, reconstruction, movement, enlargement, conversion, alteration, repair, removal, demolition, or arrangement of apartment houses, hotels, motels, lodging houses and dwellings, including accessory buildings, facilities, and uses thereto.*

*The provisions regulating the erection and construction of dwellings and appurtenant structures shall not apply to existing structures as to which construction is commenced or approved prior to the effective date of these regulations. Requirements relating to use, maintenance and occupancy shall apply to all dwellings and appurtenant structures approved for construction or constructed before or after the effective date of this code.*

*For additional information regarding the use and occupancy of existing buildings and appurtenant structures, see California Code of Regulations, Title 25, Division 1, Chapter 1, Subchapter 1, commencing with Section 1.*

***1.8.3.2 Laws, Rules, and Regulations.** Other than the building standards contained in this code, and notwithstanding other provisions of law, the statutory authority and location of the laws, rules, and regulations to be enforced by local enforcing agencies are listed by statute in Sections 1.8.3.2.1 through 1.8.3.2.5 below:*

***1.8.3.2.1 State Housing Law.** Refer to the State Housing Law, California Health and Safety Code, Division 13, Part 1.5, commencing with Section 17910 and California Code of Regulations, Title 25, Division 1, Chapter 1, Subchapter 1, commencing with Section 1, for the erection, construction, reconstruction, movement, enlargement, conversion, alteration, repair, removal, demolition, or arrangement of apartment houses, hotels, motels, lodging houses and dwellings, including accessory buildings, facilities, and uses thereto.*

***1.8.3.2.2 Mobilehome Parks Act.** Refer to the Mobilehome Parks Act, California Health and Safety Code, Division 13, Part 2.1, commencing with Section 18200 and California Code of Regulations, Title 25, Division 1, Chapter 2, commencing with Section 1000 for mobilehome park administrative and enforcement authority, permits, plans, fees, violations, inspections, and penalties both within and outside mobilehome parks.*

***Exception:** Mobilehome parks where the Department of Housing and Community Development is the enforcing agency.*

***1.8.3.2.3 Special Occupancy Parks Act.** Refer to the Special Occupancy Parks Act, California Health and Safety Code, Division 13, Part 2.3, commencing with Section 18860 and California Code of Regulations, Title 25, Division 1, Chapter 2.2, commencing with Section 2000 for special occupancy park administrative and enforcement authority, permits, fees, violations, inspections, and penalties both within and outside of special occupancy parks.*

***Exception:** Special occupancy parks where the Department of Housing and Community Development is the enforcing agency.*

***1.8.3.2.4 Employee Housing Act.** Refer to the Employee Housing Act, California Health and Safety Code, Division 13, Part 1, commencing with Section 17000 and California Code of Regulations, Title 25, Division 1, Chapter 1, Subchapter 3, commencing with Section 600 for employee housing administrative and enforcement authority, permits, fees, violations, inspections, and penalties.*

***1.8.3.2.5 Factory-Built Housing Law.** Refer to the Factory-Built Housing Law, California Health and Safety Code, Division 13, Part 6 commencing with Section 19960 and California Code of Regulations, Title 25, Division 1, Chapter 3, Subchapter 1, commencing with Section 3000 for factory-built housing administrative and enforcement authority, permits, fees, violations, inspections, and penalties.*

***1.8.4 Permits, Fees, Applications, and Inspections.***

***1.8.4.1 Permits.*** *A written construction permit shall be obtained from the enforcing agency prior to the erection, construction, reconstruction, installation, relocation, or alteration of any plumbing system.*

***Exceptions:***

1. *Work exempt from permits as specified in Chapter 1, Administration, Division II, Sections 103.1.2.1 and 103.1.2.2 of this code.*
2. *Changes, alterations, or repairs of a minor nature not affecting structural features, egress, sanitation, safety, or accessibility as determined by the enforcing agency.*

*Exemptions from permit requirements shall not be deemed to grant authorization for any work to be done in any manner in violation of other provisions of law or this code.*

***1.8.4.2 Fees.*** *Subject to other provisions of law, the governing body of any city, county, or city and county may prescribe fees to defray the cost of enforcement of rules and regulations promulgated by the Department of Housing and Community Development. The amount of the fees shall not exceed the amount reasonably necessary to administer or process permits, certificates, forms, or other documents, or to defray the costs of enforcement. For additional information, see State Housing Law, Health and Safety Code, Division 13, Part 1.5, Section 17951 and California Code of Regulations, Title 25, Division 1, Chapter 1, Subchapter 1, Article 3, commencing with Section 6.*

***1.8.4.3 Plan Review and Time Limitations.*** *Subject to other provisions of law, provisions related to plan checking, prohibition of excessive delays, and contracting with or employment of private parties to perform plan checking are set forth in the State Housing Law, Health and Safety Code Section 17960.1, and for employee housing, in Health and Safety Code Section 17021.*

***1.8.4.3.1 Retention of Plans.*** *The building department of every city, county, or city and county shall maintain an official copy, microfilm, or electronic or other type of photographic copy of the plans of every building, during the life of the building, for which the department issued a building permit.*

***Exceptions:***

1. *Single or multiple dwellings not more than two stories and basement in height.*
2. *Garages and other structures appurtenant to buildings listed in Exception 1.*
3. *Farm or ranch buildings appurtenant to buildings listed in Exception 1.*
4. *Any one-story building where the span between bearing walls does not exceed 25 feet (7620 mm), except a steel frame or concrete building.*

*All plans for common interest developments as defined in Section 1351 of the California Civil Code shall be retained. For additional information regarding plan retention and reproduction of plans by an enforcing agency, see Health and Safety Code Sections 19850 through 19852.*

***1.8.4.4 Inspections.*** *Construction or work for which a permit is required shall be subject to inspection by the building official and such construction or work shall remain accessible and exposed for inspection purposes until approved. Approval as a result of an inspection shall not be construed to be an approval of a violation of the provisions of this code or other regulations of the Department of Housing and Community Development.*

***1.8.5 Right of Entry for Enforcement.***

***1.8.5.1 General.*** *Subject to other provisions of law, officers and agents of the enforcing agency may enter and inspect public and private properties to secure compliance with the rules and regulations promulgated by the Department of Housing and Community Development. For limitations and additional information regarding enforcement, see the following:*

1. *For applications subject to State Housing Law as referenced in Section 1.8.3.2.1 of this code, refer to Health and Safety Code, Division 13, Part 1.5, commencing with Section 17910 and California Code of Regulations, Title 25, Division 1, Chapter 1, Subchapter 1, commencing with Section 1.*
2. *For applications subject to the Mobilehome Parks Act as referenced in Section 1.8.3.2.2 of this code, refer to Health and Safety Code, Division 13, Part 2.1, commencing with Section 18200 and California Code of Regulations, Title 25, Division 1, Chapter 2, commencing with Section 1000.*
3. *For applications subject to the Special Occupancy Parks Act as referenced in Section 1.8.3.2.3 of this code, refer to Health and Safety Code Division 13, Part 2.3, commencing with Section 18860 and California Code of Regulations, Title 25, Division 1, Chapter 2.2, commencing with Section 2000.*
4. *For applications subject to the Employee Housing Act as referenced in Section 1.8.3.2.4 of this code, refer to Health and Safety Code, Division 13, Part 1, commencing with Section 17000 and California Code of Regulations, Title 25, Division 1, Chapter 1, Subchapter 3, commencing with Section 600.*
5. *For applications subject to the Factory-Built Housing Law as referenced in Section 1.8.3.2.5 of this code, refer to Health and Safety Code, Division 13, Part 6, commencing with Section 19960 and California Code of Regulations, Title 25, Division 1, Chapter 3, Subchapter 1, commencing with Section 3000.*

***1.8.6 Local Modification by Ordinance or Regulation.***

***1.8.6.1 General.*** *Subject to other provisions of law, a city, county, or city and county may make changes to the provisions adopted by the Department of Housing and Community Development. If any city, county, or city and county does not amend, add, or repeal by local ordinances or regulations the provisions published in this code or other regulations promulgated by the Department of Housing and Community Development, those provisions shall be applicable and shall become effective 180 days after publica-*

*tion by the California Building Standards Commission. Amendments, additions, and deletions to this code adopted by a city, county, or city and county pursuant to California Health and Safety Code Sections 17958.5, 17958.7, and 18941.5, together with all applicable portions of this code, shall also become effective 180 days after publication of the California Building Standards Code by the California Building Standards Commission.*

***1.8.6.2 Findings, Filings, and Rejections of Local Modifications.*** *Prior to making any modifications or establishing more restrictive building standards, the governing body shall make express findings and filings, as required by California Health and Safety Code Section 17958.7, showing that such modifications are reasonably necessary due to local climatic, geological, or topographical conditions. No modification shall become effective or operative unless the following requirements are met:*

1. *The express findings shall be made available as a public record.*
2. *A copy of the modification and express finding, each document marked to cross-reference the other, shall be filed with the California Building Standards Commission for a city, county, or a city and county, and with the Department of Housing and Community Development for fire protection districts.*
3. *The California Building Standards Commission has not rejected the modification or change.*

*Nothing in this section shall limit the authority of fire protection districts pursuant to California Health and Safety Code Section 13869.7(a).*

***1.8.7 Alternate Materials, Designs, Tests, and Methods of Construction.***

***1.8.7.1 General.*** *The provisions of this code as adopted by the Department of Housing and Community Development are not intended to prevent the use of any alternate material, appliance, installation, device, arrangement, design, or method of construction not specifically prescribed by this code. Consideration and approval of alternates shall comply with Section 1.8.7.2 for local building departments and Section 1.8.7.3 for the Department of Housing and Community Development.*

***1.8.7.2 Local Building Departments.*** *The building department of any city, county, or city and county may approve alternates for use in the erection, construction, reconstruction, movement, enlargement, conversion, alteration, repair, removal, demolition, or arrangement of an apartment house, hotel, motel, lodging house, or dwelling or an accessory structure, except for the following:*

1. *Structures located in mobilehome parks as defined in California Health and Safety Code Section 18214.*
2. *Structures located in special occupancy parks as defined in California Health and Safety Code Section 18862.43.*
3. *Factory-built housing as defined in California Health and Safety Code Section 19971.*

***1.8.7.2.1 Approval of Alternates.*** *The consideration and approval of alternates by a local building department shall comply with the following procedures and limitations:*

1. *The approval shall be granted on a case-by-case basis.*
2. *Evidence shall be submitted to substantiate claims that the proposed alternate, in performance, safety, and protection of life and health, conforms to, or is at least equivalent to, the standards contained in this code and other rules and regulations promulgated by the Department of Housing and Community Development.*
3. *The local building department may require tests performed by an approved testing agency at the expense of the owner or owner's agent as proof of compliance.*
4. *If the proposed alternate is related to accessibility in covered multifamily dwellings or facilities serving "COVERED MULTIFAMILY DWELLINGS" as defined in Chapter 11A of the CBC, the proposed alternate must also meet the threshold set for "EQUIVALENT FACILITATION" as defined in Chapter 11A of the CBC.*

*For additional information regarding approval of alternates by a local building department pursuant to the State Housing Law, see California Health and Safety Code Section 17951(e) and California Code of Regulations, Title 25, Division 1, Chapter 1, Subchapter 1.*

***1.8.7.3 Department of Housing and Community Development.*** *The Department of Housing and Community Development may approve alternates for use in the erection, construction, reconstruction, movement, enlargement, conversion, alteration, repair, removal, or demolition of an apartment house, hotel, motel, lodging house, dwelling, or an accessory thereto. The consideration and approval of alternates shall comply with the following:*

1. *The department may require tests at the expense of the owner or owner's agent to substantiate compliance with the California Building Standards Code.*
2. *The approved alternate shall, for its intended purpose, be at least equivalent in performance and safety to the materials, designs, tests, or methods of construction prescribed by this code.*

***1.8.8 Appeals Board.***

***1.8.8.1 General.*** *Every city, county, or city and county shall establish a process to hear and decide appeals of orders, decisions, and determinations made by the enforcing agency relative to the application and interpretation of this code and other regulations governing use, maintenance and change of occupancy. The governing body of any city, county, or city and county may establish a local appeals board and a housing appeals board to serve this purpose. Members of the appeals board(s) shall not be employees of the enforcing agency and shall be knowl-*

*edgeable in the applicable building codes, regulations and ordinances as determined by the governing body of the city, county, or city and county.*

*Where no such appeals boards or agencies have been established, the governing body of the city, county, or city and county shall serve as the local appeals board or housing appeals board as specified in California Health and Safety Code Sections 17920.5 and 17920.6.*

***1.8.8.2 Definitions.*** *The following terms shall for the purposes of this section have the meaning shown.*

***Housing Appeals Board.*** *The board or agency of a city, county or city and county which is authorized by the governing body of the city, county, or city and county to hear appeals regarding the requirements of the city, county, or city and county relating to the use, maintenance, and change of occupancy of buildings and structures, including requirements governing alteration, additions, repair, demolition, and moving. In any area in which there is no such board or agency, "housing appeals board" means the local appeals board having jurisdiction over the area.*

***Local Appeals Board.*** *The board or agency of a city, county, or city and county which is authorized by the governing body of the city, county, or city and county to hear appeals regarding the building requirements of the city, county, or city and county. In any area in which there is no such board or agency, "local appeals board" means the governing body of the city, county, or city and county having jurisdiction over the area.*

***1.8.8.3 Appeals.*** *Except as otherwise provided by law, any person, firm, or corporation adversely affected by a decision, order, or determination by a city, county, or city and county relating to the application of building standards published in the California Building Standards Code, or any other applicable rule or regulation adopted by the Department of Housing and Community Development, or any lawfully enacted ordinance by a city, county, or city and county, may appeal the issue for resolution to the local appeals board or housing appeals board as appropriate.*

*The local appeals board shall hear appeals relating to new building construction and the housing appeals board shall hear appeals relating to existing buildings.*

***1.8.9 Unsafe Buildings or Structures.***

***1.8.9.1 Authority to Enforce.*** *Subject to other provisions of law, the administration, enforcement, actions, proceedings, abatement, violations, and penalties for unsafe buildings and structures are contained in the following statutes and regulations:*

1. *For applications subject to State Housing Law as referenced in Section 1.8.3.2.1 of this code, refer to Health and Safety Code, Division 13, Part 1.5, commencing with Section 17910 and California Code of Regulations, Title 25, Division 1, Chapter 1, Subchapter 1, commencing with Section 1.*
2. *For applications subject to the Mobilehome Parks Act as referenced in Section 1.8.3.2.2 of this code, refer to Health and Safety Code, Division 13, Part 2.1, commencing with Section 18200 and California Code of Regulations, Title 25, Division 1, Chapter 2, commencing with Section 1000.*
3. *For applications subject to the Special Occupancy Parks Act as referenced in Section 1.8.3.2.3 of this code, refer to Health and Safety Code, Division 13, Part 2.3, commencing with Section 18860 and California Code of Regulations, Title 25, Division 1, Chapter 2.2, commencing with Section 2000.*
4. *For applications subject to the Employee Housing Act as referenced in Section 1.8.3.2.4 of this code, refer to Health and Safety Code, Division 13, Part 1, commencing with Section 17000 and California Code of Regulations, Title 25, Division 1, Chapter 1, Subchapter 3, commencing with Section 600.*
5. *For applications subject to the Factory-Built Housing Law as referenced in Section 1.8.3.2.5 of this code, refer to Health and Safety Code, Division 13, Part 6, commencing with Section 19960 and California Code of Regulations, Title 25, Division 1, Chapter 3, Subchapter 1, commencing with Section 3000.*

***1.8.9.2 Actions and Proceedings.*** *Subject to other provisions of law, punishments, penalties, and fines for violations of building standards are contained in the following statutes and regulations:*

1. *For applications subject to the State Housing Law as referenced in Section 1.8.3.2.1 of this code, refer to Health and Safety Code, Division 13, Part 1.5, commencing with Section 17910 and California Code of Regulations, Title 25, Division 1, Chapter 1, Subchapter 1, commencing with Section 1.*
2. *For applications subject to the Mobilehome Parks Act as referenced in Section 1.8.3.2.2 of this code, refer to Health and Safety Code, Division 13, Part 2.1, commencing with Section 18200 and California Code of Regulations, Title 25, Division 1, Chapter 2, commencing with Section 1000.*
3. *For applications subject to the Special Occupancy Parks Act as referenced in Section 1.8.3.2.3. of this code, refer to Health and Safety Code, Division 13, Part 2.3, commencing with Section 18860 and California Code of Regulations, Title 25, Division 1, Chapter 2.2, commencing with Section 2000.*
4. *For applications subject to the Employee Housing Act as referenced in Section 1.8.3.2.4 of this code, refer to Health and Safety Code, Division 13, Part 1, commencing with Section 17000 and California Code of Regulations, Title 25, Division 1, Chapter 1, Subchapter 3, commencing with Section 600.*
5. *For applications subject to the Factory-Built Housing Law as referenced in Section 1.8.3.2.5 of this code, refer to Health and Safety Code, Division 13, Part 6, commencing with Section 19960 and California Code of Regulations, Title 25, Division 1, Chapter 3, Subchapter 1, commencing with Section 3000.*

***1.8.10 Other Building Regulations.***

***1.8.10.1 Existing Structures.*** *Notwithstanding other provisions of law, the replacement, retention, and extension of original materials and the use of original methods of*

*construction for any existing building or accessory structure, or portions thereof, shall be permitted. For additional information, see California Health and Safety Code Sections 17912 and 17958.8.*

***1.8.10.2 Moved Structures.*** *Subject to the requirements of California Health and Safety Code Sections 17922.3 and 17958.9, local ordinances or regulations relating to a moved residential or accessory structure shall, after July 1, 1978, permit the retention of existing materials and methods of construction so long as the structure does not become or continue to be a substandard building.*

***Note:***

***Authority Cited*** *– Health and Safety Code Sections 17040, 17050, 17920.9, 17921, 17921.3, 17921.6, 17921.10, 17922, 17922.6, 17922.12, 17927, 17928, 17959.6, 18300, 18552, 18554, 18620, 18630, 18640, 18670, 18690, 18691, 18865, 18871.3, 18871.4, 18873, 18873.1, 18873.2, 18873.3, 18873.4, 18873.5, 18938.3, 18944.11, and 19990; and Government Code Section 12955.1.*

***References*** *– Health and Safety Code Sections 17000 through 17062.5, 17910 through 17995.5, 18200 through 18700, 18860 through 18874, and 19960 through 19997; and Government Code Sections 12955.1 and 12955.1.1.*

***1.9.0 Division of the State Architect.***

***1.9.1 Division of the State Architect – Access Compliance.*** ***Note:*** *For applications listed in Section 1.9.1 of the California Building Code, regulated by the Division of the State Architect – Access Compliance see California Code of Regulations, Title 24, Part 2 (California Building Code), Chapter 1 (Division 1 California Administration) under authority cited by Government Code Section 4450 and in reference cited by Government Code Sections 4450 through 4461, 12955.1, and Health and Safety Code Sections 18949.1, 19952 through 19959.*

***1.9.1.1 Adopting Agency Identification.***

*The provisions of this code applicable to buildings identified in this Subsection 1.9.1 will be identified in the Matrix Adoption Tables under the acronym DSA AC.*

***1.9.2 Division of the State Architect – Structural Safety.***

***1.9.2.1 DSA-SS (Division of the State Architect – Structural Safety).***

***Application*** *– Public elementary and secondary schools, community college buildings, and state-owned or state-leased essential services buildings.*

***Enforcing Agency*** *– (Division of the State Architect – Structural Safety) (DSA-SS).*

*The Division of the State Architect has been delegated the responsibility and authority by the Department of General Services to review and approve the design and observe the construction of public elementary and secondary schools, community colleges, and state-owned or state-leased essential services buildings.*

***Authority Cited*** *– Education Code Section 17310 and 81142, and Health and Safety Code Section 16022.*

***References*** *–Education Code Sections 17280 through 17317 and 81130 through 81147, and Health and Safety Code Sections 16000 through 16023.*

***1.9.2.1.1 Adopting Agency Identification.***

*The provisions of this code applicable to buildings identified in this Subsection 1.9.2 will be identified in the Matrix Adoption Tables under the acronym DSA SS.*

***1.9.2.2 DSA-SS/CC (Division of the State Architect – Structural Safety/Community Colleges).***

***Application*** *– Community Colleges.*

*The Division of the State Architect has been delegated the authority by the Department of General Services to promulgate alternate building standards for application to community colleges, which a community college may elect to use in lieu of standards promulgated by DSA-SS in accordance with Section 1.9.2.1. Refer to Title 24, Part 2, Section 1.9.2.2.*

***Enforcing Agency*** *– Division of the State Architect – Structural Safety/Community Colleges (DSA-SS/CC).*

*The Division of the State Architect has been delegated the authority by the Department of General Services to review and approve the design and oversee construction of community colleges electing to use the alternative building standards as provided in this section.*

***Authority Cited*** *– Education Code Section 81053.*

***References*** *– Education Code Sections 81052, 81053, and 81130 through 81147.*

***1.9.2.2.1 Adopting Agency Identification.***

*The provisions of this code applicable to buildings identified in this Subsection 1.9.2.2 will be identified in the Matrix Adoption Tables under the acronym DSA SS/CC.*

***1.10.0 Office of Statewide Health Planning and Development.***

***1.10.1 OSHPD 1.*** *Specific scope of application of the agency responsible for enforcement, enforcement agency, specific authority to adopt and enforce such provisions of this code, unless otherwise stated.*

***OSHPD 1***

***Application*** *– General acute-care hospitals and acute psychiatric hospitals, excluding distinct part units or distinct part freestanding buildings providing skilled nursing or intermediate-care services. For Structural Regulations: Skilled nursing facilities and/or intermediate-care facilities except those skilled nursing facilities and intermediate-care facilities of single story, Type V, wood or light steel-frame construction.*

***Enforcing Agency*** *– Office of Statewide Health Planning and Development (OSHPD). The office shall enforce the Division of the State Architect access compliance regulations and the regulations of the Office of the State Fire Marshal for the above stated facility types.*

***1.10.1.1 Applicable Administrative Standards.***

1. *Title 24, Part 1, California Code of Regulations: Chapters 6 and 7.*

2. *Title 24, Part 2, California Code of Regulations: Sections 1.1.0 and 1.10.0, Chapter 1, Division I and Sections 101-117, Chapter 1, Division II.*

***1.10.1.2 Applicable Building Standards.*** *California Building Standards Code, Title 24, Parts 2, 3, 4, 5, 9, 10, and 11.*

***Authority Cited*** *– Health and Safety Code Sections 127010, 127015, 1275, and 129850.*

***References*** *– Health and Safety Code Sections 19958, 127010, 127015, 129680, 1275, and 129675 through 130070.*

***1.10.1.3 Adopting Agency Identification.***

*The provisions of this code applicable to buildings identified in this Subsection 1.10.1 will be identified in the Matrix Adoption Tables under the acronym OSHPD 1.*

***1.10.2 OSHPD 2.*** *Specific scope of application of the agency responsible for enforcement, enforcement agency, specific authority to adopt and enforce such provisions of this code, unless otherwise stated.*

***OSHPD 2***

***Application*** *– Skilled nursing facilities and intermediate-care facilities, including distinct part skilled nursing and intermediate-care services on a general acute-care or acute psychiatric hospital license, provided either in a rate unit or a freestanding building. For Structural Regulations: Single-story, Type V skilled nursing facility and/or intermediate-care facilities utilizing wood or light steel-frame construction.*

***Enforcing Agency*** *– Office of Statewide Health Planning and Development (OSHPD). The office shall also enforce the Division of the State Architect access compliance regulations and the regulations of the Office of the State Fire Marshal for the above stated facility type.*

***1.10.2.1 Applicable Administrative Standards.***

1. *Title 24, Part 1, California Code of Regulations: Chapter 7.*
2. *Title 24, Part 2, California Code of Regulations: Sections 1.1.0 and 1.10.0, Chapter 1, Division I and Sections 101-117, Chapter 1, Division II.*

***1.10.2.2 Applicable Building Standards.*** *California Building Standards Code, Title 24, Parts 2, 3, 4, 5, 9, 10, and 11.*

***Authority Cited*** *– Health and Safety Code Sections 127010, 127015, 1275, and 129850.*

***References*** *– Health and Safety Code Sections 127010, 127015, 1275, and 129680.*

***1.10.2.3 Adopting Agency Identification.***

*The provisions of this code applicable to buildings identified in this Subsection 1.10.2 will be identified in the Matrix Adoption Tables under the acronym OSHPD 2.*

***1.10.3 OSHPD 3.*** *Specific scope of application of the agency responsible for enforcement, enforcement agency, specific authority to adopt and enforce such provisions of this code, unless otherwise stated.*

***OSHPD 3***

***Application*** *– Licensed clinics and any freestanding building under a hospital license where outpatient clinical services are provided.*

***Enforcing Agency*** *– Local building department.*

***1.10.3.1 Applicable Administrative Standards.***

1. *Title 24, Part 1, California Code of Regulations: Chapter 7.*
2. *Title 24, Part 2, California Code of Regulations: Sections 1.1.0 and 1.10.0, Chapter 1, Division I and Sections 101-117, Chapter 1, Division II.*

***1.10.3.2 Applicable Building Standards.*** *California Building Standards Code, Title 24, Parts 2, 3, 4, 5, 9, 10, and 11.*

***Authority Cited*** *– Health and Safety Code Sections 127010, 127015, and 1226.*

***References*** *– Health and Safety Code Sections 127010, 127015, 129885, and 1226, Government Code Section 54350, and State Constitution Article 11, Section 7.*

***1.10.3.3 Adopting Agency Identification.***

*The provisions of this code applicable to buildings identified in this Subsection 1.10.3 will be identified in the Matrix Adoption Tables under the acronym OSHPD 3.*

***1.10.4 OSHPD 4.*** *Specific scope of application of the agency responsible for enforcement, enforcement agency, specific authority to adopt and enforce such provisions of this code, unless otherwise stated.*

***OSHPD 4***

***Application*** *– Correctional Treatment Centers.*

***Enforcing Agency*** *–Office of Statewide Health Planning and Development (OSHPD). The office shall also enforce the Division of the State Architect access compliance regulations and the regulations of the Office of the State Fire Marshal for the above stated facility types.*

***1.10.4.1 Applicable Administrative Standards.***

1. *Title 24, Part 1, California Code of Regulations: Chapter 7.*
2. *Title 24, Part 2, California Code of Regulations: Sections 1.1.0 and 1.10.0, Chapter 1, Division I and Sections 101-117, Chapter 1, Division II.*

***1.10.4.2 Applicable Building Standards.*** *California Building Standards Code, Title 24, Parts 2, 3, 4, 5, 9, 10 and 11.*

***Authority Cited*** *– Health and Safety Code Sections 127010, 127015, and 129790.*

***References*** *– Health and Safety Code Sections 127010, 127015, 1275, and 129675 through 130070.*

***1.10.4.3. Adopting Agency Identification.***

*The provisions of this code applicable to buildings identified in this Subsection 1.10.4 will be identified in the Matrix Adoption Tables under the acronym OSHPD 4.*

*1.11.0 Office of the State Fire Marshal.*

*1.11.1 SFM-Office of the State Fire Marshal. Specific scope of application of the agency responsible for enforcement, the enforcement agency and the specific authority to adopt and enforce such provisions of this code, unless otherwise stated.*

*Application:*

***Institutional, Educational, or any Similar Occupancy.*** *Any building or structure used or intended for use as an asylum, jail, mental hospital, hospital, sanitarium, home for the aged, children's nursery, children's home, school, or any similar occupancy of any capacity.*

***Authority Cited*** *– Health and Safety Code Section 13143.*
***Reference*** *– Health and Safety Code Section 13143.*

***Assembly or Similar Place of Assemblage.*** *Any theater, dance-hall, skating rink, auditorium, assembly hall, meeting hall, nightclub, fair building, or similar place of assemblage where 50 or more persons may gather together in a building, room or structure for the purpose of amusement, entertainment, instruction, deliberation, worship, drinking or dining, awaiting transportation, or education.*

***Authority Cited*** *– Health and Safety Code Section 13143.*
***Reference*** *– Health and Safety Code Section 13143.*

***Small Family Day-Care Homes.***

***Authority Cited*** *– Health and Safety Code Sections 1597.45, 1597.54, 13143, and 17921.*

***Reference*** *– Health and Safety Code Section 13143.*

***Large Family Day-Care Homes.***

***Authority Cited*** *– Health and Safety Code Sections 1597.46, 1597.54, and 17921.*

***Reference*** *– Health and Safety Code Section 13143.*

***Residential Facilities and Residential Facilities for the Elderly.***

***Authority Cited*** *– Health and Safety Code Section 13133.*
***Reference*** *– Health and Safety Code Section 13143.*

***Any State Institution or Other State-Owned or State-Occupied Building.***

***Authority Cited*** *– Health and Safety Code Section 13108.*

***Reference*** *– Health and Safety Code Section 13143.*

***High-Rise Structures.***

***Authority Cited*** *– Health and Safety Code Section 13211.*

***Reference*** *– Health and Safety Code Section 13143.*

***Motion Picture Production Studios.***

***Authority Cited*** *– Health and Safety Code Section 13143.1.*

***Reference*** *– Health and Safety Code Section 13143.*

***Organized Camps.***

***Authority Cited*** *– Health and Safety Code Section 18897.3.*
***Reference*** *– Health and Safety Code Section 13143.*

***Residential.***

*All hotels, motels, lodging houses, apartment houses and dwellings, including congregate residences and buildings and structures accessory thereto. Multiple-story structures existing on January 1, 1975, let for human habitation, including and limited to, hotels, motels, apartment houses, less than 75 feet (22 860 mm) above the lowest floor level having building access, wherein rooms used for sleeping are let above the ground floor.*

***Authority Cited*** *– Health and Safety Code Sections 13143.2 and 17921.*

***Reference*** *– Health and Safety Code Section 13143.*

***Residential Care Facilities.***

*Certified family-care homes, out-of-home placement facilities, halfway houses, drug and/or alcohol rehabilitation facilities, and any building or structure used or intended for use as a home or institution for the housing of any person of any age when such person is referred to or placed within such home or institution for protective social care and supervision services by any governmental agency.*

***Authority Cited*** *– Health and Safety Code Section 13143.6.*
***Reference*** *– Health and Safety Code Section 13143.*

***Tents, Awnings, or Other Fabric Enclosures Used in Connection with Any Occupancy.***

***Authority Cited*** *– Health and Safety Code Section 13116.*

***Reference*** *– Health and Safety Code Section 13143.*

***Fire Alarm Devices, Equipment, and Systems in Connection with Any Occupancy.***

***Authority Cited*** *– Health and Safety Code Section 13114.*

***Reference*** *– Health and Safety Code Section 13143.*

***Hazardous Materials.***

***Authority Cited*** *– Health and Safety Code Section 13143.9.*

***Reference*** *– Health and Safety Code Section 13143.*

***Flammable and Combustible Liquids. Authority Cited*** *– Health and Safety Code Section 13143.6.*

***Reference*** *– Health and Safety Code Section 13143.*

***Public School Automatic Fire Detection, Alarm, and Sprinkler Systems.***

***Authority Cited*** *– Health and Safety Code Section 13143 and California Education Code Article 7.5, Sections 17074.50, 17074.52, and 17074.54.*

*References – Government Code Section 11152.5, Health and Safety Code Section 13143 and California Education Code Chapter 12.5, Leroy F. Greene School Facilities Act of 1998, Article 1.*

***Wildland-Urban Interface Fire Area.***

***Authority Cited** – Health and Safety Code Sections 13143, 13108.5(a), and 18949.2(b) and (c); and Government Code Section 51189.*

***References** – Health and Safety Code Sections 13143, Government Code Sections 51176, 51177, 51178, and 51179; and Public Resources Code Sections 4201 through 4204.*

***1.11.2 Duties and Powers of the Enforcing Agency.***

***1.11.2.1 Enforcement.***

***1.11.2.1.1** The responsibility for enforcement of building standards adopted by the State Fire Marshal and published in the California Building Standards Code relating to fire and panic safety and other regulations of the State Fire Marshal shall except as provided in Section 1.11.2.1.2 be as follows:*

1. *The city, county, or city and county, with jurisdiction in the area affected by the standard or regulation shall delegate the enforcement of the building standards relating to fire and panic safety and other regulations of the State Fire Marshal as they relate to Group R-3 occupancies, as described in Section 310.1 of Part 2 of the California Building Standards Code, to either of the following:*

   *1.1. The chief of the fire authority of the city, county, or city, and county or an authorized representative.*

   *1.2. The chief building official of the city, county, or city and county, or an authorized representative.*
2. *The chief of any city or county fire department or of any fire protection district, and authorized representatives, shall enforce within the jurisdiction the building standards and other regulations of the State Fire Marshal, except those described in Item 1 or 4.*
3. *The State Fire Marshal shall have authority to enforce the building standards and other regulations of the State Fire Marshal in areas outside of corporate cities and districts providing fire protection services.*
4. *The State Fire Marshal shall have authority to enforce the building standards and other regulations of the State Fire Marshal in corporate cities and districts providing fire-protection services on request of the chief fire official or the governing body.*
5. *Any fee charged pursuant to the enforcement authority of this section shall not exceed the estimated reasonable cost of providing the service for which the fee is charged pursuant to Section 66014 of the Government Code.*

***1.11.2.1.2** Pursuant to Health and Safety Code Section 13108, and except as otherwise provided in this section, building standards adopted by the State Fire Marshal published in the California Building Standards Code relating to fire and panic safety shall be enforced by the State Fire Marshal in all state-owned buildings, state-occupied buildings, and state institutions throughout the state. Upon the written request of the chief fire official of any city, county, or fire-protection district, the State Fire Marshal may authorize such chief fire official and his or her authorized representatives, in their geographical area of responsibility, to make fire-prevention inspections of state-owned or state-occupied buildings, other than state institutions, for the purpose of enforcing the regulations relating to fire and panic safety adopted by the State Fire Marshal pursuant to this section and building standards relating to fire and panic safety published in the California Building Standards Code. Authorization from the State Fire Marshal shall be limited to those fire departments or fire districts which maintain a fire-prevention bureau staffed by paid personnel.*

*Pursuant to Health and Safety Code Section 13108, any requirement or order made by any chief fire official who is authorized by the State Fire Marshal to make fire-prevention inspections of state-owned or state-occupied buildings, other than state institutions, may be appealed to the State Fire Marshal. The State Fire Marshal shall, upon receiving an appeal and subject to the provisions of Chapter 5 (commencing with Section 18945) of Part 2.5 of Division 13 of the Health and Safety Code, determine if the requirement or order made is reasonably consistent with the fire and panic safety regulations adopted by the State Fire Marshal and building standards relating to fire and panic safety published in the California Building Code.*

*Any person may request a code interpretation from the State Fire Marshal relative to the intent of any regulation or provision adopted by the State Fire Marshal. When the request relates to a specific project, occupancy or building, the State Fire Marshal shall review the issue with the appropriate local enforcing agency prior to rendering such code interpretation.*

***1.11.2.1.3** Pursuant to Health and Safety Code Section 13112, any person who violates any order, rule or regulation of the State Fire Marshal is guilty of a misdemeanor punishable by a fine of not less than $100.00 or more than $500.00, or by imprisonment for not less than six months, or by both. A person is guilty of a separate offense each day during which he or she commits, continues, or permits a violation of any provision of, or any order, rule or regulation of, the State Fire Marshal as contained in this code.*

*Any inspection authority who, in the exercise of his or her authority as a deputy State Fire Marshal, causes any legal complaints to be filed or any arrest to be made shall notify the State Fire Marshal immediately following such action.*

***1.11.2.2 Right of Entry.*** *The fire chief of any city, county, or fire-protection district, or such person's authorized representative, may enter any state institution or any other state-owned or state-occupied building for the purpose of preparing a fire-suppression preplanning program or for the purpose of investigating any fire in a state-occupied building.*

*The State Fire Marshal, his or her deputies or salaried assistants, the chief of any city or county fire department or fire-protection district and his or her authorized representatives may enter any building or premises not used for dwelling purposes at any reasonable hour for the purpose of enforcing this chapter. The owner, lessee, manager, or operator of any such building or premises shall permit the State Fire Marshal, his or her deputies or salaried assistants and the chief of any city or county fire department or fire-protection district and his or her authorized representatives to enter and inspect them at the time and for the purpose stated in this section.*

***1.11.2.3 More Restrictive Fire and Panic Safety Building Standards.***

***1.11.2.3.1*** *Any fire-protection district organized pursuant to Health and Safety Code Part 2.7 (commencing with Section 13800) of Division 12 may adopt building standards relating to fire and panic safety that are more stringent than those building standards adopted by the State Fire Marshal and contained in the California Building Standards Code. For these purposes, the district board shall be deemed a legislative body and the district shall be deemed a local agency. Any changes or modifications that are more stringent than the requirements published in the California Building Standards Code relating to fire and panic safety shall be subject to Section 1.1.8.1.*

***1.11.2.3.2*** *Any fire protection district that proposes to adopt an ordinance pursuant to this section shall, not less than 30 days prior to noticing a proposed ordinance for public hearing, provide a copy of that ordinance, together with the adopted findings made pursuant to Section 1.11.2.3.1, to the city, county, or city and county where the ordinance will apply. The city, county, or city and county may provide the district with written comments, which shall become part of the fire-protection district's public hearing record.*

***1.11.2.3.3*** *The fire-protection district shall transmit the adopted ordinance to the city, county, or city and county where the ordinance will apply. The legislative body of the city, county, or city and county may ratify, modify or deny an adopted ordinance and transmit its determination to the district within 15 days of the determination. Any modification or denial of an adopted ordinance shall include a written statement describing the reasons for any modifications or denial. No ordinance adopted by the district shall be effective until ratification by the city, county, or city and county where the ordinance will apply. Upon ratification of an adopted ordinance, the city, county, or city and county shall file a copy of the findings of the district, and any findings of the city, county, or city and county together with the adopted ordinance expressly marked and identified to which each finding refers, in accordance with Section 1.1.8.1(3).*

***1.11.2.4 Request for Alternate Means of Protection.*** *Requests for approval to use an alternative material, assembly or materials, equipment, method of construction, method of installation of equipment, or means of protection shall be made in writing to the enforcing agency by the owner or the owner's authorized representative and shall be accompanied by a full statement of the conditions. Sufficient evidence or proof shall be submitted to substantiate any claim that may be made regarding its conformance. The enforcing agency may require tests and the submission of a test report from an approved testing organization as set forth in Title 19, California Code of Regulation, to substantiate the equivalency of the proposed alternative means of protection.*

*When a request for alternate means of protection involves hazardous materials, the Authority Having Jurisdiction may consider implementation of the findings and recommendations identified in a Risk Management Plan (RMP) developed in accordance with Title 19, Division 2, Chapter 4.5, Article 3.*

*Approval of a request for use of an alternative material, assembly of materials, equipment, method of construction, method of installation of equipment, or means of protection made pursuant to these provisions shall be limited to the particular case covered by request and shall not be construed as establishing any precedent for any future request.*

***1.11.2.5 Appeals.*** *When a request for an alternate means of protection has been denied by the enforcing agency, the applicant may file a written appeal to the State Fire Marshal for consideration of the applicant's proposal. In considering such appeal, the State Fire Marshal may seek the advice of the State Board of Fire Services. The State Fire Marshal shall, after considering all of the facts presented, including any recommendations of the State Board of Fire Services, determine if the proposal is for the purposes intended, at least equivalent to that specified in these regulations in quality, strength, effectiveness, fire resistance, durability, and safety, and shall transmit such findings and any recommendations to the applicant and to the enforcing agency.*

***1.11.3 Construction Documents.*** *In addition to the provisions of this Section, see Title 24, Part 2, California Building Code, Appendix Chapter 1, Section 106 for additional requirements.*

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*1.11.3.1* ***Public Schools.*** *Plans and specifications for the construction, alteration or addition to any building owned, leased or rented by any public school district shall be submitted to the Division of the State Architect.*

*1.11.3.2* ***Movable Walls and Partitions.*** *Plans or diagrams shall be submitted to the enforcing agency for approval before the installation of, or rearrangement of, any movable wall or partition in any occupancy. Approval shall be granted only if there is no increase in the fire hazard.*

*1.11.3.3* ***New Construction High-Rise Buildings.***

1. *Complete plans or specifications, or both, shall be prepared covering all work required to comply with new construction high-rise buildings. Such plans and specifications shall be submitted to the enforcing agency having jurisdiction.*
2. *All plans and specifications shall be prepared under the responsible charge of an architect or a civil or structural engineer authorized by law to develop construction plans and specifications, or by both such architect and engineer. Plans and specifications shall be prepared by an engineer duly qualified in that branch of engineering necessary to perform such services. Administration of the work of construction shall be under the charge of the responsible architect or engineer except that where plans and specifications involve alterations or repairs, such work of construction may be administered by an engineer duly qualified to perform such services and holding a valid certificate under Chapter 7 (commencing with Section 65700) of Division 3 of the Business and Professions Code for performance of services in that branch of engineering in which said plans, specifications and estimates and work of construction are applicable.*

   *This section shall not be construed as preventing the design of fire-extinguishing systems by persons holding a C-16 license issued pursuant to Division 3, Chapter 9, Business and Professions Code. In such instances, however, the responsibility charge of this section shall prevail.*

*1.11.3.4* ***Existing High-Rise Buildings.***

1. *Complete plans or specifications, or both, shall be prepared covering all work required by Section 3412 for existing high-rise buildings. Such plans or specifications shall be submitted to the enforcing agency having jurisdiction.*
2. *When new construction is required to conform with the provisions of these regulations, complete plans or specifications, or both, shall be prepared in accordance with the provisions of this subsection. As used in this section "new construction" is not intended to include repairs, replacements or minor alterations which do not disrupt or appreciably add to or affect the structural aspects of the building.*

*1.11.3.5* ***Retention of Plans.*** *Refer to Building Standards Law, Health and Safety Code Sections 19850 and 19851, for permanent retention of plans.*

*1.11.4 Fees.*

*1.11.4.1* ***Other Fees.*** *Pursuant to Health and Safety Code Section 13146.2, a city, county, or district which inspects a hotel, motel, lodging house, or apartment house may charge and collect a fee for the inspection from the owner of the structure in an amount, as determined by the city, county, or district, sufficient to pay its costs of that inspection.*

*1.11.4.2* ***Large Family Day Care.*** *Pursuant to Health and Safety Code Section 1597.46, Large Family Day-Care Homes, the local government shall process any required permit as economically as possible, and fees charged for review shall not exceed the costs of the review and permit process.*

*1.11.4.3* ***High-Rise.*** *Pursuant to Health and Safety Code Section 13217, High-Rise Structure Inspection: Fees and Costs, a local agency which inspects a high-rise structure pursuant to Health and Safety Code Section 13217 may charge and collect a fee for the inspection from the owner of the high-rise structure in an amount, as determined by the local agency, sufficient to pay its costs of that inspection.*

*1.11.4.4* ***Fire Clearance Preinspection.*** *Pursuant to Health and Safety Code Section 13235, Fire Clearance Preinspection, Fee; upon receipt of a request from a prospective licensee of a community care facility, as defined in Section 1502, of a residential-care facility for the elderly, as defined in Section 1569.2, or of a child day-care facility, as defined in Section 1596.750, the local fire enforcing agency, as defined in Section 13244, or State Fire Marshal, whichever has primary jurisdiction, shall conduct a preinspection of the facility prior to the final fire clearance approval. At the time of the preinspection, the primary fire enforcing agency shall price consultation and interpretation of the fire safety regulations and shall notify the prospective licensee of the facility in writing of the specific fire safety regulations which shall be enforced in order to obtain fire clearance approval. A fee of not more than $50.00 may be charged for the preinspection of a facility with a capacity to serve 25 or fewer persons. A fee of not more than $100.00 may be charged for a preinspection of a facility with a capacity to serve 26 or more persons.*

*1.11.4.5* ***Care Facilities.*** *The primary fire enforcing agency shall complete the final fire clearance inspection for a community care facility, residential-care facility for the elderly, or child day-care facility within 30 days of receipt of the request for the final inspection, or as of the date the prospective facility requests the final prelicensure inspection by the State Department of Social Services, whichever is later.*

*Pursuant to Health and Safety Code Section 13235, a preinspection fee of not more than $50 may be charged for a facility with a capacity to serve 25 or less clients. A fee of not more than $100 may be charged for a preinspection of a facility with a capacity to serve 26 or more clients.*

*Pursuant to Health and Safety Code Section 13131.5, a reasonable final inspection fee, not to exceed the actual cost of inspection services necessary to complete a final inspection may be charged for occupancies classified as residential care facilities for the elderly (RCFE).*

*Pursuant to Health and Safety Code Section 1569.84, neither the State Fire Marshal nor any local public entity shall charge any fee for enforcing fire inspection regulations pursuant to state law or regulation or local ordinance, with respect to residential-care facilities for the elderly (RCFE) which service six or fewer persons.*

***1.11.4.6 Requests of the Office of the State Fire Marshal.*** *Whenever a local Authority Having Jurisdiction requests that the State Fire Marshal perform plan review and/or inspection services related to a building permit, the applicable fees for such shall be payable to the Office of the State Fire Marshal.*

***1.11.5 Inspections.*** *Work performed subject to the provisions of this code shall comply with the inspection requirements of Title 24, Part 2, California Building Standards Code, Sections 109.1, 109.3, 109.3.4, 109.3.5, 109.3.6, 109.3.8, 109.3.9, 109.3.10, 109.5, and 109.6 as adopted by the Office of the State Fire Marshal.*

***1.11.5.1 Existing Group I-1 or R occupancies.*** *Licensed 24-hour care in a Group I-1 or R occupancy in existence and originally classified under previously adopted state codes shall be reinspected under the appropriate previous code, provided there is no change in the use or character which would place the facility in a different occupancy group.*

***1.11.6 Certificate of Occupancy.*** *A Certificate of Occupancy shall be issued as specified in Title 24, Part 2, California Building Code, Section 111.*

***Exception:*** *Group R-3 and Group U Occupancies.*

***1.11.7 Temporary Structures and Uses.*** *See Title 24, Part 2, California Building Code, Section 107.*

***1.11.8 Service Utilities.*** *See Title 24, Part 2, California Building Code, Section 112.*

***1.11.9 Stop Work Order.*** *See Title 24, Part 2, California Building Code, Section 115.*

***1.11.10 Unsafe Buildings, Structures, and Equipment.*** *See Title 24, Part 2, California Building Code, Section 116.*

***1.11.11 Adopting Agency Identification.***

*The provisions of this code applicable to buildings identified in this section will be identified in the Matrix Adoption Tables under the acronym SFM.*

***1.12.0 Reserved for the State Librarian.***

***1.13.0 Department of Water Resources (DWR).***

***1.13.1 Application*** *– Construction, installation, or alteration of graywater systems for subsurface irrigation and other safe uses.*

***Enforcing Agency*** *– Local building department or the Department of Water Resources.*

***Authority Cited*** *– Water Code Sections 14875 through 14877.3.*

***References*** *– Water Code Sections 14875 through 14877.3.*

***1.13.2 Application*** *– Installation, construction, alteration, or repair of recycled water systems for water closets, urinals, trap primers for floor drains, floor sinks and other allowed uses.*

***Enforcing Agency*** *– State or local agency specified by the applicable provisions of law.*

***Authority Cited*** *– Water Code Section 13557.*

***References*** *– Water Code Section 13553.*

***1.13.3 Adopting Agency Identification.*** *The provisions of this code applicable to buildings identified in this section will be identified in the Matrix Adoption Tables under the acronym DWR.*

***1.14.0 Reserved for the State Lands Commission.***

# DIVISION II
## ADMINISTRATION

**101.0 General.**

**101.1 Title.** This document shall be known as the "Uniform Plumbing Code," may be cited as such, and will be referred to herein as "this code."

**101.2 Scope.** The provisions of this code shall apply to the erection, installation, alteration, repair, relocation, replacement, addition to, use, or maintenance of plumbing systems within this jurisdiction.

**101.3 Purpose.** This code is an ordinance providing minimum requirements and standards for the protection of the public health, safety, and welfare.

**101.4 Conflicts Between Codes.** Where the requirements within the jurisdiction of this plumbing code conflict with the requirements of the mechanical code, this code shall prevail. In instances where the code, applicable standards, or the manufacturer's installation instructions conflict, the more stringent provisions shall prevail. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall prevail.

**101.5 Plans Required.** The Authority Having Jurisdiction shall be permitted to require the submission of plans, specifications, drawings, and such other information in accordance with the Authority Having Jurisdiction, prior to the commencement of, and at a time during the progress of, work regulated by this code.

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

**101.6 Repairs and Alterations.** In existing buildings or premises in which 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.

**101.6.1 Building Sewers and Drains.** Existing building sewers and building drains shall be permitted to be used in connection with new buildings or new plumbing and drainage work where they are found on examination and test to be in accordance with the requirements governing new work, and the proper Authority Having Jurisdiction shall notify the owner to make changes necessary to be in accordance with this code. No building, or part thereof, shall be erected or placed over a part of a drainage system that is constructed of materials other than those approved elsewhere in this code for use under or within a building.

**101.6.2 Openings.** Openings into a drainage or vent system, excepting those openings to which plumbing fixtures are properly connected or which constitute vent terminals, shall be permanently plugged or capped in an approved manner, using the appropriate materials in accordance with this code.

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

**101.8 Existing Construction.** No provision of this code shall be deemed to require a change in a portion of a plumbing or drainage system or other work regulated by this code in or on an existing building or lot where such work was installed and is maintained in accordance with law in effect prior to the effective date of this code, except where such plumbing or drainage 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.

**101.9 Additions, Alterations, or Repairs.** Additions, alterations, repairs, and replacement of plumbing systems shall comply with the provisions for new systems except as otherwise provided in Section 101.11.

**101.10 Appendices.** The provisions in the appendices are intended to supplement the requirements of this code and shall not be considered part of this code unless formally adopted as such.

**101.11 Application to Existing Plumbing System.** Additions, alterations, or repairs shall be permitted to be made to a plumbing system without requiring the existing plumbing system to be in accordance with the requirements of this code, provided the addition, alteration, or repair is in accordance with that required for a new plumbing system. Additions, alterations, or repairs shall not cause an existing system to become unsafe, insanitary, or overloaded.

**101.11.1 Health and Safety.** Where compliance with the provisions of this code fail to eliminate or alleviate a nuisance, or other dangerous or insanitary condition that involves health or safety hazards, the owner or the owner's agent shall install such additional plumbing and drainage facilities or shall make such repairs or alterations as ordered by the Authority Having Jurisdiction.

**101.11.2 Existing Installation.** Plumbing systems lawfully in existence at the time of the adoption of this code shall be permitted to have their use, maintenance, or repair continued where 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 plumbing system.

**101.11.3 Changes in Building Occupancy.** Plumbing systems that are a part of a building or structure undergoing a change in use or occupancy, as defined in the building code, shall be in accordance with the requirements of this code that are applicable to the new use or occupancy.

**101.11.4 Operating Condition.** Plumbing systems, materials, and appurtenances, both existing and new, and parts thereof shall be maintained in operating condition. Devices or safeguards required by this code shall be maintained in accordance with the code edition under which installed. The owner or the owner's designated agent shall be responsible for maintenance of plumbing systems. To determine compliance with this subsection, the Authority Having Jurisdiction shall be permitted to cause a plumbing system to be reinspected.

**101.11.5 Moved Buildings.** Plumbing systems that are part of buildings or structures moved into this jurisdiction shall be in accordance with the provisions of this code for new installations, except as provided for in Section 103.5.8.2.

**102.0 Organization and Enforcement.**

**102.1 Authority Having Jurisdiction.** The Authority Having Jurisdiction shall be the Authority duly appointed to enforce this code. For such purposes, the Authority Having Jurisdiction shall have the powers of a law enforcement officer. The Authority Having Jurisdiction shall have the power to render interpretations of this code and to adopt and enforce rules and regulations supplemental to this code as deemed necessary in order to clarify the application of the provisions of this code. Such interpretations, rules, and regulations shall comply with the intent and purpose of this code.

In accordance with the prescribed procedures and with the approval of the appointing authority, the Authority Having Jurisdiction shall be permitted to appoint such number of technical officers, inspectors, and other employees as shall be authorized from time to time. The Authority Having Jurisdiction shall be permitted to deputize such inspectors or employees as necessary to carry out the functions of the code enforcement agency.

**102.2 Duties and Powers of the Authority Having Jurisdiction.** The Authority Having Jurisdiction shall be permitted to request the assistance and cooperation of other officials of this jurisdiction so far as required in the discharge of the duties in accordance with this code or other pertinent law or ordinance.

**102.2.1 Right of Entry.** Where it is necessary to make an inspection to enforce the provisions of this code, or where the Authority Having Jurisdiction has reasonable cause to believe that there exists in a building or upon a premises a condition or violation of this code that makes the building or premises unsafe, insanitary, dangerous, or hazardous, the Authority Having Jurisdiction shall be permitted to enter the building or premises at reasonable times to inspect or to perform the duties imposed upon the Authority Having Jurisdiction by this code, provided that where such building or premises is occupied, the Authority Having Jurisdiction shall present credentials to the occupant and request entry. Where such building or premises is unoccupied, the Authority Having Jurisdiction shall first make a reasonable effort to locate the owner or other person having charge or control of the building or premises and request entry. Where entry is refused, the Authority Having Jurisdiction has recourse to every remedy provided by law to secure entry.

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

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

**102.2.3 Authority to Disconnect Utilities in Emergencies.** The Authority Having Jurisdiction shall have the authority to disconnect a 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.

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

Where such plumbing system is to be disconnected, written notice shall be given. In cases of immediate danger to life or property, such disconnection shall be permitted to be made immediately without such notice.

**102.2.5 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 damage that accrues to persons or property as a result of an act or by reason of an 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 provisions of this code shall be defended by legal counsel provided by this jurisdiction until final termination of such proceedings.

**102.3 Board of Appeals.** In order to hear and decide appeals of orders, decisions, or determinations made by the Authority Having Jurisdiction relative to the application and interpretations of this code, there shall be and is hereby created a Board of Appeals consisting of members who are qualified by experience and training to pass upon matters pertaining to plumbing design, construction, and maintenance and the public health aspects of plumbing systems and who are not employees of the jurisdiction. The Authority Having Jurisdiction shall be an ex-officio member and shall act as secretary to said board but shall have no vote upon a matter before the board. The Board of Appeals shall be appointed by the governing body and shall hold office at its pleasure. The board shall adopt rules of procedure for conducting its business and shall render decisions and findings in writing to the appellant with a duplicate copy to the Authority Having Jurisdiction.

**102.3.1 Limitations of Authority.** The Board of Appeals shall have no authority relative to interpretation of the administrative provisions of this code, nor shall the board be empowered to waive requirements of this code.

**102.4 Violations.** It shall be unlawful for a person, firm, or corporation to erect, construct, enlarge, alter, repair, move, improve, remove, convert, demolish, equip, use, or maintain plumbing or permit the same to be done in violation of this code.

**102.5 Penalties.** A person, firm, or corporation violating a provision of this code shall be deemed guilty of a misdemeanor, and upon conviction thereof, shall be punishable by a fine, imprisonment, or both set forth by the governing laws of the jurisdiction. Each separate day or portion thereof, during which a violation of this code occurs or continues, shall be deemed to constitute a separate offense.

**103.0 Permits and Inspections.**

**103.1 Permits Required.** It shall be unlawful for a person, firm, or corporation to make an installation, alteration, repair, replacement, or remodel a plumbing system regulated by this code except as permitted in Section 103.1.1, or to cause the same to be done without first obtaining a separate plumbing permit for each separate building or structure.

**103.1.1 Exempt Work.** A permit shall not be required for the following:

(1) The stopping of leaks in drains, soil, waste, or vent pipe, provided, however, that a trap, drain pipe, soil, waste, or vent pipe 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.

(2) The clearing of stoppages, including the removal and reinstallation of water closets, 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 work to be done in violation of the provisions of the code or other laws or ordinances of this jurisdiction.

**103.1.2 Licensing.** Provision for licensing shall be determined by the Authority Having Jurisdiction.

**103.2 Application for Permit.** To obtain a permit, the applicant shall first file an application therefore in writing on a form furnished by the Authority Having Jurisdiction for that purpose. Such application shall:

(1) Identify and describe the work to be covered by the permit for which application is made.

(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.

(3) Indicate the use or occupancy for which the proposed work is intended.

(4) Be accompanied by plans, diagrams, computations, and other data in accordance with Section 103.2.1.

(5) Be signed by the permittee or the permittee's authorized agent. The Authority Having Jurisdiction shall be permitted to require evidence to indicate such authority.

(6) Give such other data and information in accordance with the Authority Having Jurisdiction.

**103.2.1 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 shall be permitted to require plans, computations, and specifications to be prepared by, and the plumbing designed by, an engineer, an architect, or both who shall be licensed by the state to practice as such.

**Exception:** The Authority Having Jurisdiction shall be permitted to waive the submission of plans, calculations, or other data where 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.

**103.2.2 Information on Plans and Specifications.** Plans and specifications shall be drawn to scale upon substantial paper or cloth and shall indicate the location, nature, and extent of the work proposed and show in detail that it is in accordance with the provisions of this code and relevant laws, ordinances, rules, and regulations.

**103.3 Permit 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 shall be permitted to be reviewed by other departments of this jurisdiction to verify compliance with applicable laws under their jurisdiction. Where the Authority Having Jurisdiction finds that the work described in an application for per-

mit and the plans, specifications, and other data filed therewith are in accordance with 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 therefore to the applicant.

Where 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 the work shall be done in accordance with approved plans.

The Authority Having Jurisdiction shall be permitted to 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 in accordance with the pertinent requirements of this code. The holder of such permit shall be permitted to proceed at the holder's risk without assurance that the permit for the entire building, structure, or plumbing system will be granted.

**103.3.1 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 times during which the work authorized thereby is in progress.

**103.3.2 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, a violation of the provisions of this code or 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 where in violation of this code or of other ordinances of this jurisdiction.

**103.3.3 Expiration.** A permit issued by the Authority Having Jurisdiction under the provisions of this code shall expire by limitation and become null and void where the work authorized by such permit is not commenced within 180 days from the date of such permit, or where the work authorized by such permit is suspended or abandoned at a time after the work is commenced for a period of 180 days. Before such work is recommenced, a new permit shall first be obtained to do so, and the fee therefore shall be one-half the amount required for a new permit for such work, provided no changes have been made or will be made in the original plans and specifications for such work, and provided further that such suspensions or abandonment has not exceeded 1 year.

A permittee holding an unexpired permit shall be permitted to apply for an extension of the time within which work shall be permitted to commence under that permit where the permittee is unable to commence work within the time required by this section. The Authority Having Jurisdiction shall be permitted to extend the time for action by the permittee for a period not exceeding 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.

**103.3.4 Suspension or Revocation.** The Authority Having Jurisdiction shall be permitted to, in writing, suspend or revoke a permit issued under the provisions of this code where the permit is issued in error or on the basis of incorrect information supplied or in violation of other ordinance or regulation of the jurisdiction.

**103.4 Fees.** Fees shall be assessed in accordance with the provisions of this section and as set forth in the fee schedule Table 103.4. The fees are to be determined and adopted by this jurisdiction.

**103.4.1 Plan Review Fees.** Where a plan or other data is required to be submitted by Section 103.2.1, a plan review fee shall be paid at the time of submitting plans and specifications for review.

The plan review fees for plumbing work 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.

Where plans are incomplete or changed so as to require additional review, a fee shall be charged at the rate shown in Table 103.4.

**103.4.2 Expiration of Plan Review.** Applications for which no permit is issued within 180 days following the date of application shall expire by limitation, plans and other data submitted for review thereafter, shall be returned to the applicant or destroyed by the Authority Having Jurisdiction. The Authority Having Jurisdiction shall be permitted to exceed the time for action by the applicant for a period not to exceed 180 days upon request by the applicant showing that circumstances beyond the control of the applicant have prevented action from being taken. No application shall be extended more than once. In order to renew action on an application after expiration, the applicant shall resubmit plans and pay a new plan review fee.

**103.4.3 Investigation Fees – Work Without a Permit.** Where 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 shall be issued for such work.

**103.4.3.1 Fees.** 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 is required by this code if a permit were to be issued. The payment of such investigation fee shall not exempt a person from compliance with other provisions of this code, nor from a penalty prescribed by law.

**103.4.4 Fee Refunds.** The Authority Having Jurisdiction shall be permitted to authorize the refunding of a fee paid hereunder that was erroneously paid or collected.

**103.4.4.1 Percentage.** The Authority Having Jurisdiction shall be permitted to authorize the refunding of not more than a percentage, as determined by this jurisdiction where no work has been done under a permit issued in accordance with this code.

**103.4.4.2 In Writing.** The Authority Having Jurisdiction shall not authorize the refunding of a fee paid except upon written application filed by the original permittee not to exceed 180 days after the date of fee payment.

**103.5 Inspections.** Plumbing systems for which a permit is required by this code shall be inspected by the Authority Having Jurisdiction.

No portion of a 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. Where 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.

**103.5.1 Water Supply System.** No water supply system or portion thereof shall be covered or concealed until it first has been tested, inspected, and approved.

**103.5.2 New Plumbing Work.** New plumbing work and such portions of existing systems as affected by new work, or changes, shall be inspected by the Authority Having Jurisdiction to ensure compliance with the requirements of this code and to ensure that the installation and construction of the plumbing system is in accordance with approved plans.

**103.5.3 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.

**103.5.4 Uncovering.** Where a 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.

**103.5.5 Operation of Plumbing Equipment.** The requirements of this section shall not be considered to prohibit the operation of 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 72 hours after such replacement work is completed, and before a portion of such plumbing system is concealed by a permanent portion of the building.

**103.5.6 Testing of Systems.** Plumbing systems shall be tested and approved in accordance with this code or the Authority Having Jurisdiction.

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

**103.5.6.2 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.

**103.5.6.3 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 shall be permitted to 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.

**103.5.6.4 Tightness.** Joints and connections in the plumbing system shall be gastight and watertight for the pressures required by the test.

**103.5.7 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 shall be permitted to require that a request for inspection be filed not less than 1 working day before such inspection is desired. Such request shall be in writing or by telephone, at the option of the Authority Having Jurisdiction.

It shall be the duty of the person requesting inspections in accordance with this code to provide access to and means for inspection of such work.

**103.5.7.1 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 24 hours before the work is to be inspected.

**103.5.7.2 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.

**103.5.8 Other Inspections.** In addition to the inspections required by this code, the Authority Having Jurisdiction shall be permitted to require other inspections of plumbing work to ascertain compliance with the provisions of this code and other laws that are enforced by the Authority Having Jurisdiction.

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

**103.5.8.2 Moved Structures.** Parts of the plumbing systems of a 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 where other equivalent means of inspection acceptable to the Authority Having Jurisdiction are provided.

**103.5.9 Reinspections.** A reinspection fee shall be permitted to be assessed for each inspection or reinspection where such portion of work for which inspection is called is not complete or where 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 be in accordance 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 shall be permitted to be assessed where 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 therefore in writing upon a form furnished for that purpose and pay the reinspection fee in accordance with Table 103.4.

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

**103.5.9.1 Corrections.** Notices of correction or violation shall be written by the Authority Having Jurisdiction and shall be permitted to 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 such notice or order within 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.

**103.5.9.2 Retesting.** Where the Authority Having Jurisdiction finds that the work will not pass the test, necessary corrections shall be made, and the work shall be resubmitted for test or inspection.

**103.5.9.3 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.

**103.6 Connection Approval.** No person shall make connections from a source of energy or fuel to a plumbing system or equipment regulated by this code and for which a permit is required until approved by the Authority Having Jurisdiction.

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

**103.6.2 Temporary Connections.** The Authority Having Jurisdiction shall be permitted to authorize temporary connection of the plumbing equipment to the source of energy or fuel for the purpose of testing the equipment.

**103.7 Unconstitutional.** Where a section, subsection, sentence, clause, or phrase of this code is, for a 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 one or more sections, subsections, sentences, clauses, and phrases are declared unconstitutional.

**103.8 Validity.** Where a provision of this code, or the application thereof to a 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.

TABLE 103.4

PLUMBING 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 plumbing fixture on one trap or a set of fixtures on one trap (including water, drainage piping, and backflow protection therefore) ..... *_____
2. For each building sewer and each trailer park sewer ..... *_____
3. Rainwater systems – per drain (inside building) ..... *_____
4. For each cesspool (where permitted) ..... *_____
5. For each private sewage disposal system ..... *_____
6. For each water heater, vent, or both ..... *_____
7. For each gas piping system of one to five outlets ..... *_____
8. For each additional gas piping system outlet, per outlet ..... *_____
9. For each industrial waste pretreatment interceptor, including its trap and vent, except kitchen-type grease interceptors functioning as fixture traps ..... *_____
10. For each installation, alteration, or repair of water piping, water treating equipment, or both ..... *_____
11. For each repair or alteration of drainage or vent piping, each fixture ..... *_____
12. For each lawn sprinkler system on one meter including backflow protection devices therefore ..... *_____
13. For atmospheric-type vacuum breakers not referenced in Item 12:
    - One to 5 ..... *_____
    - over 5, each ..... *_____
14. For each backflow protective device other than atmospheric-type vacuum breakers:
    - Two inch (50 mm) diameter and smaller ..... *_____
    - over 2 inch (50 mm) diameter ..... *_____
15. For each gray water system ..... *_____
16. For initial installation and testing for a reclaimed water system ..... *_____
17. For each annual cross-connection testing of a reclaimed water system (excluding initial test) ..... *_____
18. For each medical gas piping system serving one to five inlet(s)/outlet(s) for a specific gas ..... *_____
19. For each additional medical gas inlet(s)/outlet(s) ..... *_____

## 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 – ½ hour) ..... *_____

For SI units: 1 inch = 25 mm

* Jurisdiction will indicate their fees here.

## CALIFORNIA PLUMBING CODE. MATRIX ADOPTION TABLE
## CHAPTER 2 - DEFINITIONS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | X | | | | | X | X | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | X | | X | X | X | | | | X | X | X | X | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | X | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| 203.0 | | | X | X | | | | | | | | | | | | | | | |
| 204.0 | | | X | X | | | | | | | | | | | | | | | |
| 205.0 | X | | X | | X | | | | | | | | | X | | | | | |
| 206.0 | X | | X | X | X | | | | | | | | | | | | | | |
| 207.0 | X | | X | X | X | | | | | | | | | | | | | | |
| 208.0 | | | | | | | | | | | | | | X | | | | | |
| 209.0 | X | | X | | | | | | | | | | | | | | | | |
| 210.0 | | | | | | | | | X | X | X | X | | | | | | | |
| 211.0 | X | | X | | | | | | | | | | | | | | | | |
| 214.0 | | | X | X | | | | | | | | | | | | | | | |
| 215.0 | X | | X | | | | | | | | | | | | | | | | |
| 216.0 | | | X | X | | | | | | | | | | | | | | | |
| 217.0 | X | | X | | | | | | | | | | | | | | | | |
| 220.0 | X | | X | | | | | | | | | | | | | | | | |
| 221.0 | X | | X | | | | | | X | X | X | X | | | | | | | |
| 222.0 | X | | X | X | | | | | X | X | X | X | | | | | | | |
| 223.0 | | | X | X | | | | | | | | | | X | | | | | |
| 225.0 | | | X | X | | | | | | | | | | | | | | | |

# CHAPTER 2
## DEFINITIONS

**201.0 General.**

**201.1 Applicability.** For the purpose of this code, the following terms 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 a word has been used loosely and it is necessary to define its meaning as used in this code to avoid misunderstanding.

**202.0 Definition of Terms.**

**202.1 General.** The definitions of terms are arranged alphabetically according to the first word of the term.

**203.0 – A –**

**ABS.** Acrylonitrile-butadiene-styrene.

**Accessible.** Where 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.

**Accessible, Readily.** Having a direct access without the necessity of removing a panel, door, or similar obstruction.

**Air Break.** A physical separation which may be a low inlet into the indirect waste receptor from the fixture, appliance, or device indirectly connected.

**Air Gap, Drainage.** The unobstructed vertical distance through the free atmosphere between the lowest opening from a pipe, plumbing fixture, appliance, or appurtenance conveying waste to the flood-level rim of the receptor.

**Air Gap, Water Distribution.** The unobstructed vertical distance through the free atmosphere between the lowest opening from a pipe or faucet conveying potable water to the flood-level rim of a tank, vat, or fixture.

**Alternate Water Source.** Nonpotable source of water that includes but not limited to gray water, on-site treated nonpotable water, rainwater, and reclaimed (recycled) water.

**Anchors.** See Supports.

**Appliance Categorized Vent Diameter/Area.** The minimum vent area/diameter permissible for Category I appliances to maintain a nonpositive vent static pressure where tested in accordance with nationally recognized standards. [NFPA 54:3.3.7]

**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.

**Approved.** Acceptable to the Authority Having Jurisdiction.

***Exception: [HCD 1 & HCD 2]*** *"Approved" means meeting the approval of the Enforcing Agency, except as otherwise provided by law, when used in connection with any system, material, type of construction, fixture or appliance as the result of investigations and tests conducted by the agency, or by reason of accepted principles or tests by national authorities, or technical, health, or scientific organizations or agencies.*

*Notes:*

1. *See Health and Safety Code Section 17920 for "Approved" as applied to residential construction and buildings or structures accessory thereto as referenced in Section 1.8.2.*
2. *See Health and Safety Code Section 17921.1 for "Approved" as applied to the use of the hotplates in residential construction as referenced in Section 1.8.2.*
3. *See Health and Safety Code 19966 for "Approved" as applied to Factory-Built Housing as referenced in Section 1.8.3.2.5.*
4. *See Health and Safety Code Section 18201 for "Approved" as applied to Mobilehome Parks as referenced in Section 1.8.2.*
5. *See Health and Safety Code Section 18862.1 for "Approved" as applied to Special Occupancy Parks as referenced in Section 1.8.2.*

**Approved Testing Agency.** An organization primarily established for purposes of testing to approved standards and approved by the Authority Having Jurisdiction.

***[HCD 1 & HCD 2]*** *"Approved Testing Agency" is any agency which is determined by the enforcing agency, except as otherwise provided by statute, to have adequate personnel and expertise to carry out the testing of systems, materials, and construction fixtures or appliances.*

**Area Drain.** A receptor designed to collect surface or storm water from an open area.

**Aspirator.** A fitting or device supplied with water or other fluid under positive pressure that passes through an integral orifice or constriction, causing a vacuum.

**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.

***[HCD 1 & HCD 2]*** *"Authority Having Jurisdiction" shall mean "Enforcing Agency" as defined in Section 207.0 of this code.*

**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 sources other than its intended source. See Backsiphonage, Backpressure Backflow.

**Backflow Connection.** An arrangement whereby backflow can occur.

**Backflow Preventer.** A backflow prevention device, an assembly, or other method to prevent backflow into the potable water system.

**Backpressure Backflow.** Backflow due to an increased pressure above the supply pressure, which may be due to pumps, boilers, gravity, or other sources of pressure.

**Backsiphonage.** 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.

**Backwater Valve.** A device installed in a drainage system to prevent reverse flow.

**Bathroom Group.** A group of fixtures consisting of a water closet, one or two lavatories, and either a bathtub, a combination bath/shower, or a shower and may include a urinal or bidet and an emergency floor drain.

**Bathroom, Half.** A room equipped with only a water closet and lavatory.

**Battery of Fixtures.** A group of two or more similar, adjacent fixtures that discharge into a common horizontal waste or soil branch.

**Boiler Blowoff.** An outlet on a boiler to permit emptying or discharge of sediment.

**Bonding Jumper.** A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected. [NFPA 70:100.1]

**Branch.** A part of the piping system other than a main, riser, or stack.

**Branch, Fixture.** See Fixture Branch.

**Branch, Horizontal.** See Horizontal Branch.

**Branch Vent.** A vent connecting one or more individual vents with a vent stack or stack vent.

**Building.** A structure built, erected, and framed of component structural parts designed for the housing, shelter, enclosure, or support of persons, animals, or property of any kind.

***Exceptions: [HCD 1 & HCD 2]*** *"BUILDING" shall not include the following:*

1. *Any mobilehome as defined in Health and Safety Code Section 18008.*
2. *Any manufactured home as defined in Health and Safety Code Section 18007.*
3. *Any commercial modular as defined in Health and Safety Code Section 18001.8 or any special purpose commercial modular as defined in Section 18012.5.*
4. *Any recreational vehicle as defined in Section Health and Safety Code 18010.*
5. *Any multifamily manufactured home as defined in Health and Safety Code Section 18008.7.*

*For additional information, see Health and Safety Code Section 18908.*

**Building Drain.** 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 2 feet (610 mm) outside the building wall.

**Building Drain (Sanitary).** A building drain that conveys sewage only.

**Building Drain (Storm).** A building drain that conveys storm water or other drainage, but no sewage.

**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.

**Building Sewer (Combined).** A building sewer that conveys both sewage and storm water or other drainage.

**Building Sewer (Sanitary).** A building sewer that conveys sewage only.

**Building Sewer (Storm).** A building sewer that conveys storm water or other drainage, but no sewage.

**Building Subdrain.** That portion of a drainage system that does not drain by gravity into the building sewer.

**Building Supply.** The pipe carrying potable water from the water meter or other source of water supply to a building or other point of use or distribution on the lot.

**205.0 – C –**

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

**Cesspool.** A lined excavation in the ground that receives the discharge of a drainage system or part thereof, so designed as to retain the organic matter and solids discharging therein, but permitting the liquids to seep through the bottom and sides.

**Chemical Waste.** See Special Wastes.

**Chimney.** A vertical shaft enclosing one or more flues for conveying flue gases to the outside atmosphere.

**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 54:3.3.18.2]

**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 54:3.3.18.3]

**Chimney, Metal.** A chimney constructed of metal with a minimum thickness not less than 0.127 inch (3.23 mm) (No. 10 manufacturer's standard gauge) steel sheet.

**Clarifier.** See Interceptor.

**Clear Water Waste.** Cooling water and condensate drainage from refrigeration and air-conditioning equipment; cooled condensate from steam heating systems; and cooled boiler blowdown water.

**Clinic Sink.** A sink designed primarily to receive wastes from bedpans and having a flush rim, an integral trap with a visible trap seal, and the same flushing and cleansing characteristics as a water closet.

***Clothes Washer System [HCD 1].*** *A gray water system utilizing only a single domestic clothes washing machine in a one- or two family dwelling.*

**Code.** A standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards.

**Combination Thermostatic/Pressure Balancing Valve.** A mixing valve that senses outlet temperature and incoming hot and cold water pressure and compensates for fluctuations in incoming hot and cold water temperatures, pressures, or both to stabilize outlet temperatures.

**Combination Waste and Vent System.** A specially designed system of waste piping embodying the horizontal wet venting of one or more sinks or floor drains by means of a common waste and vent pipe, adequately sized to provide free movement of air above the flow line of the drain.

**Combined Building Sewer.** See Building Sewer (Combined).

**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, 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 54:3.3.67.1]

***Commissaries Serving Mobile Food Preparation Units [DHS].*** *A food establishment in which food, containers, equipment or supplies are stored or handled for use in vehicles, mobile food preparation units, food carts or vending machines.*

**Common.** That part of a plumbing system that is so designed and installed as to serve more than one appliance, fixture, building, or system.

***Complex System [BSC, HCD 1].*** *Gray water systems that discharge over 250 gallons (947 L) per day.*

**Conductor.** A pipe inside the building that conveys storm water from the roof to a storm drain, combined building sewer, or other approved point of disposal.

**Confined Space.** A room or space having a volume less than 50 cubic feet per 1000 British thermal units per hour (Btu/h) (4.83 $m^3$/kW) of the aggregate input rating of all fuel-burning appliances installed in that space.

**Contamination.** An impairment of the quality of the potable water that creates an actual hazard to the public health through poisoning or through the spread of disease by sewage, industrial fluids, or waste. Also defined as High Hazard.

**Continuous Vent.** A vertical vent that is a continuation of the drain to which it connects.

**Continuous Waste.** A drain connecting the compartments of a set of fixtures to a trap or connecting other permitted fixtures to a common trap.

***Covered Multifamily Dwellings [HCD 1-AC].*** *See Section 1.8.2.1.2.*

**CPVC.** Chlorinated Poly (Vinyl Chloride).

**Critical Care Area.** Those special care units, intensive care units, coronary care units, angiography laboratories, cardiac catheterization laboratories, delivery rooms, operating rooms, post anesthesia recovery rooms, emergency departments, and similar areas in which patients are intended to be subjected to invasive procedures and connected to line-operated, patient-care-related electrical appliances. [NFPA 99:3.3.138.1]

**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. Where a backflow prevention device does not bear a critical level marking, the bottom of the vacuum breaker, combination valve, or the bottom of such approved device shall constitute the critical level.

**Cross-Connection.** A connection or arrangement, physical or otherwise, between a potable water supply system and a plumbing fixture or a tank, receptor, equipment, or device, through which it may be possible for nonpotable, used, unclean, polluted, and contaminated water, or other substances to enter into a part of such potable water system under any condition.

## 206.0 – D –

**Debris Excluder.** A device installed on the rainwater catchment conveyance system to prevent the accumulation of leaves, needles, or other debris in the system.

***Department [HCD 1, HCD 2 and HCD 1-AC].*** *"Department" means the Department of Housing and Community Development.*

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

***[HCD 1 & HCD 2]*** *"Department Having Jurisdiction" shall mean "Enforcing Agency" as defined in Section 207.0 of this code.*

**Design Flood Elevation.** The elevation of the "design flood," including wave height, relative to the datum specified on the community's legally designated flood hazard map. In areas designated as Zone AO, the design flood elevation is the elevation of the highest existing grade of the building's perimeter plus the depth number (in feet) specified on the flood hazard map. In areas designated as Zone AO where a depth number is not specified on the map, the depth number is taken as being equal to 2 feet (610 mm).

**Developed Length.** The length along the center line of a pipe and fittings.

**Diameter.** Unless specifically stated, "diameter" is the nominal diameter as designated commercially.

**Direct-Vent Appliances.** Appliances that are constructed and installed so that air for combustion is derived directly from the outdoors and flue gases are discharged to the outdoors. [NFPA 54:3.3.6.3]

***Disposal Field [BSC & HCD 1].*** *An intended destination for gray water, including but not limited to, a mulch basin or receiving landscape feature, gray water leach field, or other approved method of disposal.*

**Domestic Sewage.** The liquid and water-borne wastes derived from the ordinary living processes, free from industrial wastes, and of such character as to permit satisfactory disposal, without special treatment, into the public sewer or by means of a private sewage disposal system.

**Downspout.** The rain leader from the roof to the building storm drain, combined building sewer, or other means of disposal located outside of the building. See Conductor and Leader.

**Drain.** A pipe that carries waste or waterborne wastes in a building drainage system.

**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.

**Durham System.** A soil or waste system in which all piping is threaded pipe, tubing, or other such rigid construction, using recessed drainage fittings to correspond to the types of piping.

## 207.0 – E –

**Effective Ground-Fault Current Path.** An intentionally constructed, low-impedance electrically conductive path designed and intended to carry current under ground-fault conditions from the point of a ground fault on a wiring system to the electrical supply source and that facilitates the operation of the overcurrent protective device or ground-fault detectors on high-impedance grounded systems. [NFPA 54-12:3.3.36]

**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) where the opening is not circular, the diameter of a circle of equivalent cross-sectional area. (This is applicable also to air gap.)

***Enforcing Agency [BSC, HCD 1, HCD 2, and HCD 1-AC].*** *"Enforcing Agency" is the designated department or agency as specified by statute or regulation.*

**Essentially Nontoxic Transfer Fluid.** Essentially nontoxic at practically nontoxic, Toxicity Rating Class 1 (reference "Clinical Toxicology of Commercial Products" by Gosselin, Smith, Hodge, & Braddock).

**Excess Flow Valve (EFV).** A valve designed to activate where the fuel gas passing through it exceeds a prescribed flow rate. [NFPA 54:3.3.105.3]

**Existing Work.** A plumbing system or any part thereof that has been installed prior to the effective date of this code.

## 208.0 – F –

**F Rating.** The time period that the penetration firestop system limits the spread of fire through the penetration, where tested in accordance with ASTM E 814 or UL 1479.

**Fixture Branch.** A water supply pipe between the fixture supply pipe and the water distribution pipe.

**Fixture Drain.** The drain from the trap of a fixture to the junction of that drain with any other drain pipe.

**Fixture Supply.** A water supply pipe connecting the fixture with the fixture branch.

**Fixture Unit.** A quantity in terms of which the load-producing effects on the plumbing system of different kinds of plumbing fixtures are expressed on some arbitrarily chosen scale.

**Flammable Vapor or Fumes.** The concentration of flammable constituents in air that exceeds 25 percent of its lower flammability limit (LFL).

**Flood Hazard Area.** The greater of the following two areas:

(1) The area within a floodplain subject to a 1 percent or greater chance of flooding in any given year.

(2) The area designated as a flood hazard area on a community's flood hazard map, or otherwise legally designated.

**Flood Hazard Area Subject to High-Velocity Wave Action.** Area within the flood hazard area that is subject to high velocity wave action, and shown on a Flood Insurance Rate Map or other flood hazard map as Zone V, VO, VE or V1-30.

**Flood Level.** See Flooded.

**Flood-Level Rim.** The top edge of a receptor from which water overflows.

**Flooded.** A fixture is flooded where the liquid therein rises to the flood-level rim.

**Flue Collar.** That portion of an appliance designed for the attachment of a draft hood, vent connector, or venting system. [NFPA 54:3.3.46]

**Flush Tank.** A tank located above or integral with water closets, urinals, or similar fixtures for the purpose of flushing the usable portion of the fixture.

**Flush Valve.** A valve located at the bottom of a tank for the purpose of flushing water closets and similar fixtures.

**Flushometer Tank.** A tank integrated within an air accumulator vessel that is designed to discharge a predetermined quantity of water to fixtures for flushing purposes.

**Flushometer Valve.** A valve that discharges a predetermined quantity of water to fixtures for flushing purposes and is actuated by direct water pressure.

**FOG Disposal System.** A grease interceptor that reduces nonpetroleum fats, oils, and grease (FOG) in effluent by separation, mass, and volume reduction.

***Food Establishment [DPH].*** *Any room, building, place or portion thereof, maintained, used or operated for purpose of storing, preparing, serving, packaging, transporting, salvaging or otherwise handling food at the retail level.*

**Fuel Gas.** Natural, manufactured, liquefied petroleum, or a mixture of these.

**Fuel Gas Quick-Disconnect.** 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 where the device is disconnected. [NFPA 54:3.3.29.3]

**Fuel Gas Vent.** A listed factory-made vent pipe and vent fittings for conveying flue gases to the outdoors.

**Fuel Gas Venting System.** A continuous open passageway from the flue collar or draft hood of an appliance to the outdoors for the purpose of removing flue or vent gases. [NFPA 54:3.3.100.7]

**209.0 – G –**

**Gang or Group Shower.** Two or more showers in a common area.

**Gas Piping.** An installation of pipe, valves, or fittings that is used to convey fuel gas, installed on a premises or in a building, but shall not include:

(1) A portion of the service piping.

(2) An approved piping connection 6 feet (1829 mm) or less in length between an existing gas outlet and a gas appliance in the same room with the outlet.

**Gas Piping System.** An arrangement of gas piping or regulators after the point of delivery and each arrangement of gas piping serving a building, structure, or premises, whether individually metered or not.

**General Care Areas.** General care areas are patient bedrooms, examining rooms, treatment rooms, clinics, and similar areas in which it is intended that the patient will come in contact with ordinary appliances such as a nurses-call system, electric beds, examining lamps, telephones, and entertainment devices. [NFPA 99:3.3.138.2]

**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.

**Gravity Grease Interceptor.** A plumbing appurtenance or appliance that is installed in a sanitary drainage system to intercept nonpetroleum fats, oils, and greases (FOG) from a wastewater discharge and is identified by volume, 30 minute retention time, baffle(s), not less than two compartments, a total volume of not less than 300 gallons (1135 L), and gravity separation. [These interceptors comply with the requirements of Chapter 10 or are designed by a registered professional engineer.] Gravity grease interceptors are generally installed outside.

***Graywater [BSC & HCD 1].*** *Pursuant to Health and Safety Code Section 17922.12, "graywater" means untreated wastewater that has not been contaminated by any toilet discharge, has not been affected by infectious, contaminated, or unhealthy bodily wastes, and does not present a threat from contamination by unhealthful processing, manufacturing, or operating wastes. "Graywater" includes, but is not limited to, wastewater from bathtubs, showers, bathroom washbasins, clothes washing machines, and laundry tubs, but does not include wastewater from kitchen sinks or dishwashers.*

***Note:*** *For the purpose of applying the standards contained in this code, "Graywater" as defined above, has the same meaning as "gray water", "grey water", and "greywater".*

***Gray Water System [BSC].*** *A system designed to collect gray water to be treated on-site for reuse or distribution to an irrigation or disposal field. A gray water system may include, on-site treated nonpotable water devices or equipment, tanks, valves, filters, pumps or other appurtenances along with piping and receiving landscape.*

***Gray Water System [HCD 1].*** *A system designed to collect gray water on-site for reuse or distribution to an irrigation or disposal field. A gray water system may include, on-site treated nonpotable water devices or equipment, tanks, valves, filters, pumps or other appurtenances along with piping and receiving landscape.*

**Grease Interceptor.** A plumbing appurtenance or appliance that is installed in a sanitary drainage system to intercept nonpetroleum fats, oil, and greases (FOG) from a wastewater discharge.

**Grease Removal Device (GRD).** A hydromechanical grease interceptor that automatically, mechanically removes nonpetroleum fats, oils and grease (FOG) from the interceptor, the control of which are either automatic or manually initiated.

**Grounding Electrode.** A device that establishes an electrical connection to the earth.

**210.0 – H –**

***Handwashing Fixture [OSHPD 1, 2, 3 & 4].*** *Handwash fixtures consist of faucet, trim and sink as described:*

*(1) Faucets and Trim*

*a. Hand washing fixtures used by medical and nursing staff, patients, and food handlers shall be trimmed with valves that can be operated without the use of hands.*

*i. Wrist or elbow blades shall be permitted where allowed per Table 4-2.*

*ii. Blade handles used for this purpose shall be at least 4 inches (102 mm) in length.*

*b. Sensor operated fixtures shall be capable of functioning during loss of normal power.*

*c. Faucets shall not be equipped with an aerator but may be equipped with a non-aerating laminar flow device.*

*d. If deck-mounted manual temperature controls are used they shall use wrist blades at least 4 inches (102 mm) in length.*

*e. Faucets shall be equipped with gooseneck spouts. A gooseneck spout is a deck or fixture-mounted spout so the discharge point of the spout return is at least 5 inches (127 mm) above the fixture rim.*

*(2) Sinks*

*a. Sinks in hand-washing fixtures shall be designed and installed to prevent splashing outside of the sink.*

*b. Sinks shall have well-fitted and sealed basins to prevent water leaks onto or into the cabinetry or wall spaces.*

c. *Design of sinks and cabinetry shall not permit storage beneath the sink basin.*

**Hangers.** See Supports.

**Heat-Fusion Weld Joints.** A joint used in some thermoplastic systems to connect pipe to fittings or pipe lengths directly to one another (butt-fusion). This method of joining pipe to fittings includes socket-fusion, electro-fusion, and saddle-fusion. This method of welding involves the application of heat and pressure to the components, allowing them to fuse together forming a bond between the pipe and fitting.

**High Hazard.** See Contamination.

**Horizontal Branch.** A drain pipe extending laterally from a soil or waste stack or building drain with or without vertical sections or branches, which receives the discharge from one or more fixture drains and conducts it to the soil or waste stack or to the building drain.

**Horizontal Pipe.** A pipe or fitting that is installed in a horizontal position or which makes an angle of less than 45 degrees (0.79 rad) with the horizontal.

**Hot Water.** Water at a temperature exceeding or equal to 120°F (49°C).

**House Drain.** See Building Drain.

**House Sewer.** See Building Sewer.

**Hydromechanical Grease Interceptor.** A plumbing appurtenance or appliance that is installed in a sanitary drainage system to intercept nonpetroleum fats, oil, and grease (FOG) from a wastewater discharge and is identified by flow rate, and separation and retention efficiency. The design incorporates air entrainment, hydromechanical separation, interior baffling, or barriers in combination or separately, and one of the following:

A - External flow control, with air intake (vent), directly connected.

B - External flow control, without air intake (vent), directly connected.

C - Without external flow control, directly connected.

D - Without external flow control, indirectly connected.

These interceptors comply with the requirements of Table 1014.2.1. Hydromechanical grease interceptors are generally installed inside.

## 211.0 – I –

**Indirect-Fired Water Heater.** A water heater consisting of a storage tank equipped with an internal or external heat exchanger used to transfer heat from an external source to heat potable water. The storage tank either contains heated potable water or water supplied from an external source, such as a boiler.

**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.

**Individual Vent.** A pipe installed to vent a fixture trap and that connects with the vent system above the fixture served or terminates in the open air.

**Industrial Waste.** Liquid or water-borne waste from industrial or commercial processes, except domestic sewage.

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

Conditions to which "insanitary" shall apply include the following:

(1) A trap that does not maintain a proper trap seal.

(2) An opening in a drainage system, except where lawful, that is not provided with an approved liquid-sealed trap.

(3) A 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) A defective fixture, trap, pipe, or fitting.

(5) A trap, except where in this code exempted, directly connected to a drainage system, the seal of which is not protected against siphonage and backpressure by a vent pipe.

(6) A connection, cross-connection, construction, or condition, temporary or permanent, that would permit or make possible by any means whatsoever for an 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.

**Interceptor (Clarifier).** A device designed and installed so as to separate and retain deleterious, hazardous, or undesirable matter from normal wastes and permit normal sewage or liquid wastes to discharge into the disposal terminal by gravity.

**Invert.** The lowest portion of the inside of a horizontal pipe.

***Irrigation Field [BSC & HCD 1].*** *An intended destination for gray water in the receiving landscape, including but not limited to, a drip irrigation system, mulch basin, or other approved method of dispersal for irrigation purposes.*

## 212.0 – J –

**Joint, Brazed.** A joint obtained by joining of metal parts with alloys that melt at temperatures exceeding 840°F (449°C), but less than the melting temperature of the parts to be joined.

**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).

**Joint, Welded.** A gastight joint obtained by the joining of metal parts in the plastic molten state.

## 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).

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*[HCD 1 & HCD 2] "Labeled" means equipment or materials to which has been attached a label, symbol or other identifying mark of an organization, approved by the Department, that maintains a periodic inspection program of production of labeled products, installations, equipment, or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.*

**Lavatories in Sets.** Two or three lavatories that are served by one trap.

***Lavatory [HCD 1 & HCD 2].*** *"Lavatory" shall mean a plumbing fixture used for washing the hands, arms, face and head.*

**Leader.** An exterior vertical drainage pipe for conveying storm water from roof or gutter drains. See Downspout.

***Limited-Density Owner-Built Rural Dwelling [HCD 1].*** *"Limited-density owner-built rural dwelling" shall mean any structure consisting of one or more habitable rooms intended or designed to be occupied by one family with facilities for living or sleeping, with use restricted to rural areas designated by local jurisdiction in compliance with the requirements of Health and Safety Code Section 17958.2.*

**Liquefied Petroleum Gas (LPG) Facilities.** Liquefied petroleum gas (LPG) facilities means tanks, containers, container valves, regulating equipment, meters, appurtenances, or any combination thereof for the storage and supply of liquefied petroleum gas for a building, structure, or premises.

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

***Listed [HCD 1 & HCD 2].*** *"Listed" means all products that appear in a list published by an approved testing or listing agency. For additional information, see Health and Safety Code Section 17920(h).*

**Listed (Third-party certified).** Equipment or materials included in a list published by a listing 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.

**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, a periodic inspection on current production of listed (certified) products, and makes available a published report of such listing in which specific information is included that the material or product is in accordance with applicable standards and found safe for use in a specific manner.

*[HCD 1 & HCD 2] "Listing Agency" means an agency approved by the department that is in the business of listing and labeling products, materials, equipment, and installations tested by an approved testing agency, and that maintains a periodic inspection program on current production of listed products, equipment, and installations, and that, at least annually, makes available a published report of these listings. For additional information, see Health and Safety Code Section 17920(i).*

**Lot.** A single or individual parcel or area of land legally recorded or validated by other means acceptable to the Authority Having Jurisdiction on which is situated a building or which is the site of any work regulated by this code, together with the yards, courts, and unoccupied spaces legally required for the building or works, and that is owned by or is in the lawful possession of the owner of the building or works.

**Low Hazard.** See Pollution.

***Low VOC Cement [HCD 1 & HCD 2].*** *Cement with a volatile organic compound (VOC) content of less than or equal to 490 g/L for CPVC Cement, 510 g/L for PVC Cement, and 325 g/L for ABS Cement, as determined by the South Coast Air Quality Management District's Laboratory Methods of Analysis for Enforcement Samples, Method 316A.*

***Low VOC One-Step Cement [HCD 1 & HCD 2].*** *Listed solvent cements that do not require the use of primer with a volatile organic compound (VOC) content of less than or equal to 490 g/L for CPVC Cement, 510 g/L for PVC Cement, and 325 g/L for ABS Cement, as determined by the South Coast Air Quality Management District's Laboratory Methods of Analysis for Enforcement Samples, Method 316A.*

***Low VOC Primer [HCD 1 & HCD 2].*** *Primer with a volatile organic compound (VOC) content of less than or equal to 550 g/L, as determined by the South Coast Air Quality Management District's Laboratory Methods of Analysis for Enforcement Samples, Method 316A.*

## 215.0 – M –

**Macerating Toilet System.** A system comprised of a sump with macerating pump and with connections for a water closet and other plumbing fixtures, which is designed to accept, grind, and pump wastes to an approved point of discharge.

**Main.** The principal artery of a system of continuous piping to which branches may be connected.

**Main Sewer.** See Public Sewer.

**Main Vent.** The principal artery of the venting system to which vent branches may be connected.

**May.** A permissive term.

**Medical Air.** For purposes of this code, medical air is air supplied from cylinders, bulk containers, medical air compressors, or has been reconstituted from oxygen USP and oil-free, dry nitrogen NF [NFPA 99:3.3.106]. Medical air shall be required to have the following characteristics:

(1) Be supplied from cylinders, bulk containers, medical air compressor sources, or be reconstituted from oxygen USP and oil-free dry nitrogen NF.

(2) Meet the requirements of medical air USP.

(3) Have no detectable liquid hydrocarbons.

(4) Have less than 25 parts per million (ppm) gaseous hydrocarbons.

(5) Have equal to or less than 1.8 E-10 pounds per cubic inch (lb/in³) (5 mg/m³) of permanent particulates sized one micron or larger in the air at normal atmospheric pressure. [NFPA 99:5.1.3.5.1]

**Medical Gas.** Gas used in a medical facility, including oxygen, nitrous oxide, carbon dioxide, helium, medical air, and mixtures of these gases. Standards of purity apply.

**Medical Gas Building Supply.** The pipe from the source of supply to a building or structure.

**Medical Gas Manifold.** A device for connecting outlets of one or more gas cylinders to the central piping system for that specific gas. [NFPA 99:3.3.103]

**Medical Gas System.** Complete system consisting of a central supply system (manifold, bulk, or compressors), including control equipment and piping extending to station outlets at the points where medical gases are required.

**Medical Vacuum System.** See Vacuum System – Level 1.

**Mobile Home Park Sewer.** That part of the horizontal piping of a drainage system that begins 2 feet (610 mm) downstream from the last mobile home site and conveys it to a public sewer, private sewer, private sewage disposal system, or other point of disposal.

**Mulch.** Organic materials, such as wood chips and fines, tree bark chips, and pine needles that are used in a mulch basin to conceal gray water outlets and permit the infiltration of gray water.

***Mulch Basin [BSC & HCD 1].*** *A subsurface type of irrigation or disposal field filled with mulch or other approved permeable material of sufficient depth, length, and width to prevent ponding or runoff. A mulch basin may include a basin around a tree, a trough along a row of plants, or other shapes necessary for irrigation or disposal.*

## 216.0 – N –

**Nitrogen, NF (Oil-Free, Dry) (Nitrogen for Brazing and Testing).** Nitrogen complying, at a minimum, with oil-free, dry nitrogen NF. [NFPA 99:3.3.120.1]

***Nonwater Supplied Urinal [HCD 1].*** *A plumbing fixture which does not require water supply and is designed to receive and convey the uninhibited flow of liquid waste to the gravity drainage system.*

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

(1) A public nuisance known at common law or in equity jurisprudence.

(2) Where 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.

*[HCD 1 & HCD 2] "Nuisance" shall mean any nuisance as defined in Health and Safety Code Section 17920(k).*

*Notes:*

1. *For applications subject to the Mobilehome Parks Act as referenced in Section 1.8.3.2.2 of this code, refer to California Code of Regulations, Title 25, Division 1, Chapter 2 for the definition of "Nuisance".*
2. *For applications subject to the Special Occupancy Parks Act as referenced in Section 1.8.3.2.3 of this code, refer to California Code of Regulations, Title 25, Division 1, Chapter 2.2 for the definition of "Nuisance".*

## 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.

**Oil Interceptor.** See Interceptor.

***On-Site Treated Nonpotable Water [BSC & HCD 1].*** *Nonpotable water that has been collected, treated, and intended to be used on-site and is suitable for direct beneficial use. Sources for on-site treated nonpotable water include, but are not limited to, gray water; rainwater; stormwater; reclaimed (recycled) water; cooling tower blow-down water; and foundation drainage.*

***OSHPD 3SE.*** *This is a subcategory of OSHPD 3. OSHPD 3SE facilities have exemptions from selected requirements in the California Plumbing Code. Such facilities are often contained within existing commercial or residential buildings as "storefront" units, but they may also be freestanding new or converted structures. The services provided and the size of the units limit use and occupancy, thereby minimizing hazards and allowing for less stringent standards. OSHPD 3SE classification consists of the following facility types:*

*(1) Primary Care Clinics providing services limited to those listed in California Building Code Section 1226.6 (i.e. clinics without treatment rooms and that perform procedures limited to those that may be performed in exam rooms as defined in California Building Code Section 1224.3). Outpatient clinical services of a hospital providing services equivalent to a primary care clinic may also be classified as OSHPD 3SE.*

***Exception:*** *Primary Care Clinics that include treatment rooms, procedure rooms, or patient treatment spaces that require positive or negative pressure other than airborne infection isolation exam rooms, shall not be classified OSHPD 3SE.*

*(2) Rehabilitation Clinics providing services limited to those listed in California Building Code Section 1226.10.*

*(3) Psychology Clinics providing services limited to those listed in California Building Code Section 1226.12.*

*No other clinics or outpatient clinical services of a hospital, when provided in a freestanding building, considered as OSHPD 3 facilities shall be classified as OSHPD 3SE.*

## 218.0 – P –

**Patient Care Area.** A portion of a health care facility wherein patients are intended to be examined or treated. [NFPA 99:3.3.138]

**PB.** Polybutylene.

**PE.** Polyethylene.

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

**PE-RT.** Polyethylene of raised temperature.

**Penetration Firestop System.** A specific assemblage of field-assembled materials, or a factory-made device, which has been tested to a standard test method and, where installed properly on penetrating piping materials, is capable of maintaining the fire- resistance rating of assemblies penetrated.

**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.

**PEX.** Cross-linked polyethylene.

**PEX-AL-PEX.** Cross-linked polyethylene–aluminum-cross-linked polyethylene.

**Pipe.** A cylindrical conduit or conductor conforming to the particular dimensions commonly known as "pipe size."

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

**Plumbing Appliance.** A special class of device or equipment that is intended to perform a special plumbing function. Its operation, control, or both may be dependent upon one or more energized components, such as motors, controls, heating elements, or pressure- or temperature-sensing elements. Such device or equipment may operate automatically through one or more of the following actions: a time cycle, a temperature range, a pressure range, a measured volume or weight; or the device or equipment may be manually adjusted or controlled by the user or operator.

**Plumbing Appurtenance.** A manufactured device, a prefabricated assembly, or an on-the-job assembly of component parts that is an adjunct to the basic piping system and plumbing fixtures. An appurtenance demands no additional water supply, nor does it add a discharge load to a fixture or the drainage system. It performs some useful function in the operation, maintenance, servicing, economy, or safety of the plumbing system.

**Plumbing Fixture.** An approved-type installed receptacle, device, or appliance that is supplied with water or that receives liquid or liquid-borne wastes and discharges such wastes into the drainage system to which it may be directly or indirectly connected. Industrial or commercial tanks, vats, and similar processing equipment are not plumbing fixtures, but may be connected to or discharged into approved traps or plumbing fixtures where and as otherwise provided for elsewhere in this code.

**Plumbing Official.** See Authority Having Jurisdiction.

**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.

**Plumbing Vent.** A pipe provided to ventilate a plumbing system, to prevent trap siphonage and backpressure, or to equalize the air pressure within the drainage system.

**Plumbing 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 backpressure.

**Pollution.** An impairment of the quality of the potable water to a degree that does not create a hazard to the public health but which does adversely and unreasonably affect the aesthetic qualities of such potable water for domestic use. Also defined as Low Hazard.

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

**PP.** Polypropylene.

**Pressed Fitting.** 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.

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

**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.

**Static Pressure.** The pressure existing without any flow.

**Pressure-Balancing Valve.** A mixing valve that senses incoming hot and cold water pressures and compensates for fluctuations in either to stabilize outlet temperature.

**Pressure-Lock-Type Connection.** A 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.

**Private or Private Use.** Applies to plumbing fixtures in residences and apartments, to private bathrooms in hotels and hospitals, and to restrooms in commercial establishments where the fixtures are intended for the use of a family or an individual.

**Private Sewage Disposal System.** A septic tank with the effluent discharging into a subsurface disposal field, into one or more seepage pits, or into a combination of subsurface disposal field and seepage pit or of such other facilities as may be permitted under the procedures set forth elsewhere in this code.

**Private Sewer.** A building sewer that receives the discharge from more than one building drain and conveys it to a public sewer, private sewage disposal system, or other point of disposal.

**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]

**Public or Public Use.** Applies to plumbing fixtures that are not defined as private or private use.

**Public Sewer.** A common sewer directly controlled by public authority.

**Purge, Flow (Medical Gas).** The removal of oxygen from a system by oil-free dry nitrogen during brazing.

**Purge, System (Medical Gas).** The removal of nitrogen from a system with the medical gas required for that system.

**Push Fit Fitting.** A mechanical fitting where the connection is assembled by pushing the tube or pipe into the fitting and is sealed with an "O" ring.

**PVC.** Poly(vinyl chloride).

**PVDF.** Polyvinylidene Fluoride.

**219.0 – Q –**

**Quick-Disconnect Device.** A hand-operated device that provides a means for connecting and disconnecting a hose to a water supply and that is equipped with a means to shut off the water supply where the device is disconnected.

**220.0 – R –**

***Rainwater [BSC & HCD 1].*** *Precipitation on any public or private parcel that has not entered an offsite storm drain system or channel, a flood control channel, or any other stream channel, and has not previously been put to beneficial use.*

***Rainwater Catchment System [BSC & HCD 1].*** *A facility designed to capture, retain, and store rainwater flowing off a building, parking lot, or any other manmade impervious surface for subsequent onsite use. Rainwater catchment system is also known as "Rainwater Harvesting System" or "Rainwater Capture System."*

**Rainwater Storage Tank.** The central component of the rainwater catchment system. Also known as a cistern or rain barrel.

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

***Receiving Landscape [BSC & HCD 1].*** *Includes features such as soil, basins, swales, mulch, and plants.*

***Reclaimed (Recycled) Water [BSC & HCD 1].*** *Nonpotable water that meets California Department of Public Health statewide uniform criteria for disinfected tertiary recycled water. Reclaimed (recycled) water is also known as "recycled water" or "reclaimed water".*

**Regulating Equipment.** Includes valves and controls used in a plumbing system that are required to be accessible or readily accessible.

**Relief Vent.** A vent, the primary function of which is to provide circulation of air between drainage and vent systems or to act as an auxiliary vent on a specially designed system.

**Remote Outlet.** Where used for sizing water piping, it is the furthest outlet dimension, measuring from the meter, either the developed length of the cold-water piping or through the water heater to the furthest outlet on the hot-water piping.

**Rim.** See Flood-Level Rim.

**Riser.** A water supply pipe that extends vertically one full story or more to convey water to branches or fixtures.

**Roof Drain.** A drain installed to receive water collecting on the surface of a roof and to discharge it into a leader, downspout, or conductor.

**Roof Washer.** A device or method for removal of sediment and debris from a collection surface by diverting initial rainfall from entry into the cistern(s). Also known as a first flush device.

**Roughing-In.** The installation of all parts of the plumbing system that can be completed prior to the installation of fixtures. This includes drainage, water supply, gas piping, vent piping, and the necessary fixture supports.

**221.0 – S –**

**Sand Interceptor.** See Interceptor.

**SCFM.** Standard cubic feet per minute. [NFPA 99:3.3.163]

***Scrub Sink [OSHPD 1, 2, 3, & 4].*** *Is a sink used to wash and scrub the hands and arms during the septic preparation for surgery and equipped with a supply spout and controls as required for a handwashing fixture. Sensor operated fixtures shall be capable of functioning during loss of normal power.*

**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.

**Seam, Welded.** See Joint, Welded.

**Seepage Pit.** A lined excavation in the ground which receives the discharge of a septic tank so designed as to permit the effluent from the septic tank to seep through its bottom and sides.

**Septic Tank.** A watertight receptacle that receives the discharge of a drainage system or part thereof, designed and constructed so as to retain solids, digest organic matter through a period of detention, and allow the liquids to discharge into the soil outside of the tank through a system of open joint piping or a seepage pit meeting the requirements of this code.

**Service Piping.** The piping and equipment between the street gas main and the gas piping system inlet that is installed by, and is under the control and maintenance of, the serving gas supplier.

**Sewage.** Liquid waste containing animal or vegetable matter in suspension or solution and that may include liquids containing chemicals in solution.

**Sewage Ejector.** A device for lifting sewage by entraining it on a high-velocity jet stream, air, or water.

**Sewage Pump.** A permanently installed mechanical device, other than an ejector, for removing sewage or liquid waste from a sump.

**Shall.** Indicates a mandatory requirement.

**Shielded Coupling.** An approved elastomeric sealing gasket with an approved outer shield and a tightening mechanism.

**Shock Arrester.** See Water Hammer Arrester.

**Should.** Indicates a recommendation or that which is advised but not required.

***Simple System [BSC & HCD 1].*** *A gray water system serving one-and two-family dwellings, townhouses, or other occupancies with a discharge of 250 gallons (947 L) per day or less. Simple systems exceed a clothes washer system.*

**Size and Type of Tubing.** See Diameter.

**Slip Joint.** An adjustable tubing connection, consisting of a compression nut, a friction ring, and a compression washer, designed to fit a threaded adapter fitting or a standard taper pipe thread.

**Slope.** See Grade.

**Soil Pipe.** A pipe that conveys the discharge of water closets, urinals, clinic sinks, or fixtures having similar functions of collection and removal of domestic sewage, with or without the discharge from other fixtures, to the building drain or building sewer.

**Special Hazard Area (Medical Gas).** An area such as a kitchen or electrical switch-gear room.

**Special Wastes.** Wastes that require some special method of handling, such as the use of indirect waste piping and receptors, corrosion-resistant piping, sand, oil or grease interceptors, condensers, or other pretreatment facilities.

**Stack.** The vertical main of a system of soil, waste, or vent piping extending through one or more stories.

**Stack Vent.** The extension of a soil or waste stack above the highest horizontal drain connected to the stack.

**Standard.** A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which 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.

**Station Inlet.** An inlet point in a medical-surgical piped vacuum distribution system at which the user makes connections and disconnections. [NFPA 99:3.3.171]

**Station Outlet.** An inlet point in a piped medical/surgical vacuum distribution system at which the user makes connections and disconnections. [NFPA 99:3.3.172]

**Storm Drain.** See Building Drain (Storm).

**Storm Sewer.** A sewer used for conveying rainwater, surface water, condensate, cooling water, or similar liquid wastes.

**Subsoil Drain.** A drain that collects subsurface or seepage water and conveys it to a place of disposal.

**Subsoil Irrigation Field.** Gray water irrigation field installed in a trench within the layer of soil below the topsoil. This system is typically used for irrigation of deep rooted plants.

**Subsurface Irrigation Field.** Gray water irrigation field installed below finished grade within the topsoil.

**Sump.** An approved tank or pit that receives sewage or liquid waste and which is located below the normal grade of the gravity system and which must be emptied by mechanical means.

**Supports.** Supports, hangers, and anchors are devices for properly supporting and securing pipe, fixtures, and equipment.

**Surge Tank.** A reservoir to modify the fluctuation in flow rates to allow for uniform distribution of gray water to the points of irrigation.

## 222.0 – T –

**T Rating.** The time period that the penetration firestop system, including the penetrating item, limits the maximum temperature rise of 325°F (163°C) above its initial temperature through the penetration on the nonfire side, where tested in accordance with ASTM E 814 or UL 1479.

**Tailpiece.** The pipe or tubing that connects the outlet of a plumbing fixture to a trap.

***Testing Agency [HCD 1].*** *See "Approved Testing Agency".*

**Thermostatic (Temperature Control) Valve.** A mixing valve that senses outlet temperature and compensates for fluctuations in incoming hot or cold water temperatures.

***Toilet [OSHPD 1, 2, 3 & 4].*** *A fixture within a toilet room which is used for defection or urination.*

***Toilet Room [OSHPD 1, 2, 3 & 4].*** *A room within or on the premises containing water closets, urinals, and other required facilities.*

**Transition Gas Riser.** A 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.

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

**Trap Arm.** That portion of a fixture drain between a trap and the vent.

**Trap Primer.** A device and system of piping that maintains a water seal in a remote trap.

**Trap Seal.** The vertical distance between the crown weir and the top dip of the trap.

**Crown Weir (Trap Weir).** The lowest point in the cross-section of the horizontal waterway at the exit of the trap.

**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.

***Treated Gray Water [BSC & HCD 1].*** *Nonpotable water meeting the definition of "gray water" collected and treated on-site suitable for direct beneficial use.*

**Type B Gas Vent.** A factory-made gas vent listed by nationally recognized testing agency for venting listed or approved appliances equipped to burn only gas.

**Type BW Gas Vent.** A factory-made gas vent listed by a nationally recognized testing agency for venting listed or approved gas-fired vented wall furnaces.

**Type L Gas Vent.** A venting system consisting of listed vent piping and fittings for use with oil-burning appliances listed for use with Type L or with listed gas appliances.

## 223.0 – U –

**Unconfined Space.** A room or space having a volume equal to not less than 50 cubic feet per 1000 Btu/h (4.83 $m^3$/kW) 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.

**Unsanitary.** See Insanitary.

***UPC [HCD 1].*** *"UPC" is the latest edition of the Uniform Plumbing Code, published by the International Association of Plumbing and Mechanical Officials.*

**Use Point.** A room or area of a room where medical gases are dispensed to a single patient for medical purposes. A use point is permitted to be comprised of a number of station outlets of different gases.

**User Outlet.** See Station Outlet.

**224.0 – V –**

**Vacuum.** A pressure less than that exerted by the atmosphere.

**Vacuum Breaker.** See Backflow Preventer.

**Vacuum Relief Valve.** A device that prevents excessive vacuum in a pressure vessel.

**Vacuum System-Level 1.** A system consisting of central vacuum-producing equipment with pressure and operating controls, shutoff valves, alarm warning systems, gauges, and a network of piping extending to and terminating with suitable station inlets at locations where patient suction could be required. [NFPA 99:3.3.91]

**Valve, Isolation.** A valve that isolates one piece of equipment from another.

**Valve, Riser.** A valve at the base of a vertical riser that isolates that riser.

**Valve, Service.** A valve serving horizontal piping extending from a riser to a station outlet or inlet.

**Valve, Source.** A single valve at the source that controls a number of units that make up the source.

**Valve, Zone.** A valve that controls the gas or vacuum to a particular area.

**Vent.** See Plumbing Vent.

**Vent Connector, Gas.** That portion of a gas venting system that connects a listed gas appliance to a gas vent and is installed within the space or area in which the appliance is located.

**Vent Pipe.** See Plumbing Vent.

**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.

**Vent System.** See Plumbing Vent System.

**Vented Flow Control Device.** A device installed upstream from the hydromechanical grease interceptor having an orifice that controls the rate of flow through the interceptor, and an air intake (vent) downstream from the orifice, which allows air to be drawn into the flow stream.

**Vertical Pipe.** A pipe or fitting that is installed in a vertical position or that makes an angle of not more than 45 degrees (0.79 rad) with the vertical.

**225.0 – W –**

**Wall-Hung Water Closet.** A water closet installed in such a way that no part of the water closet touches the floor.

**Waste.** See Liquid Waste and Industrial Waste.

**Waste Anesthetic Gas Disposal.** The process of capturing and carrying away gases vented from the patient breathing circuit during the normal operation of gas anesthesia or analgesia equipment. [NFPA 99:3.3.184]

**Waste Pipe.** A pipe that conveys only liquid waste, free of fecal matter.

***Water Closet [HCD 1].*** *"Water Closet" is a plumbing fixture (which may be used for both solids and liquids) in which the waste matter is removed by flushing with water.*

**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.

**Water Distribution Pipe.** In a building or premises, a pipe that conveys potable water from the building supply pipe to the plumbing fixtures and other water outlets.

**Water Hammer Arrester.** A device designed to provide protection against hydraulic shock in the building water supply system.

**Water Heater or Hot Water Heating Boiler.** An appliance designed primarily to supply hot water for domestic or commercial purposes and equipped with automatic controls limiting water temperature to a maximum of 210°F (99°C).

**Water Main (Street Main).** A water supply pipe for public or community use.

**Water Supply System.** The building supply pipe, the water distribution pipes, and the necessary connecting pipes, fittings, control valves, backflow prevention devices, and all appurtenances carrying or supplying potable water in or adjacent to the building or premises.

**Water/Wastewater Utility.** A public or private entity which may treat, deliver, or do both functions to reclaimed (recycled) water, potable water, or both to wholesale or retail customers.

**Welder, Pipe.** A person who specializes in the welding of pipes and holds a valid certificate of competency from a recognized testing laboratory, based on the requirements of the ASME Boiler and Pressure Vessels code, Section IX.

**Wet Vent.** A vent that also serves as a drain.

**Whirlpool Bathtub.** A bathtub fixture equipped and fitted with a circulating piping system designed to accept, circulate, and discharge bathtub water upon each use.

**226.0 – X –**

No definitions.

**227.0 – Y –**

**Yoke Vent.** A pipe connecting upward from a soil or waste stack to a vent stack for the purpose of preventing pressure changes in the stacks.

**228.0 – Z –**

No definitions.

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## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 3 - GENERAL REGULATIONS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | X | | | | | | X | X | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | X | X | X | | | | | X | X | X | X | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| 301.2 | | | X | X | | | | | | | | | | | | | | | |
| 301.2.1 | | | † | † | | | | | | | | | | | | | | | |
| 301.2.1.1 | | | † | † | | | | | | | | | | | | | | | |
| 301.2.1.2 | | | † | † | | | | | | | | | | | | | | | |
| 301.5 | | | X | X | | | | | | | | | | | | | | | |
| 303.1 Exception | | | X | | | | | | | | | | | | | | | | |
| 304.1 Exception | | | X | | | | | | | | | | | | | | | | |
| 310.9 | | | | | | | | | X | X | X | X | | | | | | | |
| 310.10 | | | | | | | | | X | | X | X | | | | | | | |
| 310.11 | | X | | | | | | | | | | | | | | | | | |
| 310.12 | | | | | | | | | X | X | | X | | | | | | | |
| 313.8 | | | | | | | | | X | X | X | X | X | | | | | | |
| 319.0 | | | | | | | | | X | X | X | X | | | | | | | |

The state agency does not adopt sections identified by the following symbol: †

# CHAPTER 3
## GENERAL REGULATIONS

**301.0 Materials – Standards and Alternates.**

**301.1 Minimum Standards.** Pipe, pipe fittings, traps, fixtures, material, and devices used in a plumbing system shall be listed or labeled (third-party certified) by a listing agency (accredited conformity assessment body) and shall comply with the approved applicable recognized standards referenced in this code, and shall be free from defects. Plastic pipe and the fittings used for plastic pipe, other than those for gas, shall meet the requirements of NSF 14. Unless otherwise provided for in this code, 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.

**301.1.1 Marking.** Each length of pipe and each pipe fitting, trap, fixture, material, and device used in a plumbing system shall have cast, stamped, or indelibly marked on it the manufacturer's mark or name, which shall readily identify the manufacturer to the end user of the product. Where required by the approved standard that applies, the product shall be marked with the weight and the quality of the product. Materials and devices used or entering into the construction of plumbing and drainage systems, or parts thereof, shall be marked and identified in a manner satisfactory to the Authority Having Jurisdiction. Such marking shall be done by the manufacturer. Field markings shall not be acceptable.

**301.1.2 Standards.** Standards listed or referred to in this chapter or other chapters cover materials that will conform to the requirements of this code, where 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, the portion of the listed standard that is applicable shall be used. Design and materials for special conditions or materials not provided for herein shall be permitted to 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 plumbing material standards is referenced in Table 1401.1. IAPMO Installation Standards are referenced in Appendix I for the convenience of the users of this code. They are not considered as a part of this code unless formally adopted as such by the Authority Having Jurisdiction.

**301.1.3 Existing Buildings.** In existing buildings or premises in which 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 proposal to deviate is first submitted for proper determination in order that health and safety requirements, as they pertain to plumbing, shall be observed.

**301.2 Alternate Materials and Methods of Construction 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 Authority Having Jurisdiction shall have the authority to approve or disapprove the system, method, or device for the intended purpose. *[HCD 1] (See Section 1.8.7).*

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. An alternate material or method of construction so approved shall not be considered as in accordance with the requirements, intent, or both of this code for a purpose other than that granted by the Authority Having Jurisdiction where the submitted data does not prove equivalency.

**301.3 Flood Hazard Areas.** Plumbing systems shall be located above the elevation in accordance with the building code for utilities and attendant equipment or the elevation of the lowest floor, whichever is higher.

**Exception:** Plumbing systems shall be permitted to be located below the elevation in accordance with the building code for utilities and attendant equipment or the elevation of the lowest floor, whichever is higher, provided that the systems are designed and installed to prevent water from entering or accumulating within their components and the systems are constructed to resist hydrostatic and hydrodynamic loads and stresses, including the effects of buoyancy, during the occurrence of flooding to such elevation.

**301.3.1 Flood Hazard Areas Subject to High- Velocity Wave Action.** Plumbing systems in buildings located in flood hazard areas subject to high-velocity wave action shall be in accordance with the requirements of Section 301.3, and plumbing systems, pipes, and fixtures shall not be mounted on or penetrate through walls that are intended to breakaway under flood loads in accordance with the building code.

**301.4 Alternative Engineered Design.** An alternative engineered design shall comply with the intent of the provisions of this code and shall provide an equivalent level of quality, strength, effectiveness, fire resistance, durability, and safety. Material, equipment, or components shall be designed and installed in accordance with the manufacturer's installation instructions.

**301.4.1 Permit Application.** The registered professional engineer shall indicate on the design documents that the plumbing system, or parts thereof, is an alternative engineered design so that it is noted on the construction permit application. The permit and permanent permit records shall indicate that an alternative engineered design was part of the approved installation.

**301.4.2 Technical Data.** The registered professional engineer shall submit sufficient technical data to sub-

stantiate the proposed alternative engineered design and to prove that the performance meets the intent of this code.

**301.4.3 Design Documents.** The registered professional engineer shall provide two complete sets of signed and sealed design documents for the alternative engineered design for submittal to the Authority Having Jurisdiction. The design documents shall include floor plans and a riser diagram of the work. Where appropriate, the design documents shall indicate the direction of flow, pipe sizes, grade of horizontal piping, loading, and location of fixtures and appliances.

**301.4.4 Design Approval.** An approval of an alternative engineered design shall be at the discretion of the Authority Having Jurisdiction. The exercise of this discretionary approval by the Authority Having Jurisdiction shall have no effect beyond the jurisdictional boundaries of said Authority Having Jurisdiction. An alternative engineered design so approved shall not be considered as in accordance with the requirements, intent, or both of this code for a purpose other than that granted by the Authority Having Jurisdiction.

**301.4.5 Design Review.** The Authority Having Jurisdiction shall have the authority to require testing of the alternative engineered design in accordance to Section 301.4.6, including the authority to require an independent review of the design documents by a registered professional engineer selected by the Authority Having Jurisdiction and at the expense of the applicant.

**301.4.6 Inspection and Testing.** The alternative engineered design shall be tested and inspected in accordance with the submitted testing and inspection plan and the requirements of this code.

***301.5 One- and Two-Family Dwellings. [HCD 1]*** *The provisions contained in this code shall not apply to one and two-family dwelling private sewage disposal systems and minimum plumbing facilities when alternate facilities or installations have been approved by the local health authority, provided that such alternative facilities or installations provide substantially equivalent or greater protection to health and safety.*

**302.0 Iron Pipe Size (IPS) Pipe.**

**302.1 General.** Iron, steel, brass, and copper pipe shall be standard-weight iron pipe size (IPS) pipe.

**303.0 Disposal of Liquid Waste.**

**303.1 General.** It shall be unlawful for a person to cause, suffer, or permit the disposal of sewage, human excrement, or other liquid wastes, in a place or manner, except through and by means of an approved drainage system, installed and maintained in accordance with the provisions of this code.

***Exception: [HCD 1]*** *Limited-density owner-built rural dwellings. A water closet shall not be required when an alternate system is provided and has been approved by the local health official. Where an alternative to the water closet is installed, a system for the disposal or treatment of graywater shall be provided to the dwelling. Graywater systems shall be designed according to water availability, use and discharge. The design, use and maintenance standards of such systems shall be the prerogative of the local health official.*

**304.0 Connections to Plumbing System Required.**

**304.1 General.** Plumbing fixtures, drains, appurtenances, and appliances, used to receive or discharge liquid wastes or sewage, shall be connected properly to the drainage system of the building or premises, in accordance with the requirements of this code.

***Exception: [HCD 1]*** *Limited-density owner-built rural dwellings. Where conventional plumbing, in all or in part, is installed within the structure, it shall be installed in accordance with the provisions of this code. Alternative materials and methods shall be permitted provided that the design complies with the intent of the code, and that such alternatives shall perform to protect health and safety for the intended purpose.*

**305.0 Damage to Drainage System or Public Sewer.**

**305.1 Unlawful Practices.** It shall be unlawful for a person to deposit, by any means whatsoever, into a plumbing fixture, floor drain, interceptor, sump, receptor, or device, which is connected to a drainage system, public sewer, private sewer, septic tank, or cesspool, any ashes; cinders; solids; rags; inflammable, poisonous, or explosive liquids or gases; oils; grease; or any other thing whatsoever that is capable of causing damage to the drainage system or public sewer.

**306.0 Industrial Wastes.**

**306.1 Detrimental Wastes.** Wastes detrimental to the public sewer system or detrimental to the functioning of the sewage treatment plant shall be treated and disposed of as found necessary and directed by the Authority Having Jurisdiction.

**306.2 Safe Discharge.** Sewage or other waste from a plumbing system that is capable of being deleterious to surface or subsurface waters shall not be discharged into the ground or into a waterway unless it has first been rendered safe by some acceptable form of treatment in accordance with the Authority Having Jurisdiction.

**307.0 Location.**

**307.1 System.** Except as otherwise provided in this code, no plumbing system, drainage system, building sewer, private sewage disposal system, or parts thereof shall be located in a lot other than the lot that is the site of the building, structure, or premises served by such facilities.

**307.2 Ownership.** No subdivision, sale, or transfer of ownership of existing property shall be made in such manner that the area, clearance, and access requirements of this code are decreased.

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**308.0 Improper Location.**

**308.1 General.** Piping, fixtures, or equipment shall not be so located as to interfere with the normal use thereof or with the normal operation and use of windows, doors, or other required facilities.

**309.0 Workmanship.**

**309.1 Engineering Practices.** Design, construction, and workmanship shall be in accordance with accepted engineering practices and shall be of such character as to secure the results sought to be obtained by this code.

**309.2 Concealing Imperfections.** It is unlawful to conceal cracks, holes, or other imperfections in materials by welding, brazing, or soldering or by using therein or thereon a paint, wax, tar, solvent cement, or other leak-sealing or repair agent.

**309.3 Burred Ends.** Burred ends of pipe and tubing shall be reamed to the full bore of the pipe or tube, and chips shall be removed.

**309.4 Installation Practices.** Plumbing systems shall be installed in a manner that is in accordance with this code, applicable standards, and the manufacturer's installation instructions.

**310.0 Prohibited Fittings and Practices.**

**310.1 Fittings.** No double hub fitting, single or double tee branch, single or double tapped tee branch, side inlet quarter bend, running thread, band, or saddle shall be used as a drainage fitting, except that a double hub sanitary tapped tee shall be permitted to be used on a vertical line as a fixture connection.

**310.2 Drainage and Vent Piping.** 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.

**310.3 Waste Connection.** No waste connection shall be made to a closet bend or stub of a water closet or similar fixture.

**310.4 Use of Vent and Waste Pipes.** Except as hereinafter provided in Section 908.0, Section 909.0, and Section 910.0, no vent pipe shall be used as a soil or waste pipe, nor shall a soil or waste pipe be used as a vent. Also, single-stack drainage and venting systems with unvented branch lines are prohibited.

**310.5 Obstruction of Flow.** No fitting, fixture and piping connection, appliance, device, or method of installation that obstructs or retards the flow of water, wastes, sewage, or air in the drainage or venting systems, in an amount exceeding the normal frictional resistance to flow, shall be used unless it is indicated as acceptable in this code or is approved in accordance with Section 301.1 of this code. The enlargement of a 3 inch (76 mm) closet bend or stub to 4 inches (102 mm) shall not be considered an obstruction.

**310.6 Dissimilar Metals.** Except for necessary valves, where inter-membering or mixing of dissimilar metals occurs, the point of connection shall be confined to exposed or accessible locations.

**310.7 Direction of Flow.** Valves, pipes, and fittings shall be installed in correct relationship to the direction of flow.

**310.8 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.

***310.9 [OSHPD 1, 2, 3 & 4]*** *Drainage piping over operating and delivery rooms, nurseries, food preparation centers, food-serving facilities, food storage areas, and other sensitive areas shall be kept to a minimum and shall not be exposed. Special precautions shall be taken to protect these areas from possible leakage from necessary overhead drainage piping systems. Piping over switchboards, panel boards, and motor control centers are subject to restrictions of the California Electrical Code where applicable.*

***310.10 [OSHPD 1, 3 & 4]*** *Floor drains shall not be installed in operating and delivery rooms. Floor drains with self-priming traps may be installed in cystoscopic rooms.*

***310.11 [SFM]*** *For applications listed in Section 111 regulated by the Office of the State Fire Marshal, plastic piping shall not be exposed as a portion of the interior room finish in a building or structure if the piping has a flame-spread rating exceeding 75 when tested in accordance with ASTM E 84-77a, "Test for Surface Burning Characteristics of Building Materials."*

***310.12 [OSHPD 1, 2 & 4] Services/Systems and Utilities.*** *Refer to Section 1224.4.1, California Building Code.*

**311.0 Independent Systems.**

**311.1 General.** The drainage system of each new building and of new work installed in an existing building shall be separate and independent from that of any other building, and, where available, every building shall have an independent connection with a public or private sewer.

**Exception:** Where one building stands in the rear of another building on an interior lot, and no private sewer is available or can be constructed to the rear building through an adjoining court, yard, or driveway, the building drain from the front building shall be permitted to be extended to the rear building.

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

**312.1 General.** Piping passing under or through walls shall be protected from breakage. Piping passing through or under cinders or other corrosive materials shall be protected from external corrosion in an approved manner. Approved provisions shall be made for expansion of hot water piping. Voids around piping passing through concrete floors on the ground shall be sealed.

**312.2 Installation.** 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.

**312.3 Building Sewer and Drainage Piping.** 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 2 feet (610 mm) of a building or structure, or less than 1 foot (305 mm) below the surface of the ground.

**312.4 Corrosion, Erosion, and Mechanical Damage.** Piping subject to corrosion, erosion, or mechanical damage shall be protected in an approved manner.

**312.5 Protectively Coated Pipe.** Protectively coated pipe shall be inspected and tested, and a visible void, damage, or imperfection to the pipe coating shall be repaired in accordance with Section 312.0.

**312.6 Freezing Protection.** 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.

**312.7 Fire-Resistant Construction.** 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 *California* Building Code.

**312.8 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.

**312.9 Steel Nail Plates.** Plastic and copper piping penetrating framing members to within 1 inch (25.4 mm) of the exposed framing shall be protected by steel nail plates not less than No. 18 gauge (0.0478 inches) (1.2 mm) in thickness. The steel nail plate shall extend along the framing member not less than 1½ inches (38 mm) beyond the outside diameter of the pipe or tubing.

**Exception:** See Section 1210.3.3.

**312.10 Sleeves.** Sleeves shall be provided to protect piping through concrete and masonry walls and concrete floors.

**Exception:** Sleeves shall not be required where openings are drilled or bored.

**312.10.1 Building Loads.** Piping through concrete or masonry walls shall not be subject to a load from building construction.

**312.10.2 Exterior Walls.** In exterior walls, annular space between sleeves and pipes shall be sealed and made watertight, as approved by the Authority Having Jurisdiction. A penetration through fire-resistive construction shall be in accordance with Section 312.7.

**312.10.3 Firewalls.** A pipe sleeve through a firewall shall have the space around the pipe completely sealed with an approved fire-resistive material in accordance with other codes.

**312.11 Structural Members.** A 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.

**312.12 Rodentproofing.** Strainer plates on drain inlets shall be designed and installed so that no opening exceeds ½ of an inch (12.7 mm) in the least dimension.

**312.12.1 Meter Boxes.** Meter boxes shall be constructed in such a manner that rats cannot enter a building by following the service pipes from the box into the building.

**312.12.2 Metal Collars.** 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.

**312.12.3 Tub Waste Openings.** Tub waste openings in framed construction to crawl spaces at or below the first floor shall be protected by the installation of approved metal collars or metal screen securely fastened to the adjoining structure with no opening exceeding ½ of an inch (12.7 mm) in the least dimension.

**313.0 Hangers and Supports.**

**313.1 Suspended Piping.** Suspended piping shall be supported at intervals not to exceed those shown in Table 313.1.

**313.2 Piping Support.** Piping shall be supported in such a manner as to maintain its alignment and prevent sagging.

**313.3 Underground Piping.** Piping in the ground shall be laid on a firm bed for its entire length; where other support is otherwise provided, it shall be approved in accordance with Section 301.0 of this code.

**313.4 Strength.** Hangers and anchors shall be of sufficient strength to support the weight of the pipe and its contents. Piping shall be isolated from incompatible materials.

**313.5 Piping, Fixtures, Appliances, and Appurtenances.** Piping, fixtures, appliances, and appurtenances shall be adequately supported in accordance with this code, the manufacturer's installation instructions, and in accordance with the Authority Having Jurisdiction.

**313.6 Hanger Rod Sizes.** Hanger rod sizes shall be no smaller than those shown in Table 313.6.

**TABLE 313.6**
**HANGER ROD SIZES**

| PIPE AND TUBE SIZE (inches) | ROD SIZE (inches) |
|---|---|
| ½ – 4 | ⅜ |
| 5 – 8 | ½ |
| 10 – 12 | ⅝ |

For SI units: 1 inch = 25.4 mm

**313.7 Gas Piping.** Gas piping shall be supported by metal straps or hooks at intervals not to exceed those shown in Table 1210.2.4.1.

***313.8 [OSHPD 1, 2, 3 & 4]*** *Refer to Title 24, Part 2 of the California Building Code for seismic anchorage and bracing requirements and accommodations for building displacements.*

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**314.0 Trenching, Excavation, and Backfill.**

**314.1 Trenches.** Trenches deeper than the footing of a building or structure and paralleling the same shall be not less than 45 degrees (0.79 rad) therefrom, or as approved in accordance with Section 301.0 of this code.

**314.2 Tunneling and Driving.** Tunneling and driving shall be permitted to be done in yards, courts, or driveways of a building site. Where sufficient depth is available to permit, tunnels shall be permitted to be used between open-cut trenches. Tunnels shall have a clear height of 2 feet (610 mm) above the pipe and shall be limited in length to one-half the depth of the trench, with a maximum length of 8 feet (2438 mm). Where pipes are driven, the drive pipe shall be not less than one size larger than the pipe to be laid.

**314.3 Open Trenches.** Excavations required to be made for the installation of a building drainage system or part thereof, within the walls of a building, shall be open trench work and shall be kept open until the piping has been inspected, tested, and accepted.

**314.4 Excavations.** Excavations shall be completely backfilled as soon after inspection as practicable. Precaution shall be taken to ensure compactness of backfill around piping without damage to such piping. Trenches shall be backfilled in thin layers to 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 will damage or break the piping or cause corrosive action. Mechanical devices such as bulldozers, graders, etc., shall be permitted to then be used to complete backfill to grade. Fill shall be properly compacted. Precautions shall be taken to ensure permanent stability for pipe laid in filled or made ground.

**315.0 Joints and Connections.**

**315.1 Unions.** Approved unions shall be permitted to be used in drainage piping where accessibly located in the trap seal or between a fixture and its trap in the vent system, except underground or in wet vents, at a point in the water supply system, and in gas piping as permitted by Section 1211.5.

**315.2 Prohibited Joints and Connections.** A fitting or connection that has an enlargement, chamber, or recess with a ledge, shoulder, or reduction of pipe area that offers an obstruction to flow through the drain shall be prohibited.

**315.2.1 Obstruction.** No fitting or connection that offers abnormal obstruction to flow shall be used. The enlargement of a 3 inch (76 mm) closet bend or stub to 4 inches (102 mm) shall not be considered an obstruction.

**316.0 Increasers and Reducers.**

**316.1 General.** Where different sizes of 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.

**317.0 Food-Handling Establishments.**

**317.1 General.** Food or drink shall not be stored, prepared, or displayed beneath soil or drain pipes, unless those areas are protected against leakage or condensation from such pipes reaching the food or drink as described below. Where building design requires that soil or drain pipes be located over such areas, the installation shall be made with the least possible number of joints and shall be installed so as to connect to the nearest adequately sized vertical stack with the provisions as follows:

(1) Openings through floors over such areas shall be sealed watertight to the floor construction.

(2) Floor and shower drains installed above such areas shall be equipped with integral seepage pans.

(3) Soil or drain pipes shall be of an approved material as listed in Table 1401.1 and Section 701.1. Materials shall comply with established standards. Cleanouts shall be extended through the floor construction above.

(4) Piping subject to operation at temperatures that will form condensation on the exterior of the pipe shall be thermally insulated.

(5) Where pipes are installed in ceilings above such areas, the ceiling shall be of the removable type, or shall be provided with access panels in order to form a ready access for inspection of piping.

**318.0 Test Gauges.**

**318.1 General.** Tests in accordance with this code, which are performed utilizing dial gauges, shall be limited to gauges having the following pressure graduations or incrementations.

**318.2 Pressure Tests (10 psi or less).** Required pressure tests of 10 pounds-force per square inch (psi) (69 kPa) or less shall be performed with gauges of 0.10 psi (0.69 kPa) incrementation or less.

**318.3 Pressure Tests (greater than 10 psi to 100 psi).** Required pressure tests exceeding 10 psi (69 kPa) but less than or equal to 100 psi (689 kPa) shall be performed with gauges of 1 psi (7 kPa) incrementation or less.

**318.4 Pressure Tests (exceeding 100 psi).** Required pressure tests exceeding 100 psi (689 kPa) shall be performed with gauges incremented for 2 percent or less of the required test pressure.

**318.5 Pressure Range.** Test gauges shall have a pressure range not exceeding twice the test pressure applied.

**319.0 *[Not permitted for OSHPD 1, 2, 3 & 4]* Medical Gas and Vacuum Systems.**

**319.1 General.** Such piping shall be installed, tested, and verified in accordance with the applicable standards referenced in Table 1401.1 and the requirements of Chapter 13. The Authority Having Jurisdiction shall require evidence of the competency of the installers and verifiers.

**TABLE 313.1**
**HANGERS AND SUPPORTS**

| MATERIALS | TYPES OF JOINTS | HORIZONTAL | VERTICAL |
|---|---|---|---|
| Cast | Lead and Oakum | 5 feet, except 10 feet where 10 foot lengths are installed[1, 2, 3] | Base and each floor, not to exceed 15 feet |
| | Compression Gasket | Every other joint, unless over 4 feet then support each joint[1, 2, 3] | Base and each floor, not to exceed 15 feet |
| Cast-Iron Hubless | Shielded Coupling | Every other joint, unless over 4 feet then support each joint[1,2,3,4] | Base and each floor, not to exceed 15 feet |
| Copper Tube and Pipe | Soldered or Brazed | 1½ inches and smaller, 6 feet; 2 inches and larger, 10 feet | Each floor, not to exceed 10 feet[5] |
| Steel and Brass Pipe for Water or DWV | Threaded or Welded | ¾ inch and smaller, 10 feet; 1 inch and larger, 12 feet | Every other floor, not to exceed 25 feet[5] |
| Steel, Brass, and Tinned Copper Pipe for Gas | Threaded or Welded | ½ inch, 6 feet; ¾ inch and 1 inch, 8 feet; 1¼ inches and larger, 10 feet | ½ inch, 6 feet; ¾ inch and 1 inch, 8 feet; 1¼ inches every floor level |
| Schedule 40 PVC and ABS DWV | Solvent Cemented | All sizes, 4 feet; allow for expansion every 30 feet[3,6] | Base and each floor; provide mid-story guides; provide for expansion every 30 feet[6] |
| CPVC | Solvent Cemented | 1 inch and smaller, 3 feet; 1¼ inches and larger, 4 feet | Base and each floor; provide mid-story guides[6] |
| Lead | Wiped or Burned | Continuous Support | Not to exceed 4 feet |
| Copper | Mechanical | In accordance with standards acceptable to the Authority Having Jurisdiction | |
| Steel and Brass | Mechanical | In accordance with standards acceptable to the Authority Having Jurisdiction | |
| PEX | Cold Expansion, Insert and Compression | 1 inch and smaller, 32 inches; 1¼ inches and larger, 4 feet | Base and each floor; provide mid-story guides |
| PEX-AL-PEX | Metal Insert and Metal Compression | ½ inch, ¾ inch, 1 inch } All sizes 98 inches | Base and each floor; provide mid-story guides |
| PE-AL-PE | Metal Insert and Metal Compression | ½ inch, ¾ inch, 1 inch } All sizes 98 inches | Base and each floor; provide mid-story guides |
| Polypropylene (PP) | Fusion weld (socket, butt, saddle, electrofusion), threaded (metal threads only), or mechanical | 1 inch and smaller, 32 inches; 1¼ inches and larger, 4 feet | Base and each floor; provide mid-story guides |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm

**Notes:**

[1] Support adjacent to joint, not to exceed 18 inches (457 mm).

[2] Brace not to exceed 40 foot (12 192 mm) intervals to prevent horizontal movement.

[3] Support at each horizontal branch connection.

[4] Hangers shall not be placed on the coupling.

[5] Vertical water lines shall be permitted to be supported in accordance with recognized engineering principles with regard to expansion and contraction, where first approved by the Authority Having Jurisdiction.

[6] See the appropriate IAPMO Installation Standard for expansion and other special requirements.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 4 - PLUMBING FIXTURES AND FIXTURE FITTINGS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | X | | X | X | | | X | X | X | X | X | X | | X | X | | X | | |
| Adopt only those sections that are listed below | | | | | X | X | | | | | | | X | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| Note Under Title | | | | | | X | | | | | | | | | | | | | |
| 403.2 & subsections | | | X | X | | | | | | | | | | | | | | | |
| 403.3.1 & subsections | | | X | X | | | | | | | | | | | | | | | |
| 403.6 | | | X | | | | | | | | | | | | | | | | |
| 403.7 | | | X | | | | | | | | | | | | | | | | |
| 403.8 | | | X | X | | | | | | | | | | | | | | | |
| 408.2 | | | X | | | | | | | | | | | | | | | | |
| 408.5 Exception 1 | | | | | X | | | | | | | | | | | | | | |
| 408.6 Exception 3 | | | | | X | | | | | | | | | | | | | | |
| 413.3 | | | | | | | | | X | X | X | X | | | | | | | |
| 415.1 | | | X | | | | | | | | | | | | | | | | |
| 421.1 | | | | | X | | | | | | | | | | | | | | |
| 422.2 | | | † | † | | | | | | | | | | | | | | | |
| 422.2.1 & Exception | | | | | | | | | X | X | X | X | | | | | | | |
| 422.4 | | | † | † | | | | | | | | | | | | | | | |
| 422.5 | | | † | † | | | | | | | | | | | | | | | |
| 422.6 | | | | | | | | | | | | | | | | | X | | |
| 422.7 | | | | | | | | | | | | | | | | | X | | |
| 422.8 | | | | | | | | | | | | | | | | | | | |
| 422.9 | | | | | | | | | | | | | | X | | | | | |
| Table A | X | | | | | | X | X | | | | | | | | | | | |
| Table 422.1 | X | | X | X | X | X | X | X | X | X | X | X | | | | | | | |
| Table 4-2 | | | | | | | | | X | X | X | X | | | | | | | |
| Table 4-3 | X | | | | | | | | | | | | | | X | | | | |
| Table 4-4 | X | | | | | | | | | | | | | X | | | | | |

The state agency does not adopt sections identified by the following symbol: †

# CHAPTER 4

## PLUMBING FIXTURES AND FIXTURE FITTINGS

*Note: In addition the requirements of this chapter, which provide access to, or egress from, buildings or facilities where accessibility is required for applications listed in Section 109, of the California Building Code, regulated by the Division of the State Architect– Access Compliance shall also comply with Chapter 11A for public housing and Chapter 11B for public accommodations under authority cited by Gov. Code §4450 and in reference cited by Gov. Code §4450 through 4461, 12955.1 and H&SC §18949.1, 19952 through 19959.*

**401.0 Materials – General Requirements.**

**401.1 Quality of Fixtures.** Plumbing fixtures shall be constructed of dense, durable, non-absorbent materials and shall have smooth, impervious surfaces, free from unnecessary concealed fouling surfaces. Except as permitted elsewhere in this code, fixtures shall comply with the quality and design of nationally recognized applicable standards referenced in Table 1401.1.

**401.2 Lead.** Sheet lead shall be not less than the following:

For safe pans not less than 4 pounds per square foot (lb/ft$^2$) (19 kg/m$^2$) or 1/16 of an inch (1.6 mm) thick. (See Table 1401.1)

**402.0 Installation.**

**402.1 Cleaning.** Plumbing fixtures shall be installed in a manner to afford easy access for repairs and cleaning. Pipes from fixtures shall be run to the nearest wall.

**402.2 Joints.** Where a fixture comes in contact with the wall or floor, the joint between the fixture and the wall or floor shall be made watertight.

**402.3 Securing Fixtures.** Floor-outlet or floor-mounted fixtures shall be rigidly secured to the drainage connection and to the floor, where so designed, by screws or bolts of copper, brass, or other equally corrosion-resistant material.

**402.4 Wall-Hung Fixtures.** Wall-hung fixtures shall be rigidly supported by metal supporting members so that no strain is transmitted to the connections. Flush tanks and similar appurtenances shall be secured by approved non-corrosive screws or bolts.

**402.5 Setting.** Fixtures shall be set level and in proper alignment with reference to adjacent walls. No water closet or bidet shall be set closer than 15 inches (381 mm) from its center to a side wall or obstruction nor closer than 30 inches (762 mm) center to center to a similar fixture. The clear space in front of a water closet or bidet shall be not less than 24 inches (610 mm). No urinal shall be set closer than 12 inches (305 mm) from its center to a side wall or partition nor closer than 24 inches (610 mm) center to center.

**Exception:** The installation of paper dispensers or accessibility grab bars shall not be considered obstructions.

**402.6 Flanged Fixture Connections.** Fixture connections between drainage pipes and water closets, floor outlet service sinks and urinals shall be made by means of approved brass, hard lead, ABS, PVC, or iron flanges caulked, soldered, solvent cemented; rubber compression gaskets; or screwed to the drainage pipe. The connection shall be bolted with an approved gasket, washer, or setting compound between the fixture and the connection. The bottom of the flange shall be set on an approved firm base.

Wall-mounted water closet fixtures shall be securely bolted to an approved carrier fitting. The connecting pipe between the carrier fitting and the fixture shall be an approved material and designed to accommodate an adequately sized gasket. Gasket material shall be neoprene, felt, or similar approved types.

**402.6.1 Closet Rings (Closet Flanges).** Closet rings (closet flanges) for water closets or similar fixtures shall be of an approved type and shall be bronze, copper, hard lead, cast-iron, galvanized malleable iron, ABS, PVC, or other approved materials. Each such closet ring (closet flange) shall be approximately 7 inches (178 mm) in diameter and, where installed, shall, together with the soil pipe, present a 1½ inch (38 mm) wide flange or face to receive the fixture gasket or closet seal.

Caulked-on closet rings (closet flanges) shall be not less than ¼ of an inch (6.4 mm) thick and not less than 2 inches (51 mm) in overall depth.

Closet rings (closet flanges) shall be burned or soldered to lead bends or stubs, shall be caulked to cast-iron soil pipe, shall be solvent cemented to ABS and PVC, and shall be screwed or fastened in an approved manner to other materials.

Closet bends or stubs shall be cut off so as to present a smooth surface even with the top of the closet ring before rough inspection is called.

Closet rings (closet flanges) shall be adequately designed and secured to support fixtures connected thereto.

**402.6.2 Securing Closet Flanges.** Closet screws, bolts, washers, and similar fasteners shall be of brass, copper, or other listed, equally corrosion-resistant materials. Screws and bolts shall be of a size and number to properly support the fixture installed.

**402.6.3 Securing Floor-Mounted, Back-Outlet Water Closet Bowls.** Floor-mounted, back-outlet water closet bowls shall be set level with an angle of 90 degrees (1.57 rad) between the floor and wall at the centerline of the fixture outlet. The floor and wall shall have a flat mounting surface not less than 5 inches (127 mm) to the right and left of the fixture outlet centerline. The fixture shall be secured to the wall outlet flange or drainage connection and to the floor by corrosion-resistant screws or bolts. The closet flange shall be secured to a firm base.

Where floor-mounted, back-outlet water closets are used, the soil pipe shall be not less than 3 inches (80 mm) in diameter. Offset, eccentric, or reducing floor flanges shall not be used.

**402.7 Accessible Plumbing Facilities.** Where accessible facilities are required in applicable building regulations, the facilities shall be installed in accordance with those regulations. *[HCD 1-AC] For specific requirements regarding accommodations for persons with disabilities, see California Code of Regulations, Title 24, Part 2, Chapter 11A.*

**402.8 Supply Fittings.** The supply lines and fittings for every plumbing fixture shall be so installed as to prevent backflow in accordance with Chapter 6.

**402.9 Installation.** Water-conserving fixtures shall be installed in strict accordance with the manufacturer's installation instructions to maintain their rated performance.

**402.10 Design and Installation of Plumbing Fixtures.** Plumbing fixtures shall be installed such that fixture fittings shall be in accordance with the backflow prevention requirements of ASME A112.18.1/CSA B125.1. These requirements shall not be compromised by the designated fixture fitting mounting surface.

**402.11 Slip Joint Connections.** Fixtures having concealed slip joint connections shall be provided with an access panel or utility space not less than 12 inches (305 mm) in its least dimension and so arranged without obstructions as to make such connections accessible for inspection and repair.

**402.12 Future Fixtures.** Where provisions are made for the future installation of fixtures, those provided for shall be considered in determining the required sizes of drain pipes. Construction for future installations shall be terminated with a plugged fitting or fittings. Where the plugged fitting is at the point where the trap of a fixture is installed, the plumbing system for such fixture shall be complete and be in accordance with the plumbing requirements of this code.

**403.0 Water-Conserving Fixtures and Fittings.**

**403.1 Flush Volumes.** Flush volumes for low-consumption and water-saver water closets and urinals shall comply with applicable standards referenced in Table 1401.1.

**403.2 Water Closets.** Water closets, either flush tank, flushometer tank, or flushometer valve operated, shall have an average consumption not to exceed 1.6 gallons (6.0 Lpf) of water per flush.

***403.2.1 Water Closets on or after July 1, 2011 [HCD 1 & HCD 2]*** *Water closets, either flush tank, flushometer tank, or flushometer valve operated installed on or after July 1, 2011, shall have an effective flush volume in compliance with the following:*

*(1) Single Flush Toilets - The effective flush volume shall not exceed 1.28 gallons (4.8 liters) when tested in accordance with ASME A112.19.2, Standard for Vitreous China Plumbing Fixtures and Hydraulic Fixtures Requirements for Water Closets and Urinals*

*(2) Dual Flush Toilets - The effective flush volume shall not exceed 1.28 gallons (4.8 liters) when tested in accordance with ASME A112.19.2, Standard for Vitreous China Plumbing Fixtures and Hydraulic Fixtures Requirements for Water Closets and Urinals, and ASME A112.19.14, Standard for Six-Liter Water Closets Equipped with a Dual Flushing Device.*

***403.2.1.1 Performance [HCD 1 & HCD 2]*** *Water closets installed on or after July 2, 2011, shall meet or exceed the minimum performance criteria developed for certification of high-efficiency toilets under the WaterSense program sponsored by the U.S. Environmental Protection Agency (EPA).*

**403.3 Urinals.** Urinals shall have an average water consumption not to exceed *0.5* gallons (*2* L) of water per flush.

**403.3.1 Nonwater Urinals.** Nonwater urinals shall be listed and comply with the applicable standards referenced in Table 1401.1. Nonwater urinals shall have a barrier liquid sealant to maintain a trap seal. Nonwater urinals shall permit the uninhibited flow of waste through the urinal to the sanitary drainage system. Nonwater urinals shall be cleaned and maintained in accordance with the manufacturer's instructions after installation. Where nonwater urinals are installed they shall have a water distribution line rough-in to the urinal location to allow for the installation of an approved backflow prevention device in the event of a retrofit. *For additional information, see Health and Safety Code Section 17921.4.*

***403.3.1.1 Nonwater Urinal Drainage Connections.*** *Where nonwater urinals are installed, not less than one water supplied fixture rated at not less than 1 drainage fixture unit (DFU) shall be installed upstream on the same drain line to facilitate drain line flow and rinsing.*

**403.4 Metered Faucets.** Self-closing or self-closing metering faucets shall be installed on lavatories intended to serve the transient public, such as those in, but not limited to, service stations, train stations, airports, restaurants, and convention halls. Metered faucets shall deliver a maximum of 0.25 gallons (0.95 L) of water per use.

**403.5 Pre-Rinse Spray Valve.** Commercial food service pre-rinse spray valves shall have a maximum flow rate of 1.6 gallons per minute (gpm) at 60 pounds-force per square inch (psi) (6.0 L/m at 414 kPa) in accordance with ASME A112.18.1/CSA B125.1 and shall be equipped with an integral automatic shutoff.

***403.6 Kitchen Faucets. [HCD 1]*** *The maximum flow rate of kitchen faucets shall not exceed 1.8 gallons (6.81 L) per minute at 60 psi. Kitchen faucets may temporarily increase the flow above the maximum rate, but not to exceed 2.2 gallons (8.32 L) per minute at 60 psi, and must default to a maximum flow rate of 1.8 gallons (6.81 L) per minute at 60 psi.*

***Note:*** *Where faucets meeting the maximum flow rate of 1.8 gpm (6.81 L) are unavailable, aerators or other means may be used to achieve reduction.*

***403.7 Residential Lavatory Faucets. [HCD 1]*** *The maximum flow rate of residential lavatory faucets shall not exceed 1.5 gallons (5.68 L) per minute at 60 psi. The minimum flow rate of residential lavatory faucets shall not be less than 0.8 gallons (3.03 L) per minute at 20 psi.*

*403.8 Lavatory Faucets in Common and Public Use Areas. [HCD 1 & HCD 2] The maximum flow rate of lavatory faucets, installed in common and public use areas (outside of dwellings or sleeping units) in residential buildings, shall not exceed 0.5 gallons (1.89 L) per minute at 60 psi.*

**404.0 Overflows.**

**404.1 General.** Where a fixture is provided with an overflow, the waste shall be so arranged that the standing water in the fixture shall not rise in the overflow where the stopper is closed or remain in the overflow where the fixture is empty. The overflow pipe from a fixture shall be connected on the house or inlet side of the fixture trap, except that overflow on flush tanks shall be permitted to discharge into the water closets or urinals served by them, but it shall be unlawful to connect such overflows with any other part of the drainage system.

**405.0 Strainers and Connections.**

**405.1 Strainers.** Plumbing fixtures, other than water closets and urinals, shall be equipped with approved strainers having an approved waterway area. Strainers serving shower drains shall have a waterway equivalent to the area of the tailpiece.

**405.2 Continuous Wastes.** Continuous wastes and fixture tailpieces shall be constructed from the materials specified in Section 701.1 for drainage piping, provided, however, that such connections where exposed or accessible shall be permitted to be of seamless drawn brass not less than No. 20 B & S Gauge (0.032 inches) (0.8 mm). Each such tailpiece, continuous waste, or waste and overflow shall be not less than 1½ inches (40 mm) O.D. for sinks, dishwashers, laundry tubs, bathtubs, urinals, and similar fixtures, and not less than 1¼ inches (32 mm) for lavatories, drinking fountains, and similar small fixtures.

**406.0 Prohibited Fixtures.**

**406.1 Prohibited Water Closets.** Water closets having an invisible seal or an unventilated space or having walls which are not thoroughly washed at each discharge shall be prohibited. A water closet that might permit siphonage of the contents of the bowl back into the tank shall be prohibited.

**406.2 Prohibited Urinals.** Trough urinals and urinals with an invisible seal shall be prohibited.

**406.3 Miscellaneous Fixtures.** Fixed wooden, or tile wash trays or sinks for domestic use shall not be installed in a building designed or used for human habitation. No sheet metal-lined wooden bathtub shall be installed or reconnected. No dry or chemical closet (toilet) shall be installed in a building used for human habitation, unless first approved by the Health Officer.

**407.0 Special Fixtures and Specialties.**

**407.1 Water and Waste Connections.** Baptisteries, ornamental and lily ponds, aquaria, ornamental fountain basins, and similar fixtures and specialties requiring water, waste connections, or both shall be submitted for approval to the Authority Having Jurisdiction prior to installation.

**407.2 Special Use Sinks.** Restaurant kitchen and other special use sinks shall be permitted to be made of approved-type bonderized and galvanized sheet steel of not less than No. 16 U.S. gauge (0.0625 inches) (1.6 mm). Sheet-metal plumbing fixtures shall be adequately designed, constructed, and braced in an approved manner to accomplish their intended purpose.

**407.3 Special Use Fixtures.** Special use fixtures shall be made of one of the following:

(1) Soapstone
(2) Chemical stoneware
(3) Copper-based alloy
(4) Nickel-based alloy
(5) Corrosion-resistant steel
(6) Other materials suited for the intended use of the fixture

**407.4 Zinc Alloy Components.** Zinc alloy components shall comply with applicable nationally recognized standards and shall be used in accordance with their listing.

**408.0 Showers.**

**408.1 Application.** Manufactured shower receptors shall comply with the applicable standards referenced in Table 1401.1.

**408.2 Water Consumption.** *[HCD 1] Showerheads shall have a maximum flow rate of 2.0 gallons (7.57 L) per minute measured at 80 psi and must comply with Division 4.3 of the California Green Building Standards Code (CALGreen).*

**408.3 Individual Shower and Tub-Shower Combination Control Valves.** Showers and tub-shower combinations shall be provided with individual control valves of the pressure balance, thermostatic, or combination pressure balance/thermostatic mixing valve type that provide scald and thermal shock protection for the rated flow rate of the installed showerhead. These valves shall be installed at the point of use and in accordance with ASSE 1016 or ASME A112.18.1/CSA B125.1. Gang showers, where supplied with a single temperature-controlled water supply pipe, shall be controlled by a mixing valve that is in accordance with ASSE 1069. Handle position stops shall be provided on such valves and shall be adjusted per the manufacturer's instructions to deliver a maximum mixed water setting of 120°F (49°C). Water heater thermostats shall not be considered a suitable control for meeting this provision.

**408.4 Waste Outlet.** Showers shall have a waste outlet and fixture tailpiece not less than 2 inches (50 mm) in diameter. Fixture tailpieces shall be constructed from the materials specified in Section 701.1 for drainage piping. Strainers serving shower drains shall have a waterway at least equivalent to the area of the tailpiece.

**408.5 Finished Curb or Threshold.** Where a shower receptor has a finished dam, curb, or threshold it shall be not less than 1 inch (25.4 mm) lower than the sides and back of such receptor. In no case shall a dam or threshold be less than 2 inches (51 mm) or exceeding 9 inches (229 mm) in depth where measured from the top of the dam or threshold to the

top of the drain. Each such receptor shall be provided with an integral nailing flange to be located where the receptor meets the vertical surface of the finished interior of the shower compartment. The flange shall be watertight and extend vertically not less than 1 inch (25.4 mm) above the top of the sides of the receptor. The finished floor of the receptor shall slope uniformly from the sides towards the drain not less than ¼ inch per foot (20.8 mm/m), nor more than ½ inch per foot (41.8 mm/m).

Thresholds shall be of sufficient width to accommodate a minimum 22 inch (559 mm) door. Shower doors shall open so as to maintain not less than a 22 inch (559 mm) unobstructed opening for egress.

**Exceptions:**

(1) Showers that are designed to be in accordance with the accessibility standards listed in Table 1401.1. ***[HCD 1-AC]*** *Specific requirements regarding accommodations for persons with disabilities are contained in California Code of Regulations, Title 24, Part 2, Chapter 11A. Table 1401.1 does not contain the correct accessibility standards for use in California.*

(2) A cast-iron shower receptor flange shall be not less than 0.3 of an inch (7.62 mm) in height.

(3) For flanges not used as a means of securing, the sealing flange shall be not less than 0.3 of an inch (7.62 mm) in height.

**408.6 Shower Compartments.** Shower compartments, regardless of shape, shall have a minimum finished interior of 1024 square inches (0.6606 $m^2$) and shall also be capable of encompassing a 30 inch (762 mm) circle. The minimum required area and dimensions shall be measured at a height equal to the top of the threshold and at a point tangent to its centerline. The area and dimensions shall be maintained to a point of not less than 70 inches (1778 mm) above the shower drain outlet with no protrusions other than the fixture valve or valves, shower head, soap dishes, shelves, and safety grab bars, or rails. Fold-down seats in accessible shower stalls shall be permitted to protrude into the 30 inch (762 mm) circle.

**Exceptions**:

(1) Showers that are designed to comply with *Chapter 11A of the California Building Code.*

(2) The minimum required area and dimension shall not apply for a shower receptor having overall dimensions of not less than 30 inches (762 mm) in width and 60 inches (1524 mm) in length.

(3) ***[HCD 1-AC]*** *Specific requirements regarding accommodations for persons with disabilities are contained in California Code of Regulations, Title 24, Part 2, Chapter 11A. ICC A117.1, Standard for Accessible and Usable Buildings and Facilities, does not contain the correct accessibility standards for use in California.*

**408.7 Lining for Showers and Receptors.** Shower receptors built on-site shall be watertight and shall be constructed from approved-type dense, nonabsorbent, and noncorrosive materials. Each such receptor shall be adequately reinforced, shall be provided with an approved flanged floor drain designed to make a watertight joint in the floor, and shall have smooth, impervious, and durable surfaces.

Shower receptors shall have the subfloor and rough side of walls to a height of not less than 3 inches (76 mm) above the top of the finished dam or threshold shall be first lined with sheet plastic, lead, or copper, or shall be lined with other durable and watertight materials. Showers that are provided with a built in place, permanent seat or seating area that is located within the shower enclosure, shall be first lined with sheet plastic, lead, copper, or shall be lined with other durable and watertight materials that extend not less than 3 inches (76 mm) above horizontal surfaces of the seat or the seating area.

Lining materials shall be pitched ¼ inch per foot (20.8 mm/m) to weep holes in the subdrain of a smooth and solidly formed subbase. Such lining materials shall extend upward on the rough jambs of the shower opening to a point not less than 3 inches (76 mm) above the horizontal surfaces of the seat or the seating area, the top of the finished dam or threshold and shall extend outward over the top of the permanent seat, permanent seating area, or rough threshold and be turned over and fastened on the outside face of both the permanent seat, permanent seating area, or rough threshold and the jambs.

Nonmetallic shower subpans or linings shall be permitted to be built up on the job site of not less than three layers of standard grade 15 pound (6.8 kg) asphalt-impregnated roofing felt. The bottom layer shall be fitted to the formed subbase and each succeeding layer thoroughly hot-mopped to that below. Corners shall be carefully fitted and shall be made strong and watertight by folding or lapping, and each corner shall be reinforced with suitable webbing hot-mopped in place.

Folds, laps, and reinforcing webbing shall extend not less than 4 inches (102 mm) in all directions from the corner, and webbing shall be of approved type and mesh, producing a tensile strength of not less than 50 $lb/ft^2$ (244 $kg/m^2$) in either direction. Nonmetallic shower subpans or linings shall be permitted to consist of multilayers of other approved equivalent materials suitably reinforced and carefully fitted in place on the job site as elsewhere required in this section.

Linings shall be properly recessed and fastened to approved backing so as not to occupy the space required for the wall covering, and shall not be nailed or perforated at a point that is less than 1 inch (25.4 mm) above the finished dam or threshold. An approved-type subdrain shall be installed with a shower subpan or lining. Each such subdrain shall be of the type that sets flush with the subbase and shall be equipped with a clamping ring or other device to make a tight connection between the lining and the drain. The subdrain shall have weep holes into the waste line. The weep holes located in the subdrain clamping ring shall be protected from clogging.

Shower lining materials shall comply with approved standards acceptable to the Authority Having Jurisdiction. Lead and copper subpans or linings shall be insulated from conducting substances other than their connecting drain by 15 pound (6.8 kg) asphalt felt or its equivalent, and no lead pan or liner shall be constructed of material weighing less

than 4 lb/ft$^2$ (19 kg/m$^2$). Copper pans or liners shall be not less than No. 24 B & S Gauge (0.02 inches) (0.51 mm). Joints in lead pans or liners shall be burned. Joints in copper pans or liners shall be soldered or brazed. Plastic pans shall not be coated with asphalt-based materials.

**408.7.1 Tests for Shower Receptors.** Shower receptors shall be tested for watertightness by filling with water to the level of the rough threshold. The test plug shall be so placed that both upper and under sides of the subpan shall be subjected to the test at the point where it is clamped to the drain.

**408.8 Public Shower Floors.** Floors of public shower rooms shall have a nonskid surface and shall be drained in such a manner that wastewater from one bather shall not pass over areas occupied by other bathers. Gutters in public or gang shower rooms shall have rounded corners for easy cleaning and shall be sloped not less than 2 percent toward drains. Drains in gutters shall be spaced at a maximum of 8 feet (2438 mm) from sidewalls nor more than 16 feet (4877 mm) apart.

**408.9 Location of Valves and Heads.** Control valves and showerheads shall be located on the sidewall of shower compartments or otherwise arranged so that the showerhead does not discharge directly at the entrance to the compartment so that the bather can adjust the valves prior to stepping into the shower spray.

**408.10 Water Supply Riser.** A water supply riser from the shower valve to the showerhead outlet, whether exposed or not, shall be securely attached to the structure.

## 409.0 Bathtubs and Whirlpool Bathtubs.

**409.1 Application.** Bathtubs and whirlpool bathtubs shall comply with the applicable standards referenced in Table 1401.1. Pressure sealed doors within a bathtub or whirlpool bathtub enclosure shall comply with the applicable standards referenced in Table 1401.1.

**409.2 Waste Outlet.** Bathtubs and whirlpool bathtubs shall be provided with a waste outlet and tailpiece not less than 1½ inches (40 mm) in diameter. Fixture tailpieces shall be constructed of materials in accordance with Section 701.1. Waste outlets shall be provided with an approved stopper or strainer.

**409.3 Overflow.** Overflows shall be installed in accordance with Section 404.1.

**409.4 Limitation of Hot Water in Bathtubs and Whirlpool Bathtubs.** The maximum hot water temperature discharging from the bathtub and whirlpool bathtub filler shall be limited to 120°F (49°C) by a device that is in accordance with ASSE 1070 or CSA B125.3. Water heater thermostats shall not be considered a control for meeting this provision.

**409.5 Backflow Protection.** The water supply to a bathtub and whirlpool bathtub filler valve shall be protected by an air gap or in accordance with Section 417.0.

**409.6 Installation and Access.** Bathtubs and whirlpool bathtubs shall be installed in accordance with the manufacturer's installation instructions. Access openings shall be of size and opening to permit the removal and replacement of the circulation pump.

Whirlpool pump access located in the crawl space shall be located not more than 20 feet (6096 mm) from an access door, trap door, or crawl hole.

The circulation pump shall be located above the crown weir of the trap.

The pump and the circulation piping shall be self-draining to minimize water retention. Suction fittings on whirlpool bathtubs shall be listed in accordance with ASME A112.19.7.

## 410.0 Bidets.

**410.1 Application.** Bidets shall comply with the applicable standards referenced in Table 1401.1.

**410.2 Backflow Protection.** The water supply to the bidet shall be protected by an air gap or in accordance with Section 603.3.2, Section 603.3.5, or Section 603.3.6.

**410.3 Limitation of Water Temperature in Bidets.** The maximum hot water temperature discharging from a bidet shall be limited to 110°F (43°C) by a device that is in accordance with ASSE 1070 or CSA B125.3. Water heater thermostats shall not be considered a control for meeting this provision.

## 411.0 Water Closets.

**411.1 Water Closet Bowls.** Water closet bowls for public use shall be of the elongated type. In nurseries, schools, and other similar places where plumbing fixtures are provided for the use of children less than 6 years of age, water closets shall be of a size and height suitable for children's use. Water closets shall be equipped with seats in accordance with Section 411.2 through Section 411.2.2.

**411.2 Water Closet Seats.** Water closet seats shall be of smooth, non-absorbent material. Seats for public use shall comply with the applicable standards referenced in Table 1401.1.

**411.2.1 Type.** Water closet seats, for public use, shall be of the elongated type and either of the open front type or have an automatic seat cover dispenser.

**411.2.2 Size.** Water closet seats shall be properly sized for the water closet bowl type.

## 412.0 Urinals.

**412.1 General.** A water supply to a urinal shall be protected by an approved-type vacuum breaker or other approved backflow prevention device in accordance with Section 603.5.

## 413.0 Flushing Devices for Water Closets and Urinals.

**413.1 Application.** Flushometer valves, flushometer tanks, or flush tanks shall comply with the applicable standards referenced in Table 1401.1.

**413.2 Flushing Devices Required.** Each water closet, urinal, clinic sink, or other plumbing fixture that depends on trap siphonage to discharge its waste contents shall be provided with a flushometer valve, flushometer tank, or flush tank designed and installed so as to supply water in sufficient quantity and rate of flow to flush the contents of the fixture to

which it is connected, to cleanse the fixture, and to refill the fixture trap, without excessive water use. Flushing devices shall meet antisiphon requirements in accordance with Section 603.5.

**413.3 Flushometer Valves.** No manually controlled flushometer valve shall be used to flush more than one urinal, and each such urinal flushometer valve shall be an approved, self-closing type discharging a predetermined quantity of water. Flushometers shall be installed so that they will be accessible for repair. Flushometer valves shall not be used where the water pressure is insufficient to properly operate them. Where the valve is operated, it shall complete the cycle of operation automatically, opening fully, and closing positively under the line water pressure. Each flushometer shall be provided with a means for regulating the flow through it. *[OSHPD 1, 2, 3, & 4] Sensor operated flush valves shall be capable of functioning during loss of normal power.*

**413.4 Water Supply for Flush Tanks.** An adequate quantity of water shall be provided to flush and clean the fixture served. The water supply for flushing tanks and flushometer tanks equipped for manual flushing shall be controlled by a float valve or other automatic device designed to refill the tank after each discharge and to completely shut off the water flow to the tank where the tank is filled to operational capacity. Provision shall be made to automatically supply water to the fixture so as to refill the trap seal after each flushing.

**413.5 Overflows in Flush Tanks.** Flush tanks shall be provided with overflows discharging into the water closet or urinal connected thereto. Overflows supplied as original parts with the fixture shall be of sufficient size to prevent tank flooding at the maximum rate at which the tank is supplied with water under normal operating conditions and where installed in accordance with the manufacturer's installation instructions.

**414.0 Dishwashing Machines.**

**414.1 Application.** Domestic or commercial dishwashing machines shall comply with the applicable standards referenced in Table 1401.1.

**414.2 Backflow Protection.** The water supply connection to a commercial dishwashing machine shall be protected by an air gap or a backflow prevention device in accordance with Section 603.3.2, Section 603.3.5, or Section 603.3.6.

**414.3 Drainage Connection.** Domestic dishwashing machines shall discharge indirectly through an air gap fitting in accordance with Section 807.4 into a waste receptor, a wye branch fitting on the tailpiece of a kitchen sink, or dishwasher connection of a food waste grinder. Commercial dishwashing machines shall discharge indirectly through an air gap or direct connection in accordance with Section 704.3 with floor drain protection.

**415.0 Drinking Fountains.**

**415.1 Application.** Drinking fountains shall be self-closing and comply with NSF 61 and to the applicable standards referenced in Table 1401.1. *[HCD 1] Drinking fountains shall be installed and so regulated that a jet of water extending at least 2 inches (51 mm) in height from the water orifice shall be constantly available. The orifice shall not be accessible to the mouth of the drinker nor subject to immersion.*

**415.2 Where Required.** Where food is consumed indoors, water stations shall be permitted to be substituted for drinking fountains. Drinking fountains shall not be required for an occupant load of 30 or less.

**415.3 Drainage Connection.** Drinking fountains shall be permitted to discharge directly into the drainage system or indirectly through an air break in accordance with Section 809.1.

**415.4 Location.** Drinking fountains shall not be installed in toilet rooms.

**416.0 Emergency Eyewash and Shower Equipment.**

**416.1 Application.** Emergency eyewash and shower equipment shall comply with ISEA Z358.1.

**416.2 Water Supply.** Emergency eyewash and shower equipment shall not be limited in the water supply flow rates. Flow rate, discharge pattern, and temperature of flushing fluids shall be provided in accordance with ISEA Z358.1 based on the hazardous material.

**416.3 Installation.** Emergency eyewash and shower equipment shall be installed in accordance with the manufacturer's installation instructions.

**416.4 Location.** Emergency eyewash and shower equipment shall be located on the same level as the hazard and accessible for immediate use. The path of travel shall be free of obstructions and shall be clearly identified with signage.

**416.5 Drain.** A drain shall not be required for emergency eyewash or shower equipment. Where a drain is provided, the discharge shall be in accordance with Section 811.0.

**417.0 Faucets and Fixture Fittings.**

**417.1 Application.** Faucets and fixture fittings shall comply with ASME A112.18.1/CSA B125.1. Fixture fittings covered under the scope of NSF 61 shall be in accordance with the requirements of NSF 61.

**417.2 Deck Mounted Bath/Shower Valves.** Deck mounted bath/shower transfer valves with integral backflow protection shall comply with ASME A112.18.7. This shall include handheld showers and other bathing appliances mounted on the deck of bathtubs or other bathing appliances that incorporate a hose or pull out feature.

**417.3 Handheld Showers.** Handheld showers shall comply with ASME A112.18.1/CSA B125.1. Handheld showers with integral backflow protection shall comply with ASME A112.18.1/CSA B125.1 or shall have a backflow prevention device that is in accordance with ASME A112.18.3.

**417.4 Faucets and Fixture Fittings with Hose Connected Outlets.** Faucets and fixture fittings with pull out spout shall comply with ASME A112.18.1/CSA B125.1. Faucets and fixture fittings with pull out spouts with integral backflow protection shall comply with ASME A112.18.1/CSA B125.1 or shall have a backflow preventer device that is in accordance with ASME A112.18.3.

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**417.5 Separate Controls for Hot and Cold Water.** Where two separate handles control the hot and cold water, the left-hand control of the faucet where facing the fixture fitting outlet shall control the hot water. Faucets and diverter shall be connected to the water distribution system so that hot water corresponds to the left side of the fittings.

Single-handle mixing valves shall have the flow of hot water correspond to the markings on the fitting.

**418.0 Floor Drains.**

**418.1 Application.** Floor drains shall comply with the applicable standards referenced in Table 1401.1.

**418.2 Strainer.** Floor drains shall be considered plumbing fixtures, and each such drain shall be provided with an approved-type strainer having a waterway equivalent to the area of the tailpiece. Floor drains shall be of an approved type and shall provide a watertight joint in the floor.

**418.3 Location of Floor Drains.** Floor drains shall be installed in the following areas:

(1) Toilet rooms containing two or more water closets or a combination of one water closet and one urinal, except in a dwelling unit.

(2) Commercial kitchens and in accordance with Section 704.3.

(3) Laundry rooms in commercial buildings and common laundry facilities in multi-family dwelling buildings.

**418.4 Food Storage Areas.** Where drains are provided in storerooms, walk-in freezers, walk-in coolers, refrigerated equipment, or other locations where food is stored, such drains shall have indirect waste piping. Separate waste pipes shall be run from each food storage area, each with an indirect connection to the building sanitary drainage system. Traps shall be provided in accordance with Section 801.2.2 of this code and shall be vented.

Indirect drains shall be permitted to be located in freezers or other spaces where freezing temperatures are maintained, provided that traps, where supplied, shall be located where the seal will not freeze. Otherwise, the floor of the freezer shall be sloped to a floor drain located outside of the storage compartment.

**418.5 Floor Slope.** Floors shall be sloped to floor drains.

**419.0 Food Waste Disposal Units.**

**419.1 Application.** Food waste disposal units shall comply with the applicable standards referenced in Table 1401.1.

**419.2 Drainage Connection.** Approved wye or other directional-type branch fittings shall be installed in continuous wastes connecting or receiving the discharge from a food waste disposal unit. No dishwasher drain shall be connected to a sink tailpiece, continuous waste, or trap on the discharge side of a food waste disposal unit.

**419.3 Water Supply.** A cold water supply shall be provided for food waste disposal units. Such connection to the water supply shall be protected by an air gap or backflow prevention device in accordance with Section 603.2.

**420.0 Sinks.**

**420.1 Application.** Sinks shall comply with the applicable standards referenced in Table 1401.1.

**420.2 Water Consumption.** Sink faucets shall have a maximum flow rate of not more than 2.2 gpm at 60 psi (8.3 L/m at 414 kPa) in accordance with ASME A112.18.1/CSA B125.1.

**Exceptions:**

(1) Clinical sinks

(2) Laundry trays

(3) Service sinks

**420.3 Waste Outlet.** Kitchen and laundry sinks shall have a waste outlet and fixture tailpiece not less than 1½ inches (40 mm) in diameter. Service sinks shall have a waste outlet and fixture tailpiece not less than 2 inches (50 mm) in diameter. Fixture tailpieces shall be constructed from the materials specified in Section 701.1 for drainage piping, provided, however, that such connections where exposed or accessible shall be permitted to be of seamless drawn brass not less than No. 20 B & S Gauge (0.032 inches) (0.81 mm). Waste outlets shall be provided with an approved strainer.

**421.0 Fixtures and Fixture Fittings for Persons with Disabilities.**

**421.1 General.** Plumbing fixtures and fixture fittings for persons with disabilities shall comply with the appropriate standards referenced in Table 1401.1 of this code. ***[HCD 1-AC]*** *Specific requirements regarding accommodations for persons with disabilities are contained in California Code of Regulations, Title 24, Part 2, Chapter 11A. Table 1401.1 does not contain the correct accessibility standards for use in California.*

**421.2 Limitation of Hot Water Temperature for Public Lavatories.** Hot water delivered from public-use lavatories shall be limited to a maximum temperature of 120°F (49°C) by a device that is in accordance with ASSE 1070 or CSA B125.3. The water heater thermostat shall not be considered a control for meeting this provision.

**422.0 Minimum Number of Required Fixtures.**

**422.1 Fixture Count.** Plumbing fixtures shall be provided for the type of building occupancy and in the minimum number shown in Table 422.1 ***[OSHPD 1, 2, 3 & 4]*** *and Table 4-2*. The total occupant load and occupancy classification shall be determined in accordance with *Occupant Load Factor Table A*. Occupancy classification not shown in Table 422.1 shall be considered separately by the Authority Having Jurisdiction.

The minimum number of fixtures shall be calculated at 50 percent male and 50 percent female based on the total occupant load. Where information submitted indicates a difference in distribution of the sexes such information shall be used in order to determine the number of fixtures for each sex. Once the occupancy load and occupancy are determined, Table 422.1 shall be applied to determine the minimum number of plumbing fixtures required. Where applying the fixture

ratios in Table 422.1 results in fractional numbers, such numbers shall be rounded to the next whole number. For multiple occupancies, fractional numbers shall be first summed and then rounded to the next whole number.

**422.1.1 Family or Assisted-Use Toilet and Bathing Facilities.** Where family or assisted-use toilet and bathing rooms are required, in applicable building regulations, the facilities shall be installed in accordance with those regulations.

*422.1.2 [DSA-AS] Effective January 1, 1990, in new construction and those existing facilities which occupancy type are listed in Tables 422.1 and 4-4 for public use, which apply for permit to undertake construction, structural alterations, repairs or improvement which exceed 50 percent of the square footage of the entire facility, shall install water closets, urinals, lavatories and drinking fountains as stipulated in Tables 422.1 and 4-4 for public use. Community and/or municipal parks with a bleacher capacity not exceeding 500 seats shall be exempt from the requirements of this section and Tables 422.1 and 4-4. Each bathroom shall comply with Part 2, Chapter 11A and 11B of the California Building Code.*

**422.2 Separate Facilities.** Separate toilet facilities shall be provided for each sex.

**Exceptions:**

(1) Residential installations.

(2) In occupancies with a total occupant load of 10 or less, including customers and employees, one toilet facility, designed for use by no more than one person at a time, shall be permitted for use by both sexes.

(3) In business and mercantile occupancies with a total occupant load of 50 or less including customers and employees, one toilet facility, designed for use by no more than one person at a time, shall be permitted for use by both sexes.

*422.2.1 [OSHPD 1, 2, 3 & 4] Separate toilet facilities shall be provided for the use of patients, staff personnel and visitors.*

***Exception for Primary Care Clinics only:** Where a facility contains no more than three examination and/or treatment rooms, the patient toilet shall be permitted to serve waiting areas.*

**422.3 Fixture Requirements for Special Occupancies.** Additional fixtures shall be permitted to be required where unusual environmental conditions or referenced activities are encountered. In food preparation areas, fixture requirements shall be permitted to be dictated by health codes.

**422.4 Toilet Facilities Serving Employees and Customers.** Each building or structure shall be provided with toilet facilities for employees and customers. Requirements for customers and employees shall be permitted to be met with a single set of restrooms accessible to both groups.

Required toilet facilities for employees and customers located in shopping malls or centers shall be permitted to be met by providing a centrally located toilet facility accessible to several stores. The maximum travel distance from entry to any store to the toilet facility shall not exceed 300 feet (91 440 mm).

Required toilet facilities for employees and customers in other than shopping malls or centers shall have a maximum travel distance not to exceed 500 feet (152.4 m).

**422.4.1 Access to Toilet Facilities.** In multi-story buildings, accessibility to the required toilet facilities shall not exceed one vertical story. Access to the required toilet facilities for customers shall not pass through areas designated as for employee use only such as kitchens, food preparation areas, storage rooms, closets, or similar spaces. Toilet facilities accessible only to private offices shall not be counted to determine compliance with this section.

**422.5 Toilet Facilities for Workers.** Toilet facilities shall be provided and maintained in a sanitary condition for the use of workers during construction.

***422.6 [CA] Cosmetology.** Each school shall provide public toilet rooms for each sex on the licensed premises in accordance with the California Plumbing Code, Table 422.1.*

***422.7 [CA] Cosmetology Establishments.** Each establishment where hairdressing services are performed shall provide at least one public toilet room located on the premises in accordance with the California Plumbing Code, Table 422.1.*

***422.8 [DHS] Commissaries Serving Mobile Food Preparation Units.** Commissaries serving mobile food preparation units shall have at least one hose bib. The hose bib shall be supplied with hot and cold water and be provided with a single spout, a backflow-preventer device and shall be located on the premises of the establishment.*

***422.9 [DPH] Employee Lavatories in Food Establishments.** Employee lavatories installed in food establishments shall be equipped with an approved single spout capable of providing tempered (100°F - 115°F) (37.8°C - 46.1°C) running water.*

***Note:** This requirement applies only to commissaries serving mobile food preparation units.*

## TABLE 422.1
## MINIMUM PLUMBING FACILITIES[1]

Each building shall be provided with sanitary facilities, including provisions for persons with disabilities as prescribed by the Department Having Jurisdiction[4]. Table 422.1 applies to new buildings, additions to a building, and changes of occupancy or type in an existing building resulting in increased occupant load.

*For requirements for persons with disabilities, Chapter 11A or 11B of the California Building Code shall be used.*

*The total occupant load shall be determined in accordance with the **[BSC, DSA-SS & DSA-SS/CC]** Occupant Load Factor Table A.*

***Exceptions:***

(1) ***[HCD 1-AC & HCD 2]*** *For applications listed in Sections 1.8.2.1.2 and 1.8.2.1.3 regulated by the Department of Housing and Community Development, each building shall be provided with sanitary facilities, including provisions for persons with disabilities as prescribed by the Department. Covered multifamily dwellings required to be accessible to persons with disabilities shall comply with California Code of Regulations, Title 24, Part 2, Chapter 11A. Permanent buildings in mobilehome parks and special occupancy parks required to be accessible by persons with disabilities, shall comply with California Code of Regulations, Title 24, Part 2, Chapter 11B.*

(2) ***[HCD 1]*** *For limited density owner-built rural dwelling sanitary facilities, the type, design and number of facilities as required and approved by the local health official shall be provided to the dwelling sites. It shall not be required that such facilities be located within the dwelling.*

| TYPE OF OCCUPANCY[2] | WATER CLOSETS (FIXTURES PER PERSON)[3] | | URINALS (FIXTURES PER PERSON) | LAVATORIES (FIXTURES PER PERSON) | | BATHTUBS OR SHOWERS (FIXTURES PER PERSON) | DRINKING FOUNTAINS/ FACILITIES (FIXTURES PER PERSON) | OTHER |
|---|---|---|---|---|---|---|---|---|
| **A-1** Assembly occupancy (fixed or permanent seating)- theatres, concert halls and auditoriums | Male<br>1: 1-100<br>2: 101-200<br>3: 201-400 | Female<br>1: 1-25<br>2: 26-50<br>3: 51-100<br>4: 101-200<br>6: 201-300<br>8: 301-400 | Male<br>1: 1-200<br>2: 201-300<br>3: 301-400<br>4: 401-600 | Male<br>1: 1-200<br>2: 201-400<br>3: 401-600<br>4: 601-750 | Female<br>1: 1-100<br>2: 101-200<br>4: 201-300<br>5: 301-500<br>6: 501-750 | — | 1: 1-250<br>2: 251-500<br>3: 501-750 | 1 service sink or laundry tray |
| | Over 400, add 1 fixture for each additional 500 males and 1 fixture for each additional 125 females. | | Over 600, add 1 fixture for each additional 300 males. | Over 750, add 1 fixture for each additional 250 males and 1 fixture for each additional 200 females. | | | Over 750, add 1 fixture for each additional 500 persons. | |
| **A-2** Assembly occupancy- restaurants, pubs, lounges, night clubs and banquet halls | Male<br>1: 1-50<br>2: 51-150<br>3: 151-300<br>4: 301-400 | Female<br>1: 1-25<br>2: 26-50<br>3: 51-100<br>4: 101-200<br>6: 201-300<br>8: 301-400 | Male<br>1: 1-200<br>2: 201-300<br>3: 301-400<br>4: 401-600 | Male<br>1: 1-150<br>2: 151-200<br>3: 201-400 | Female<br>1: 1-150<br>2: 151-200<br>4: 201-400 | — | 1: 1-250<br>2: 251-500<br>3: 501-750 | 1 service sink or laundry tray |
| | Over 400, add 1 fixture for each additional 250 males and 1 fixture for each 125 females. | | Over 600, add 1 fixture for each additional 300 males. | Over 400, add 1 fixture for each additional 250 males and 1 fixture for each additional 200 females. | | | Over 750, add 1 fixture for each additional 500 persons. | |
| **A-3** Assembly occupancy (typical without fixed or permanent seating)- arcades, places of worship, museums, libraries, lecture halls, gymnasiums (without spectator seating), indoor pools (without spectator seating) | Male<br>1: 1-100<br>2: 101-200<br>3: 201-400 | Female<br>1: 1-25<br>2: 26-50<br>3: 51-100<br>4: 101-200<br>6: 201-300<br>8: 301-400 | Male<br>1: 1-100<br>2: 101-200<br>3: 201-400<br>4: 401-600 | Male<br>1: 1-200<br>2: 201-400<br>3: 401-600<br>4: 601-750 | Female<br>1: 1-100<br>2: 101-200<br>4: 201-300<br>5: 301-500<br>6: 501-750 | — | 1: 1-250<br>2: 251-500<br>3: 501-750 | 1 service sink or laundry tray |
| | Over 400, add 1 fixture for each additional 500 males and 1 fixture for each additional 125 females. | | Over 600, add 1 fixture for each additional 300 males. | Over 750, add 1 fixture for each additional 250 males and 1 fixture for each additional 200 females. | | | Over 750, add 1 fixture for each additional 500 persons. | |

**TABLE 422.1**
**MINIMUM PLUMBING FACILITIES[1] (continued)**

| TYPE OF OCCUPANCY[2] | WATER CLOSETS (FIXTURES PER PERSON)[3] | | URINALS (FIXTURES PER PERSON) | LAVATORIES (FIXTURES PER PERSON) | | BATHTUBS OR SHOWERS (FIXTURES PER PERSON) | DRINKING FOUNTAINS/ FACILITIES (FIXTURES PER PERSON) | OTHER |
|---|---|---|---|---|---|---|---|---|
| **A-4** Assembly occupancy (indoor activities or sporting events with spectator seating)- swimming pools, skating rinks, arenas and gymnasiums | Male<br>1: 1-100<br>2: 101-200<br>3: 201-400 | Female<br>1: 1-25<br>2: 26-50<br>3: 51-100<br>4: 101-200<br>6: 201-300<br>8: 301-400 | Male<br>1: 1-100<br>2: 101-200<br>3: 201-400<br>4: 401-600 | Male<br>1: 1-200<br>2: 201-400<br>3: 401-750 | Female<br>1: 1-100<br>2: 101-200<br>4: 201-300<br>5: 301-500<br>6: 501-750 | — | 1: 1-250<br>2: 251-500<br>3: 501-750 | 1 service sink or laundry tray |
| | Over 400, add 1 fixture for each additional 500 males and 1 fixture for each additional 125 females. | | Over 600, add 1 fixture for each additional 300 males. | Over 750, add 1 fixture for each additional 250 males and 1 fixture for each additional 200 females. | | | Over 750, add 1 fixture for each additional 500 persons. | |
| **A-5** Assembly occupancy (outdoor activities or sporting events)- amusement parks, grandstands and stadiums | Male<br>1: 1-100<br>2: 101-200<br>3: 201-400 | Female<br>1: 1-25<br>2: 26-50<br>3: 51-100<br>4: 101-200<br>6: 201-300<br>8: 301-400 | Male<br>1: 1-100<br>2: 101-200<br>3: 201-400<br>4: 401-600 | Male<br>1: 1-200<br>2: 201-400<br>3: 401-750 | Female<br>1: 1-100<br>2: 101-200<br>4: 201-300<br>5: 301-500<br>6: 501-750 | — | 1: 1-250<br>2: 251-500<br>3: 501-750 | 1 service sink or laundry tray |
| | Over 400, add 1 fixture for each additional 500 males and 1 fixture for each additional 125 females. | | Over 600, add 1 fixture for each additional 300 males. | Over 750, add 1 fixture for each additional 250 males and 1 fixture for each additional 200 females. | | | Over 750, add 1 fixture for each additional 500 persons. | |
| **B** Business occupancy (office, professional or service type transactions)- banks, vet clinics, hospitals, car wash, banks, beauty salons, ambulatory health care facilities, laundries and dry cleaning, educational institutions (above high school), or training facilities not located within school, post offices and printing shops | Male<br>1: 1-50<br>2: 51-100<br>3: 101-200<br>4: 201-400 | Female<br>1: 1-15<br>2: 16-30<br>3: 31-50<br>4: 51-100<br>8: 101-200<br>11: 201-400 | Male<br>1: 1-100<br>2: 101-200<br>3: 201-400<br>4: 401-600 | Male<br>1: 1-75<br>2: 76-150<br>3: 151-200<br>4: 201-300<br>5: 301-400 | Female<br>1: 1-50<br>2: 51-100<br>3: 101-150<br>4: 151-200<br>5: 201-300<br>6: 301-400 | — | 1 per 150 | 1 service sink or laundry tray |
| | Over 400, add 1 fixture for each additional 500 males and 1 fixture for each additional 150 females. | | Over 600, add 1 fixture for each additional 300 males. | Over 400, add 1 fixture for each additional 250 males and 1 fixture for each additional 200 females. | | | | |
| **E** Educational occupancy-private or public schools | Male<br>1 per 50 | Female<br>1 per 30 | Male<br>1 per 100 | Male<br>1 per 40 | Female<br>1 per 40 | — | 1 per 150 | 1 service sink or laundry tray |
| **F1, F2** Factory or Industrial occupancy-fabricating or assembly work | Male<br>1: 1-50<br>2: 51-75<br>3: 76-100 | Female<br>1: 1-50<br>2: 51-75<br>3: 76-100 | — | Male<br>1: 1-50<br>2: 51-75<br>3: 76-100 | Female<br>1: 1-50<br>2: 51-75<br>3: 76-100 | 1 shower for each 15 persons exposed to excessive heat or to skin contamination with poisonous, infectious or irritating material. | 1: 1-250<br>2: 251-500<br>3: 501-750 | 1 service sink or laundry tray |
| | Over 100, add 1 fixture for each additional 40 persons. | | | Over 100, add 1 fixture for each additional 40 persons. | | | Over 750, add 1 fixture for each additional 500 persons. | |

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**TABLE 422.1**
**MINIMUM PLUMBING FACILITIES[1] (continued)**

| TYPE OF OCCUPANCY[2] | | WATER CLOSETS (FIXTURES PER PERSON)[3] | URINALS (FIXTURES PER PERSON) | LAVATORIES (FIXTURES PER PERSON) | BATHTUBS OR SHOWERS (FIXTURES PER PERSON) | DRINKING FOUNTAINS/ FACILITIES (FIXTURES PER PERSON) | OTHER |
|---|---|---|---|---|---|---|---|
| **I-1** Institutional occupancy (houses more than 16 persons on a 24-hour basis)- substance abuse centers, assisted living, group homes, or residential facilities. | | Female 1 per 15 / Male 1 per 15 | — | Female 1 per 15 | 1 per 8 | 1 per 150 | 1 service sink or laundry tray |
| **I-2** Institutional occupancy-medical, psychiatric, surgical or nursing homes | Hospitals and nursing homes-individual rooms and ward room | 1 per room | — | 1 per room | 1 per room | 1 per 150 | 1 service sink or laundry tray |
| | | 1 per 8 patients | — | 1 per 10 patients | 1 per 20 patients | | |
| | Hospital Waiting or Visitor Rooms | 1 per room | — | 1 per room | — | 1 per room | — |
| | Employee Use | Male 1: 1-15 2: 16-35 3: 36-55 / Female 1: 1-15 3: 16-35 4: 36-55 | — | Male 1 per 40 / Female 1 per 40 | — | — | — |
| | | Over 55, add 1 fixture for each additional 40 persons. | | | | | |
| **I-3** Institutional occupancy (houses more than 5 people) | Prisons | 1 per cell | — | 1 per cell | 1 per 20 | 1 per cell block/floor | — |
| | Correctional facilities or juvenile center | 1 per 8 | — | 1 per 10 | 1 per 8 | 1 per floor | 1 service sink or laundry tray |
| | Employee Use | Male 1: 1-15 2: 16-35 3: 36-55 / Female 1: 1-15 3: 16-35 4: 36-55 | — | Male 1 per 40 / Female 1 per 40 | — | 1 per 150 | — |
| | | Over 55, add 1 fixture for each additional 40 persons. | | | | | |
| **I-4** Institutional occupancy (any age that receives care for less than 24 hours) | | Male 1: 1-15 2: 16-35 3: 36-55 / Female 1: 1-15 3: 16-35 4: 36-55 | — | Male 1 per 40 / Female 1 per 40 | — | 1 per 150 | 1 service sink or laundry tray |
| | | Over 55, add 1 fixture for each additional 40 persons. | | | | | |

**TABLE 422.1**
**MINIMUM PLUMBING FACILITIES[1] (continued)**

| TYPE OF OCCUPANCY[2] | | WATER CLOSETS (FIXTURES PER PERSON)[3] | | URINALS (FIXTURES PER PERSON) | LAVATORIES (FIXTURES PER PERSON) | | BATHTUBS OR SHOWERS (FIXTURES PER PERSON) | DRINKING FOUNTAINS/ FACILITIES (FIXTURES PER PERSON) | OTHER |
|---|---|---|---|---|---|---|---|---|---|
| **M** Mercantile occupancy (the sale of merchandise and accessible to the public) | | Male<br>1: 1-100<br>2: 101-200<br>3: 201-400 | Female<br>1: 1-100<br>2: 101-200<br>4: 201-300<br>6: 301-400 | Male<br>0: 1-200<br>1: 201-400 | Male<br>1: 1-200<br>2: 201-400 | Female<br>1: 1-200<br>2: 201-300<br>3: 301-400 | — | 1: 1-250<br>2: 251-500<br>3: 501-750 | 1 service sink or laundry tray |
| | | Over 400, add 1 fixture for each additional 500 males and 1 fixture for each 200 females. | | Over 400, add 1 fixture for each additional 500 males. | Over 400, add 1 fixture for each additional 500 males and 1 fixture for each 400 females. | | — | Over 750, add 1 fixture for each additional 500 persons. | — |
| **R-1** Residential occupancy (minimal stay)-hotels, motels, bed and breakfast homes | | 1 per sleeping room | | — | 1 per sleeping room | | 1 per sleeping room | — | 1 service sink or laundry tray |
| **R-2** Residential occupancy (long-term or permanent) | Dormitories | Male<br>1 per 10 | Female<br>1 per 8 | 1 per 25 | Male<br>1 per 12 | Female<br>1 per 12 | 1 per 8 | 1 per 150 | 1 service sink or laundry tray |
| | | Add 1 fixture for each additional 25 males and 1 fixture for each additional 20 females. | | Over 150, add 1 fixture for each additional 50 males. | Add 1 fixture for each additional 20 males and 1 fixture for each additional 15 females. | | | | |
| | Employee Use | Male<br>1: 1-15<br>2: 16-35<br>3: 36-55 | Female<br>1: 1-15<br>3: 16-35<br>4: 36-55 | — | Male<br>1 per 40 | Female<br>1 per 40 | — | | |
| | | Over 55, add 1 fixture for each additional 40 persons | | | | | | | |
| | Apartment house/unit | 1 per apartment | | — | 1 per apartment | | 1 per apartment | — | 1 kitchen sink per apartment. 1 laundry tray or 1 automatic clothes washer connection per unit or 1 laundry tray or 1 automatic clothes washer connection for each 12 units |
| **R-3** Residential occupancy (long-term or permanent in nature) for more than 5 but does not exceed 16 occupants) | | Male<br>1 per 10 | Female<br>1 per 8 | — | Male<br>1 per 12 | Female<br>1 per 12 | 1 per 8 | 1 per 150 | 1 service sink or laundry tray |
| | | Add 1 fixture for each additional 25 males and 1 fixture for each additional 20 females. | | | Add 1 fixture for each additional 20 males and 1 fixture for each additional 15 females. | | | | |
| **R-3** Residential occupancy (one and two family dwellings) | | 1 per one and two family dwelling | | — | 1 per one and two family dwelling | | 1 per one and two family dwelling | — | 1 kitchen sink and 1 automatic clothes washer connection per one and two family dwelling |

**TABLE 422.1**
**MINIMUM PLUMBING FACILITIES[1] (continued)**

| TYPE OF OCCUPANCY[2] | WATER CLOSETS (FIXTURES PER PERSON)[3] | | URINALS (FIXTURES PER PERSON) | LAVATORIES (FIXTURES PER PERSON) | | BATHTUBS OR SHOWERS (FIXTURES PER PERSON) | DRINKING FOUNTAINS/ FACILITIES (FIXTURES PER PERSON) | OTHER |
|---|---|---|---|---|---|---|---|---|
| **R-4** Residential occupancy (residential care or assisted living) | Male<br>1 per 10 | Female<br>1 per 8 | — | Male<br>1 per 12 | Female<br>1 per 12 | 1 per 8 | 1 per 150 | 1 service sink or laundry tray |
| | Add 1 fixture for each additional 25 males and 1 fixture for each additional 20 females. | | | Add 1 fixture for each additional 20 males and 1 fixture for each additional 15 females. | | | | |
| **S-1, S-2** Storage occupancy-storage of goods, warehouse, aircraft hanger, food products, appliances | Male<br>1: 1-100<br>2: 101-200<br>3: 201-400 | Female<br>1: 1-100<br>2: 101-200<br>3: 201-400 | — | Male<br>1: 1-200<br>2: 201-400<br>3: 401-750 | Female<br>1: 1-200<br>2: 201-400<br>3: 401-750 | — | 1: 1-250<br>2: 251-500<br>3: 501-750 | 1 service sink or laundry tray |
| | Over 400, add 1 fixture for each additional 500 males and 1 fixture for each additional 150 females. | | | Over 750, add 1 fixture for each additional 500 persons. | | | Over 750, add 1 fixture for each additional 500 persons. | |

**Notes:**

1 The figures shown are based upon one fixture being the minimum required for the number of persons indicated or any fraction thereof.

2 A restaurant is defined as a business that sells food to be consumed on the premises.

a. The number of occupants for a drive-in restaurant shall be considered as equal to the number of parking stalls.

b. Hand-washing facilities shall be available in the kitchen for employees.

3 The total number of required water closets for females shall be not less than the total number of required water closets and urinals for males. *[BSC] This requirement shall not apply when single occupancy toilet facilities are provided for each sex in an A or E occupancy with an occupant load of less than 50. Either*

*a. The required urinal shall be permitted to be omitted or*

*b. If installed, the urinal shall not require a second water closet to be provided for the female.*

4 ***[BSC, DSA-AC, DSA-SS, DSA-SS/CC, HCD 1 & HCD 2, OSHPD 1, 2, 3 & 4]*** *In accordance with Sections 1.8.7 and 301.2, the Authority Having Jurisdiction may approve alternative designs criteria when determining the minimum number of plumbing fixtures.*

***TABLE A.***
***OCCUPANT LOAD FACTOR:***
***[BSC, DSA-SS & DSA-SS/CC]***

| OCCUPANCY*, ** | OCCUPANT LOAD FACTOR (square feet) (CBC 2001, Table A-29A) |
|---|---|
| **Group A** | |
| 1. Auditoriums, convention halls, dance floors, lodge rooms, stadiums, and casinos (where no fixed seating is provided) (use ½ "one-half" the number of fixed seating) | 15 |
| 2. Conference rooms, dining rooms, drinking establishments, exhibit rooms, gymnasiums, lounges, stages, and similar uses, including restaurants classified as Group B occupancies | 30 |
| 3. Worship places; principal assembly area, educational and activity unit (where no fixed seating is provided) (use ½ "one-half" the number of fixed seating) | 30 |
| **Group B** Office or public buildings (area accessible to the public) | 200 |
| **Group E** Schools for day care, elementary, secondary | 50 |
| **Educational Facilities Other than Group E** Colleges, universities, adult centers, etc. | 50 |
| **Group F** Workshops, foundries and similar establishments | 2,000 |
| **Group H** Hazardous materials fabrication and storage | 2,000 |
| **Group I** Hospital general use area, health care facilities | 200 |
| **Group M** Retail or wholesale stores | 200 |
| **Group R** Congregate residence, Group R-1 | 200 |
| **Group S** Warehouse | 5,000 |

* Any uses not specifically listed shall be based on similar uses listed in this table.

** For building or space with mixed occupancies, use appropriate occupancy group for each area (for example, a school may have an "A" occupancy for the gymnasium, a "B" occupancy for the office, an "E" occupancy for the classrooms, etc.)
Accessory areas may be excluded (for example: hallway, restroom, stair enclosure)

**TABLE 4-2**
**[OSHPD 1, 2, 3 & 4][24] MINIMUM PLUMBING FACILITIES**

| SPACE | HANDWASHING FIXTURE | SCRUB SINKS[3] | TOILETS | BATHTUBS OR SHOWERS | SERVICE SINKS[1] | CLINIC SINKS |
|---|---|---|---|---|---|---|
| ***Administration Lobby*** | | | | | | |
| *Public Toilet - Male* | *1*[2] | | *1* | | | |
| *Public Toilet - Female* | *1*[2] | | *1* | | | |
| *Airborne infection isolation room* | *1* | | | | | |
| *Airborne infection isolation anteroom* | *1*[20] | | | | | |
| *Airborne infection isolation toilet room* | *1*[2] | | *1*[5] | *1*[5] | | |
| *Cardiac Catheterization procedure room* | | *1*[4, 33] | | | | |
| *Central Sterile Supply* | *1*[15] | | | | | |
| ***Cesarean/Delivery Service Space*** | | | | | | |
| *Labor Rooms* | *1*[33] | | *1*[9] | *1*[9] | | |
| *Recovery Room* | *1*[33] | | | | | *1* |
| *Drug distribution station* | *1* | | | | | |
| *Cesarean operating room* | | *2*[10, 33] | | | | |
| *Delivery room* | | *1*[10, 33] | | | | |
| ***Staff lounge*** | | | | | | |
| *Staff Toilet - Male* | *1*[2] | | *1:1-15* | | | |
| *Staff Toilet - Female* | *1*[2] | | *1:1-15* | | | |
| *LDR or LDRP room* | *1*[33] | | *1* | *1* | | |
| ***Waiting area/room*** | | | | | | |
| *Public Toilet - Male* | *1*[2] | | *1* | | | |
| *Public Toilet - Female* | *1*[2] | | *1* | | | |
| *Clinical Laboratory Service Space*[11] | *1* | | | | | |
| ***Dietetic Service Space*** | | | | | *1* | |
| *Kitchen* | *1*[33] | | | | | |
| *Food serving area* | *1*[33] | | | | | |
| *Food Preparation* | *1*[33] | | | | | |
| *Dietary Staff Toilet - Male* | *1*[2] | | *1:1-15* | | | |
| *Dietary Staff Toilet - Female* | *1*[2] | | *1:1-15* | | | |
| ***Emergency Service Treatment room*** | *1* | | | | | |
| *Open plan* | *1:4 cubicles* | | | | | |
| *Observation units* | *1:4 cubicles* | | | | | |
| *Trauma/Cardiac, Emergency surgery, Cystoscopy, Cast Room* | | *1*[4,33] | | | | |
| ***Intensive Care Units***[7] | | | | | *1* | *1* |
| *Open plan* | *1:3 beds*[33] | | | | | |
| *Patient rooms*[28] | *1*[33] | | | | | |
| *Newborn Intensive Care Unit (NICU)* | *1:4 bassinets*[17, 33] | | | | *1* | *1* |
| *Control station* | *1*[33] | | | | | |
| *Staff lounge* | | | | | | |
| *Staff Toilet - Male* | *1*[2] | | *1:1-15* | | | |
| *Staff Toilet - Female* | *1*[2] | | *1:1-15* | | | |
| ***Employee dressing rooms and lockers*** | | | | | | |
| *Staff Toilet - Male* | *1*[2] | | *1:1-15* | | | |

| SPACE | HANDWASHING FIXTURE | SCRUB SINKS[3] | TOILETS | BATHTUBS OR SHOWERS | SERVICE SINKS[1] | CLINIC SINKS |
|---|---|---|---|---|---|---|
| *Staff Toilet - Female* | *1*[2] | | *1:1-15* | | | |
| *Exam and treatment rooms* | *1* | | | | | |
| *Housekeeping room*[1] | | | | | *1* | |
| *Laboratories* | *1*[15] | | | | | |
| *Laundry soiled linen, receiving, holding and sorting* | *1* | | | | | |
| *Medicine preparation room* | *1*[19] | | | | | |
| ***Morgue and Autopsy*** | *1* | | | | | |
| *Nourishment area* | *1+1*[2] | | | | | |
| *Nuclear Medicine room* | *1* | | | | | |
| *Mold room* | *1* | | | | | |
| *Patient room* | *1* | | | | | |
| *Patient toilet and bath facilities*[13] | *1*[2] | | *1:4 beds* | *1:12*[16] | | |
| *Central bathing facility*[16] | | | *1* | *1* | | |
| *Administration Center or Nurses' Stations*[27] | *1* | | *1*[12] | | | |
| *Newborn/well baby nursery* | *1:6 bassinets*[33] | | | | | |
| *Workroom* | *1*[33] | | | | | |
| *Gastrointestinal endoscopy procedure room* | *1*[33] | | | | | |
| *Pediatric and Adolescent Unit toilet room* | *1*[2,26] | | *1*[26] | | | |
| ***Pharmacy*** | *1*[25] | | | | | |
| *Staff Toilet - Male* | *1*[2] | | *1:1-15* | | | |
| *Staff Toilet - Female* | *1*[2] | | *1:1-15* | | | |
| *Compounding area for parenteral solutions* | *1* | | | | | |
| *Postanesthesia care units (PACU)* | | | | | | *1* |
| *Open plan* | *1:4 gurney spaces*[33] | | | | | |
| *Individual rooms* | *1*[33] | | | | | |
| *Protective environment room* | *1*[33] | | | | | |
| *Protective environment anteroom* | *1*[20,33] | | | | | |
| *Protective environment toilet room* | *1*[2] | | *1*[5] | *1*[5] | | |
| *Psychiatric unit patient room* | *1* | | *1* | | | |
| ***Radiological/Imaging Services Space*** | *1* | | *1*[29] | | | |
| *Computerized tomography (CT)* | | | | | | |
| *Ultrasound*[8] | | | *1*[30] | | | |
| *Angiography* | | *1*[4, 31] | | | | |
| *Fluoroscopy*[8] | | | *1*[30] | | | |
| *Staff Toilet*[18] *- Male* | *1*[2] | | *1:1-15* | | | |
| *Staff Toilet*[18] *- Female* | *1*[2] | | *1:1-15* | | | |
| ***Rehabilitation Therapy Space*** | | | | | | |
| *Training toilet* | | | *1* | | | |
| *Physical therapy service space* | *1* | | | | | |
| *Occupational therapy service space* | *1* | | | | | |
| *Speech pathology* | *1* | | | | | |
| ***Renal Dialysis Service Space*** | *1:4 stations* | | | | *1* | |
| *Bloodborne Infection Isolation Room* | *1* | | | | | |
| *Nurses' station* | *1* | | | | | |
| *Medication dispensing* | *1* | | | | | |
| *Home training room* | *1* | | | | | |

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| SPACE | HANDWASHING FIXTURE | SCRUB SINKS[3] | TOILETS | BATHTUBS OR SHOWERS | SERVICE SINKS[1] | CLINIC SINKS |
|---|---|---|---|---|---|---|
| *Repair room*[11] | *1* | | | | *1* | |
| *Dialysis Patient toilet* | *1* | | *1* | | | |
| *Staff lounge* | | | | | | |
| *Staff Toilet - Male* | *1*[2] | | *1:1-15* | *1 shower* | | |
| *Staff Toilet - Female* | *1*[2] | | *1:1-15* | *1 shower* | | |
| ***Surgical Service Space*** | | *2*[33] | | | *1* | |
| *Staff clothing change areas* | | | | | | |
| *Staff Toilet - Male* | *1*[2] | | *1* | *1 shower* | | |
| *Staff Toilet - Female* | *1*[2] | | *1* | *1 shower* | | |
| *Clean-up rooms* | *1* | | | | | |
| *Substerile area* | *1* | | | | | |
| *Anesthesia workroom* | *1* | | | | | *1*[34] |
| *Soiled workroom or soiled holding* | *1* | | | | | |
| *Cancer treatment/infusion therapy treatment* | *1:4 stations* | | | | | |
| ***Utility/Work Room*** | | | | | | |
| *Clean*[21] | *1* | | | | | *1*[14] |
| *Soiled*[22] | *1* | | | | | |
| *Patient beds [Skilled Nursing/Intermediate Care Facilities][medical model]* | *1:8*[2] | | *1:6* | *1:20* | | |
| *Patient toilet and bath facilities*[13] *[Correctional Treatment Center]* | *1:8*[2] | | *1:6* | *1:12* | | |
| *Airborne infection isolation anteroom*[6] *[Correctional Treatment Center]* | *1*[6] | | *1*[6] | *1*[6] | | |
| *Airborne infection isolation anteroom [Correctional Treatment Center]* | *1* | | | | | |
| *Protective environment room*[6] *[Correctional Treatment Center]* | *1*[6] | | *1*[6] | *1*[6] | | |
| *Protective environment anteroom [Correctional Treatment Center]* | *1* | | | | | |

***Notes:***

*[1] Each department or nursing unit shall be served by a housekeeping room equipped with a service sink. Departments may share service closets provided the departmental services are compatible. A dedicated housekeeping room shall be provided for the following services: Surgical/Catherization, ICU, NICU, nursery, dietary, renal dialysis and outpatient surgery.*

*[2] Conventional spouts and controls on hot-and cold-water supplies are acceptable. Aerators are not permitted. Non-aerating laminar flow devices are permitted. Nourishment areas shall have a handwashing fixture in or immediately accessible from the nourishment area, in addition to a nourishment sink.*

*[3] Scrub sinks shall be located outside of sterile procedure rooms. A minimum of two scrub sinks shall be provided in a surgical unit containing one operating room. Four scrub sinks shall be provided in surgical units containing two operating rooms. One additional scrub sink shall be provided per each additional operating room.*

*[4] The scrub sink is in addition to the required number for surgeries.*

*[5] The following fixtures shall be provided in airborne infection or protective environment rooms of hospitals only:*

*a. Within an adjoining toilet room, a lavatory, a shower containing a seat or a space for a shower chair, and toilet equipped with bedpan flushing attachment with a vacuum breaker.*

*b. A handwashing fixture within a separate anteroom.*

*[6] The following fixtures shall be provided in isolation rooms of correctional treatment centers only:*

*a. Within an adjoining toilet area, a handwashing fixture, a shower containing a seat or a space for a shower chair, and water closet equipped with bedpan flushing attachment with a vacuum breaker.*

*b. A handwashing fixture within a separate anteroom.*

*[7] Includes burn center spaces, acute respiratory-care service spaces, and coronary-care service spaces.*

*[8] A toilet room with handwashing fixture shall directly adjoin each procedure room.*

*[9] One toilet with lavatory and one shower may serve two labor rooms.*

*[10] One additional scrub sink for each additional cesarean or delivery operating room.*

*[11] Provide emergency eye-wash and shower.*

*[12] Conveniently located for staff use.*

*[13] Fixtures serving individual patient rooms shall not be considered as meeting the required ratios for bedrooms not served by individual adjoining toilet or bathrooms.*

*[14] The clinic sink may be deleted if all bedrooms in the nursing unit are provided with adjoining toilets with bedpan flushing devices.*

*[15] Conventional controls on hot-and cold-water supplies are acceptable. The water discharge points shall be 5 inches (127 millimeters) above the fixture rim. Aerators are not permitted. Non-aerating laminar flow devices are permitted.*

[16] A minimum of one bathtub is required on each floor of an acute care or acute psychiatric hospital providing skilled nursing or intermediate care services. Special bathing facilities/gurney shower shall be provided at a minimum ratio of one per 100 beds for acute care facilities.
[17] In a multiple-bed room, every bed position shall be within 20 feet (6 meters) of a hands-free handwashing fixture. Where an individual room concept is used, a handwashing fixture shall be provided within each infant care room.
[18] When three or more procedure rooms are provided.
[19] If a separate medicine room is provided, the room shall be equipped with a sink in addition to the nurses' station handwashing fixture. Hot-water supplies are optional.
[20] Not required when there is a handwash fixture in the patient bed room.
[21] Handwashing fixtures may be deleted if room is used for storage and holding only.
[22] If room is used only for temporary holding of soiled materials, clinic sink and work counter may be omitted. If the flushing-rim clinical sink is eliminated, facilities for cleaning bedpans shall be provided elsewhere.
[23] Toilet shall be equipped with a bedpan flushing attachment.
[24] Optional services approved by the licensing agency shall comply with the applicable space requirements of OSHPD 1 and 2.
[25] Shall be provided in each separate room where open medication is handled.
[26] Conveniently accessible throughout the unit.
[27] Includes rooms or areas within coronary and intensive-care units and postanethesia recovery rooms.
[28] Modular toilet/sink combination units located within a privacy curtain may be used within individual patient space or private room. The toilet fixture shall be completely contained within cabinetry when not in use, and shall be enclosed when flushed. Bedpan washers shall not be permitted in patient bedrooms.
[29] In service spaces with procedure rooms that do not have dedicated patient toilets, provide a minimum of one patient toilet room with a separate handwashing fixture within the service space.
[30] Toilet room shall be accessible from the procedure room.
[31] Scrub sink shall be located outside the staff entrance to the procedure room.
[32] Not used.
[33] Handwashing and scrub sink fixtures shall not be equipped with wrist or elbow blades but shall be equipped with sensor controls, or controls that do not involve contact with the upper extremities.
[34] If room is used only for temporary holding of soiled material, clinic sink and work counter may be omitted.

**TABLE 4-3**

| TYPE OF BUILDING OR OCCUPANCY | WATER CLOSETS (FIXTURES PER PERSON) MALE | WATER CLOSETS (FIXTURES PER PERSON) FEMALE | URINALS (TROUGH URINAL TO INDIVIDUAL URINAL EQUIVALENCE) MALE | LAVATORIES (FIXTURES PER PERSON) | BATHTUBS OR SHOWERS FIXTURES PER PERSON)[7] | DRINKING FOUNTAINS (FIXTURES PER PERSON)[3] |
|---|---|---|---|---|---|---|
| Nonindustrial—office buildings, public buildings and similar establishments | 1 1-15<br>2 16-35<br>3 36-55<br>4 56-80<br>5 81-110<br>6 111-150<br>1 additional for each additional 40 employees or fraction thereof | 1 1-15<br>2 16-35<br>3 36-55<br>4 56-80<br>5 81-110<br>6 111-150 | Length of trough urinal / Number of individual urinals<br>24" (610 mm) 1<br>36" (914 mm) 2<br>48" (1219 mm) 2<br>60" (1524 mm) 3 | 1 1-15<br>2 16-35<br>3 36-60<br>4 61-90<br>5 91-125<br>1 additional for each additional 4 employees or fraction thereof | 1:10 persons per shift required to shower | — |
| Industrial–factories, warehouses, loft buildings and similar establishments | 1 1-15<br>2 16-35<br>3 36-55<br>4 56-80<br>5 81-110<br>6 111-150<br>1 additional for each additional 40 employees or fraction thereof | 1 1-15<br>2 16-35<br>3 36-55<br>4 56-80<br>5 81-110<br>6 111-150 | 24" (610 mm) 1<br>36" (914 mm) 2<br>48" (1219 mm) 2<br>60" (1524 mm) 3<br>72" (1829 mm) 4 | 1 to 100 employees 1 per 10<br>Over 100 employees 1 additional for each additional 15 employees or fraction thereof | 1:10 persons per shift required to shower | — |

*Notes:*
1 The figures shown are based on one fixture being the minimum required for the number of persons indicated or any fraction thereof.
2 Each water closet shall occupy a separate compartment which shall be equipped with a door, door latch and clothes hook. The door and the walls or partitions between fixtures shall be sufficient to assure privacy.
3 Drinking fountains shall not be located in toilet rooms.
4 Washing facilities shall be reasonably accessible to all employees.
5 Toilet facilities shall be accessible to the employees at all times. Where practicable, toilet facilities should be within 200 feet (61 m) of locations at which workers are regularly employed and should not be more than one floor-to-floor flight of stairs from working areas.
6 Urinals may be installed instead of water closets in toilet rooms to be used only by men provided that the number of water closets shall not be less than two thirds of the minimum number of toilet facilities specified. The length of trough urinals to the equivalent number of individual urinals shall be based on the above table.
7 When there are less than five employees, separate toilet rooms for each sex are not required provided toilet rooms can be locked from the inside and contain at least one water closet.
8 Twenty-four linear inches of wash sink or 18 inches of circular basin, when provided with water outlets for such space, shall be considered equivalent to one lavatory.
**Exception:** The requirements of Table 4-3 do not apply to mobile crews or to normally unattended work locations provided employees at these locations have immediately available transportation to nearby toilet facilities which meet the requirements of Table 4-3.

TABLE 4-4

| TYPE OF BUILDING OR OCCUPANCY[2] | WATER CLOSETS (FIXTURES PER PERSON) | URINALS (FIXTURES PER MALE) | LAVATORIES (FIXTURES PER PERSON) | BATHTUBS OR SHOWERS (FIXTURES PER PERSON) | DRINKING FOUNTAINS (FIXTURES PER PERSON) |
|---|---|---|---|---|---|
| Day Use Public Beaches[1,2] | Male 1 1-100<br>Female 1 1-100<br>No sex designated 1 1-500<br>Minimum of 2 | May be substituted for up to two-thirds of the water closets required | | | |
| Picnic Areas | Male 1 1-50<br>Female 1 1-50 | | | | |
| Overnight Use Public Beaches[2] | 1 1-7.5 campsites[3]<br>1 1-7.5 campsites[3] | May be substituted for up to one-third of the water closets required[3] | | 1 1-12.5 campsites[4] | |
| Organized Camps | 1 1-15[3] | | 1 1-15 | 1 1-156 | Minimum 1 per camp |

*Notes:*

1 *Toilets shall be located in accordance with actual use patterns on the beach. The reasonable intent of the toilet requirements is that it should apply on the basis of average daily use during periods of peak use. The health officer may determine how many days the population standard may be exceeded.*

2 *Laundry facilities are not required, but if they are provided, must be a minimum of two laundry trays or a washing machine.*

3 *Toilet facilities shall not be farther than 400 feet from any lot or campsite.*

4 *Showers are not required, but it provided, they shall be provided on the indicated ratio. Outdoor rinse-off showers may be cold water only.*

5 *Toilets shall be located within 300 feet from the living accommodations they serve.*

6 *Showers shall be provided in the living area or in a centrally located structure.*

***Exception:*** *Intermittent short-term organized camps are not required to provide shower facilities, but it provided, they shall comply with this part.*

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## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 5 - WATER HEATERS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | X | | | | | | X | X | X | X | X | X | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | X | X | X | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| 507.2 | | X | X | X | | | | | | | | | | | | | | | |

6012

# CHAPTER 5
## WATER HEATERS

**501.0 General.**

**501.1 Applicability.** The regulations of this chapter shall govern the construction, location, and installation of fuel-burning and other water heaters heating potable water, together with chimneys, vents, and their connectors. The minimum capacity for storage water heaters shall be in accordance with the first hour rating listed in Table 501.1. Design, construction, and workmanship shall be in accordance with accepted engineering practices, manufacturer's 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 with the type and model of each size thereof approved by the Authority Having Jurisdiction. A list of accepted gas appliance standards are referenced in Table 1401.1.

**502.0 Permits.**

**502.1 General.** It shall be unlawful for a person to install, remove, or replace or cause to be installed, removed, or replaced a water heater without first obtaining a permit from the Authority Having Jurisdiction to do so.

**503.0 Inspection.**

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

**503.2 Final Water Heater Inspection.** This inspection shall be made after work authorized by the permit has been installed. The Authority Having Jurisdiction will make such inspection as deemed necessary to be assured that the work has been installed in accordance with the intent of this code. No appliance or part thereof shall be covered or concealed until the same has been inspected and approved by the Authority Having Jurisdiction.

**504.0 Water Heater Requirements.**

**504.1 Location.** Water heater installations in bedrooms and bathrooms shall be in accordance with one of the following [NFPA 54:10.28.1]:

(1) Fuel-burning water heaters shall be permitted to be installed in a closet located in the bedroom or bathroom provided the closet is equipped with a listed, gasketed door assembly and a listed self-closing device. The self-closing door assembly shall meet the requirements of Section 504.1.1. The door assembly shall be installed with a threshold and bottom door seal and shall meet the requirements of Section 504.1.2. Combustion air for such installations shall be obtained from the outdoors in accordance with Section 506.4. The closet shall be for the exclusive use of the water heater.

(2) Water heater shall be of the direct vent type. [NFPA 54:10.28.1(2)]

**504.1.1 Self-Closing Doors.** Self-closing doors shall swing easily and freely and shall be equipped with a self-closing device to cause the door to close and latch each time it is opened. The closing mechanism shall not have a hold-open feature. [NFPA 80:6.1.4.2]

**504.1.2 Gasketing.** Gasketing on gasketed doors or frames shall be furnished in accordance with the published listings of the door, frame, or gasketing material manufacturer. [NFPA 80:6.4.8]

**Exception:** Where acceptable to the Authority Having Jurisdiction, gasketing of non-combustible or limited-combustible material shall be permitted to be applied to the frame, provided closing and latching of the door are not inhibited.

**504.2 Vent.** Water heaters of other than the direct-vent type shall be located as close as practical to the chimney or gas vent.

**504.3 Clearance.**

**504.3.1 Listed Water Heaters.** 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 listings and the manufacturer's installation instructions. [NFPA 54:10.28.2.1]

**504.3.2 Unlisted Water Heaters.** Unlisted water heaters shall be installed with a clearance of 12 inches (305 mm) on all sides and rear. Combustible floors under unlisted water heaters shall be protected in an approved manner. [NFPA 54:10.28.2.2]

**TABLE 501.1**
**FIRST HOUR RATING[1]**

| Number of Bathrooms | 1 to 1.5 | | | 2 to 2.5 | | | | 3 to 3.5 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of Bedrooms | 1 | 2 | 3 | 2 | 3 | 4 | 5 | 3 | 4 | 5 | 6 |
| First Hour Rating,[2] Gallons | 42 | 54 | 54 | 54 | 67 | 67 | 80 | 67 | 80 | 80 | 80 |

For SI units: 1 gallon = 3.785 L

**Notes:**

[1] The first hour rating is found on the "Energy Guide" label.

[2] Solar water heaters shall be sized to meet the appropriate first hour rating as shown in the table.

**504.4 Pressure-Limiting Devices.** A water heater installation shall be provided with overpressure protection by means of an approved, listed device installed in accordance with the terms of its listing and the manufacturer's installation instructions. [NFPA 54:10.28.3]

**504.5 Temperature-Limiting Devices.** A 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 manufacturer's installation instructions. [NFPA 54:10.28.4]

**504.6 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 installed in accordance with the terms of their listings and the manufacturer's installation 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 British thermal units (Btu) (kW•h) discharge capacity or the rated steam relief capacity of the device shall be not less than the input rating of the water heater. [NFPA 54:10.28.5]

**505.0 Oil-Burning and Other Water Heaters.**

**505.1 Water Heaters.** Water heaters deriving heat from fuels or types of energy other than gas shall be constructed and installed in accordance with approved standards. Vents or chimneys for such appliances shall be approved types. An adequate supply of air for combustion and for adequate ventilation of heater rooms or compartments shall be provided. Each such appliance shall be installed in a location approved by the Authority Having Jurisdiction and local and state fire-prevention agencies.

**505.2 Safety Devices.** 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 and a combination temperature and pressure-relief valve.

**505.3 Oil-Fired Water Heaters.** Oil-fired water heaters shall be installed in accordance with NFPA 31.

**505.4 Indirect-Fired Water Heaters.** Indirect-fired water heaters shall comply with the applicable sections of the ASME Boiler and Pressure Vessel Code, or to one of the other applicable standards shown in Table 1401.1. Each water heater shall bear a label in accordance with ASME requirements, or an approved testing agency, certifying and attesting that such an appliance has been tested, inspected and meets the requirements of the applicable standards or code.

**505.4.1 Single-Wall Heat Exchanger.** Indirect-fired water heater that incorporate a single-wall heat exchanger shall meet the following requirements:

(1) Connected to a low-pressure hot water boiler limited to a maximum of 30 pounds-force per square inch gauge (psig) (207 kPa) by an approved safety or relief valve.

(2) Heater transfer medium is either potable water or contains fluids having a toxicity rating or Class of 1.

(3) Bear a label with the word "Caution," followed by the following statements:

(a) The heat-transfer medium shall be water or other nontoxic fluid having a toxic rating or Class of 1 as listed in Clinical Toxicology of Commercial Products, 5th edition.

(b) The pressure of the heat-transfer medium shall be limited to a maximum of 30 psig (207 kPa) by an approved safety or relief valve.

The word "Caution" and the statements in letters shall have an uppercase height of not less than 0.120 of an inch (3.048 mm). The vertical spacing between lines of type shall be not less than 0.046 of an inch (1.168 mm). Lowercase letters shall be compatible with the uppercase letter size specification.

**506.0 Air for Combustion and Ventilation.**

**506.1 General.** Air for combustion, ventilation, and dilution of flue gases for appliances installed in buildings shall be obtained by application of one of the methods covered in Section 506.2.1 through Section 506.7.3. Where infiltration does not provide the necessary air, outdoor air shall be introduced in accordance with methods covered in Section 506.4 through Section 506.7.3.

**Exception:** This provision shall not apply to direct-vent appliances. [NFPA 54:9.3.1.1]

**506.1.1 Other Types of Appliances.** Appliances of 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. [NFPA 54:9.3.1.2]

**506.1.2 Draft Hood and Regulators.** Where used, a draft hood or a barometric draft regulator shall be installed in the same room or enclosure as the appliance served so as to prevent a difference in pressure between the hood or regulator and the combustion air supply. [NFPA 54:9.3.1.4]

**506.1.3 Makeup Air.** Where exhaust fans, clothes dryers, and kitchen ventilation systems interfere with the operation of appliances, makeup air shall be provided. [NFPA 54:9.3.1.5]

**506.2 Indoor Combustion Air.** The required volume of indoor air shall be determined in accordance with Section 506.2.1 or Section 506.2.2 except that where the air infiltration rate is known to be less than 0.40 *ACH* (air change per hour), Section 506.2.2 shall be used. The total required volume shall be the sum of the required volume calculated for appliances located within the space. Rooms communicating directly with the space in which the appliances are installed through openings not furnished with doors, and through combustion air openings sized and located in accordance with

Section 506.3 are considered a part of the required volume. [NFPA 54:9.3.2]

**506.2.1 Standard Method.** The required volume shall be not less than 50 cubic feet per 1000 British thermal units per hour (Btu/h) (4.83 m³/kW). [NFPA 54:9.3.2.1]

**506.2.2 Known Air Infiltration Rate Method.** Where the air infiltration rate of a structure is known, the minimum required volume shall be determined as follows [NFPA 54:9.3.2.2]:

(1) For appliances having other than fan-assisted combustion systems, calculate using Equation 506.2.2(1). [NFPA 54:9.3.2.2(1)]

(2) For fan-assisted combustion system appliances, calculate using Equation 506.2.2(2). [NFPA 54:9.3.2.2(2)]

(3) For purpose of this calculation, an infiltration rate greater than 0.60 *ACH* shall not be used in the equations. [NFPA 54:9.3.2.2(3)]

[Equation 506.2.2(1)]

Required volume $_{other} \geq (21\ ft^3/ACH) \times (I_{other}/1000$ Btu/h)

[Equation 506.2.2(2)]

Required volume $_{fan} \geq (15\ ft^3/ACH) \times (I_{fan}/1000$ Btu/h)

Where:

$I_{other}$ = Appliances other than fan-assisted input in Btu/h

$I_{fan}$ = Fan-assisted appliance input in Btu/h

*ACH* = Air change per hour (percent of volume of space exchanged per hour, expressed as a decimal)

For SI units: 1 cubic foot = 0.0283 m³, 1000 British thermal units per hour = 0.293 kW

**506.3 Indoor Opening Size and Location.** Openings used to connect indoor spaces shall be sized and located in accordance with the following:

(1) Each opening shall have a free area of not less than 1 square inch per 1000 Btu/h (0.002 m²/kW) of the total input rating of appliances in the space, but not less than 100 square inches (0.065 m²). One opening shall commence within 12 inches (305 mm) of the top, and one opening shall commence within 12 inches (305 mm) of the bottom of the enclosure (see Figure 506.3). The dimension of air openings shall be not less than 3 inches (76 mm).

(2) 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 free area of not less than 2 square inches per 1000 Btu/h (0.004 m²/kW) of total input rating of appliances. [NFPA 54:9.3.2.3]

**506.4 Outdoor Combustion Air.** Outdoor combustion air shall be provided through opening(s) to the outdoors in accordance with methods in Section 506.4.1 or Section 506.4.2. The dimension of air openings shall be not less than 3 inches (76 mm). [NFPA 54:9.3.3]

**506.4.1 Two Permanent Openings Method.** Two permanent openings, one commencing within 12 inches (305 mm) of the top and one commencing within 12 inches (305 mm) of the bottom of the enclosure shall be provided. The openings shall communicate directly, or by ducts, with the outdoors or spaces that freely communicate with the outdoors as follows:

(1) Where directly communicating with the outdoors or where communicating to the outdoors through vertical ducts, each opening shall have a free area of not less than 1 square inch per 4000 Btu/h (0.0005 m²/kW) of total input rating of appliances in the enclosure. [See Figure 506.4(1) and Figure 506.4(2)]

(2) Where communicating with the outdoors through horizontal ducts, each opening shall have a free area of not less than 1 square inch per 2000 Btu/h (0.001 m²/kW) of total input rating of appliances in the enclosure. [See Figure 506.4(3)] [NFPA 54:9.3.3.1]

**506.4.2 One Permanent Opening Method.** One permanent opening, commencing within 12 inches (305 mm) of the top of the enclosure, shall be provided. The appliance shall have clearances of not less than 1 inch (25.4 mm) from the sides and back and 6 inches (152 mm) from the front of the appliance. The opening shall

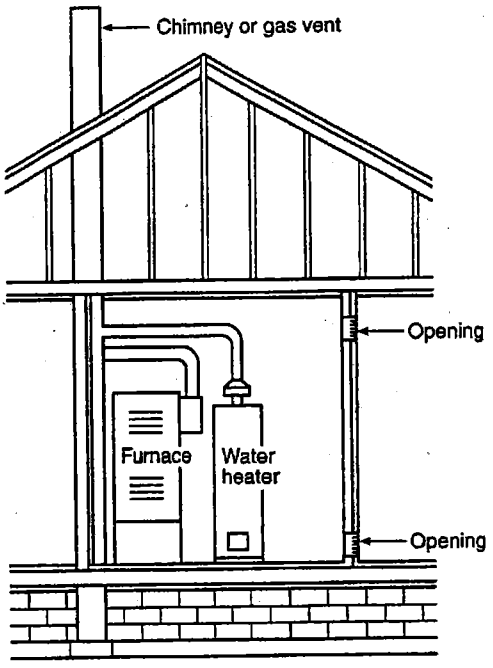



**FIGURE 506.3**
**COMBUSTION AIR FROM ADJACENT INDOOR SPACES THROUGH INDOOR COMBUSTION AIR OPENINGS [NFPA 54: FIGURE A.9.3.2.3(1)]**

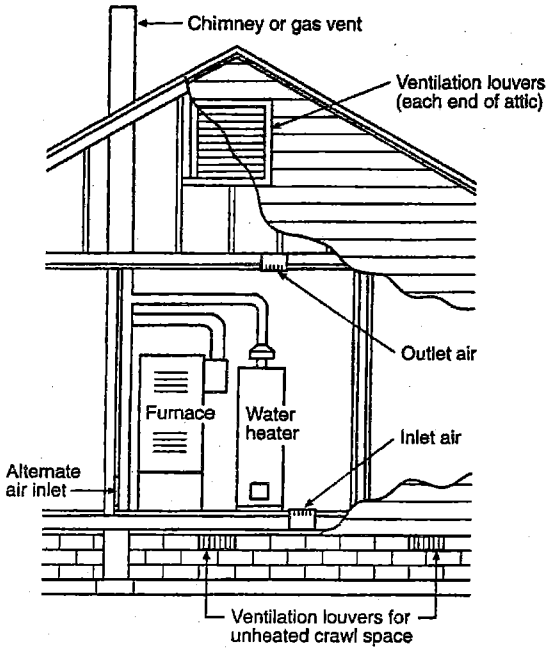



FIGURE 506.4(1)
COMBUSTION AIR FROM OUTDOORS
INLET AIR FROM VENTILATED CRAWL SPACE AND
OUTLET AIR TO VENTILATED ATTIC
[NFPA 54: FIGURE A.9.3.3.1(1)(a)]

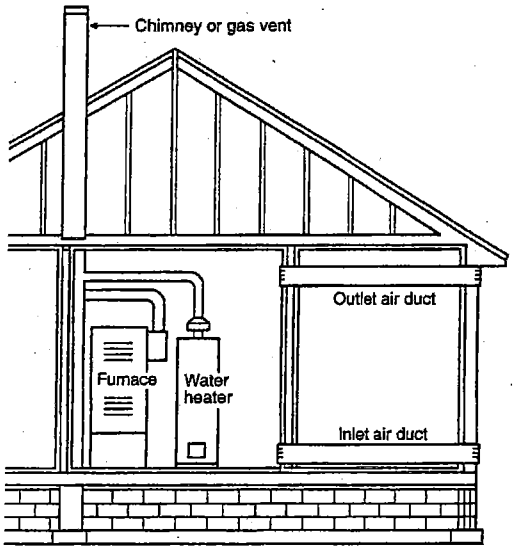
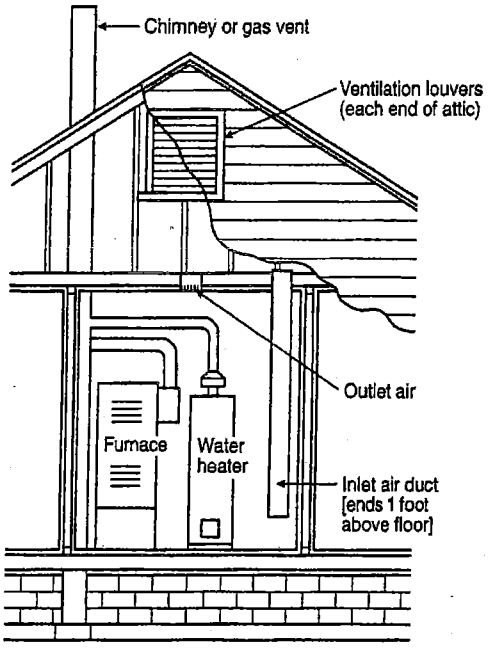



FIGURE 506.4(3)
COMBUSTION AIR FROM
OUTDOORS THROUGH HORIZONTAL DUCTS
[NFPA 54: FIGURE A.9.3.3.1(2)]




For SI units: 1 foot = 304.8 mm

FIGURE 506.4(2)
COMBUSTION AIR FROM OUTDOORS
THROUGH VENTILATED ATTIC
[NFPA 54: FIGURE A.9.3.3.1(1)(b)]

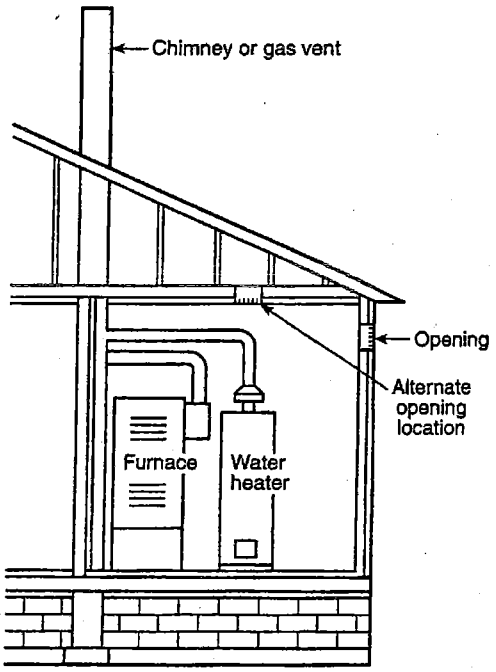



FIGURE 506.4.2
COMBUSTION AIR FROM OUTDOORS THROUGH
SINGLE COMBUSTION AIR OPENING
[NFPA 54: FIGURE A.9.3.3.2]

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 506.4.2) and shall have a minimum free area of the following:

(1) One square inch per 3000 Btu/h (0.0007 m²/kW) of the total input rating of appliances located in the enclosure, and

(2) Not less than the sum of the areas of vent connectors in the space. [NFPA 54:9.3.3.2]

**506.5 Combination Indoor and Outdoor Combustion Air.** The use of a combination of indoor and outdoor combustion air shall be in accordance with Section 506.5.1, Section 506.5.2, and Section 506.5.3 (see Appendix J). [NFPA 54:9.3.4]

**506.5.1 Indoor Openings.** Where used, openings connecting the interior spaces shall be in accordance with Section 506.3. [NFPA 54:9.3.4(1)]

**506.5.2 Outdoor Openings.** Outdoor openings shall be located in accordance with Section 506.4.1 or Section 506.4.2. [NFPA 54:9.3.4(2)]

**506.5.3 Outdoor Openings Size.** The outdoor openings size shall be calculated in accordance with the following:

(1) The ratio of interior spaces shall be the volume of communicating spaces divided by the volume.

(2) The outdoor size reduction factor shall be one minus the ratio of interior spaces.

(3) The minimum size of outdoor openings shall be the full size of outdoor openings calculated in accordance with Section 506.4.1 or Section 506.4.2, multiplied by the reduction factor. The dimension of air openings shall be not less than 3 inches (76 mm). [NFPA 54:9.3.4(3)]

**506.6 Engineered Installations.** Engineered combustion air installations shall provide a supply of combustion, ventilation, and dilution air that is approved by the Authority Having Jurisdiction. [NFPA 54:9.3.5]

**506.7 Mechanical Combustion Air Supply.** Where 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 cubic feet per minute per 1000 Btu/h [0.034 (m³/min)/kW] for appliances located within the space. [NFPA 54:9.3.6]

**506.7.1 Exhaust Fans.** Where exhaust fans are installed, additional air shall be provided to replace the exhausted air. [NFPA 54:9.3.6.1]

**506.7.2 Interlock.** Each of the appliances 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 54:9.3.6.2]

**506.7.3 Specified Combustion Air.** 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 54:9.3.6.3]

**506.8 Louvers, Grilles, and Screens.** 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 have 25 percent free area and metal louvers and grilles have 75 percent free area. Nonmotorized louvers and grilles shall be fixed in the open position. [NFPA 54:9.3.7.1]

**506.8.1 Minimum Screen Mesh Size.** Screens shall be not less than ¼ of an inch (6.4 mm) mesh. [NFPA 54:9.3.7.2]

**506.8.2 Motorized Louvers.** Motorized louvers shall be interlocked with the appliance 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 where the louver fail to open during burner start-up and to shut down the main burner where the louvers close during burner operation. [NFPA 54:9.3.7.3]

**506.9 Combustion Air Ducts.** Combustion air ducts shall comply with the following [NFPA 54:9.3.8]:

(1) Ducts shall be of galvanized steel or a material having equivalent corrosion resistance, strength, and rigidity.

**Exception:** Within dwelling units, unobstructed stud and joist spaces shall not be prohibited from conveying combustion air, provided that not more than one fireblock is removed. [NFPA 54:9.3.8.1]

(2) Ducts shall terminate in an unobstructed space, allowing free movement of combustion air to the appliances. [NFPA 54:9.3.8.2]

(3) Ducts shall serve a single space. [NFPA 54:9.3.8.3]

(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 54:9.3.8.4]

(5) Ducts shall not be screened where terminating in an attic space. [NFPA 54:9.3.8.5]

(6) Combustion air intake openings located on the exterior of the building shall have the lowest side of the combustion air intake openings located not less than 12 inches (305 mm) vertically from the adjoining finished ground level. [NFPA 54:9.3.8.8]

(7) Horizontal upper combustion air ducts shall not slope downward toward the source of combustion air. [NFPA 54:9.3.8.6]

(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 54:9.3.8.7]

**507.0 Other Water Heater Installation Requirements.**

**507.1 Dielectric Insulator.** The Authority Having Jurisdiction shall have the authority to require the use of an approved dielectric insulator on the water piping connections of water heaters and related water heating appliances.

**507.1.1 Support of Appliances.** Appliances shall be furnished either with load-distributing bases or with an approved number of supports to prevent damage to either the building structure or appliance. [NFPA 54:9.1.8.3]

**507.2 Seismic Provisions.** *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 (⅓) and lower one-third (⅓) 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.*

***Note: [HCD 1 & HCD 2]*** *Reference Health and Safety Code Section 19211(a) which addresses new, replacement, and existing water heaters.*

***Note:*** *The applicable subsection of Health and Safety Code Section 19211(a) which addresses new, replacement, and existing water heaters is repeated here for clarity and reads as follows:*

*Section 19211(a) Notwithstanding Section 19100, all new and replacement water heaters, and all existing residential water heaters shall be braced, anchored, or strapped to resist falling or horizontal displacement due to earthquake motion. At a minimum, any water heater shall be secured in accordance with the California Plumbing Code, or modifications made thereto by a city, county, or city and county pursuant to Section 17958.5.*

**507.2.1 Structural Capacity.** At the locations selected for installation of the appliances and equipment, the dynamic and static load-carrying capacities of the building structure shall be checked to determine whether they are capable to carry the additional loads. The appliance shall be supported and shall be connected to the piping so as not to exert undue stress on the connections. [NFPA 54:9.1.8.4]

**507.3 Ground Support.** A water heater supported from the ground shall rest on level concrete or other approved base extending not less than 3 inches (76 mm) above the adjoining ground level.

**507.4 Drainage Pan.** Where a water heater is located in an attic, attic-ceiling assembly, floor-ceiling assembly, or floor-subfloor assembly where damage results from a leaking water heater, a watertight pan of corrosion-resistant materials shall be installed beneath the water heater with not less than ¾ of an inch (20 mm) diameter drain to an approved location.

**507.5 Relief Valve Discharge.** Discharge from a relief valve into a water heater pan shall be prohibited.

**507.6 Added or Converted Appliances.** Where an additional or replacement appliance is installed or an appliance is converted to gas from another fuel, the location in which the appliance is to be operated shall be checked to verify the following [NFPA 54:9.1.2]:

(1) Air for combustion and ventilation is provided where required, in accordance with the provisions of Section 506.0. Where existing facilities are not adequate, they shall be upgraded to Section 506.0 specifications. [NFPA 54:9.1.2(1)]

(2) The installation components and appliances 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 appliances and their vent connectors are specified in Table 509.7.3 and Table 509.7.3(1). [NFPA 54:9.2.2]. It shall be determined that the installation and operation of the additional or replacement appliance does not render the remaining appliance unsafe for continued operation. [NFPA 54:9.1.2(2)]

(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 in accordance with this chapter. [NFPA 54:9.1.2(3)]

**507.7 Types of Gases.** The appliance shall be connected to the fuel gas for which it was designed. No attempt shall be made to convert the appliance 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 appliance manufacturer for complete instructions. [NFPA 54-12:9.1.3]

**507.8 Safety Shutoff Devices for Unlisted LP-Gas Appliance Used Indoors.** Unlisted appliances for use with undiluted liquefied petroleum gases and installed indoors shall be equipped with safety shutoff devices of the complete shutoff type. [NFPA 54:9.1.4]

**507.9 Use of Air or Oxygen Under Pressure.** Where air or oxygen under pressure is used in connection with the gas supply, effective means such as a backpressure regulator and relief valve shall be provided to prevent air or oxygen from passing back into the gas piping. Where oxygen is used, installation shall be in accordance with NFPA 51. [NFPA 54:9.1.5]

**507.10 Protection of Gas Appliances from Fumes or Gases other than Products of Combustion.** Non-direct vent-type gas appliances installed in beauty shops, barbershops, or other facilities where chemicals that generate corrosive or flammable products such as aerosol sprays are routinely used shall be located in an equipment room separate or partitioned off from other areas with provisions for combustion and dilution air from outdoors. Direct vent appliances shall be installed in accordance with the appliance manufacturer's installation instructions. [NFPA 54:9.1.6.2]

**507.11 Process Air.** In addition to air needed for combustion in commercial or industrial processes, process air shall be provided as required for cooling of equipment or material, controlling dew point, heating, drying, oxidation, dilution, safety exhaust, odor control, air for compressors, and for comfort and proper working conditions for personnel. [NFPA 54:9.1.7]

**507.12 Flammable Vapors.** Gas appliances 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. Appliances installed in accordance with Section

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507.13, Section 507.14, or Section 507.15 shall be considered to be in accordance with the intent of this provision. [NFPA 54:9.1.9]

**507.13 Installation in Garages.** Appliances in 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 burners and burner-ignition devices are located not less than 18 inches (457 mm) above the floor unless listed as flammable vapor ignition resistant. [NFPA 54:9.1.10.1]

**507.13.1 Physical Damage.** Appliances installed in garages, warehouses, or other areas subject to mechanical damage shall be guarded against such damage by being installed behind protective barriers or by being elevated or located out of the normal path of vehicles.

**507.13.2 Access from the Outside Only.** Where such appliances installed within a garage are enclosed in a separate, approved compartment having access only from outside of the garage, such appliances shall be permitted to be installed at floor level, provided the required combustion air is taken from and discharged to the exterior of the garage. [NFPA 54:9.1.10.3]

**507.14 Installation in Commercial Garages.**

**507.14.1 Parking Structures.** Appliances installed in enclosed, basement, and underground parking structures shall be installed in accordance with NFPA 88A. [NFPA 54:9.1.11.1]

**507.14.2 Repair Garages.** Appliances installed in repair garages shall be installed in a detached building or room, separated from repair areas by walls or partitions, floors, or floor-ceiling assemblies that are constructed so as to prohibit the transmission of vapors and having a fire-resistance rating of not less than 1 hour, and that have no openings in the wall separating the repair area within 8 feet (2438 mm) of the floor. Wall penetrations shall be firestopped. Air for combustion purposes shall be obtained from outside the building. The heating room shall not be used for the storage of combustible materials.

**Exceptions:**

(1) Overhead heaters where installed not less than 8 feet (2438 mm) above the floor shall be permitted.

(2) Heating appliances for vehicle repair areas where there is no dispensing or transferring of Class I or Class II flammable or combustible liquids or liquefied petroleum gas shall be installed in accordance with NFPA 30A. [NFPA 54:9.1.11.2]

**507.15 Installation in Aircraft Hangars.** Heaters in aircraft hangars shall be installed in accordance with NFPA 409. [NFPA 54:9.1.12]

**507.16 Venting of Flue Gases.** Appliances shall be vented in accordance with the provisions of this chapter. [NFPA 54:9.1.14]

**507.17 Extra Device or Attachment.** No device or attachment shall be installed on an appliance that is capable of impairing the combustion of gas. [NFPA 54:9.1.15]

**507.18 Adequate Capacity of Piping.** Where additional appliances are being connected to a gas piping system, the existing piping shall be checked to determine where it has adequate capacity. 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 appliance. [NFPA 54:9.1.16]

**507.19 Avoiding Strain on Gas Piping.** Appliances shall be supported and so connected to the piping as not to exert undue strain on the connections. [NFPA 54:9.1.17]

**507.20 Gas Appliance Pressure Regulators.** Where the gas supply pressure is higher than that at which the appliance is designed to operate or varies beyond the design pressure limits of the appliance, a gas appliance pressure regulator shall be installed. [NFPA 54:9.1.18]

**507.21 Venting of Gas Appliance Pressure Regulators.** Venting of gas appliance pressure regulators shall be in accordance with the following requirements:

(1) Gas appliance pressure regulators requiring access to the atmosphere for successful operation shall be equipped with vent piping leading outdoors or, where the regulator vent is an integral part of the appliance, 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.

(2) Vent limiting means shall be employed on listed gas appliance pressure regulators.

(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.

(4) Under no circumstances shall a regulator be vented to the appliance flue or exhaust system.

(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.

(6) Vent lines from a gas appliance pressure regulator and 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 54:9.1.19]

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

(1) Diaphragm-type valves shall be equipped to convey bleed gas to the outdoors or into the combustion chamber adjacent to a continuous pilot.

(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.

(3) Bleed lines shall not terminate in the appliance flue or exhaust system.

(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.

(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 54:9.1.20]

**507.23 Combination of Appliances.** A combination of appliances, attachments, or devices used together in a manner shall be in accordance with the standards that apply to the individual appliance. [NFPA 54:9.1.21]

**507.24 Installation Instructions.** The installing agency shall comply with the appliance manufacturer's installation instructions in completing an installation. The installing agency shall leave the manufacturer's installation, operating, and maintenance instructions in a location on the premises where they will be readily available for reference and guidance for the Authority Having Jurisdiction, service personnel, and the owner or operator. [NFPA 54:9.1.22]

**507.25 Protection of Outdoor Appliances.** Appliances not listed for outdoor installation but installed outdoors shall be provided with protection to the degree that the environment requires. Appliances listed for outdoor installation shall be permitted to be installed without protection in accordance with the provisions of its listing. [NFPA 54:9.1.23]

**507.26 Accessibility for Service.** Appliances shall be located with respect to building construction and other equipment so as to permit access to the appliance. 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, where provided. For attic installation, the passageway and servicing area adjacent to the appliance shall be floored. [NFPA 54:9.2.1]

**508.0 Appliances on Roofs.**

**508.1 General.** Appliances on roofs shall be designed or enclosed so as to withstand climatic conditions in the area in which they are installed. Where enclosures are provided, each enclosure shall permit easy entry and movement, shall be of reasonable height, and shall have not less than a 30 inch (762 mm) clearance between the entire service access panel(s) of the appliance and the wall of the enclosure. [NFPA 54:9.4.1.1]

**508.1.1 Load Capacity.** Roofs on which an appliance is to be installed shall be capable of supporting the additional load or shall be reinforced to support the additional load. [NFPA 54:9.4.1.2]

**508.1.2 Fasteners.** Access locks, screws, and bolts shall be of corrosion-resistant material. [NFPA 54:9.4.1.3]

**508.2 Installation of Appliances on Roofs.** Appliances shall be installed in accordance with its listing and the manufacturer's installation instructions. [NFPA 54:9.4.2.1]

**508.2.1 Clearance.** Appliances shall be installed on a well-drained surface of the roof. Not less than 6 feet (1829 mm) of clearance shall be between a part of the appliance and the edge of a roof or similar hazard, or rigidly fixed rails, guards, parapets, or other building structures not less than 42 inches (1067 mm) in height shall be provided on the exposed side. [NFPA 54:9.4.2.2]

**508.2.2 Electrical Power.** Appliances 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 appliance that will completely de-energize the appliance.

(2) A 120-VAC grounding-type receptacle outlet on the roof adjacent to the appliance. The receptacle outlet shall be on the supply side of the disconnect switch. [NFPA 54:9.4.2.3]

**508.2.3 Platform or Walkway.** Where water stands on the roof of the appliance or in the passageways to the appliance, or where the roof is of a design having a water seal, an approved platform, walkway, or both shall be provided above the waterline. Such platforms or walkways shall be located adjacent to the appliance and control panels so that the appliance is capable of being safely serviced where water stands on the roof. [NFPA 54:9.4.2.4]

**508.3 Access to Equipment and Appliances on Roofs.** Equipment and appliances located on roofs or other elevated locations shall be accessible. [NFPA 54:9.4.3.1]

**508.3.1 Access.** Buildings exceeding 15 feet (4572 mm) in height shall have an inside means of access to the roof, unless other means acceptable to the Authority Having Jurisdiction are used. [NFPA 54:9.4.3.2]

**508.3.2 Access Type.** 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 not less than 22 inches by 24 inches (559 mm by 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.

Not less than 6 feet (1829 mm) of clearance shall be between the access opening and the edge of the roof or similar hazard, or rigidly fixed rails or guards not less than 42 inches (1067 mm) 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 not less than 42 inches (1067 mm) in height. [NFPA 54:9.4.3.3]

**508.3.3 Permanent Lighting.** 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 54:9.4.3.4]

**508.4 Appliances in Attics and Under-Floor Spaces.** An attic or under-floor space in which an appliance is installed shall be accessible through an opening and passageway not less than as large as the largest component of the appliance, and not less than 22 inches by 30 inches (559 mm by 762 mm).

**508.4.1 Length of Passageway.** Where the height of the passageway is less than 6 feet (1829 mm), the distance from the passageway access to the appliance shall not exceed 20 feet (6096 mm) measured along the centerline of the passageway. [NFPA 54:9.5.1.1]

**508.4.2 Width of Passageway.** The passageway shall be unobstructed and shall have solid flooring not less than 24 inches (610 mm) wide from the entrance opening to the appliance. [NFPA 54:9.5.1.2]

**508.4.3 Work Platform.** A level working platform not less than 30 inches (762 mm) by 30 inches (762 mm) shall be provided in front of the service side of the appliance. [NFPA 54:9.5.2]

**508.4.4 Lighting and Convenience Outlet.** A permanent 120-volt receptacle outlet and a lighting fixture shall be installed near the appliance. The switch controlling the lighting fixture shall be located at the entrance to the passageway. [NFPA 54:9.5.3]

**509.0 Venting of Appliances.**

**509.1 Minimum Safe Performance.** Venting systems shall be designed and constructed to convey flue, vent, or both gases to the outdoors. [NFPA 54-12:12.1]

**509.1.1 Installation.** Listed vents shall be installed in accordance with this chapter and the manufacturer's installation instructions. [NFPA 54:12.2.3]

**509.1.2 Prohibited Discharge.** Appliance vents shall not discharge into a space enclosed by screens having openings less than ¼ of an inch (6.4 mm) mesh.

**509.2 Connection to Venting Systems.** Except as permitted in Section 509.2.1 through Section 509.2.5, appliances shall be connected to venting systems. [NFPA 54:12.3.1]

**509.2.1 Appliances Not Required to be Vented.** The following appliances shall not be required to be vented [NFPA 54:12.3.2]:

(1) A single listed booster-type (automatic instantaneous) water heater, where designed and used solely for the sanitizing rinse requirements of a dish-washing machine, provided that the appliance is installed with the draft hood in place and unaltered where a draft hood is required, in a commercial kitchen having a mechanical exhaust system; where installed in this manner, the draft hood outlet shall be not less than 36 inches (914 mm) vertically and 6 inches (152 mm) horizontally from a surface other than the appliance. [NFPA 54:12.3.2(5)]

(2) Other appliances listed for unvented use and not provided with flue collars. [NFPA 54:12.3.2(10)]

Where appliances in Section 509.2.1(1) and Section 509.2.1(2) are installed so the aggregate input rating exceeds 20 British thermal units per hour per cubic foot [(Btu/h)/ft³] (0.21 kW/m³) of room or space in which it is installed, one or more shall be provided with venting systems or other approved means for conveying the vent gases to the outdoors so the aggregate input rating of the remaining unvented appliance does not exceed 20 [(Btu/h)/ft³] (0.21 kW/m³). Where the calculation includes the volume of an adjacent room or space, the room or space in which the appliance is installed shall be directly connected to the adjacent room or space by a doorway, archway, or other opening of comparable size that cannot be closed. [NFPA 54:12.3.2.1, 12.3.2.2]

**509.2.2 Ventilating Hoods.** Ventilating hoods and exhaust systems shall be permitted to be used to vent appliances installed in commercial applications and to vent industrial appliances, particularly where the process itself requires fume disposal. [NFPA 54:12.3.3]

**509.2.3 Well-Ventilated Spaces.** The operation of industrial appliances such that its flue gases are discharged directly into a large and well-ventilated space shall be permitted. [NFPA 54:12.3.4]

**509.2.4 Direct-Vent Appliances.** Listed direct-vent appliances shall be installed in accordance with the manufacturer's installation instructions and Section 509.8.2. [NFPA 54:12.3.5]

**509.2.5 Appliances with Integral Vents.** Appliances incorporating integral venting means shall be installed in accordance with the manufacturer's installation instructions, Section 509.8, and Section 509.8.1. [NFPA 54-12:12.3.6]

**509.3 Design and Construction.** A venting system shall be designed and constructed so as to develop a positive flow to convey flue or vent gases to the outdoors. [NFPA 54:12.1]

**509.3.1 Appliance Draft Requirements.** A venting system shall satisfy the draft requirements of the appliance in accordance with the manufacturer's instructions. [NFPA 54:12.4.1]

**509.3.2 Appliance Venting Requirements.** Appliances required to be vented shall be connected to a venting system designed and installed in accordance with the provisions of Section 509.4 through Section 509.14 of this code. [NFPA 54:12.4.2]

**509.3.3 Mechanical Draft Systems.** Mechanical draft systems shall be listed and shall be installed in accordance with both the appliance and the mechanical draft system manufacturer's installation instructions. [NFPA 54:12.4.3.1]

**509.3.3.1 Venting.** Appliances requiring venting shall be permitted to be vented by means of mechanical draft systems of either forced or induced draft design.

**Exception:** Incinerators. [NFPA 54:12.4.3.2]

**509.3.3.2 Leakage.** Forced draft systems and 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 54:12.4.3.3]

**509.3.3.3 Vent Connectors.** Vent connectors serving appliances vented by natural draft shall not be connected into mechanical draft systems operating under positive pressure. [NFPA 54:12.4.3.4]

**509.3.3.4 Operation.** Where a mechanical draft system is employed, provision shall be made to prevent the flow of gas to the main burners where the draft system is not performing so as to satisfy the operating requirements of the appliance for safe performance. [NFPA 54:12.4.3.5]

**509.3.3.5 Exit Terminals.** The exit terminals of mechanical draft systems shall be not less than 7 feet (2134 mm) above finished ground level where located adjacent to public walkways and shall be located as specified in Section 509.8 and Section 509.8.1 of this code. [NFPA 54:12.4.3.6]

**509.3.4 Ventilating Hoods and Exhaust Systems.** Ventilating hoods and exhaust systems shall be permitted to be used to vent appliances installed in commercial applications. [NFPA 54:12.4.4.1]

**509.3.4.1 Automatically Operated Appliances.** Where automatically operated appliances, other than commercial cooking appliances, are vented through a ventilating hood or exhaust system equipped with a damper or with a power means of exhaust, provisions shall be made to allow the flow of gas to the main burners where the damper is open to a position to properly vent the appliance and where the power means of exhaust is in operation. [NFPA 54:12.4.4.2]

**509.3.5 Circulating Air Ducts and Furnace Plenums.** Venting systems shall not extend into or pass through a fabricated air duct or furnace plenum. [NFPA 54:12.4.5.1]

**509.4 Type of Venting System to be Used.** The type of venting system to be used shall be in accordance with Table 509.4. [NFPA 54:12.5.1]

**509.4.1 Plastic Piping.** Plastic piping used for venting appliances listed for use with such venting materials shall be approved. [NFPA 54:12.5.2]

**509.4.2 Plastic Vent Joints.** Plastic pipe and fittings used to vent appliances shall be installed in accordance with the appliance manufacturer's installation instructions. Where primer is required, it shall be of a contrasting color. [NFPA 54:12.5.3]

**509.4.3 Special Gas Vent.** Special gas vent shall be listed and installed in accordance with the special gas vent manufacturer's installation instructions. [NFPA 54:12.5.4]

**509.5 Masonry, Metal, and Factory-Built Chimneys.**

**509.5.1 Factory-Built Chimneys.** Factory-built chimneys shall be installed in accordance with the manufacturer's installation instructions. Factory-built chimneys used to vent appliances that operate at positive vent pressure shall be listed for such application. [NFPA 54:12.6.1.1]

**509.5.2 Metal Chimneys.** Metal chimneys shall be built and installed in accordance with NFPA 211. [NFPA 54:12.6.1.2]

**509.5.3 Masonry Chimneys.** Masonry chimneys shall be built and installed in accordance with NFPA 211 and lined with approved clay flue lining, a listed chimney lining system, or other approved material that resists corrosion, erosion, softening, or cracking from vent gases at temperatures not exceeding 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 accor-

**TABLE 509.4**
**TYPE OF VENTING SYSTEM TO BE USED**
**[NFPA 54: TABLE 12.5.1]**

| APPLIANCES | TYPE OF VENTING SYSTEM |
|---|---|
| Listed Category I appliances | Type B gas vent (Section 509.6) |
| Listed appliances equipped with draft hood | Chimney (Section 509.5) |
| Appliances listed for Type B gas vent | Single-wall metal pipe (Section 509.7)<br>Listed chimney lining system for gas venting (Section 509.5.3)<br>Special gas vent listed for this appliance (Section 509.4.3) |
| Listed vented wall furnaces | Type B-W gas vent (Section 509.6, Section 509.6.2.2) |
| Category II appliances<br>Category III appliances<br>Category IV appliances | As specified or furnished by manufacturers of listed appliance (Section 509.4.1, Section 509.4.3) |
| Incinerators, outdoors | Single-wall metal pipe (Section 509.7, Section 509.7.2) |
| Incinerators, indoors<br>Appliances that are capable of being converted to use of solid fuel<br>Unlisted combination gas- and oil-burning appliances<br>Combination gas- and solid-fuel-burning appliances<br>Appliances listed for use with chimneys only<br>Unlisted appliances | Chimney (Section 509.5) |
| Listed combination gas- and oil-burning appliances | Type L vent (Section 509.6) or chimney (Section 509.5) |
| Decorative appliance in vented fireplace | Chimney (UMC Section 907.2) |
| Direct-vent appliances | See Section 509.2.4 |
| Appliances with integral vent | See Section 509.2.5 |

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dance with the liner manufacturer's installation instructions. 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 54:12.6.1.3]

**509.5.4 Termination.** A chimney for a residential-type or low-heat appliance shall extend not less than 3 feet (914 mm) above the highest point where it passes through the roof of a building and not less than 2 feet (610 mm) higher than a portion of a building within a horizontal distance of 10 feet (3048 mm). (See Figure 509.5.4) [NFPA 54:12.6.2.1]

**509.5.4.1 Medium-Heat Gas Appliances.** A chimney for a medium-heat appliance shall extend not less than 10 feet (3048 mm) above a portion of a building within 25 feet (7620 mm). [NFPA 54:12.6.2.2]

**509.5.4.2 Chimney Height.** A chimney shall extend not less than 5 feet (1524 mm) above the highest connected appliance draft hood outlet or flue collar. [NFPA 54:12.6.2.3]

**509.5.4.3 Decorative Shrouds.** Decorative shrouds shall not be installed at the termination of factory-built chimneys except where such shrouds are listed and labeled for use with the specific factory-built chimney system and are installed in accordance with the manufacturer's installation instructions. [NFPA 54:12.6.2.4]

**509.5.5 Size of Chimneys.** The effective area of a chimney venting system serving listed appliances with draft hoods, Category I appliances, and other appliances listed for use with Type B vents shall be in accordance with one of the following methods [NFPA 54:12.6.3.1]:

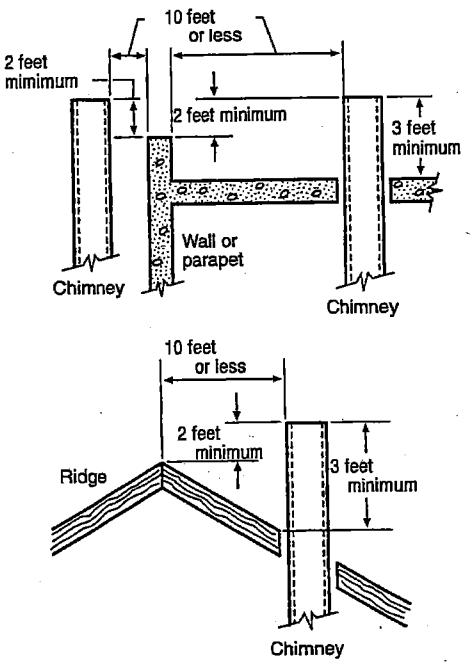
(1) Section 510.0. [NFPA 54:12.6.3.1(1)]

(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 exceeding seven times the draft hood outlet area. [NFPA 54:12.6.3.1(2)]

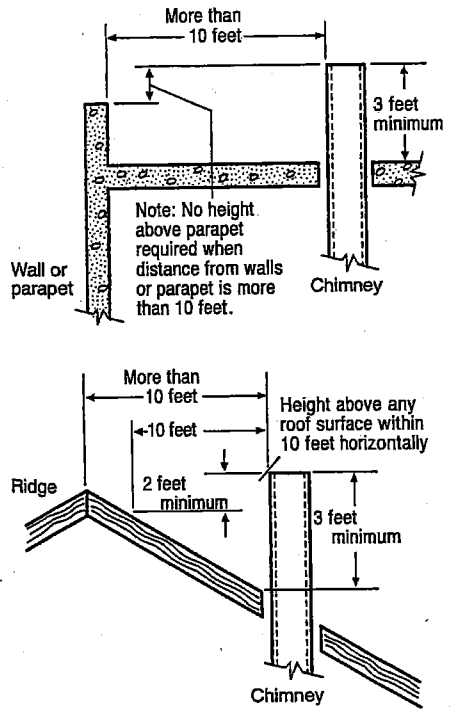
(3) For sizing a chimney venting system connected to two appliances with draft hoods, the effective area of the chimney flue shall be not less than the area of the larger draft hood outlet plus 50 percent of the area of the smaller draft hood outlet, or exceeding seven times the smallest draft hood outlet area. [NFPA 54:12.6.3.1(3)]

(4) Other approved engineering methods. [NFPA 54:12.6.3.1(5)]

(5) Chimney venting systems using mechanical draft shall be sized in accordance with approved engineering methods. [NFPA 54:12.6.3.1(4)]




(a) Termination 10 feet or Less from Ridge, Wall, or Parapet




(b) Termination More Than 10 feet from Ridge, Wall, or Parapet

For SI units: 1 foot = 304.8 mm

**FIGURE 509.5.4**
**TYPICAL TERMINATION LOCATIONS FOR CHIMNEYS AND SINGLE-WALL METAL PIPES SERVING RESIDENTIAL-TYPE AND LOW-HEAT APPLIANCE [NFPA 54: FIGURE 12.6.2.1]**

**509.5.6 Inspection of Chimneys.** Before replacing an existing appliance or connecting a vent connector to a chimney, the chimney passageway shall be examined to ascertain that it is clear and free of obstructions and shall be cleaned where previously used for venting solid- or liquid-fuel-burning appliances or fireplaces. [NFPA 54:12.6.4.1]

**509.5.6.1 Standard.** Chimneys shall be lined in accordance with NFPA 211.

**Exception:** Existing chimneys shall be permitted to have their use continued where an appliance is replaced by an appliance of similar type, input rating, and efficiency, where the chimney is in accordance with Section 509.5.6, and the sizing of the chimney is in accordance with Section 509.5.5. [NFPA 54:12.6.4.2]

**509.5.6.2 Cleanouts.** Cleanouts shall be examined to determine that they will remain tightly closed where not in use. [NFPA 54:12.6.4.3]

**509.5.6.3 Existing Chimney.** Where inspection reveals that an existing chimney is not safe for the intended application, it shall be repaired, rebuilt, lined, relined, or replaced with a vent or chimney in accordance with NFPA 211 and shall be approved for the appliances to be attached. [NFPA 54:12.6.4.4]

**509.5.7 Chimney Serving Appliances Burning Other Fuels.** An appliance shall not be connected to a chimney flue serving a separate appliance designed to burn solid fuel. [NFPA 54:12.6.5.1]

**509.5.7.1 Multiple Appliances.** Where one chimney serves gas appliances and liquid fuel-burning appliances, the appliances shall be connected through separate openings or shall be connected through a single opening where joined by a 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 appliance is automatically controlled, it shall be equipped with a safety shutoff device. [NFPA 54:12.6.5.2]

**509.5.7.2 Manual Reset Device.** A listed combination gas- and solid-fuel-burning appliance connected to a single chimney flue shall be equipped with a manual reset device to shut off gas to the main burner in the event of sustained backdraft or flue gas spillage. The chimney flue shall be sized to properly vent the appliance. [NFPA 54:12.6.5.3]

**509.5.7.3 Combination Gas- and Oil-Burning Appliances.** A single chimney flue serving a listed combination gas- and oil-burning appliance shall be sized to properly vent the appliance. [NFPA 54:12.6.5.4]

**509.5.8 Support of Chimneys.** Portions of chimneys shall be supported for the design and weight of the materials employed. Listed factory-built chimneys shall be supported and spaced in accordance with their listings and the manufacturer's instructions. [NFPA 54:12.6.6]

**509.5.9 Cleanouts.** Where a chimney that formerly carried flue products from liquid- or solid-fuel-burning appliances is used with an appliance using fuel gas, an accessible cleanout shall be provided. The cleanout shall have a tight-fitting cover and be installed so its upper edge is not less than 6 inches (152 mm) below the lower edge of the lowest chimney inlet opening. [NFPA 54:12.6.7]

**509.5.10 Space Surrounding Lining or Vent.** The remaining space surrounding a chimney liner, gas vent, special gas vent, or plastic piping installed within a masonry chimney flue shall not be used to vent another appliance.

**Exception:** The insertion of another liner or vent within the chimney as provided in this code and the liner or vent manufacturer's instructions. [NFPA 54:12.6.8.1]

**509.5.10.1 Combustion Air.** 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.

**Exception:** Direct-vent appliances designed for installation in a solid-fuel-burning fireplace where installed in accordance with the manufacturer's installation instructions. [NFPA 54:12.6.8.2]

**509.6 Gas Vents.** 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 54:12.7.2(6)]

**509.6.1 Installation.** Type B or Type L vents shall extend in a vertical direction with offsets not exceeding 45 degrees (0.79 rad), except that a vent system having not more than one 60 degree (1.05 rad) offset shall be permitted. An angle greater than 45 degrees (0.79 rad) from the vertical is considered horizontal. The total horizontal distance of a vent plus the horizontal vent connector serving draft hood-equipped appliances shall be not greater than 75 percent of the vertical height of the vent. [NFPA 54:12.7.3.2]

**509.6.1.1 Fasteners.** Screws, rivets and other fasteners shall not penetrate the inner wall of double wall gas vents except at the transition from the appliance draft hood outlet, flue collar, or single wall metal connector to a double wall vent. [NFPA 54:12.7.1(4)]

**509.6.2 Additional Termination Requirements.** A gas vent shall terminate in accordance with one of the following:

(1) Gas vents that are 12 inches (305 mm) or less in size and located not less than 8 feet (2438 mm) from a vertical wall or similar obstruction shall terminate above the roof in accordance with Figure 509.6.2 and Table 509.6.2. Gas vents that are over 12 inches (305 mm) in size or are located less than 8 feet (2438 mm) from

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a vertical wall or similar obstruction, shall terminate not less than 2 feet (610 mm) above the highest point where they pass through the roof and not less than 2 feet (610 mm) above a portion of a building within 10 feet (3048 mm) horizontally.

(2) Industrial appliances as provided in Section 509.2.3.

(3) Direct-vent systems as provided in Section 509.2.4.

(4) Appliances with integral vents as provided in Section 509.2.5.

(5) Mechanical draft systems as provided in Section 509.3.3.

(6) Ventilating hoods and exhaust systems as provided in Section 509.3.4. [NFPA 54:12.7.2(1)]

**509.6.2.1 Type B and L Vents.** A Type B or a Type L gas vent shall terminate not less than 5 feet (1524 mm) in vertical height above the highest connected appliance draft hood or flue collar. [NFPA 54:12.7.2(2)]

**509.6.2.2 Type B-W Vents.** A Type B-W gas vent shall terminate not less than 12 feet (3658 mm) in vertical height above the bottom of the wall furnace. [NFPA 54:12.7.2(3)]

**509.6.2.3 Exterior Wall Termination.** A gas vent extending through an exterior wall shall not terminate adjacent to the wall or below eaves or parapets, except as provided in Section 509.2.4 and Section 509.3.3. [NFPA 54:12.7.2(4)]

**509.6.2.4 Decorative Shrouds.** Decorative shrouds shall not be installed at the termination of gas vents except where such shrouds are listed for use with the specific gas venting system and are installed in accordance with manufacturer's installation instructions. [NFPA 54:12.7.2(5)]

**509.6.2.5 Forced Air Inlet.** A gas vent shall terminate not less than 3 feet (914 mm) above a forced air inlet located within 10 feet (3048 mm). [NFPA 54:12.7.2(7)]

**509.6.3 Size of Gas Vents.** Venting systems shall be sized and constructed in accordance with Section 510.0 or other approved engineering methods and the gas vent and gas appliance manufacturer's instructions. [NFPA 54:12.7.3]

**509.6.3.1 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:

(1) The provisions of Section 510.0.

(2) Vents serving fan-assisted combustion system appliances, or combinations of fan-assisted combustion systems and draft hood-equipped appliances, shall be sized in accordance with Section 510.0 or other approved engineering methods.

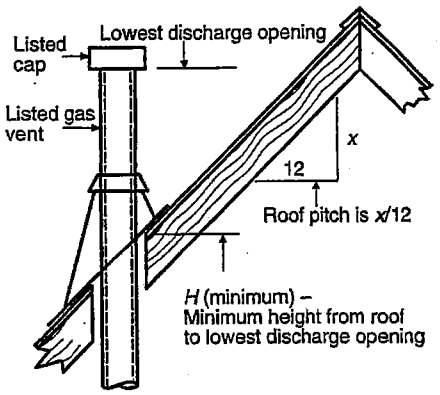



**FIGURE 509.6.2**
**GAS VENT TERMINATION LOCATIONS FOR LISTED CAPS 12 INCHES OR LESS IN SIZE NOT LESS THAN 8 FEET FROM A VERTICAL WALL**
**[NFPA 54: FIGURE 12.7.2]**

**TABLE 509.6.2**
**ROOF PITCH HEIGHT**
**[NFPA 54: TABLE 12.7.2]**

| ROOF PITCH | H (minimum) (feet) |
|---|---|
| Flat to 6/12 | 1.0 |
| Over 6/12 to 7/12 | 1.25 |
| Over 7/12 to 8/12 | 1.5 |
| Over 8/12 to 9/12 | 2.0 |
| Over 9/12 to 10/12 | 2.5 |
| Over 10/12 to 11/12 | 3.25 |
| Over 11/12 to 12/12 | 4.0 |
| Over 12/12 to 14/12 | 5.0 |
| Over 14/12 to 16/12 | 6.0 |
| Over 16/12 to 18/12 | 7.0 |
| Over 18/12 to 20/12 | 7.5 |
| Over 20/12 to 21/12 | 8.0 |

For SI Units: 1 inch = 25.4 mm, 1 foot = 304.8 mm

(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 exceeding seven times the draft hood outlet area.

(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 exceeding seven times the smaller draft hood outlet area.

(5) Approved engineering practices. [NFPA 54:12.7.3.1]

**509.6.3.2 Sizing.** Chimney venting systems using mechanical draft shall be sized in accordance with approved engineering methods. [NFPA 54:12.7.3.4]

**509.6.4 Gas Vents Serving Appliances on more than One Floor.** A common vent shall be permitted in multistory installations to vent Category I appliances located on more than one floor level, provided the venting system is designed and installed in accordance with approved engineering methods.

For the purpose of this section, crawl spaces, basements, and attics shall be considered as floor levels. [NFPA 54-12:12.7.4.1]

**509.6.4.1 Habitable Space.** Appliances connected to the common vent shall be located in rooms separated from a habitable space. Each of these rooms shall have provisions for an adequate supply of combustion, ventilation, and dilution air that is not supplied from a habitable space. (See Figure 509.6.4.1) [NFPA 54:12.7.4.2]

The size of the connectors and common segments of multistory venting systems for appliances listed for use with Type B double-wall gas vent shall be in accordance with Table 510.2(1), provided:

(1) The total height (*H*) for each segment of a multistory venting system is the vertical distance between the level of the highest draft hood outlet or flue collar on that floor and the centerline of the next highest interconnection tee.

(2) The size of the connector for a segment is determined from the appliance's gas input rate and connector rise, and shall not be smaller than the draft hood outlet or flue collar size.

(3) The size of the common vertical vent segment, and of the interconnection tee at the base of that segment, shall be based on the total appliance heat input entering that segment and its total height. [NFPA 54:12.7.4.3]

**509.6.5 Support of Gas Vents.** Gas vents shall be supported and spaced in accordance with their listings and the manufacturer's instructions. [NFPA 54:12.7.5]

**509.6.6 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 54:12.7.6]

**509.7 Single-Wall Metal Pipe.** Single-wall metal pipe shall be constructed of galvanized sheet steel not less than 0.0304 of an inch (0.7722 mm) thick or of other approved, noncombustible, corrosion-resistant material. [NFPA 54:12.8.1]

**509.7.1 Cold Climate.** Uninsulated single-wall metal pipe shall not be used outdoors for venting appliances. For venting appliances in regions where the 99 percent winter design temperature is below 32°F (0°C). [NFPA 54:12.8.2]

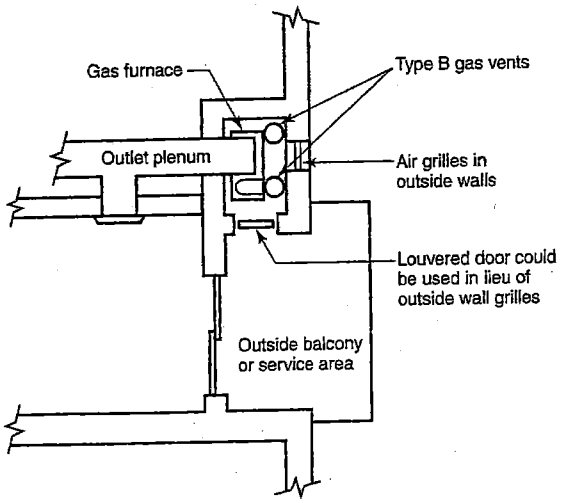



**FIGURE 509.6.4.1**
**PLAN VIEW OF PRACTICAL SEPARATION METHOD FOR MULTISTORY GAS VENTING**
**[NFPA 54: FIGURE 12.7.4.2]**

**509.7.2 Termination.** The termination of single-wall metal pipe shall comply with the following requirements:

(1) Single-wall metal pipe shall terminate not less than 5 feet (1524 mm) in vertical height above the highest connected appliance draft hood outlet or flue collar.

(2) Single-wall metal pipe shall extend not less than 2 feet (610 mm) above the highest point where it passes through the roof of a building and not less than 2 feet (610 mm) exceeding a portion of a building within a horizontal distance of 10 feet (3048 mm). (See Figure 509.5.4)

(3) An approved cap or roof assembly shall be attached to the terminus of a single-wall metal pipe. [NFPA 54:12.8.3]

**509.7.3 Installation with Appliances Permitted by Table 509.4.** Single-wall metal pipe shall not be used as a vent in dwellings and residential occupancies. [NFPA 54:12.8.4.1]

**509.7.3.1 Limitations.** Single-wall metal pipe shall be used for runs directly from the space in which the appliance 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 54:12.8.4.2]

**509.7.3.2 Attic or Concealed Space.** Single-wall metal pipe shall not originate in an unoccupied attic or concealed space and shall not pass through an attic, inside wall, concealed space, or floor. For the installation of a single-wall metal pipe through an exterior combustible wall see Section 509.7.3.5. [NFPA 54:12.8.4.3]

**509.7.3.3 Incinerator.** Single-wall metal pipe used for venting an incinerator shall be exposed and readily examinable for its full length and shall have required clearances maintained. [NFPA 54:12.8.4.4]

**509.7.3.4 Clearances.** Minimum clearances from single-wall metal pipe to combustible material shall be in accordance with Table 509.7.3. Reduced clearances from single-wall metal pipe to combustible material shall be as specified for vent connectors in Table 509.7.3(1). [NFPA 54:12.8.4.5]

**509.7.3.5 Exterior.** Single-wall metal pipe shall not pass through a combustible exterior wall unless guarded at the point of passage by a ventilated metal thimble not smaller than the following:

(1) For listed appliances with draft hoods and appliances listed for use with Type B gas vents, the thimble shall be not less than 4 inches (102 mm) larger in diameter than the metal pipe. Where there is a run of not less than 6 feet (1829 mm) of metal pipe in the opening between the draft hood outlet and the thimble, the thimble shall be a minimum 2 inches (51 mm) larger in diameter than the metal pipe.

(2) For unlisted appliances having draft hoods, the thimble shall be a minimum 6 inches (152 mm) larger in diameter than the metal pipe.

(3) For residential and low-heat appliances, the thimble shall be not less than 12 inches (305 mm) larger in diameter than the metal pipe.

**Exception:** In lieu of thimble protection, combustible material in the wall shall be removed a sufficient distance from the metal pipe to provide the specified clearance from such metal pipe to combustible material. Any material used to close up such opening shall be noncombustible. [NFPA 54:12.8.4.7]

**509.7.3.6 Roof Thimble.** Where a single-wall metal pipe passes through a roof constructed of combustible material, a noncombustible, nonventilating thimble shall be used at the point of passage. The thimble shall extend not less than 18 inches (457 mm) above and 6 inches (152 mm) below the roof with the annular space open at the bottom and closed at the top. The thimble shall be sized in accordance with Section 509.7.3.5. [NFPA 54:12.8.4.6]

**509.7.4 Size of Single-Wall Metal Pipe.** Single-wall metal piping shall comply with the following sections. [NFPA 54:12.8.5]

**509.7.4.1 Sizing of Venting System.** A venting system of a single-wall metal pipe shall be sized in accordance with one of the following methods and the gas appliance manufacturer's instructions:

(1) For a draft hood-equipped appliance, in accordance with Section 510.0.

(2) For a venting system for a single appliance with a draft hood, the areas of the connector and the pipe each shall be not less than the area of the appliance flue collar or draft hood outlet, whichever is smaller. The vent area shall not exceed seven times the draft hood outlet area.

(3) Other approved engineering methods. [NFPA 54:12.8.5(1)]

**509.7.4.2 Non-Round Metal Pipe.** Where a single-wall metal pipe is used and has a shape other than round, it shall have an effective area equal to the effective area of the round pipe for which it is substituted, and the internal dimension of the pipe shall be not less than 2 inches (51 mm). [NFPA 54:12.8.5(2)]

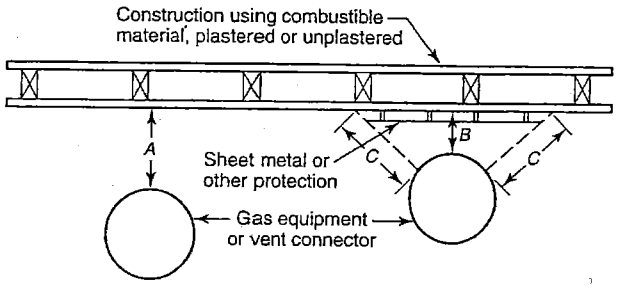
**509.7.4.3 Venting Capacity.** The vent cap or a roof assembly shall have a venting capacity not less than that of the pipe to which it is attached. [NFPA 54:12.8.5(3)]

**TABLE 509.7.3**
**CLEARANCE FOR CONNECTORS**
**[NFPA 54: TABLE 12.8.4.5]***

| | MINIMUM DISTANCE FROM COMBUSTIBLE MATERIAL (inches) | | | |
|---|---|---|---|---|
| APPLIANCE | LISTED TYPE B GAS VENT MATERIAL | LISTED TYPE L VENT MATERIAL | SINGLE-WALL METAL PIPE | FACTORY-BUILT CHIMNEY SECTIONS |
| Listed appliances with draft hoods and appliances listed for use with Type B gas vents | As listed | As listed | 6 | As listed |
| Residential boilers and furnaces with listed gas conversion burner and with draft hood | 6 | 6 | 9 | As listed |
| Residential appliances listed for use with Type L vents | Not permitted | As listed | 9 | As listed |
| Unlisted residential appliances with draft hood | Not permitted | 6 | 9 | As listed |
| Residential and low-heat appliances other than those above | Not permitted | 9 | 18 | As listed |
| Medium-heat appliances | Not permitted | Not permitted | 36 | As listed |

For SI units: 1 inch = 25.4 mm

* These clearances shall apply unless the installation instructions of a listed appliance or connector specify different clearances, in which case the listed clearances shall apply.

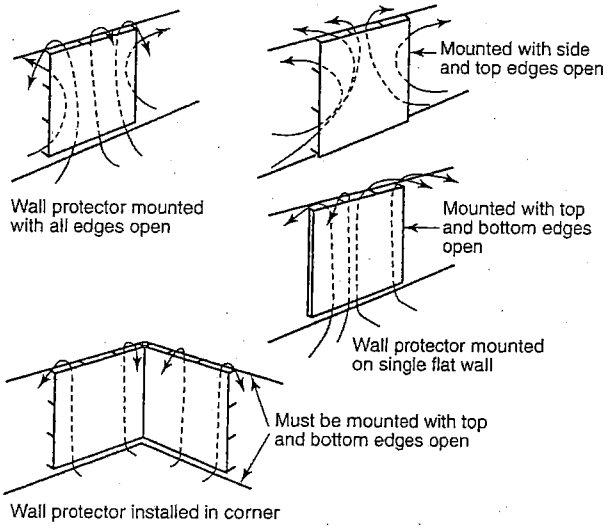


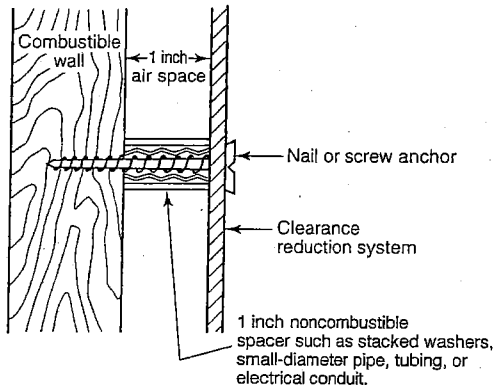

**Notes:**

A – Equals the clearance with no protection specified in Table 509.7.3 and Table 509.7.3(1) and in the sections applying to various types of appliances.

B – Equals the reduced clearance permitted in accordance with Table 509.7.3. The protection applied to the construction using combustible material shall extend far enough in each direction to make C equal to A.

**FIGURE 509.7.3**
**EXTENT OF PROTECTION NECESSARY TO REDUCE CLEARANCES FROM GAS APPLIANCES OR VENT CONNECTORS**
**[NFPA 54: FIGURE 10.3.2.2(a)]**




For SI units: 1 inch = 25.4 mm

**Note:** Masonry walls shall be attached to combustible walls using wall ties. Spacers shall not be used directly behind appliance or connector.

**FIGURE 509.7.3(1)**
**WALL PROTECTION REDUCTION SYSTEM**
**[NFPA 54: FIGURE 10.3.2.2(b)]**

**509.7.5 Support of Single-Wall Metal Pipe.** Portions of single-wall metal pipe shall be supported for the design and weight of the material employed. [NFPA 54:12.8.6]

**509.7.6 Marking.** Single-wall metal pipe shall comply with the marking provisions of Section 509.6.6. [NFPA 54:12.8.7]

**509.8 Through-the-Wall Vent Termination.** (See Figure 509.8.) A mechanical draft venting system shall terminate not less than 3 feet (914 mm) above a forced air inlet located within 10 feet (3048 mm).

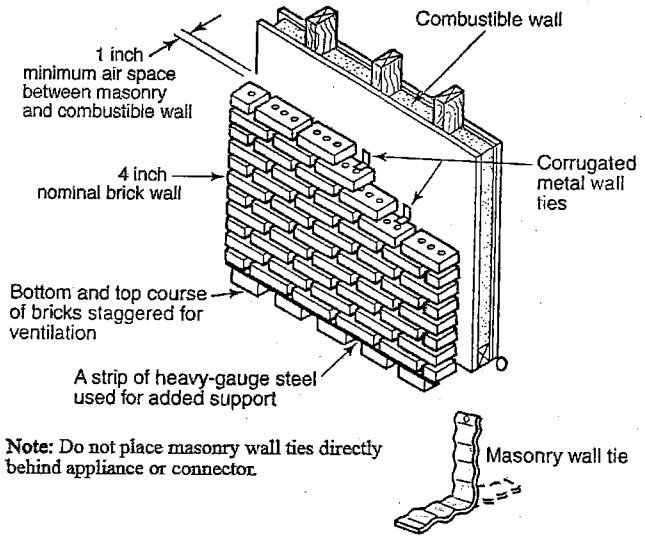
**Exceptions:**

(1) This provision shall not apply to the combustion air intake of a direct-vent appliance.

(2) This provision shall not apply to the separation of the integral outdoor air inlet and flue gas discharge of listed outdoor appliances. [NFPA 54:12.9.1]

**509.8.1 Mechanical Draft Venting System.** A mechanical draft venting system of other than direct-vent type shall terminate not less than 4 feet (1219 mm) below, 4 feet (1219 mm) horizontally from, or 1 foot (305 mm) above a door, operable window, or gravity air inlet into a building. The bottom of the vent terminal shall be located not less than 12 inches (305 mm) above finished grade. [NFPA 54:12.9.2]

**509.8.2 Direct-Vent Appliance.** The vent terminal of a direct-vent appliance with an input of 10 000 Btu/h (3 kW) or less shall be located not less than 6 inches (152 mm) from an air opening into a building, and such an appliance with an input over 10 000 Btu/h (3 kW) but not exceeding 50 000 Btu/h (14.7 kW) shall be installed with




For SI units: 1 inch = 25.4 mm

**FIGURE 509.7.3(2)**
**MASONRY CLEARANCE REDUCTION SYSTEM**
**[NFPA 54: FIGURE 10.3.2.2(c)]**

a 9 inch (229 mm) vent termination clearance, and an appliance with an input over 50 000 Btu/h (14.7 kW) shall have not less than a 12 inch (305 mm) vent termination clearance. The bottom of the vent terminal and the air intake shall be located not less than 12 inches (305 mm) above finished grade. [NFPA 54:12.9.3]

**509.8.3 Nuisance and Hazard.** Through-the-wall vents for Category II and Category IV appliances and noncategorized condensing appliances shall not terminate over public walkways or over an area where condensate or vapor is capable of creating a nuisance or hazard 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.

Drains for condensate shall be installed in accordance with the appliance and the vent manufacturer's installation instructions. [NFPA 54-12:12.9.4]

**509.8.4 Annular Spaces.** Where vents, including those for direct-vent appliances or combustion air intake pipes, penetrate outside walls of buildings, the annular spaces around such penetrations shall be permanently sealed using approved materials to prevent entry of combustion products into the building. [NFPA 54:12.9.5]

**509.8.5 Vent Terminals.** Vent terminals that terminate through an outside wall of a building shall be located not less than 10 feet (3048 mm) horizontally from an operable opening in an adjacent building. This shall not apply to operable openings that are not less than 2 feet (610 mm) below or 25 feet (7620 mm) above the elevation of the vent terminal. [NFPA 54-12:12.9.6]

**509.9 Condensation Drain.** Provision shall be made to collect and dispose of condensate from venting systems serving Category II and Category IV appliances and noncategorized condensing appliances in accordance with Section 509.8.3. [NFPA 54:12.10.1]

**509.9.1 Local Experience.** 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 appliances in accordance with Section 509.8.3. [NFPA 54:12.10.2]

**509.10 Vent Connectors for Category I Appliances.** A vent connector shall be used to connect an appliance 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 appliance. [NFPA 54:12.11.1]

**509.10.1 Materials.** A vent connector shall be made of noncombustible, corrosion resistant material capable of withstanding the vent gas temperature produced by the appliance and of a thickness to withstand physical damage. [NFPA 54:12.11.2.1]

**509.10.1.1 Unconditioned Area.** Where the vent connector used for an appliance having a draft hood or a Category I appliance is located in or passes through an unconditioned area, attic or crawl space, that portion of the vent connector shall be listed Type B, Type L, or listed vent material having equivalent insulation qualities.

**Exception:** Single-wall metal pipe located within the exterior walls of the building and located in an uncon-

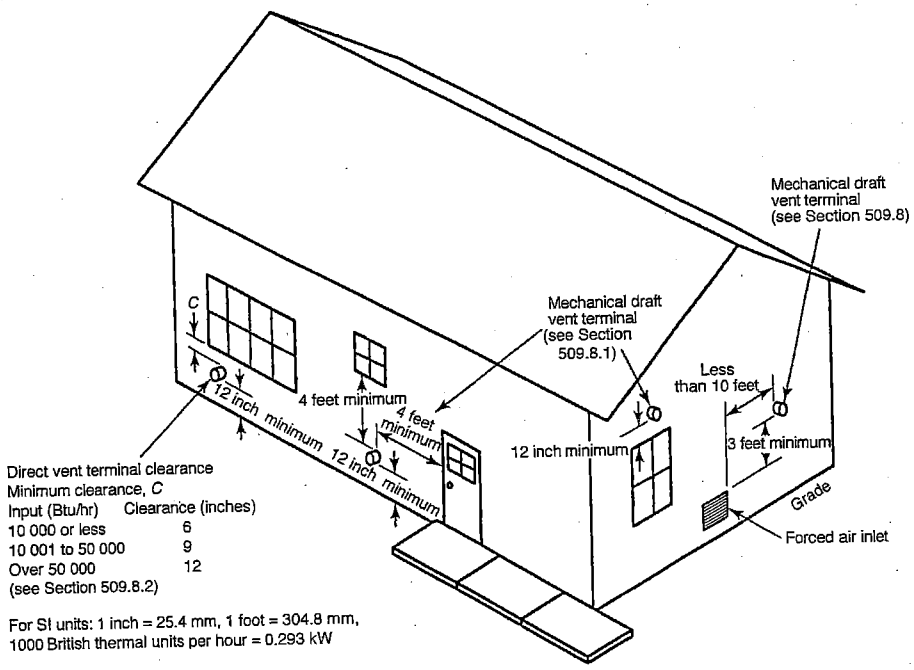



FIGURE 509.8
EXIT TERMINALS OF MECHANICAL DRAFT AND DIRECT-VENT VENTING SYSTEMS
[NFPA 54: FIGURE A.12.9]

## TABLE 509.7.3(1)
## REDUCTION OF CLEARANCES WITH SPECIFIED FORMS OF PROTECTION[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11]
## [NFPA 54: TABLE 10.2.3(b)]

| TYPE OF PROTECTION APPLIED TO AND COVERING SURFACES OF COMBUSTIBLE MATERIAL WITHIN THE DISTANCE SPECIFIED AS THE REQUIRED CLEARANCE WITH NO PROTECTION [SEE FIGURE 509.7.3 THROUGH FIGURE 509.7.3(2)] | WHERE THE REQUIRED CLEARANCE WITH NO PROTECTION FROM APPLIANCE, VENT CONNECTOR, OR SINGLE-WALL METAL PIPE IS: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 36 (inches) | | 18 (inches) | | 12 (inches) | | 9 (inches) | | 6 (inches) | |
| | ALLOWABLE CLEARANCES WITH SPECIFIED PROTECTION (inches) | | | | | | | | | |
| | USE COLUMN 1 FOR CLEARANCES ABOVE APPLIANCE OR HORIZONTAL CONNECTOR. USE COLUMN 2 FOR CLEARANCES FROM APPLIANCES, VERTICAL CONNECTOR, AND SINGLE-WALL METAL PIPE. | | | | | | | | | |
| | ABOVE COLUMN 1 | SIDES AND REAR COLUMN 2 | ABOVE COLUMN 1 | SIDES AND REAR COLUMN 2 | ABOVE COLUMN 1 | SIDES AND REAR COLUMN 2 | ABOVE COLUMN 1 | SIDES AND REAR COLUMN 2 | ABOVE COLUMN 1 | SIDES AND REAR COLUMN 2 |
| (1) 3½ inch thick masonry wall without ventilated air space | — | 24 | — | 12 | — | 9 | — | 6 | — | 5 |
| (2) ½ of an inch insulation board over 1 inch glass fiber or mineral wool batts | 24 | 18 | 12 | 9 | 9 | 6 | 6 | 5 | 4 | 3 |
| (3) 0.024 inch sheet metal over 1 inch glass fiber or mineral wool batts reinforced with wire on rear face with ventilated air space | 18 | 12 | 9 | 6 | 6 | 4 | 5 | 3 | 3 | 3 |
| (4) 3½ inch thick masonry wall with ventilated air space | — | 12 | — | 6 | — | 6 | — | 6 | — | 6 |
| (5) 0.024 inch sheet metal with ventilated air space | 18 | 12 | 9 | 6 | 6 | 4 | 5 | 3 | 3 | 2 |
| (6) ½ of an inch thick insulation board with ventilated air space | 18 | 12 | 9 | 6 | 6 | 4 | 5 | 3 | 3 | 3 |
| (7) 0.024 inch sheet metal with ventilated air space over 0.024 inch sheet metal with ventilated air space | 18 | 12 | 9 | 6 | 6 | 4 | 5 | 3 | 3 | 3 |
| (8) 1 inch glass fiber or mineral wool batts sandwiched between two sheets 0.024 inch sheet metal with ventilated air space | 18 | 12 | 9 | 6 | 6 | 4 | 5 | 3 | 3 | 3 |

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

**Notes:**

1 Reduction of clearances from combustible materials shall not interfere with combustion air, draft hood clearance and relief, and accessibility of servicing.

2 Clearances shall be measured from the outer surface of the combustible material to the nearest point on the surface of the appliance, disregarding an intervening protection applied to the combustible material.

3 Spacers and ties shall be of noncombustible material. No spacer or tie shall be used directly opposite the appliance or connector.

4 Where clearance reduction systems use a ventilated air space, adequate provision for air circulation shall be provided as described. [See Figure 509.7.3(1) and Figure 509.7.3(2)]

5 There shall be not less than 1 inch (25.4 mm) between clearance reduction systems and combustible walls and ceilings for reduction systems using a ventilated air space.

6 Where a wall protector is mounted on a single flat wall away from corners, it shall have a minimum 1 inch (25.4 mm) air gap. To provide air circulation, the bottom and top edges, or only the side and top edges, or edges shall be left open.

7 Mineral wool batts (blanket or board) shall have a minimum density of 8 pounds per cubic foot (lb/ft$^3$) (128 kg/m$^3$) and a minimum melting point of 1500°F (816°C).

8 Insulation material used as part of a clearance reduction system shall have a thermal conductivity of 1 British thermal unit inch per hour square foot degree Fahrenheit [Btu•in/(h•ft$^2$•°F)] [0.1 W/(m•K)] or less.

9 There shall be not less than 1 inch (25.4 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.

10 Clearances and thicknesses are minimum; larger clearances and thicknesses are acceptable.

11 Listed single-wall connectors shall be installed in accordance with the terms of their listing and the manufacturer's installation instructions.

ditioned area other than an attic or a crawl space having a local 99 percent winter design temperature of 5°F (-15°C) or higher. [NFPA 54-12:12.11.2.2]

**509.10.1.2 Residential-Type Appliances.** Vent connectors for residential-type appliances shall comply with the following:

(1) Vent connectors for listed appliances having draft hoods, 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:
   (a) Type B or Type L vent material.
   (b) Galvanized sheet steel not less than 0.018 of an inch (0.457 mm) thick.
   (c) Aluminum (1100 or 3003 alloy or equivalent) sheet not less than 0.027 of an inch (0.686 mm) thick.
   (d) Stainless steel sheet not less than 0.012 of an inch (0.305 mm) thick.
   (e) Smooth interior wall metal pipe having resistance to heat and corrosion equal to or exceeding that of Section 509.10.1.2(1)(b), Section 509.10.1.2(1)(c), or Section 509.10.1.2(1)(d) above.
   (f) A listed vent connector.

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

**Exception:** Listed insulated vent connectors shall be installed in accordance with the manufacturer's installation instructions. [NFPA 54:12.11.2.4]

**509.10.1.3 Non-Residential Low-Heat Appliances.** A vent connector for a non-residential low-heat appliance shall be a factory-built chimney section or steel pipe having resistance to heat and corrosion equivalent to the galvanized pipe specified in Table 509.10.1. Factory-built chimney sections shall be installed in accordance with the chimney manufacturer's installation instructions. [NFPA 54:12.11.2.5]

**509.10.1.4 Medium-Heat Appliances.** Vent connectors for medium-heat appliances, and commercial and industrial incinerators, shall be constructed of factory-built, medium-heat chimney sections or steel of a thickness not less than that specified in Table 509.10.1(1) and shall comply with the following:

(1) A steel vent connector for appliances with a vent gas temperature in excess of 1000°F (538°C) measured at the entrance to the connector shall be lined with medium-duty fire brick or the equivalent.

(2) The lining shall be not less than 2½ inches (64 mm) thick for a vent connector having a diameter or greatest cross-sectional dimension of 18 inches (457 mm) or less.

(3) The lining shall be not less than 4½ inches (114 mm) thick laid on the 4½ inch (114 mm) bed for a vent connector having a diameter or cross-sectional dimension exceeding 18 inches (457 mm).

(4) Factory-built chimney sections, where employed, shall be installed in accordance with the chimney manufacturer's installation instructions. [NFPA 54:12.11.2.6]

**509.10.2 Size of Vent Connector.** A vent connector for an appliance with a single draft hood or for a Category I fan-assisted combustion system appliance shall be sized and installed in accordance with Section 510.0 or other approved engineering methods. [NFPA 54:12.11.3.1]

**509.10.2.1 Manifold.** 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 not less than 1 foot (305 mm) rise. [NFPA 54:12.11.3.2]

**TABLE 509.10.1**
**MINIMUM THICKNESS FOR GALVANIZED STEEL VENT CONNECTORS FOR LOW-HEAT APPLIANCES**
**[NFPA 54: TABLE 12.11.2.5]**

| DIAMETER OF CONNECTOR (inches) | MINIMUM THICKNESS (inches) |
|---|---|
| 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 inch = 25.4 mm, 1 square inch = 0.000645 $m^2$

**TABLE 509.10.1(1)**
**MINIMUM THICKNESS FOR STEEL VENT CONNECTORS FOR MEDIUM-HEAT APPLIANCES AND COMMERCIAL AND INDUSTRIAL INCINERATORS**
**[NFPA 54: TABLE 12.11.2.6]**

| VENT CONNECTOR SIZE | | |
|---|---|---|
| DIAMETER (inches) | AREA (square inches) | MINIMUM THICKNESS (inches) |
| 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 | Exceeding 254 | 0.123 |

For SI units: 1 inch = 25.4 mm, 1 square inch = 0.000645 $m^2$

**509.10.2.2 Size.** Where two or more appliances are connected to a common vent or chimney, each vent connector shall be sized in accordance with Section 510.0 or other approved engineering methods. [NFPA 54:12.11.3.3]

As an alternative method applicable where the appliances are draft hood-equipped, each vent connector shall have an effective area not less than the area of the draft hood outlet of the appliance to which it is connected. [NFPA 54:12.11.3.4]

**509.10.2.3 Height.** Where two or more 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 Section 510.0 or other approved engineering methods. [NFPA 54:12.11.3.5]

As an alternate method applicable where there are two draft hood-equipped appliances, the effective area of the common vent connector or vent manifold and 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 54:12.11.3.6]

**509.10.2.4 Size Increase.** Where the size of a vent connector is increased to overcome installation limitations and obtain connector capacity equal to the appliance input, the size increase shall be made at the appliance draft hood outlet. [NFPA 54:12.11.3.7]

**509.10.3 Two or More Appliances Connected to a Single Vent.** Where two or more openings are provided into one chimney flue or vent, the openings shall be at different levels, or the connectors shall be attached to the vertical portion of the chimney or vent at an angle of 45 degrees (0.79 rad) or less relative to the vertical. [NFPA 54:12.11.4.1]

**509.10.3.1 Height of Connector.** Where two or more vent connectors enter a common 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 54-12:12.11.4.2]

**509.10.3.2 Pressure.** Vent connectors serving Category I appliances shall not be connected to a portion of a mechanical draft system operating under positive static pressure, such as those serving Category III or Category IV appliances. [NFPA 54:12.11.4.3]

**509.10.4 Clearance.** Minimum clearances from vent connectors to combustible material shall comply with Table 509.7.3.

**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 509.7.3(1). [NFPA 54:12.11.5]

**509.10.5 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:

(1) By sheet metal screws.

(2) Vent connectors of listed vent material shall be assembled and connected to flue collars or draft hood outlets in accordance with the manufacturer's installation instructions.

(3) Other approved means. [NFPA 54:12.11.7]

**509.10.6 Slope.** A vent connector shall be installed without dips or sags and shall slope upward toward the vent or chimney not less than ¼ inch per foot (20.8 mm/m).

**Exception:** Vent connectors attached to a mechanical draft system installed in accordance with the appliance and draft system manufacturer's installation instructions. [NFPA 54:12.11.8]

**509.10.7 Length of Vent Connector.**

**509.10.7.1 Single Wall Connector.** The maximum horizontal length of a single-wall connector shall be 75 percent of the height of the chimney or vent except for engineered systems. [NFPA 54:12.11.9.2]

**509.10.7.2 Type B Double Wall Connector.** The maximum horizontal length of a Type B double-wall connector shall be 100 percent of the height of the chimney or vent, except for engineered systems. The maximum length of an individual connector for a chimney or vent system serving multiple appliances, 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 54:12.11.9.3]

**509.10.8 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 54:12.11.10]

**509.10.9 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 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 54:12.11.11]

**509.10.10 Inspection.** The entire length of a vent connector shall be readily accessible for inspection, cleaning, and replacement. [NFPA 54:12.11.12]

**509.10.11 Fireplaces.** A vent connector shall not be connected to a chimney flue serving a fireplace unless the fireplace flue opening is permanently sealed. [NFPA 54:12.11.13]

**509.10.12 Passage through Ceilings, Floors, or Walls.** A vent connector shall not pass through a ceiling, floor, or fire-resistance-rated wall. A single-wall metal pipe connector shall not pass through an interior wall.

**Exception:** Vent connectors made of listed Type B or Type L vent material and serving listed appliances with draft hoods and other appliances 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.

**509.10.12.1 Medium-Heat Appliances.** Vent connectors for medium-heat appliances shall not pass through walls or partitions constructed of combustible material. [NFPA 54:12.11.14.2]

**509.11 Draft Hoods and Draft Controls.** Vented appliances shall be installed with draft hoods.

**Exception:** Dual oven-type combination ranges; incinerators; direct-vent appliances; fan-assisted combustion system appliances; appliances requiring chimney draft for operation; single firebox boilers equipped with conversion burners with inputs exceeding 400 000 Btu/h (117 kW); appliances equipped with blast, power, or pressure burners that are not listed for use with draft hoods; and appliances designed for forced venting. [NFPA 54:12.13.1]

**509.11.1 Installation.** A draft hood supplied with or forming a part of listed vented appliances shall be installed without alteration, exactly as furnished and specified by the appliance manufacturer.

Where a draft hood is not supplied by the appliance 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 appliance flue collar. Where a draft hood is required with a conversion burner, it shall be of a listed or approved type.

Where a draft hood of special design is needed or preferable, the installation shall be in accordance with the recommendations of the appliance manufacturer and shall be with the approval of the Authority Having Jurisdiction. [NFPA 54:12.13.2]

**509.11.2 Draft Control Devices.** Where a draft control device is part of the appliance or is supplied by the appliance manufacturer, it shall be installed in accordance with the manufacturer's installation instructions. In the absence of manufacturer's installation instructions, the device shall be attached to the flue collar of the appliance or as near to the appliance as practical. [NFPA 54:12.13.3]

**509.11.3 Additional Devices.** Appliances (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 installation instructions. [NFPA 54:12.13.4]

**509.11.4 Location.** Draft hoods and barometric draft regulators shall be installed in the same room or enclosure as the appliance in such a manner as to prevent a difference in pressure between the hood or regulator and the combustion air supply. [NFPA 54:12.13.5]

**509.11.5 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 a part of the appliance or adjacent construction. The appliance and its draft hood shall be located so that the relief opening is accessible for checking vent operation. [NFPA 54:12.13.6]

**509.11.6 Clearance.** A draft hood shall be located so that its relief opening is not less than 6 inches (152 mm) from a surface except that of the appliance it serves and the venting system to which the draft hood is connected. Where a greater or lesser clearance is indicated on the appliance label, the clearance shall not be less than that specified on the label. Such clearances shall not be reduced. [NFPA 54:12.13.7]

**509.12 Manually Operated Dampers.** A manually operated damper shall not be placed in an appliance vent connector. Fixed baffles shall not be classified as manually operated dampers. [NFPA 54:12.14]

**509.13 Automatically Operated Vent Dampers.** An automatically operated vent damper shall be of a listed type. [NFPA 54:12.15]

**509.14 Obstructions.** Devices that retard the flow of vent gases shall not be installed in a vent connector, chimney, or vent. The following shall not be considered as obstructions:

(1) Draft regulators and safety controls specifically listed for installation in venting systems and installed in accordance with the manufacturer's installation instructions.

(2) Approved draft regulators and safety controls designed and installed in accordance with approved engineering methods.

(3) Listed heat reclaimers and automatically operated vent dampers installed in accordance with the manufacturer's installation instructions.

(4) Vent dampers serving listed appliances installed in accordance with Section 510.0 or other approved engineering methods.

(5) Approved economizers, heat reclaimers, and recuperators installed in venting systems of appliances not required to be equipped with draft hoods, provided the appliance manufacturer's installation instructions cover the installation of such a device in the venting system and performance in accordance with Section 509.3 and Section 509.3.1 is obtained. [NFPA 54:12.16]

**510.0 Sizing of Category I Venting Systems.**

**510.1 Installation.** These venting tables shall not be used where obstructions are installed in the venting system. The

installation of vents serving listed appliances with vent dampers shall be installed in accordance with the appliance manufacturer's installation instructions or in accordance with the following:

(1) The maximum capacity of the vent system shall be determined using the NAT Max column.

(2) The minimum capacity shall be determined as though 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]

**510.1.1 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 is in accordance with the following requirements:

(1) The total vent height (*H*) is not less than 10 feet (3048 mm).

(2) Vents for appliance draft hood outlets or flue collars 12 inches (305 mm) in diameter or smaller are not reduced more than one table size.

(3) Vents for appliance draft hood outlets or flue collars exceeding 12 inches (305 mm) in diameter are not reduced more than two table sizes.

(4) The maximum capacity listed in the tables for a fan-assisted appliance is reduced by 10 percent (0.90 x maximum table capacity).

(5) The draft hood outlet exceeds 4 inches (102 mm) in diameter. A 3 inch (76 mm) diameter vent shall not be connected to a 4 inch (102 mm) diameter draft hood outlet. This provision shall not apply to fan-assisted appliances. [NFPA 54:13.1.2]

**510.1.2 Elbows.** Single-appliance venting configurations with zero lateral lengths in Table 510.1.2(1), Table 510.1.2(2), and Table 510.1.2(5) shall not have elbows in the venting system. Single-appliance venting with lateral lengths, include two 90 degree (1.57 rad) elbows. For each additional elbow up to and including 45 degrees (0.79 rad), the maximum capacity listed in the venting tables shall be reduced by 5 percent. For each additional elbow greater than 45 degrees (0.79 rad) up to and including 90 degrees (1.57 rad), the maximum capacity listed in the venting tables shall be reduced by 10 percent. Where multiple offsets occur in a vent, the total lateral length of offsets combined shall not exceed that specified in Table 510.1.2(1) through Table 510.1.2(5). [NFPA 54:13.1.3]

**510.1.3 Zero Lateral.** Zero lateral (*L*) shall apply to a straight vertical vent attached to a top outlet draft hood or flue collar. [NFPA 54:13.1.4]

**510.1.4 High-Altitude Installations.** Sea level input ratings shall be used where 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]

**510.1.5 Multiple Input Ratings.** 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 exceed the highest appliance rating input. [NFPA 54:13.1.6]

**510.1.6 Corrugated Chimney Liner Reduction.** Listed corrugated metallic chimney liner systems in masonry chimneys shall be sized by using Table 510.1.2(1) or Table 510.1.2(2) for Type B vents with the maximum capacity reduced by 20 percent (0.80 x maximum capacity) and the minimum capacity as shown in Table 510.1.2(1) or Table 510.1.2(2).

Corrugated metallic liner systems installed with bends or offsets shall have their maximum capacity further reduced in accordance with Section 510.1.2. The 20 percent reduction for corrugated metallic chimney liner systems includes an allowance for one long radius 90 degree (1.57 rad) turn at the bottom of the liner. [NFPA 54:13.1.7]

**510.1.7 Connection to Chimney Liners.** Connections between chimney liners and listed double-wall connectors shall be made with listed adapters designed for such purposes. [NFPA 54:13.1.8]

**510.1.8 Vertical Vent Upsizing Using 7 x 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 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 54:13.1.9]

**510.1.9 Draft Hood Conversion Accessories.** Draft hood conversion accessories for use with masonry chimneys venting listed Category I fan-assisted appliances shall be listed and installed in accordance with the listed accessory manufacturer's installation instructions. [NFPA 54:13.1.10]

**510.1.10 Chimney and Vent Locations.** Table 510.1.2(1) through Table 510.1.2(5) shall be used for chimneys and vents not exposed to the outdoors below the roof line. A Type B vent or listed chimney lining system passing through an unused masonry chimney flue shall not be considered to be exposed to the outdoors. Where vents extend outdoors above the roof more than 5 feet (1524 mm) higher than required by Table 509.6.2, and where vents terminate in accordance with Section 509.6.2(1), the outdoor portion of the vent shall be

enclosed as required by this section for vents not considered to be exposed to the outdoors or such venting system shall be engineered. A Type B vent passing through an unventilated enclosure or chase insulated to a value of not less than R-8 shall not be considered to be exposed to the outdoors. Table 510.1.2(3) in combination with Table 510.1.2(6) shall be used for clay-tile-lined exterior masonry chimneys, provided the following requirements are met:

(1) The vent connector is Type B double wall.

(2) The vent connector length is limited to 18 inches per inch (18 mm/mm) of vent connector diameter.

(3) The appliance is draft hood-equipped.

(4) The input rating is less than the maximum capacity given in Table 510.1.2(3).

(5) For a water heater, the outdoor design temperature shall be not less than 5°F (-15°C).

(6) For a space-heating appliance, the input rating exceeds the minimum capacity given by Table 510.1.2(6). [NFPA 54-12:13.1.11]

**510.1.11 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 54:13.1.12]

**510.1.12 Upsizing.** Vent connectors shall not be upsized more than two sizes exceeding the listed appliance categorized vent diameter, flue collar diameter, or draft hood outlet diameter. [NFPA 54:13.1.13]

**510.1.13 Single Run of Vent.** In a single run of vent or vent connector, more than one diameter and type shall be permitted to be used, provided that the sizes and types are permitted by the tables. [NFPA 54:13.1.14]

**510.1.14 Interpolation.** Interpolation shall be permitted in calculating capacities for vent dimensions that fall between table entries. [NFPA 54:13.1.15]

**510.1.15 Extrapolation.** Extrapolation beyond the table entries shall not be permitted. [NFPA 54:13.1.16]

**510.1.16 Engineering Methods.** For vent heights lower than 6 feet (1829 mm) and higher than vent heights shown in the tables, engineering methods shall be used to calculate vent capacities. [NFPA 54:13.1.17]

**510.1.17 Height Entries.** Where the actual height of a vent falls between entries in the height column of the applicable table in Table 510.1.2(1) through Table 510.1.2(6), either:

(1) Interpolation shall be used.

(2) The lower vent capacity shown in the table entries shall be used for FAN Max and NAT Max column values and the higher vent capacity shall be used for the FAN Min column values. [NFPA 54-12:13.1.18]

**510.2 Additional Requirements to Multiple Appliance Vent Table 510.2(1) through Table 510.2(9).** These venting tables shall not be used where obstructions are installed in the venting system. The installation of vents serving listed appliances with vent dampers shall be installed in accordance with the appliance manufacturer's installation instructions or in accordance with the following:

(1) The maximum capacity of the vent connector shall be determined using the NAT Max column.

(2) The maximum capacity of the vertical vent or chimney shall be determined using the FAN + NAT column where the second appliance is a fan-assisted appliance, or the NAT + NAT column where the second appliance is equipped with a draft hood.

(3) The minimum capacity shall be determined as if the appliance were a fan-assisted appliance.

(a) The minimum capacity of the vent connector shall be determined using the FAN Min column.

(b) The FAN + FAN column shall be used where the second appliance is a fan-assisted appliance, and the FAN + NAT column shall be used where the second appliance is equipped with a draft hood, to determine whether the vertical vent or chimney configuration is not permitted (NA). Where the vent configuration is NA, the vent configuration shall not be permitted and an alternative venting configuration shall be utilized. [NFPA 54:13.2.1]

**510.2.1 Vent Connector Maximum Length.** The maximum vent connector horizontal length shall be 18 inches per inch (18 mm/mm) of connector diameter as shown in Table 510.2.1, or as permitted by Section 510.2.2. [NFPA 54-12:13.2.2]

**510.2.2 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 510.2.1 are permitted under the following conditions:

(1) The maximum capacity (FAN Max or NAT Max) of the vent connector shall be reduced 10 percent for each additional multiple of the length listed in Table 510.2.1. For example, the length listed for a 4 inch (102 mm) connector shall not exceed 6 feet (1829 mm). With a connector length exceeding 6 feet (1829 mm) but not exceeding 12 feet (3658 mm), the maximum capacity shall be reduced by 10 percent (0.90 x maximum vent connector capacity). With a connector length exceeding 12 feet (3658 mm) but not exceeding 18 feet (5486 mm), the maximum capacity shall be reduced by 20 percent (0.80 x maximum vent capacity).

(2) For a connector serving a fan-assisted appliance, the minimum capacity (FAN Min) of the connector shall be determined by referring to the corresponding single appliance table. For Type B double-wall connectors, Table 510.1.2(1) shall be used. For single-wall connectors, Table 510.1.2(2) shall be used. The height (*H*) and lateral (*L*) shall be meas-

ured according to the procedures for a single appliance vent, as if the other appliances were not present. [NFPA 54:13.2.3]

**510.2.3 Ten Percent Reduction.** Where the vent connectors are combined prior to entering the vertical portion of the common vent to form a common vent manifold, the size of the common vent manifold and the common vent shall be determined by applying a 10 percent reduction (0.90 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 18 inches per inch (18 mm/mm) of common vent diameter (*D*). [NFPA 54:13.2.4]

**510.2.4 Vent Offset.** Where the common vertical vent is offset, the maximum capacity of the common vent shall be reduced in accordance with Section 510.2.5, and the horizontal length of the common vent offset shall not exceed 18 inches per inch (18 mm/mm) of common vent diameter. Where multiple offsets occur in a common vent, the total horizontal length of offsets combined shall not exceed 18 inches per inch (18 mm/mm) of common vent diameter. [NFPA 54:13.2.5]

**510.2.5 Elbow Reduction.** For each elbow up to and including 45 degrees (0.79 rad) in the common vent, the maximum common vent capacity listed in the venting tables shall be reduced by 5 percent. For each elbow exceeding 45 degrees (0.79 rad) up to and including 90 degrees (1.57 rad), the maximum common vent capacity listed in the venting tables shall be reduced by 10 percent. [NFPA 54:13.2.6]

**510.2.6 Common Vent Minimum Size.** The cross-sectional area of the common vent shall be equal to or exceeding the cross-sectional area of the largest connector. [NFPA 54:13.2.8]

**510.2.7 Tee and Wye Fittings.** Tee and wye fittings connected to a common gas vent shall be considered as part of the common gas vent and constructed of materials consistent with that of the common gas vent. [NFPA 54:13.2.9]

**510.2.8 Size of Fittings.** At the point where tee or wye fittings connect to a common gas 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 gas vent connectors. [NFPA 54:13.2.10]

**510.2.9 High-Altitude Installations.** Sea level input ratings shall be used where determining maximum capacity for high-altitude installation. Actual input (derated for altitude) shall be used for determining minimum capacity for high-altitude installation. [NFPA 54:13.2.11]

**510.2.10 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 54:13.2.12]

**510.2.11 Vent Height.** For multiple units of appliances located on one floor, 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 54:13.2.13]

**510.2.12 Multistory Installations.** For multistory installations, total height (*H*) for each segment of the system shall be the vertical distance between the highest draft hood outlet or flue collar entering that segment and the centerline of the next higher interconnection tee. [NFPA 54:13.2.14]

**510.2.13 Size of Vents for Multistory Installations.** The size of the lowest connector and of the vertical vent leading to the lowest interconnection of a multistory system shall be in accordance with Table 510.1.2(1) or Table 510.1.2(2) for available total height (*H*) up to the lowest interconnection. [NFPA 54:13.2.15]

**510.2.14 Vent Type Multistory Installations.** Where used in multistory systems, vertical common vents shall be Type B double-wall and shall be installed with a listed vent cap. [NFPA 54:13.2.16]

**510.2.15 Offsets in Multistory Installations.** Offsets in multistory common vent systems shall be limited to a single offset in each system, and systems with an offset shall comply with the following:

(1) The offset angle shall not exceed 45 degrees (0.79 rad) from vertical.

(2) The horizontal length of the offset shall not exceed 18 inches per inch (18 mm/mm) of common vent diameter of the segment in which the offset is located.

(3) For the segment of the common vertical vent containing the offset, the common vent capacity listed in

**TABLE 510.2.1**
**VENT CONNECTOR MAXIMUM LENGTH**
**[NFPA 54: TABLE 13.2.2]**

| CONNECTOR DIAMETER (Inches) | MAXIMUM CONNECTOR HORIZONTAL LENGTH (feet) |
|---|---|
| 3 | 4½ |
| 4 | 6 |
| 5 | 7½ |
| 6 | 9 |
| 7 | 10½ |
| 8 | 12 |
| 9 | 13½ |
| 10 | 15 |
| 12 | 18 |
| 14 | 21 |
| 16 | 24 |
| 18 | 27 |
| 20 | 30 |
| 22 | 33 |
| 24 | 36 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm

the common venting tables shall be reduced by 20 percent (0.80 x maximum common vent capacity).

(4) A multistory common vent shall not be reduced in size above the offset. [NFPA 54:13.2.17]

**510.2.16 Flow Area of Vent.** Where two or more appliances are connected to a vertical vent or chimney, the flow area of the largest section of vertical vent or chimney shall not exceed seven times the smallest listed appliance categorized vent areas, flue collar area, or draft hood outlet area unless designed in accordance with approved engineering methods. [NFPA 54:13.2.18]

**510.2.17 Multiple Input Ratings.** 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 exceed the highest appliance input rating. [NFPA 54:13.2.19]

**510.2.18 Corrugated Metallic Chimney Liner Reduction.** Listed corrugated metallic chimney liner systems in masonry chimneys shall be sized by using Table 510.2(1) or Table 510.2(2) for Type B vents, with the maximum capacity reduced by 20 percent (0.80 x maximum capacity) and the minimum capacity as shown in Table 510.2(1) or Table 510.2(2). Corrugated metallic liner systems installed with bends or offsets shall have their maximum capacity further reduced in accordance with Section 510.2.4 and Section 510.2.5. The 20 percent reduction for corrugated metallic chimney liner systems includes an allowance for one long radius 90 degree (1.57 rad) turn at the bottom of the liner. [NFPA 54:13.2.20]

**510.2.19 Chimneys and Vents.** Table 510.2(1) through Table 510.2(5) shall be used for chimneys and vents not exposed to the outdoors below the roof line. A Type B vent passing through an unventilated enclosure or chase insulated to a value of not less than R-8 shall not be considered to be exposed to the outdoors. Where vents extend outdoors above the roof more than 5 feet (1524 mm) higher than required by Table 509.6.2, and where vents terminate in accordance with Section 509.6.2(1), the outdoor portion of the vent shall be enclosed as required by this section for vents not considered to be exposed to the outdoors or such venting system shall be engineered. Table 510.2(6) through Table 510.2(9) shall be used for clay-tile-lined exterior masonry chimneys, provided the following conditions are met:

(1) Vent connector is Type B double-wall.

(2) One appliance is draft hood-equipped.

(3) The combined appliance input rating is less than the maximum capacity given by Table 510.2(6) (for NAT + NAT) or Table 510.2(8) (for FAN + NAT).

(4) The input rating of each space-heating appliance exceeds the minimum input rating given by Table 510.2(7) (for NAT + NAT) or Table 510.2(9) (for FAN + NAT).

(5) The vent connector sizing is in accordance with Table 510.2(3). [NFPA 54-12:13.2.22]

**510.2.20 Vent Connector Size Limitations.** Vent connectors shall not be increased more than two sizes exceeding 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 is in accordance with the following conditions:

(1) Vent connectors for fan-assisted appliance flue collars 12 inches (305 mm) in diameter or smaller are not reduced by more than one table size [e.g., 12 inches to 10 inches (305 mm to 254 mm) is a one size reduction] and those exceeding 12 inches (305 mm) in diameter are not reduced exceeding two table sizes [e.g., 24 inches to 20 inches (610 mm to 508 mm) is a two size reduction].

(2) Fan-assisted appliances are common vented with a draft hood-equipped appliance.

(3) The vent connector has a smooth interior wall. [NFPA 54:13.2.24]

**510.2.21 Combination of Pipe Types and Sizes.** Combinations of pipe sizes, single-wall, and double-wall metal pipe shall be allowed within a connector run or within the common vent, provided the appropriate tables permit the desired sizes and types of pipe, where 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 shall be sized in accordance with Table 510.2(2) or Table 510.2(4). [NFPA 54:13.2.25]

**510.2.22 Multiple Connector and Vent Sizes.** Where a table permits more than one diameter of pipe to be used for a connector or vent, the permitted sizes shall be permitted to be used. [NFPA 54:13.2.26]

**510.2.23 Interpolation.** Interpolation shall be permitted in calculating capacities for vent dimensions that fall between table entries. [NFPA 54:13.2.27]

**510.2.24 Extrapolation.** Extrapolation beyond the table entries shall not be permitted. [NFPA 54:13.2.28]

**510.2.25 Engineering Methods.** For vent heights lower than 6 feet (1829 mm) and exceeding vent heights shown in the tables, engineering methods shall be used to calculate vent capacities. [NFPA 54:13.2.29]

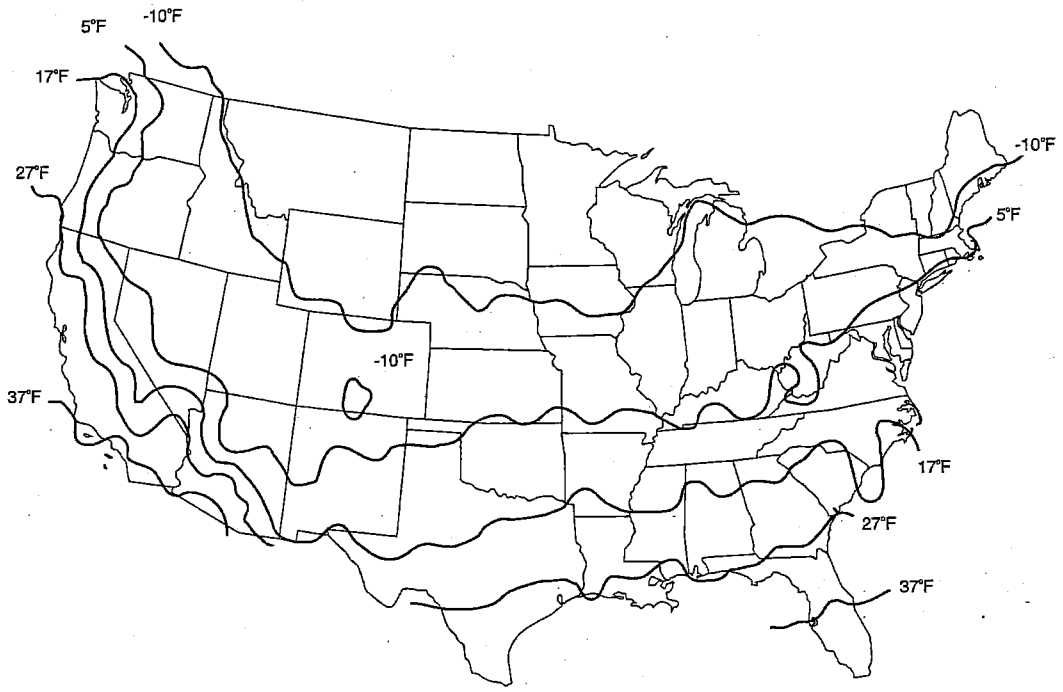
**510.2.26 Height Entries.** Where the actual height of a vent falls between entries in the height column of the applicable table in Table 510.2(1) through Table 510.2(9), either:

(1) Interpolation shall be used.

(2) The lower vent capacity shown in the table entries shall be used for FAN Max and NAT Max column values and the higher vent capacity shall be used for the FAN Min column values. [NFPA 54-12:13.2.30]

**511.0 Direct-Vent Appliances.**

**511.1 General.** Listed direct-vent appliances shall be considered properly vented where installed in accordance with the terms of its listing, the manufacturer's instructions, and Section 509.8.2. [NFPA 54:12.3.5]




**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.

For SI units: °C = (°F-32)/1.8

**FIGURE 510.1.2(6)**
**RANGE OF WINTER DESIGN TEMPERATURES USED IN ANALYZING EXTERIOR MASONRY CHIMNEYS IN THE UNITED STATES**
**[NFPA 54: FIGURE G.2.4]**

**TABLE 510.1.2(1)**
**TYPE B DOUBLE-WALL GAS VENT [NFPA 54: TABLE 13.1(a)]***

| | | NUMBER OF APPLIANCES: | SINGLE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | CATEGORY I | | | | | | | | | | | | |
| | | APPLIANCE VENT CONNECTION: | CONNECTED DIRECTLY TO VENT | | | | | | | | | | | | |
| | | VENT DIAMETER – *D* (inch) | | | | | | | | | | | | | |
| | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | |
| | | APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | | | |
| HEIGHT *H* (feet) | LATERAL *L* (feet) | 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 |
| 6 | 0 | 0 | 78 | 46 | 0 | 152 | 86 | 0 | 251 | 141 | 0 | 375 | 205 | 0 | 524 | 285 |
| | 2 | 13 | 51 | 36 | 18 | 97 | 67 | 27 | 157 | 105 | 32 | 232 | 157 | 44 | 321 | 217 |
| | 4 | 21 | 49 | 34 | 30 | 94 | 64 | 39 | 153 | 103 | 50 | 227 | 153 | 66 | 316 | 211 |
| | 6 | 25 | 46 | 32 | 36 | 91 | 61 | 47 | 149 | 100 | 59 | 223 | 149 | 78 | 310 | 205 |
| 8 | 0 | 0 | 84 | 50 | 0 | 165 | 94 | 0 | 276 | 155 | 0 | 415 | 235 | 0 | 583 | 320 |
| | 2 | 12 | 57 | 40 | 16 | 109 | 75 | 25 | 178 | 120 | 28 | 263 | 180 | 42 | 365 | 247 |
| | 5 | 23 | 53 | 38 | 32 | 103 | 71 | 42 | 171 | 115 | 53 | 255 | 173 | 70 | 356 | 237 |
| | 8 | 28 | 49 | 35 | 39 | 98 | 66 | 51 | 164 | 109 | 64 | 247 | 165 | 84 | 347 | 227 |
| 10 | 0 | 0 | 88 | 53 | 0 | 175 | 100 | 0 | 295 | 166 | 0 | 447 | 255 | 0 | 631 | 345 |
| | 2 | 12 | 61 | 42 | 17 | 118 | 81 | 23 | 194 | 129 | 26 | 289 | 195 | 40 | 402 | 273 |
| | 5 | 23 | 57 | 40 | 32 | 113 | 77 | 41 | 187 | 124 | 52 | 280 | 188 | 68 | 392 | 263 |
| | 10 | 30 | 51 | 36 | 41 | 104 | 70 | 54 | 176 | 115 | 67 | 267 | 175 | 88 | 376 | 245 |
| 15 | 0 | 0 | 94 | 58 | 0 | 191 | 112 | 0 | 327 | 187 | 0 | 502 | 285 | 0 | 716 | 390 |
| | 2 | 11 | 69 | 48 | 15 | 136 | 93 | 20 | 226 | 150 | 22 | 339 | 225 | 38 | 475 | 316 |
| | 5 | 22 | 65 | 45 | 30 | 130 | 87 | 39 | 219 | 142 | 49 | 330 | 217 | 64 | 463 | 300 |
| | 10 | 29 | 59 | 41 | 40 | 121 | 82 | 51 | 206 | 135 | 64 | 315 | 208 | 84 | 445 | 288 |
| | 15 | 35 | 53 | 37 | 48 | 112 | 76 | 61 | 195 | 128 | 76 | 301 | 198 | 98 | 429 | 275 |
| 20 | 0 | 0 | 97 | 61 | 0 | 202 | 119 | 0 | 349 | 202 | 0 | 540 | 307 | 0 | 776 | 430 |
| | 2 | 10 | 75 | 51 | 14 | 149 | 100 | 18 | 250 | 166 | 20 | 377 | 249 | 33 | 531 | 346 |
| | 5 | 21 | 71 | 48 | 29 | 143 | 96 | 38 | 242 | 160 | 47 | 367 | 241 | 62 | 519 | 337 |
| | 10 | 28 | 64 | 44 | 38 | 133 | 89 | 50 | 229 | 150 | 62 | 351 | 228 | 81 | 499 | 321 |
| | 15 | 34 | 58 | 40 | 46 | 124 | 84 | 59 | 217 | 142 | 73 | 337 | 217 | 94 | 481 | 308 |
| | 20 | 48 | 52 | 35 | 55 | 116 | 78 | 69 | 206 | 134 | 84 | 322 | 206 | 107 | 464 | 295 |
| 30 | 0 | 0 | 100 | 64 | 0 | 213 | 128 | 0 | 374 | 220 | 0 | 587 | 336 | 0 | 853 | 475 |
| | 2 | 9 | 81 | 56 | 13 | 166 | 112 | 14 | 283 | 185 | 18 | 432 | 280 | 27 | 613 | 394 |
| | 5 | 21 | 77 | 54 | 28 | 160 | 108 | 36 | 275 | 176 | 45 | 421 | 273 | 58 | 600 | 385 |
| | 10 | 27 | 70 | 50 | 37 | 150 | 102 | 48 | 262 | 171 | 59 | 405 | 261 | 77 | 580 | 371 |
| | 15 | 33 | 64 | NA | 44 | 141 | 96 | 57 | 249 | 163 | 70 | 389 | 249 | 90 | 560 | 357 |
| | 20 | 56 | 58 | NA | 53 | 132 | 90 | 66 | 237 | 154 | 80 | 374 | 237 | 102 | 542 | 343 |
| | 30 | NA | NA | NA | 73 | 113 | NA | 88 | 214 | NA | 104 | 346 | 219 | 131 | 507 | 321 |
| 50 | 0 | 0 | 101 | 67 | 0 | 216 | 134 | 0 | 397 | 232 | 0 | 633 | 363 | 0 | 932 | 518 |
| | 2 | 8 | 86 | 61 | 11 | 183 | 122 | 14 | 320 | 206 | 15 | 497 | 314 | 22 | 715 | 445 |
| | 5 | 20 | 82 | NA | 27 | 177 | 119 | 35 | 312 | 200 | 43 | 487 | 308 | 55 | 702 | 438 |
| | 10 | 26 | 76 | NA | 35 | 168 | 114 | 45 | 299 | 190 | 56 | 471 | 298 | 73 | 681 | 426 |
| | 15 | 59 | 70 | NA | 42 | 158 | NA | 54 | 287 | 180 | 66 | 455 | 288 | 85 | 662 | 413 |
| | 20 | NA | NA | NA | 50 | 149 | NA | 63 | 275 | 169 | 76 | 440 | 278 | 97 | 642 | 401 |
| | 30 | NA | NA | NA | 69 | 131 | NA | 84 | 250 | NA | 99 | 410 | 259 | 123 | 605 | 376 |
| 100 | 0 | NA | NA | NA | 0 | 218 | NA | 0 | 407 | NA | 0 | 665 | 400 | 0 | 997 | 560 |
| | 2 | NA | NA | NA | 10 | 194 | NA | 12 | 354 | NA | 13 | 566 | 375 | 18 | 831 | 510 |
| | 5 | NA | NA | NA | 26 | 189 | NA | 33 | 347 | NA | 40 | 557 | 369 | 52 | 820 | 504 |
| | 10 | NA | NA | NA | 33 | 182 | NA | 43 | 335 | NA | 53 | 542 | 361 | 68 | 801 | 493 |
| | 15 | NA | NA | NA | 40 | 174 | NA | 50 | 321 | NA | 62 | 528 | 353 | 80 | 782 | 482 |
| | 20 | NA | NA | NA | 47 | 166 | NA | 59 | 311 | NA | 71 | 513 | 344 | 90 | 763 | 471 |
| | 30 | NA | NA | NA | NA | NA | NA | 78 | 290 | NA | 92 | 483 | NA | 115 | 726 | 449 |
| | 50 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 147 | 428 | NA | 180 | 651 | 405 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.1.2(1)**
**TYPE B DOUBLE-WALL GAS VENT [NFPA 54: TABLE 13.1(a)] (continued)**

| | | NUMBER OF APPLIANCES: | SINGLE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | CATEGORY I | | | | | | | | | | | | |
| | | APPLIANCE VENT CONNECTION: | CONNECTED DIRECTLY TO VENT | | | | | | | | | | | | |
| | | VENT DIAMETER – *D* (inch) | | | | | | | | | | | | | |
| | | 8 | | | 9 | | | 10 | | | 12 | | | 14 | | |
| | | APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | | | |
| HEIGHT *H* (feet) | LATERAL *L* (feet) | 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 |
| 6 | 0 | 0 | 698 | 370 | 0 | 897 | 470 | 0 | 1121 | 570 | 0 | 1645 | 850 | 0 | 2267 | 1170 |
| | 2 | 53 | 425 | 285 | 63 | 543 | 370 | 75 | 675 | 455 | 103 | 982 | 650 | 138 | 1346 | 890 |
| | 4 | 79 | 419 | 279 | 93 | 536 | 362 | 110 | 668 | 445 | 147 | 975 | 640 | 191 | 1338 | 880 |
| | 6 | 93 | 413 | 273 | 110 | 530 | 354 | 128 | 661 | 435 | 171 | 967 | 630 | 219 | 1330 | 870 |
| 8 | 0 | 0 | 780 | 415 | 0 | 1006 | 537 | 0 | 1261 | 660 | 0 | 1858 | 970 | 0 | 2571 | 1320 |
| | 2 | 50 | 483 | 322 | 60 | 619 | 418 | 71 | 770 | 515 | 98 | 1124 | 745 | 130 | 1543 | 1020 |
| | 5 | 83 | 473 | 313 | 99 | 607 | 407 | 115 | 758 | 503 | 154 | 1110 | 733 | 199 | 1528 | 1010 |
| | 8 | 99 | 463 | 303 | 117 | 596 | 396 | 137 | 746 | 490 | 180 | 1097 | 720 | 231 | 1514 | 1000 |
| 10 | 0 | 0 | 847 | 450 | 0 | 1096 | 585 | 0 | 1377 | 720 | 0 | 2036 | 1060 | 0 | 2825 | 1450 |
| | 2 | 48 | 533 | 355 | 57 | 684 | 457 | 68 | 852 | 560 | 93 | 1244 | 850 | 124 | 1713 | 1130 |
| | 5 | 81 | 522 | 346 | 95 | 671 | 446 | 112 | 839 | 547 | 149 | 1229 | 829 | 192 | 1696 | 1105 |
| | 10 | 104 | 504 | 330 | 122 | 651 | 427 | 142 | 817 | 525 | 187 | 1204 | 795 | 238 | 1669 | 1080 |
| 15 | 0 | 0 | 970 | 525 | 0 | 1263 | 682 | 0 | 1596 | 840 | 0 | 2380 | 1240 | 0 | 3323 | 1720 |
| | 2 | 45 | 633 | 414 | 53 | 815 | 544 | 63 | 1019 | 675 | 86 | 1495 | 985 | 114 | 2062 | 1350 |
| | 5 | 76 | 620 | 403 | 90 | 800 | 529 | 105 | 1003 | 660 | 140 | 1476 | 967 | 182 | 2041 | 1327 |
| | 10 | 99 | 600 | 386 | 116 | 777 | 507 | 135 | 977 | 635 | 177 | 1446 | 936 | 227 | 2009 | 1289 |
| | 15 | 115 | 580 | 373 | 134 | 755 | 491 | 155 | 953 | 610 | 202 | 1418 | 905 | 257 | 1976 | 1250 |
| 20 | 0 | 0 | 1057 | 575 | 0 | 1384 | 752 | 0 | 1756 | 930 | 0 | 2637 | 1350 | 0 | 3701 | 1900 |
| | 2 | 41 | 711 | 470 | 50 | 917 | 612 | 59 | 1150 | 755 | 81 | 1694 | 1100 | 107 | 2343 | 1520 |
| | 5 | 73 | 697 | 460 | 86 | 902 | 599 | 101 | 1133 | 738 | 135 | 1674 | 1079 | 174 | 2320 | 1498 |
| | 10 | 95 | 675 | 443 | 112 | 877 | 576 | 130 | 1105 | 710 | 172 | 1641 | 1045 | 220 | 2282 | 1460 |
| | 15 | 111 | 654 | 427 | 129 | 853 | 557 | 150 | 1078 | 688 | 195 | 1609 | 1018 | 248 | 2245 | 1425 |
| | 20 | 125 | 634 | 410 | 145 | 830 | 537 | 167 | 1052 | 665 | 217 | 1578 | 990 | 273 | 2210 | 1390 |
| 30 | 0 | 0 | 1173 | 650 | 0 | 1548 | 855 | 0 | 1977 | 1060 | 0 | 3004 | 1550 | 0 | 4252 | 2170 |
| | 2 | 33 | 826 | 535 | 42 | 1072 | 700 | 54 | 1351 | 865 | 74 | 2004 | 1310 | 98 | 2786 | 1800 |
| | 5 | 69 | 811 | 524 | 82 | 1055 | 688 | 96 | 1332 | 851 | 127 | 1981 | 1289 | 164 | 2759 | 1775 |
| | 10 | 91 | 788 | 507 | 107 | 1028 | 668 | 125 | 1301 | 829 | 164 | 1944 | 1254 | 209 | 2716 | 1733 |
| | 15 | 105 | 765 | 490 | 124 | 1002 | 648 | 143 | 1272 | 807 | 187 | 1908 | 1220 | 237 | 2674 | 1692 |
| | 20 | 119 | 743 | 473 | 139 | 977 | 628 | 160 | 1243 | 784 | 207 | 1873 | 1185 | 260 | 2633 | 1650 |
| | 30 | 149 | 702 | 444 | 171 | 929 | 594 | 195 | 1189 | 745 | 246 | 1807 | 1130 | 305 | 2555 | 1585 |
| 50 | 0 | 0 | 1297 | 708 | 0 | 1730 | 952 | 0 | 2231 | 1195 | 0 | 3441 | 1825 | 0 | 4934 | 2550 |
| | 2 | 26 | 975 | 615 | 33 | 1276 | 813 | 41 | 1620 | 1010 | 66 | 2431 | 1513 | 86 | 3409 | 2125 |
| | 5 | 65 | 960 | 605 | 77 | 1259 | 798 | 90 | 1600 | 996 | 118 | 2406 | 1495 | 151 | 3380 | 2102 |
| | 10 | 86 | 935 | 589 | 101 | 1230 | 773 | 118 | 1567 | 972 | 154 | 2366 | 1466 | 196 | 3332 | 2064 |
| | 15 | 100 | 911 | 572 | 117 | 1203 | 747 | 136 | 1536 | 948 | 177 | 2327 | 1437 | 222 | 3285 | 2026 |
| | 20 | 113 | 888 | 556 | 131 | 1176 | 722 | 151 | 1505 | 924 | 195 | 2288 | 1408 | 244 | 3239 | 1987 |
| | 30 | 141 | 844 | 522 | 161 | 1125 | 670 | 183 | 1446 | 876 | 232 | 2214 | 1349 | 287 | 3150 | 1910 |
| 100 | 0 | 0 | 1411 | 770 | 0 | 1908 | 1040 | 0 | 2491 | 1310 | 0 | 3925 | 2050 | 0 | 5729 | 2950 |
| | 2 | 21 | 1155 | 700 | 25 | 1536 | 935 | 30 | 1975 | 1170 | 44 | 3027 | 1820 | 72 | 4313 | 2550 |
| | 5 | 60 | 1141 | 692 | 71 | 1519 | 926 | 82 | 1955 | 1159 | 107 | 3002 | 1803 | 136 | 4282 | 2531 |
| | 10 | 80 | 1118 | 679 | 94 | 1492 | 910 | 108 | 1923 | 1142 | 142 | 2961 | 1775 | 180 | 4231 | 2500 |
| | 15 | 93 | 1095 | 666 | 109 | 1465 | 895 | 126 | 1892 | 1124 | 163 | 2920 | 1747 | 206 | 4182 | 2469 |
| | 20 | 105 | 1073 | 653 | 122 | 1438 | 880 | 141 | 1861 | 1107 | 181 | 2880 | 1719 | 226 | 4133 | 2438 |
| | 30 | 131 | 1029 | 627 | 149 | 1387 | 849 | 170 | 1802 | 1071 | 215 | 2803 | 1663 | 265 | 4037 | 2375 |
| | 50 | 197 | 944 | 575 | 217 | 1288 | 787 | 241 | 1688 | 1000 | 292 | 2657 | 1550 | 350 | 3856 | 2250 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

**TABLE 510.1.2(1)**
**TYPE B DOUBLE-WALL GAS VENT [NFPA 54: TABLE 13.1(a)] (continued)**

| | | NUMBER OF APPLIANCES: | SINGLE | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | CATEGORY I | | | | | | | | | | | | | |
| | | APPLIANCE VENT CONNECTION: | CONNECTED DIRECTLY TO VENT | | | | | | | | | | | | | |
| | | VENT DIAMETER – *D* (inch) | | | | | | | | | | | | | | |
| | | 16 | | | 18 | | | 20 | | | 22 | | | 24 | | |
| | | APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | | | | |
| HEIGHT *H* (feet) | LATERAL *L* (feet) | 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 |
| 6 | 0 | 0 | 2983 | 1530 | 0 | 3802 | 1960 | 0 | 4721 | 2430 | 0 | 5737 | 2950 | 0 | 6853 | 3520 |
| | 2 | 178 | 1769 | 1170 | 225 | 2250 | 1480 | 296 | 2782 | 1850 | 360 | 3377 | 2220 | 426 | 4030 | 2670 |
| | 4 | 242 | 1761 | 1160 | 300 | 2242 | 1475 | 390 | 2774 | 1835 | 469 | 3370 | 2215 | 555 | 4023 | 2660 |
| | 6 | 276 | 1753 | 1150 | 341 | 2235 | 1470 | 437 | 2767 | 1820 | 523 | 3363 | 2210 | 618 | 4017 | 2650 |
| 8 | 0 | 0 | 3399 | 1740 | 0 | 4333 | 2220 | 0 | 5387 | 2750 | 0 | 6555 | 3360 | 0 | 7838 | 4010 |
| | 2 | 168 | 2030 | 1340 | 212 | 2584 | 1700 | 278 | 3196 | 2110 | 336 | 3882 | 2560 | 401 | 4634 | 3050 |
| | 5 | 251 | 2013 | 1330 | 311 | 2563 | 1685 | 398 | 3180 | 2090 | 476 | 3863 | 2545 | 562 | 4612 | 3040 |
| | 8 | 289 | 2000 | 1320 | 354 | 2552 | 1670 | 450 | 3163 | 2070 | 537 | 3850 | 2530 | 630 | 4602 | 3030 |
| 10 | 0 | 0 | 3742 | 1925 | 0 | 4782 | 2450 | 0 | 5955 | 3050 | 0 | 7254 | 3710 | 0 | 8682 | 4450 |
| | 2 | 161 | 2256 | 1480 | 202 | 2868 | 1890 | 264 | 3556 | 2340 | 319 | 4322 | 2840 | 378 | 5153 | 3390 |
| | 5 | 243 | 2238 | 1461 | 300 | 2849 | 1871 | 382 | 3536 | 2318 | 458 | 4301 | 2818 | 540 | 5132 | 3371 |
| | 10 | 298 | 2209 | 1430 | 364 | 2818 | 1840 | 459 | 3504 | 2280 | 546 | 4268 | 2780 | 641 | 5099 | 3340 |
| 15 | 0 | 0 | 4423 | 2270 | 0 | 5678 | 2900 | 0 | 7099 | 3620 | 0 | 8665 | 4410 | 0 | 10 393 | 5300 |
| | 2 | 147 | 2719 | 1770 | 186 | 3467 | 2260 | 239 | 4304 | 2800 | 290 | 5232 | 3410 | 346 | 6251 | 4080 |
| | 5 | 229 | 2696 | 1748 | 283 | 3442 | 2235 | 355 | 4278 | 2777 | 426 | 5204 | 3385 | 501 | 6222 | 4057 |
| | 10 | 283 | 2659 | 1712 | 346 | 3402 | 2193 | 432 | 4234 | 2739 | 510 | 5159 | 3343 | 599 | 6175 | 4019 |
| | 15 | 318 | 2623 | 1675 | 385 | 3363 | 2150 | 479 | 4192 | 2700 | 564 | 5115 | 3300 | 665 | 6129 | 3980 |
| 20 | 0 | 0 | 4948 | 2520 | 0 | 6376 | 3250 | 0 | 7988 | 4060 | 0 | 9785 | 4980 | 0 | 11 753 | 6000 |
| | 2 | 139 | 3097 | 2000 | 175 | 3955 | 2570 | 220 | 4916 | 3200 | 269 | 5983 | 3910 | 321 | 7154 | 4700 |
| | 5 | 219 | 3071 | 1978 | 270 | 3926 | 2544 | 337 | 4885 | 3174 | 403 | 5950 | 3880 | 475 | 7119 | 4662 |
| | 10 | 273 | 3029 | 1940 | 334 | 3880 | 2500 | 413 | 4835 | 3130 | 489 | 5896 | 3830 | 573 | 7063 | 4600 |
| | 15 | 306 | 2988 | 1910 | 372 | 3835 | 2465 | 459 | 4786 | 3090 | 541 | 5844 | 3795 | 631 | 7007 | 4575 |
| | 20 | 335 | 2948 | 1880 | 404 | 3791 | 2430 | 495 | 4737 | 3050 | 585 | 5792 | 3760 | 689 | 6953 | 4550 |
| 30 | 0 | 0 | 5725 | 2920 | 0 | 7420 | 3770 | 0 | 9341 | 4750 | 0 | 11 483 | 5850 | 0 | 13 848 | 7060 |
| | 2 | 127 | 3696 | 2380 | 159 | 4734 | 3050 | 199 | 5900 | 3810 | 241 | 7194 | 4650 | 285 | 8617 | 5600 |
| | 5 | 206 | 3666 | 2350 | 252 | 4701 | 3020 | 312 | 5863 | 3783 | 373 | 7155 | 4622 | 439 | 8574 | 5552 |
| | 10 | 259 | 3617 | 2300 | 316 | 4647 | 2970 | 386 | 5803 | 3739 | 456 | 7090 | 4574 | 535 | 8505 | 5471 |
| | 15 | 292 | 3570 | 2250 | 354 | 4594 | 2920 | 431 | 5744 | 3695 | 507 | 7026 | 4527 | 590 | 8437 | 5391 |
| | 20 | 319 | 3523 | 2200 | 384 | 4542 | 2870 | 467 | 5686 | 3650 | 548 | 6964 | 4480 | 639 | 8370 | 5310 |
| | 30 | 369 | 3433 | 2130 | 440 | 4442 | 2785 | 540 | 5574 | 3565 | 635 | 6842 | 4375 | 739 | 8239 | 5225 |
| 50 | 0 | 0 | 6711 | 3440 | 0 | 8774 | 4460 | 0 | 11 129 | 5635 | 0 | 13 767 | 6940 | 0 | 16 694 | 8430 |
| | 2 | 113 | 4554 | 2840 | 141 | 5864 | 3670 | 171 | 7339 | 4630 | 209 | 8980 | 5695 | 251 | 10 788 | 6860 |
| | 5 | 191 | 4520 | 2813 | 234 | 5826 | 3639 | 283 | 7295 | 4597 | 336 | 8933 | 5654 | 394 | 10 737 | 6818 |
| | 10 | 243 | 4464 | 2767 | 295 | 5763 | 3585 | 355 | 7224 | 4542 | 419 | 8855 | 5585 | 491 | 10 652 | 6749 |
| | 15 | 274 | 4409 | 2721 | 330 | 5701 | 3534 | 396 | 7155 | 4511 | 465 | 8779 | 5546 | 542 | 10 570 | 6710 |
| | 20 | 300 | 4356 | 2675 | 361 | 5641 | 3481 | 433 | 7086 | 4479 | 506 | 8704 | 5506 | 586 | 10 488 | 6670 |
| | 30 | 347 | 4253 | 2631 | 412 | 5523 | 3431 | 494 | 6953 | 4421 | 577 | 8557 | 5444 | 672 | 10 328 | 6603 |
| 100 | 0 | 0 | 7914 | 4050 | 0 | 10 485 | 5300 | 0 | 13 454 | 6700 | 0 | 16 817 | 8600 | 0 | 20 578 | 10 300 |
| | 2 | 95 | 5834 | 3500 | 120 | 7591 | 4600 | 138 | 9577 | 5800 | 169 | 11 803 | 7200 | 204 | 14 264 | 8800 |
| | 5 | 172 | 5797 | 3475 | 208 | 7548 | 4566 | 245 | 9528 | 5769 | 293 | 11 748 | 7162 | 341 | 14 204 | 8756 |
| | 10 | 223 | 5737 | 3434 | 268 | 7478 | 4509 | 318 | 9447 | 5717 | 374 | 11 658 | 7100 | 436 | 14 105 | 8683 |
| | 15 | 252 | 5678 | 3392 | 304 | 7409 | 4451 | 358 | 9367 | 5665 | 418 | 11 569 | 7037 | 487 | 14 007 | 8610 |
| | 20 | 277 | 5619 | 3351 | 330 | 7341 | 4394 | 387 | 9289 | 5613 | 452 | 11 482 | 6975 | 523 | 13 910 | 8537 |
| | 30 | 319 | 5505 | 3267 | 378 | 7209 | 4279 | 446 | 9136 | 5509 | 514 | 11 310 | 6850 | 592 | 13 720 | 8391 |
| | 50 | 415 | 5289 | 3100 | 486 | 6956 | 4050 | 572 | 8841 | 5300 | 659 | 10 979 | 6600 | 752 | 13 354 | 8100 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

**TABLE 510.1.2(2)**
**TYPE B DOUBLE-WALL GAS VENT [NFPA 54: TABLE 13.1(b)]***

| | | NUMBER OF APPLIANCES: | | | SINGLE | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | | | CATEGORY I | | | | | | | | | | | |
| | | APPLIANCE VENT CONNECTION: | | | SINGLE-WALL METAL CONNECTOR | | | | | | | | | | | |
| | | VENT DIAMETER – *D* (inch) | | | | | | | | | | | | | | |
| | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | |
| | | APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | | | | |
| HEIGHT *H* (feet) | LATERAL *L* (feet) | 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 |
| 6 | 0 | 38 | 77 | 45 | 59 | 151 | 85 | 85 | 249 | 140 | 126 | 373 | 204 | 165 | 522 | 284 |
| | 2 | 39 | 51 | 36 | 60 | 96 | 66 | 85 | 156 | 104 | 123 | 231 | 156 | 159 | 320 | 213 |
| | 4 | NA | NA | 33 | 74 | 92 | 63 | 102 | 152 | 102 | 146 | 225 | 152 | 187 | 313 | 208 |
| | 6 | NA | NA | 31 | 83 | 89 | 60 | 114 | 147 | 99 | 163 | 220 | 148 | 207 | 307 | 203 |
| 8 | 0 | 37 | 83 | 50 | 58 | 164 | 93 | 83 | 273 | 154 | 123 | 412 | 234 | 161 | 580 | 319 |
| | 2 | 39 | 56 | 39 | 59 | 108 | 75 | 83 | 176 | 119 | 121 | 261 | 179 | 155 | 363 | 246 |
| | 5 | NA | NA | 37 | 77 | 102 | 69 | 107 | 168 | 114 | 151 | 252 | 171 | 193 | 352 | 235 |
| | 8 | NA | NA | 33 | 90 | 95 | 64 | 122 | 161 | 107 | 175 | 243 | 163 | 223 | 342 | 225 |
| 10 | 0 | 37 | 87 | 53 | 57 | 174 | 99 | 82 | 293 | 165 | 120 | 444 | 254 | 158 | 628 | 344 |
| | 2 | 39 | 61 | 41 | 59 | 117 | 80 | 82 | 193 | 128 | 119 | 287 | 194 | 153 | 400 | 272 |
| | 5 | 52 | 56 | 39 | 76 | 111 | 76 | 105 | 185 | 122 | 148 | 277 | 186 | 190 | 388 | 261 |
| | 10 | NA | NA | 34 | 97 | 100 | 68 | 132 | 171 | 112 | 188 | 261 | 171 | 237 | 369 | 241 |
| 15 | 0 | 36 | 93 | 57 | 56 | 190 | 111 | 80 | 325 | 186 | 116 | 499 | 283 | 153 | 713 | 388 |
| | 2 | 38 | 69 | 47 | 57 | 136 | 93 | 80 | 225 | 149 | 115 | 337 | 224 | 148 | 473 | 314 |
| | 5 | 51 | 63 | 44 | 75 | 128 | 86 | 102 | 216 | 140 | 144 | 326 | 217 | 182 | 459 | 298 |
| | 10 | NA | NA | 39 | 95 | 116 | 79 | 128 | 201 | 131 | 182 | 308 | 203 | 228 | 438 | 284 |
| | 15 | NA | NA | NA | NA | NA | 72 | 158 | 186 | 124 | 220 | 290 | 192 | 272 | 418 | 269 |
| 20 | 0 | 35 | 96 | 60 | 54 | 200 | 118 | 78 | 346 | 201 | 114 | 537 | 306 | 149 | 772 | 428 |
| | 2 | 37 | 74 | 50 | 56 | 148 | 99 | 78 | 248 | 165 | 113 | 375 | 248 | 144 | 528 | 344 |
| | 5 | 50 | 68 | 47 | 73 | 140 | 94 | 100 | 239 | 158 | 141 | 363 | 239 | 178 | 514 | 334 |
| | 10 | NA | NA | 41 | 93 | 129 | 86 | 125 | 223 | 146 | 177 | 344 | 224 | 222 | 491 | 316 |
| | 15 | NA | NA | NA | NA | NA | 80 | 155 | 208 | 136 | 216 | 325 | 210 | 264 | 469 | 301 |
| | 20 | NA | NA | NA | NA | NA | NA | 186 | 192 | 126 | 254 | 306 | 196 | 309 | 448 | 285 |
| 30 | 0 | 34 | 99 | 63 | 53 | 211 | 127 | 76 | 372 | 219 | 110 | 584 | 334 | 144 | 849 | 472 |
| | 2 | 37 | 80 | 56 | 55 | 164 | 111 | 76 | 281 | 183 | 109 | 429 | 279 | 139 | 610 | 392 |
| | 5 | 49 | 74 | 52 | 72 | 157 | 106 | 98 | 271 | 173 | 136 | 417 | 271 | 171 | 595 | 382 |
| | 10 | NA | NA | NA | 91 | 144 | 98 | 122 | 255 | 168 | 171 | 397 | 257 | 213 | 570 | 367 |
| | 15 | NA | NA | NA | 115 | 131 | NA | 151 | 239 | 157 | 208 | 377 | 242 | 255 | 547 | 349 |
| | 20 | NA | NA | NA | NA | NA | NA | 181 | 223 | NA | 246 | 357 | 228 | 298 | 524 | 333 |
| | 30 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 389 | 477 | 305 |
| 50 | 0 | 33 | 99 | 66 | 51 | 213 | 133 | 73 | 394 | 230 | 105 | 629 | 361 | 138 | 928 | 515 |
| | 2 | 36 | 84 | 61 | 53 | 181 | 121 | 73 | 318 | 205 | 104 | 495 | 312 | 133 | 712 | 443 |
| | 5 | 48 | 80 | NA | 70 | 174 | 117 | 94 | 308 | 198 | 131 | 482 | 305 | 164 | 696 | 435 |
| | 10 | NA | NA | NA | 89 | 160 | NA | 118 | 292 | 186 | 162 | 461 | 292 | 203 | 671 | 420 |
| | 15 | NA | NA | NA | 112 | 148 | NA | 145 | 275 | 174 | 199 | 441 | 280 | 244 | 646 | 405 |
| | 20 | NA | NA | NA | NA | NA | NA | 176 | 257 | NA | 236 | 420 | 267 | 285 | 622 | 389 |
| | 30 | NA | NA | NA | NA | NA | NA | NA | NA | NA | 315 | 376 | NA | 373 | 573 | NA |
| 100 | 0 | NA | NA | NA | 49 | 214 | NA | 69 | 403 | NA | 100 | 659 | 395 | 131 | 991 | 555 |
| | 2 | NA | NA | NA | 51 | 192 | NA | 70 | 351 | NA | 98 | 563 | 373 | 125 | 828 | 508 |
| | 5 | NA | NA | NA | 67 | 186 | NA | 90 | 342 | NA | 125 | 551 | 366 | 156 | 813 | 501 |
| | 10 | NA | NA | NA | 85 | 175 | NA | 113 | 324 | NA | 153 | 532 | 354 | 191 | 789 | 486 |
| | 15 | NA | NA | NA | 132 | 162 | NA | 138 | 310 | NA | 188 | 511 | 343 | 230 | 764 | 473 |
| | 20 | NA | NA | NA | NA | NA | NA | 168 | 295 | NA | 224 | 487 | NA | 270 | 739 | 458 |
| | 30 | NA | NA | NA | NA | NA | NA | 231 | 264 | NA | 301 | 448 | NA | 355 | 685 | NA |
| | 50 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 540 | 584 | NA |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.1.2(2)**
**TYPE B DOUBLE-WALL GAS VENT [NFPA 54: TABLE 13.1(b)] (continued)***

| | | NUMBER OF APPLIANCES: | | | SINGLE | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | | | CATEGORY I | | | | | | | |
| | | APPLIANCE VENT CONNECTION: | | | SINGLE-WALL METAL CONNECTOR | | | | | | | |
| | | VENT DIAMETER – *D* (inch) | | | | | | | | | | |
| | | 8 | | | 9 | | | 10 | | | 12 | |
| | | APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | |
| HEIGHT *H* (feet) | LATERAL *L* (feet) | FAN | | NAT | FAN | | NAT | FAN | | NAT | FAN | | NAT |
| | | Min | Max | Max | Min | Max | Max | Min | Max | Max | Min | Max | Max |
| 6 | 0 | 211 | 695 | 369 | 267 | 894 | 469 | 371 | 1118 | 569 | 537 | 1639 | 849 |
| | 2 | 201 | 423 | 284 | 251 | 541 | 368 | 347 | 673 | 453 | 498 | 979 | 648 |
| | 4 | 237 | 416 | 277 | 295 | 533 | 360 | 409 | 664 | 443 | 584 | 971 | 638 |
| | 6 | 263 | 409 | 271 | 327 | 526 | 352 | 449 | 656 | 433 | 638 | 962 | 627 |
| 8 | 0 | 206 | 777 | 414 | 258 | 1002 | 536 | 360 | 1257 | 658 | 521 | 1852 | 967 |
| | 2 | 197 | 482 | 321 | 246 | 617 | 417 | 339 | 768 | 513 | 486 | 1120 | 743 |
| | 5 | 245 | 470 | 311 | 305 | 604 | 404 | 418 | 754 | 500 | 598 | 1104 | 730 |
| | 8 | 280 | 458 | 300 | 344 | 591 | 392 | 470 | 740 | 486 | 665 | 1089 | 715 |
| 10 | 0 | 202 | 844 | 449 | 253 | 1093 | 584 | 351 | 1373 | 718 | 507 | 2031 | 1057 |
| | 2 | 193 | 531 | 354 | 242 | 681 | 456 | 332 | 849 | 559 | 475 | 1242 | 848 |
| | 5 | 241 | 518 | 344 | 299 | 667 | 443 | 409 | 834 | 544 | 584 | 1224 | 825 |
| | 10 | 296 | 497 | 325 | 363 | 643 | 423 | 492 | 808 | 520 | 688 | 1194 | 788 |
| 15 | 0 | 195 | 966 | 523 | 244 | 1259 | 681 | 336 | 1591 | 838 | 488 | 2374 | 1237 |
| | 2 | 187 | 631 | 413 | 232 | 812 | 543 | 319 | 1015 | 673 | 457 | 1491 | 983 |
| | 5 | 231 | 616 | 400 | 287 | 795 | 526 | 392 | 997 | 657 | 562 | 1469 | 963 |
| | 10 | 284 | 592 | 381 | 349 | 768 | 501 | 470 | 966 | 628 | 664 | 1433 | 928 |
| | 15 | 334 | 568 | 367 | 404 | 742 | 484 | 540 | 937 | 601 | 750 | 1399 | 894 |
| 20 | 0 | 190 | 1053 | 573 | 238 | 1379 | 750 | 326 | 1751 | 927 | 473 | 2631 | 1346 |
| | 2 | 182 | 708 | 468 | 227 | 914 | 611 | 309 | 1146 | 754 | 443 | 1689 | 1098 |
| | 5 | 224 | 692 | 457 | 279 | 896 | 596 | 381 | 1126 | 734 | 547 | 1665 | 1074 |
| | 10 | 277 | 666 | 437 | 339 | 866 | 570 | 457 | 1092 | 702 | 646 | 1626 | 1037 |
| | 15 | 325 | 640 | 419 | 393 | 838 | 549 | 526 | 1060 | 677 | 730 | 1587 | 1005 |
| | 20 | 374 | 616 | 400 | 448 | 810 | 526 | 592 | 1028 | 651 | 808 | 1550 | 973 |
| 30 | 0 | 184 | 1168 | 647 | 229 | 1542 | 852 | 312 | 1971 | 1056 | 454 | 2996 | 1545 |
| | 2 | 175 | 823 | 533 | 219 | 1069 | 698 | 296 | 1346 | 863 | 424 | 1999 | 1308 |
| | 5 | 215 | 806 | 521 | 269 | 1049 | 684 | 366 | 1324 | 846 | 524 | 1971 | 1283 |
| | 10 | 265 | 777 | 501 | 327 | 1017 | 662 | 440 | 1287 | 821 | 620 | 1927 | 1243 |
| | 15 | 312 | 750 | 481 | 379 | 985 | 638 | 507 | 1251 | 794 | 702 | 1884 | 1205 |
| | 20 | 360 | 723 | 461 | 433 | 955 | 615 | 570 | 1216 | 768 | 780 | 1841 | 1166 |
| | 30 | 461 | 670 | 426 | 541 | 895 | 574 | 704 | 1147 | 720 | 937 | 1759 | 1101 |
| 50 | 0 | 176 | 1292 | 704 | 220 | 1724 | 948 | 295 | 2223 | 1189 | 428 | 3432 | 1818 |
| | 2 | 168 | 971 | 613 | 209 | 1273 | 811 | 280 | 1615 | 1007 | 401 | 2426 | 1509 |
| | 5 | 204 | 953 | 602 | 257 | 1252 | 795 | 347 | 1591 | 991 | 496 | 2396 | 1490 |
| | 10 | 253 | 923 | 583 | 313 | 1217 | 765 | 418 | 1551 | 963 | 589 | 2347 | 1455 |
| | 15 | 299 | 894 | 562 | 363 | 1183 | 736 | 481 | 1512 | 934 | 668 | 2299 | 1421 |
| | 20 | 345 | 866 | 543 | 415 | 1150 | 708 | 544 | 1473 | 906 | 741 | 2251 | 1387 |
| | 30 | 442 | 809 | 502 | 521 | 1086 | 649 | 674 | 1399 | 848 | 892 | 2159 | 1318 |
| 100 | 0 | 166 | 1404 | 765 | 207 | 1900 | 1033 | 273 | 2479 | 1300 | 395 | 3912 | 2042 |
| | 2 | 158 | 1152 | 698 | 196 | 1532 | 933 | 259 | 1970 | 1168 | 371 | 3021 | 1817 |
| | 5 | 194 | 1134 | 688 | 240 | 1511 | 921 | 322 | 1945 | 1153 | 460 | 2990 | 1796 |
| | 10 | 238 | 1104 | 672 | 293 | 1477 | 902 | 389 | 1905 | 1133 | 547 | 2938 | 1763 |
| | 15 | 281 | 1075 | 656 | 342 | 1443 | 884 | 447 | 1865 | 1110 | 618 | 2888 | 1730 |
| | 20 | 325 | 1046 | 639 | 391 | 1410 | 864 | 507 | 1825 | 1087 | 690 | 2838 | 1696 |
| | 30 | 418 | 988 | NA | 491 | 1343 | 824 | 631 | 1747 | 1041 | 834 | 2739 | 1627 |
| | 50 | 617 | 866 | NA | 711 | 1205 | NA | 895 | 1591 | NA | 1138 | 2547 | 1489 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

6044

**TABLE 510.1.2(3)**
**MASONRY CHIMNEY [NFPA 54: TABLE 13.1(c)]***

| | | NUMBER OF APPLIANCES: | SINGLE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | CATEGORY I | | | | | | | | | | | | |
| | | APPLIANCE VENT CONNECTION: | TYPE B DOUBLE-WALL CONNECTOR | | | | | | | | | | | | |
| | | TYPE B DOUBLE-WALL CONNECTOR DIAMETER – *D* (inch) TO BE USED WITH CHIMNEY AREAS WITHIN THE SIZE LIMITS AT BOTTOM | | | | | | | | | | | | | |
| | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | |
| | | APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | | | |
| HEIGHT *H* (feet) | LATERAL *L* (feet) | 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 |
| 6 | 2 | NA | NA | 28 | NA | NA | 52 | NA | NA | 86 | NA | NA | 130 | NA | NA | 180 |
| | 5 | NA | NA | 25 | NA | NA | 49 | NA | NA | 82 | NA | NA | 117 | NA | NA | 165 |
| 8 | 2 | NA | NA | 29 | NA | NA | 55 | NA | NA | 93 | NA | NA | 145 | NA | NA | 198 |
| | 5 | NA | NA | 26 | NA | NA | 52 | NA | NA | 88 | NA | NA | 134 | NA | NA | 183 |
| | 8 | NA | NA | 24 | NA | NA | 48 | NA | NA | 83 | NA | NA | 127 | NA | NA | 175 |
| 10 | 2 | NA | NA | 31 | NA | NA | 61 | NA | NA | 103 | NA | NA | 162 | NA | NA | 221 |
| | 5 | NA | NA | 28 | NA | NA | 57 | NA | NA | 96 | NA | NA | 148 | NA | NA | 204 |
| | 10 | NA | NA | 25 | NA | NA | 50 | NA | NA | 87 | NA | NA | 139 | NA | NA | 191 |
| 15 | 2 | NA | NA | 35 | NA | NA | 67 | NA | NA | 114 | NA | NA | 179 | 53 | 475 | 250 |
| | 5 | NA | NA | 35 | NA | NA | 62 | NA | NA | 107 | NA | NA | 164 | NA | NA | 231 |
| | 10 | NA | NA | 28 | NA | NA | 55 | NA | NA | 97 | NA | NA | 153 | NA | NA | 216 |
| | 15 | NA | NA | NA | NA | NA | 48 | NA | NA | 89 | NA | NA | 141 | NA | NA | 201 |
| 20 | 2 | NA | NA | 38 | NA | NA | 74 | NA | NA | 124 | NA | NA | 201 | 51 | 522 | 274 |
| | 5 | NA | NA | 36 | NA | NA | 68 | NA | NA | 116 | NA | NA | 184 | 80 | 503 | 254 |
| | 10 | NA | NA | NA | NA | NA | 60 | NA | NA | 107 | NA | NA | 172 | NA | NA | 237 |
| | 15 | NA | NA | NA | NA | NA | NA | NA | NA | 97 | NA | NA | 159 | NA | NA | 220 |
| | 20 | NA | NA | NA | NA | NA | NA | NA | NA | 83 | NA | NA | 148 | NA | NA | 206 |
| 30 | 2 | NA | NA | 41 | NA | NA | 82 | NA | NA | 137 | NA | NA | 216 | 47 | 581 | 303 |
| | 5 | NA | NA | NA | NA | NA | 76 | NA | NA | 128 | NA | NA | 198 | 75 | 561 | 281 |
| | 10 | NA | NA | NA | NA | NA | 67 | NA | NA | 115 | NA | NA | 184 | NA | NA | 263 |
| | 15 | NA | NA | NA | NA | NA | NA | NA | NA | 107 | NA | NA | 171 | NA | NA | 243 |
| | 20 | NA | NA | NA | NA | NA | NA | NA | NA | 91 | NA | NA | 159 | NA | NA | 227 |
| | 30 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 188 |
| 50 | 2 | NA | NA | NA | NA | NA | 92 | NA | NA | 161 | NA | NA | 251 | NA | NA | 351 |
| | 5 | NA | NA | NA | NA | NA | NA | NA | NA | 151 | NA | NA | 230 | NA | NA | 323 |
| | 10 | NA | NA | NA | NA | NA | NA | NA | NA | 138 | NA | NA | 215 | NA | NA | 304 |
| | 15 | NA | NA | NA | NA | NA | NA | NA | NA | 127 | NA | NA | 199 | NA | NA | 282 |
| | 20 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 185 | NA | NA | 264 |
| | 30 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Minimum internal area of chimney (square inches) | | 12 | | | 19 | | | 28 | | | 38 | | | 50 | | |
| Maximum internal area of chimney (square inches) | | Seven times the listed appliance categorized vent area, flue collar area, or draft hood outlet areas. | | | | | | | | | | | | | | |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.1.2(3)**
**MASONRY CHIMNEY [NFPA 54: TABLE 13.1(c)] (continued)***

| | | NUMBER OF APPLIANCES: | SINGLE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | CATEGORY I | | | | | | | | | |
| | | APPLIANCE VENT CONNECTION: | TYPE B DOUBLE-WALL CONNECTOR | | | | | | | | | |
| | | TYPE B DOUBLE-WALL CONNECTOR DIAMETER – *D* (inch) TO BE USED WITH CHIMNEY AREAS WITHIN THE SIZE LIMITS AT BOTTOM | | | | | | | | | | |
| | | 8 | | | 9 | | | 10 | | | 12 | | |
| | | APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | |
| HEIGHT *H* (feet) | LATERAL *L* (feet) | FAN | | NAT | FAN | | NAT | FAN | | NAT | FAN | | NAT |
| | | Min | Max | Max | Min | Max | Max | Min | Max | Max | Min | Max | Max |
| 6 | 2 | NA | NA | 247 | NA | NA | 320 | NA | NA | 401 | NA | NA | 581 |
| | 5 | NA | NA | 231 | NA | NA | 298 | NA | NA | 376 | NA | NA | 561 |
| 8 | 2 | NA | NA | 266 | 84 | 590 | 350 | 100 | 728 | 446 | 139 | 1024 | 651 |
| | 5 | NA | NA | 247 | NA | NA | 328 | 149 | 711 | 423 | 201 | 1007 | 640 |
| | 8 | NA | NA | 239 | NA | NA | 318 | 173 | 695 | 410 | 231 | 990 | 623 |
| 10 | 2 | 68 | 519 | 298 | 82 | 655 | 388 | 98 | 810 | 491 | 136 | 1144 | 724 |
| | 5 | NA | NA | 277 | 124 | 638 | 365 | 146 | 791 | 466 | 196 | 1124 | 712 |
| | 10 | NA | NA | 263 | 155 | 610 | 347 | 182 | 762 | 444 | 240 | 1093 | 668 |
| 15 | 2 | 64 | 613 | 336 | 77 | 779 | 441 | 92 | 968 | 562 | 127 | 1376 | 841 |
| | 5 | 99 | 594 | 313 | 118 | 759 | 416 | 139 | 946 | 533 | 186 | 1352 | 828 |
| | 10 | 126 | 565 | 296 | 148 | 727 | 394 | 173 | 912 | 567 | 229 | 1315 | 777 |
| | 15 | NA | NA | 281 | 171 | 698 | 375 | 198 | 880 | 485 | 259 | 1280 | 742 |
| 20 | 2 | 61 | 678 | 375 | 73 | 867 | 491 | 87 | 1083 | 627 | 121 | 1548 | 953 |
| | 5 | 95 | 658 | 350 | 113 | 845 | 463 | 133 | 1059 | 597 | 179 | 1523 | 933 |
| | 10 | 122 | 627 | 332 | 143 | 811 | 440 | 167 | 1022 | 566 | 221 | 1482 | 879 |
| | 15 | NA | NA | 314 | 165 | 780 | 418 | 191 | 987 | 541 | 251 | 1443 | 840 |
| | 20 | NA | NA | 296 | 186 | 750 | 397 | 214 | 955 | 513 | 277 | 1406 | 807 |
| 30 | 2 | 57 | 762 | 421 | 68 | 985 | 558 | 81 | 1240 | 717 | 111 | 1793 | 1112 |
| | 5 | 90 | 741 | 393 | 106 | 962 | 526 | 125 | 1216 | 683 | 169 | 1766 | 1094 |
| | 10 | 115 | 709 | 373 | 135 | 927 | 500 | 158 | 1176 | 648 | 210 | 1721 | 1025 |
| | 15 | NA | NA | 353 | 156 | 893 | 476 | 181 | 1139 | 621 | 239 | 1679 | 981 |
| | 20 | NA | NA | 332 | 176 | 860 | 450 | 203 | 1103 | 592 | 264 | 1638 | 940 |
| | 30 | NA | NA | 288 | NA | NA | 416 | 249 | 1035 | 555 | 318 | 1560 | 877 |
| 50 | 2 | 51 | 840 | 477 | 61 | 1106 | 633 | 72 | 1413 | 812 | 99 | 2080 | 1243 |
| | 5 | 83 | 819 | 445 | 98 | 1083 | 596 | 116 | 1387 | 774 | 155 | 2052 | 1225 |
| | 10 | NA | NA | 424 | 126 | 1047 | 567 | 147 | 1347 | 733 | 195 | 2006 | 1147 |
| | 15 | NA | NA | 400 | 146 | 1010 | 539 | 170 | 1307 | 702 | 222 | 1961 | 1099 |
| | 20 | NA | NA | 376 | 165 | 977 | 511 | 190 | 1269 | 669 | 246 | 1916 | 1050 |
| | 30 | NA | NA | 327 | NA | NA | 468 | 233 | 1196 | 623 | 295 | 1832 | 984 |
| Minimum internal area of chimney (square inches) | | 63 | | | 78 | | | 95 | | | 132 | | |
| Maximum internal area of chimney (square inches) | | Seven times the listed appliance categorized vent area, flue collar area, or draft hood outlet areas. | | | | | | | | | | | |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.1.2(4)**
**MASONRY CHIMNEY [NFPA 54: TABLE 13.1(d)]***

| | | NUMBER OF APPLIANCES: | SINGLE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | CATEGORY I | | | | | | | | | | | | |
| | | APPLIANCE VENT CONNECTION: | SINGLE-WALL METAL CONNECTOR | | | | | | | | | | | | |
| | | SINGLE-WALL METAL CONNECTOR DIAMETER – *D* (inch) TO BE USED WITH CHIMNEY AREAS WITHIN THE SIZE LIMITS AT BOTTOM | | | | | | | | | | | | | |
| | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | |
| | | APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | | | |
| HEIGHT *H* (feet) | LATERAL *L* (feet) | 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 |
| 6 | 2 | NA | NA | 28 | NA | NA | 52 | NA | NA | 86 | NA | NA | 130 | NA | NA | 180 |
| | 5 | NA | NA | 25 | NA | NA | 48 | NA | NA | 81 | NA | NA | 116 | NA | NA | 164 |
| 8 | 2 | NA | NA | 29 | NA | NA | 55 | NA | NA | 93 | NA | NA | 145 | NA | NA | 197 |
| | 5 | NA | NA | 26 | NA | NA | 51 | NA | NA | 87 | NA | NA | 133 | NA | NA | 182 |
| | 8 | NA | NA | 23 | NA | NA | 47 | NA | NA | 82 | NA | NA | 126 | NA | NA | 174 |
| 10 | 2 | NA | NA | 31 | NA | NA | 61 | NA | NA | 102 | NA | NA | 161 | NA | NA | 220 |
| | 5 | NA | NA | 28 | NA | NA | 56 | NA | NA | 95 | NA | NA | 147 | NA | NA | 203 |
| | 10 | NA | NA | 24 | NA | NA | 49 | NA | NA | 86 | NA | NA | 137 | NA | NA | 189 |
| 15 | 2 | NA | NA | 35 | NA | NA | 67 | NA | NA | 113 | NA | NA | 178 | 166 | 473 | 249 |
| | 5 | NA | NA | 32 | NA | NA | 61 | NA | NA | 106 | NA | NA | 163 | NA | NA | 230 |
| | 10 | NA | NA | 27 | NA | NA | 54 | NA | NA | 96 | NA | NA | 151 | NA | NA | 214 |
| | 15 | NA | NA | NA | NA | NA | 46 | NA | NA | 87 | NA | NA | 138 | NA | NA | 198 |
| 20 | 2 | NA | NA | 38 | NA | NA | 73 | NA | NA | 123 | NA | NA | 200 | 163 | 520 | 273 |
| | 5 | NA | NA | 35 | NA | NA | 67 | NA | NA | 115 | NA | NA | 183 | NA | NA | 252 |
| | 10 | NA | NA | NA | NA | NA | 59 | NA | NA | 105 | NA | NA | 170 | NA | NA | 235 |
| | 15 | NA | NA | NA | NA | NA | NA | NA | NA | 95 | NA | NA | 156 | NA | NA | 217 |
| | 20 | NA | NA | NA | NA | NA | NA | NA | NA | 80 | NA | NA | 144 | NA | NA | 202 |
| 30 | 2 | NA | NA | 41 | NA | NA | 81 | NA | NA | 136 | NA | NA | 215 | 158 | 578 | 302 |
| | 5 | NA | NA | NA | NA | NA | 75 | NA | NA | 127 | NA | NA | 196 | NA | NA | 279 |
| | 10 | NA | NA | NA | NA | NA | 66 | NA | NA | 113 | NA | NA | 182 | NA | NA | 260 |
| | 15 | NA | NA | NA | NA | NA | NA | NA | NA | 105 | NA | NA | 168 | NA | NA | 240 |
| | 20 | NA | NA | NA | NA | NA | NA | NA | NA | 88 | NA | NA | 155 | NA | NA | 223 |
| | 30 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 182 |
| 50 | 2 | NA | NA | NA | NA | NA | 91 | NA | NA | 160 | NA | NA | 250 | NA | NA | 350 |
| | 5 | NA | NA | NA | NA | NA | NA | NA | NA | 149 | NA | NA | 228 | NA | NA | 321 |
| | 10 | NA | NA | NA | NA | NA | NA | NA | NA | 136 | NA | NA | 212 | NA | NA | 301 |
| | 15 | NA | NA | NA | NA | NA | NA | NA | NA | 124 | NA | NA | 195 | NA | NA | 278 |
| | 20 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 180 | NA | NA | 258 |
| | 30 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| Minimum internal area of chimney (square inches) | | 12 | | | 19 | | | 28 | | | 38 | | | 50 | | |
| Maximum internal area of chimney (square inches) | | Seven times the listed appliance categorized vent area, flue collar area, or draft hood outlet areas. | | | | | | | | | | | | | | |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.1.2(4)**
**MASONRY CHIMNEY [NFPA 54: TABLE 13.1(d)] (continued)***

| | | NUMBER OF APPLIANCES: | SINGLE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | CATEGORY I | | | | | | | | | |
| | | APPLIANCE VENT CONNECTION: | SINGLE-WALL METAL CONNECTOR | | | | | | | | | |
| | | SINGLE-WALL METAL CONNECTOR DIAMETER – *D* (inch) TO BE USED WITH CHIMNEY AREAS WITHIN THE SIZE LIMITS AT BOTTOM | | | | | | | | | | |
| | | 8 | | | 9 | | | 10 | | | 12 | | |
| | | APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | |
| HEIGHT *H* (feet) | LATERAL *L* (feet) | FAN | | NAT | FAN | | NAT | FAN | | NAT | FAN | | NAT |
| | | Min | Max | Max | Min | Max | Max | Min | Max | Max | Min | Max | Max |
| 6 | 2 | NA | NA | 247 | NA | NA | 319 | NA | NA | 400 | NA | NA | 580 |
| | 5 | NA | NA | 230 | NA | NA | 297 | NA | NA | 375 | NA | NA | 560 |
| 8 | 2 | NA | NA | 265 | NA | NA | 349 | 382 | 725 | 445 | 549 | 1021 | 650 |
| | 5 | NA | NA | 246 | NA | NA | 327 | NA | NA | 422 | 673 | 1003 | 638 |
| | 8 | NA | NA | 237 | NA | NA | 317 | NA | NA | 408 | 747 | 985 | 621 |
| 10 | 2 | 216 | 518 | 297 | 271 | 654 | 387 | 373 | 808 | 490 | 536 | 1142 | 722 |
| | 5 | NA | NA | 276 | 334 | 635 | 364 | 459 | 789 | 465 | 657 | 1121 | 710 |
| | 10 | NA | NA | 261 | NA | NA | 345 | 547 | 758 | 441 | 771 | 1088 | 665 |
| 15 | 2 | 211 | 611 | 335 | 264 | 776 | 440 | 362 | 965 | 560 | 520 | 1373 | 840 |
| | 5 | 261 | 591 | 312 | 325 | 755 | 414 | 444 | 942 | 531 | 637 | 1348 | 825 |
| | 10 | NA | NA | 294 | 392 | 722 | 392 | 531 | 907 | 504 | 749 | 1309 | 774 |
| | 15 | NA | NA | 278 | 452 | 692 | 372 | 606 | 873 | 481 | 841 | 1272 | 738 |
| 20 | 2 | 206 | 675 | 374 | 258 | 864 | 490 | 252 | 1079 | 625 | 508 | 1544 | 950 |
| | 5 | 255 | 655 | 348 | 317 | 842 | 461 | 433 | 1055 | 594 | 623 | 1518 | 930 |
| | 10 | 312 | 622 | 330 | 382 | 806 | 437 | 517 | 1016 | 562 | 733 | 1475 | 875 |
| | 15 | NA | NA | 311 | 442 | 773 | 414 | 591 | 979 | 539 | 823 | 1434 | 835 |
| | 20 | NA | NA | 292 | NA | NA | 392 | 663 | 944 | 510 | 911 | 1394 | 800 |
| 30 | 2 | 200 | 759 | 420 | 249 | 982 | 556 | 340 | 1237 | 715 | 489 | 1789 | 1110 |
| | 5 | 245 | 737 | 391 | 306 | 958 | 524 | 417 | 1210 | 680 | 600 | 1760 | 1090 |
| | 10 | 300 | 703 | 370 | 370 | 920 | 496 | 500 | 1168 | 644 | 708 | 1713 | 1020 |
| | 15 | NA | NA | 349 | 428 | 884 | 471 | 572 | 1128 | 615 | 798 | 1668 | 975 |
| | 20 | NA | NA | 327 | NA | NA | 445 | 643 | 1089 | 585 | 883 | 1624 | 932 |
| | 30 | NA | NA | 281 | NA | NA | 408 | NA | NA | 544 | 1055 | 1539 | 865 |
| 50 | 2 | 191 | 837 | 475 | 238 | 1103 | 631 | 323 | 1408 | 810 | 463 | 2076 | 1240 |
| | 5 | NA | NA | 442 | 293 | 1078 | 593 | 398 | 1381 | 770 | 571 | 2044 | 1220 |
| | 10 | NA | NA | 420 | 355 | 1038 | 562 | 447 | 1337 | 728 | 674 | 1994 | 1140 |
| | 15 | NA | NA | 395 | NA | NA | 533 | 546 | 1294 | 695 | 761 | 1945 | 1090 |
| | 20 | NA | NA | 370 | NA | NA | 504 | 616 | 1251 | 660 | 844 | 1898 | 1040 |
| | 30 | NA | NA | 318 | NA | NA | 458 | NA | NA | 610 | 1009 | 1805 | 970 |
| Minimum internal area of chimney (square inches) | | 63 | | | 78 | | | 95 | | | 132 | | |
| Maximum internal area of chimney (square inches) | | Seven times the listed appliance categorized vent area, flue collar area, or draft hood outlet areas. | | | | | | | | | | | |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

TABLE 510.1.2(5)
SINGLE-WALL METAL PIPE OR TYPE B ASBESTOS-CEMENT VENT [NFPA 54: TABLE 13.1(e)]*

| | | NUMBER OF APPLIANCES: | SINGLE | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | DRAFT HOOD-EQUIPPED | | | | | | |
| | | APPLIANCE VENT CONNECTION: | CONNECTED DIRECTLY TO PIPE OR VENT | | | | | | |
| | | DIAMETER – *D* (inch) TO BE USED WITH CHIMNEY AREAS WITHIN THE SIZE LIMITS AT BOTTOM | | | | | | | |
| | | 3 | 4 | 5 | 6 | 7 | 8 | 10 | 12 |
| HEIGHT *H* (feet) | LATERAL *L* (feet) | 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 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.1.2(6)**
**EXTERIOR MASONRY CHIMNEY [NFPA 54-12: TABLE 13.1(f)][1, 2]**

| | NUMBER OF APPLIANCES: | SINGLE | | | | | |
|---|---|---|---|---|---|---|---|
| | APPLIANCE TYPE: | NAT | | | | | |
| | APPLIANCE VENT CONNECTION: | TYPE B DOUBLE-WALL CONNECTOR | | | | | |
| MINIMUM ALLOWABLE INPUT RATING OF SPACE-HEATING APPLIANCE IN THOUSANDS OF BTU PER HOUR | | | | | | | |
| VENT HEIGHT *H* (feet) | INTERNAL AREA OF CHIMNEY (square inches) | | | | | | | |
| | 12 | 19 | 28 | 38 | 50 | 63 | 78 | 113 |
| | 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 |
| | 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 |
| | 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 |
| | 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 |
| | 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 |
| Local 99% winter design temperature: -11°F or lower<br>Not recommended for any vent configurations | | | | | | | | |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$, °C = (°F-32)/1.8

**Notes:**

[1] See Figure 510.1.2(6) for a map showing local 99 percent winter design temperatures in the United States.

[2] NA: Not applicable.

**TABLE 510.2(1)**
**TYPE B DOUBLE-WALL VENT [NFPA 54: TABLE 13.2(a)]***

| | | NUMBER OF APPLIANCES: | TWO OR MORE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | CATEGORY I | | | | | | | | | | | | |
| | | APPLIANCE VENT CONNECTION: | TYPE B DOUBLE-WALL CONNECTOR | | | | | | | | | | | | |
| | | VENT CONNECTOR CAPACITY | | | | | | | | | | | | | |
| | | TYPE B DOUBLE-WALL VENT AND CONNECTOR DIAMETER – *D* (inch) | | | | | | | | | | | | | |
| | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | |
| | | APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | | | |
| VENT HEIGHT *H* (feet) | CONNECTOR RISE *R* (feet) | 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 |
| 6 | 1 | 22 | 37 | 26 | 35 | 66 | 46 | 46 | 106 | 72 | 58 | 164 | 104 | 77 | 225 | 142 |
| | 2 | 23 | 41 | 31 | 37 | 75 | 55 | 48 | 121 | 86 | 60 | 183 | 124 | 79 | 253 | 168 |
| | 3 | 24 | 44 | 35 | 38 | 81 | 62 | 49 | 132 | 96 | 62 | 199 | 139 | 82 | 275 | 189 |
| 8 | 1 | 22 | 40 | 27 | 35 | 72 | 48 | 49 | 114 | 76 | 64 | 176 | 109 | 84 | 243 | 148 |
| | 2 | 23 | 44 | 32 | 36 | 80 | 57 | 51 | 128 | 90 | 66 | 195 | 129 | 86 | 269 | 175 |
| | 3 | 24 | 47 | 36 | 37 | 87 | 64 | 53 | 139 | 101 | 67 | 210 | 145 | 88 | 290 | 198 |
| 10 | 1 | 22 | 43 | 28 | 34 | 78 | 50 | 49 | 123 | 78 | 65 | 189 | 113 | 89 | 257 | 154 |
| | 2 | 23 | 47 | 33 | 36 | 86 | 59 | 51 | 136 | 93 | 67 | 206 | 134 | 91 | 282 | 182 |
| | 3 | 24 | 50 | 37 | 37 | 92 | 67 | 52 | 146 | 104 | 69 | 220 | 150 | 94 | 303 | 205 |
| 15 | 1 | 21 | 50 | 30 | 33 | 89 | 53 | 47 | 142 | 83 | 64 | 220 | 120 | 88 | 298 | 163 |
| | 2 | 22 | 53 | 35 | 35 | 96 | 63 | 49 | 153 | 99 | 66 | 235 | 142 | 91 | 320 | 193 |
| | 3 | 24 | 55 | 40 | 36 | 102 | 71 | 51 | 163 | 111 | 68 | 248 | 160 | 93 | 339 | 218 |
| 20 | 1 | 21 | 54 | 31 | 33 | 99 | 56 | 46 | 157 | 87 | 62 | 246 | 125 | 86 | 334 | 171 |
| | 2 | 22 | 57 | 37 | 34 | 105 | 66 | 48 | 167 | 104 | 64 | 259 | 149 | 89 | 354 | 202 |
| | 3 | 23 | 60 | 42 | 35 | 110 | 74 | 50 | 176 | 116 | 66 | 271 | 168 | 91 | 371 | 228 |
| 30 | 1 | 20 | 62 | 33 | 31 | 113 | 59 | 45 | 181 | 93 | 60 | 288 | 134 | 83 | 391 | 182 |
| | 2 | 21 | 64 | 39 | 33 | 118 | 70 | 47 | 190 | 110 | 62 | 299 | 158 | 85 | 408 | 215 |
| | 3 | 22 | 66 | 44 | 34 | 123 | 79 | 48 | 198 | 124 | 64 | 309 | 178 | 88 | 423 | 242 |
| 50 | 1 | 19 | 71 | 36 | 30 | 133 | 64 | 43 | 216 | 101 | 57 | 349 | 145 | 78 | 477 | 197 |
| | 2 | 21 | 73 | 43 | 32 | 137 | 76 | 45 | 223 | 119 | 59 | 358 | 172 | 81 | 490 | 234 |
| | 3 | 22 | 75 | 48 | 33 | 141 | 86 | 46 | 229 | 134 | 61 | 366 | 194 | 83 | 502 | 263 |
| 100 | 1 | 18 | 82 | 37 | 28 | 158 | 66 | 40 | 262 | 104 | 53 | 442 | 150 | 73 | 611 | 204 |
| | 2 | 19 | 83 | 44 | 30 | 161 | 79 | 42 | 267 | 123 | 55 | 447 | 178 | 75 | 619 | 242 |
| | 3 | 20 | 84 | 50 | 31 | 163 | 89 | 44 | 272 | 138 | 57 | 452 | 200 | 78 | 627 | 272 |

| | COMMON VENT CAPACITY | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TYPE B DOUBLE-WALL COMMON VENT DIAMETER – *D* (inch) | | | | | | | | | | | |
| | 4 | | | 5 | | | 6 | | | 7 | | |
| | COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | |
| VENT HEIGHT *H* (feet) | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT |
| 6 | 92 | 81 | 65 | 140 | 116 | 103 | 204 | 161 | 147 | 309 | 248 | 200 |
| 8 | 101 | 90 | 73 | 155 | 129 | 114 | 224 | 178 | 163 | 339 | 275 | 223 |
| 10 | 110 | 97 | 79 | 169 | 141 | 124 | 243 | 194 | 178 | 367 | 299 | 242 |
| 15 | 125 | 112 | 91 | 195 | 164 | 144 | 283 | 228 | 206 | 427 | 352 | 280 |
| 20 | 136 | 123 | 102 | 215 | 183 | 160 | 314 | 255 | 229 | 475 | 394 | 310 |
| 30 | 152 | 138 | 118 | 244 | 210 | 185 | 361 | 297 | 266 | 547 | 459 | 360 |
| 50 | 167 | 153 | 134 | 279 | 244 | 214 | 421 | 353 | 310 | 641 | 547 | 423 |
| 100 | 175 | 163 | NA | 311 | 277 | NA | 489 | 421 | NA | 751 | 658 | 479 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.2(1)**
**TYPE B DOUBLE-WALL VENT [NFPA 54: TABLE 13.2(a)] (continued)**

| | | NUMBER OF APPLIANCES: | | | TWO OR MORE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | | | CATEGORY I | | | | | |
| | | APPLIANCE VENT CONNECTION: | | | TYPE B DOUBLE-WALL CONNECTOR | | | | | |
| | | VENT CONNECTOR CAPACITY | | | | | | | | |
| | | TYPE B DOUBLE-WALL VENT AND CONNECTOR DIAMETER – *D* (inch) | | | | | | | | |
| | | 8 | | | 9 | | | 10 | | |
| | | APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| VENT HEIGHT *H* (feet) | CONNECTOR RISE *R* (feet) | FAN | | NAT | FAN | | NAT | FAN | | NAT |
| | | Min | Max | Max | Min | Max | Max | Min | Max | Max |
| 6 | 1 | 92 | 296 | 185 | 109 | 376 | 237 | 128 | 466 | 289 |
| | 2 | 95 | 333 | 220 | 112 | 424 | 282 | 131 | 526 | 345 |
| | 3 | 97 | 363 | 248 | 114 | 463 | 317 | 134 | 575 | 386 |
| 8 | 1 | 100 | 320 | 194 | 118 | 408 | 248 | 138 | 507 | 303 |
| | 2 | 103 | 356 | 230 | 121 | 454 | 294 | 141 | 564 | 358 |
| | 3 | 105 | 384 | 258 | 123 | 492 | 330 | 143 | 612 | 402 |
| 10 | 1 | 106 | 341 | 200 | 125 | 436 | 257 | 146 | 542 | 314 |
| | 2 | 109 | 374 | 238 | 128 | 479 | 305 | 149 | 596 | 372 |
| | 3 | 111 | 402 | 268 | 131 | 515 | 342 | 152 | 642 | 417 |
| 15 | 1 | 110 | 389 | 214 | 134 | 493 | 273 | 162 | 609 | 333 |
| | 2 | 112 | 419 | 253 | 137 | 532 | 323 | 165 | 658 | 394 |
| | 3 | 115 | 445 | 286 | 140 | 565 | 365 | 167 | 700 | 444 |
| 20 | 1 | 107 | 436 | 224 | 131 | 552 | 285 | 158 | 681 | 347 |
| | 2 | 110 | 463 | 265 | 134 | 587 | 339 | 161 | 725 | 414 |
| | 3 | 113 | 486 | 300 | 137 | 618 | 383 | 164 | 764 | 466 |
| 30 | 1 | 103 | 512 | 238 | 125 | 649 | 305 | 151 | 802 | 372 |
| | 2 | 105 | 535 | 282 | 129 | 679 | 360 | 155 | 840 | 439 |
| | 3 | 108 | 555 | 317 | 132 | 706 | 405 | 158 | 874 | 494 |
| 50 | 1 | 97 | 627 | 257 | 120 | 797 | 330 | 144 | 984 | 403 |
| | 2 | 100 | 645 | 306 | 123 | 820 | 392 | 148 | 1014 | 478 |
| | 3 | 103 | 661 | 343 | 126 | 842 | 441 | 151 | 1043 | 538 |
| 100 | 1 | 91 | 810 | 266 | 112 | 1038 | 341 | 135 | 1285 | 417 |
| | 2 | 94 | 822 | 316 | 115 | 1054 | 405 | 139 | 1306 | 494 |
| | 3 | 97 | 834 | 355 | 118 | 1069 | 455 | 142 | 1327 | 555 |

| | COMMON VENT CAPACITY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | TYPE B DOUBLE-WALL COMMON VENT DIAMETER – *D* (inch) | | | | | | | | |
| | 8 | | | 9 | | | 10 | | |
| | COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| VENT HEIGHT *H* (feet) | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT |
| 6 | 404 | 314 | 260 | 547 | 434 | 335 | 672 | 520 | 410 |
| 8 | 444 | 348 | 290 | 602 | 480 | 378 | 740 | 577 | 465 |
| 10 | 477 | 377 | 315 | 649 | 522 | 405 | 800 | 627 | 495 |
| 15 | 556 | 444 | 365 | 753 | 612 | 465 | 924 | 733 | 565 |
| 20 | 621 | 499 | 405 | 842 | 688 | 523 | 1035 | 826 | 640 |
| 30 | 720 | 585 | 470 | 979 | 808 | 605 | 1209 | 975 | 740 |
| 50 | 854 | 706 | 550 | 1164 | 977 | 705 | 1451 | 1188 | 860 |
| 100 | 1025 | 873 | 625 | 1408 | 1215 | 800 | 1784 | 1502 | 975 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

**TABLE 510.2(1)**
**TYPE B DOUBLE-WALL VENT [NFPA 54: TABLE 13.2(a)] (continued)***

| | | NUMBER OF APPLIANCES: | TWO OR MORE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | CATEGORY I | | | | | | | | |
| | | APPLIANCE VENT CONNECTION: | TYPE B DOUBLE-WALL CONNECTOR | | | | | | | | |
| | | VENT CONNECTOR CAPACITY | | | | | | | | | |
| | | TYPE B DOUBLE-WALL VENT AND CONNECTOR DIAMETER – *D* (inch) | | | | | | | | | |
| | | 12 | | | 14 | | | 16 | | | 18 | | |
| | | APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | |
| VENT HEIGHT *H* (feet) | CONNECTOR RISE *R* (feet) | FAN | | NAT | FAN | | NAT | FAN | | NAT | FAN | | NAT |
| | | 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 |
| | 4 | 180 | 897 | 616 | 230 | 1231 | 827 | 287 | 1617 | 1081 | 352 | 2069 | 1370 |
| | 6 | 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 |
| | 4 | 192 | 952 | 644 | 244 | 1307 | 884 | 305 | 1719 | 1150 | 372 | 2211 | 1460 |
| | 6 | 198 | 1050 | 772 | 252 | 1445 | 1072 | 313 | 1902 | 1390 | 380 | 2434 | 1770 |
| 10 | 2 | 196 | 870 | 536 | 249 | 1195 | 730 | 311 | 1570 | 955 | 379 | 2049 | 1205 |
| | 4 | 201 | 997 | 664 | 256 | 1371 | 924 | 318 | 1804 | 1205 | 387 | 2332 | 1535 |
| | 6 | 207 | 1095 | 792 | 263 | 1509 | 1118 | 325 | 1989 | 1455 | 395 | 2556 | 1865 |
| 15 | 2 | 214 | 967 | 568 | 272 | 1334 | 790 | 336 | 1760 | 1030 | 408 | 2317 | 1305 |
| | 4 | 221 | 1085 | 712 | 279 | 1499 | 1006 | 344 | 1978 | 1320 | 416 | 2579 | 1665 |
| | 6 | 228 | 1181 | 856 | 286 | 1632 | 1222 | 351 | 2157 | 1610 | 424 | 2796 | 2025 |
| 20 | 2 | 223 | 1051 | 596 | 291 | 1443 | 840 | 357 | 1911 | 1095 | 430 | 2533 | 1385 |
| | 4 | 230 | 1162 | 748 | 298 | 1597 | 1064 | 365 | 2116 | 1395 | 438 | 2778 | 1765 |
| | 6 | 237 | 1253 | 900 | 307 | 1726 | 1288 | 373 | 2287 | 1695 | 450 | 2984 | 2145 |
| 30 | 2 | 216 | 1217 | 632 | 286 | 1664 | 910 | 367 | 2183 | 1190 | 461 | 2891 | 1540 |
| | 4 | 223 | 1316 | 792 | 294 | 1802 | 1160 | 376 | 2366 | 1510 | 474 | 3110 | 1920 |
| | 6 | 231 | 1400 | 952 | 303 | 1920 | 1410 | 384 | 2524 | 1830 | 485 | 3299 | 2340 |
| 50 | 2 | 206 | 1479 | 689 | 273 | 2023 | 1007 | 350 | 2659 | 1315 | 435 | 3548 | 1665 |
| | 4 | 213 | 1561 | 860 | 281 | 2139 | 1291 | 359 | 2814 | 1685 | 447 | 3730 | 2135 |
| | 6 | 221 | 1631 | 1031 | 290 | 2242 | 1575 | 369 | 2951 | 2055 | 461 | 3893 | 2605 |
| 100 | 2 | 192 | 1923 | 712 | 254 | 2644 | 1050 | 326 | 3490 | 1370 | 402 | 4707 | 1740 |
| | 4 | 200 | 1984 | 888 | 263 | 2731 | 1346 | 336 | 3606 | 1760 | 414 | 4842 | 2220 |
| | 6 | 208 | 2035 | 1064 | 272 | 2811 | 1642 | 346 | 3714 | 2150 | 426 | 4968 | 2700 |

| | COMMON VENT CAPACITY | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TYPE B DOUBLE-WALL COMMON VENT DIAMETER – *D* (inch) | | | | | | | | | | | |
| | 12 | | | 14 | | | 16 | | | 18 | | |
| | COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | |
| VENT HEIGHT *H* (feet) | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT |
| 6 | 900 | 696 | 588 | 1284 | 990 | 815 | 1735 | 1336 | 1065 | 2253 | 1732 | 1345 |
| 8 | 994 | 773 | 652 | 1423 | 1103 | 912 | 1927 | 1491 | 1190 | 2507 | 1936 | 1510 |
| 10 | 1076 | 841 | 712 | 1542 | 1200 | 995 | 2093 | 1625 | 1300 | 2727 | 2113 | 1645 |
| 15 | 1247 | 986 | 825 | 1794 | 1410 | 1158 | 2440 | 1910 | 1510 | 3184 | 2484 | 1910 |
| 20 | 1405 | 1116 | 916 | 2006 | 1588 | 1290 | 2722 | 2147 | 1690 | 3561 | 2798 | 2140 |
| 30 | 1658 | 1327 | 1025 | 2373 | 1892 | 1525 | 3220 | 2558 | 1990 | 4197 | 3326 | 2520 |
| 50 | 2024 | 1640 | 1280 | 2911 | 2347 | 1863 | 3964 | 3183 | 2430 | 5184 | 4149 | 3075 |
| 100 | 2569 | 2131 | 1670 | 3732 | 3076 | 2450 | 5125 | 4202 | 3200 | 6749 | 5509 | 4050 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.2(1)**
**TYPE B DOUBLE-WALL VENT [NFPA 54: TABLE 13.2(a)] (continued)***

| | | NUMBER OF APPLIANCES: | TWO OR MORE | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | CATEGORY I | | | | | | | |
| | | APPLIANCE VENT CONNECTION: | TYPE B DOUBLE-WALL CONNECTOR | | | | | | | |
| | | VENT CONNECTOR CAPACITY | | | | | | | | |
| | | TYPE B DOUBLE-WALL VENT AND CONNECTOR DIAMETER – *D* (inch) | | | | | | | | |
| | | 20 | | | 22 | | | 24 | | |
| | | APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| VENT HEIGHT *H* (feet) | CONNECTOR RISE *R* (feet) | FAN | | NAT | FAN | | NAT | FAN | | NAT |
| | | Min | Max | Max | Min | Max | Max | Min | Max | Max |
| 6 | 2 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | 4 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | 6 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| 8 | 2 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | 4 | 471 | 2737 | 1800 | 560 | 3319 | 2180 | 662 | 3957 | 2590 |
| | 6 | 478 | 3018 | 2180 | 568 | 3665 | 2640 | 669 | 4373 | 3130 |
| 10 | 2 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | 4 | 486 | 2887 | 1890 | 581 | 3502 | 2280 | 686 | 4175 | 2710 |
| | 6 | 494 | 3169 | 2290 | 589 | 3849 | 2760 | 694 | 4593 | 3270 |
| 15 | 2 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | 4 | 523 | 3197 | 2060 | 624 | 3881 | 2490 | 734 | 4631 | 2960 |
| | 6 | 533 | 3470 | 2510 | 634 | 4216 | 3030 | 743 | 5035 | 3600 |
| 20 | 2 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | 4 | 554 | 3447 | 2180 | 661 | 4190 | 2630 | 772 | 5005 | 3130 |
| | 6 | 567 | 3708 | 2650 | 671 | 4511 | 3190 | 785 | 5392 | 3790 |
| 30 | 2 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | 4 | 619 | 3840 | 2365 | 728 | 4861 | 2860 | 847 | 5606 | 3410 |
| | 6 | 632 | 4080 | 2875 | 741 | 4976 | 3480 | 860 | 5961 | 4150 |
| 50 | 2 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | 4 | 580 | 4601 | 2633 | 709 | 5569 | 3185 | 851 | 6633 | 3790 |
| | 6 | 594 | 4808 | 3208 | 724 | 5826 | 3885 | 867 | 6943 | 4620 |
| 100 | 2 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| | 4 | 523 | 5982 | 2750 | 639 | 7254 | 3330 | 769 | 8650 | 3950 |
| | 6 | 539 | 6143 | 3350 | 654 | 7453 | 4070 | 786 | 8892 | 4810 |

| | COMMON VENT CAPACITY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | TYPE B DOUBLE-WALL COMMON VENT DIAMETER – *D* (inch) | | | | | | | | |
| | 20 | | | 22 | | | 24 | | |
| | COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| VENT HEIGHT *H* (feet) | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT |
| 6 | 2838 | 2180 | 1660 | 3488 | 2677 | 1970 | 4206 | 3226 | 2390 |
| 8 | 3162 | 2439 | 1860 | 3890 | 2998 | 2200 | 4695 | 3616 | 2680 |
| 10 | 3444 | 2665 | 2030 | 4241 | 3278 | 2400 | 5123 | 3957 | 2920 |
| 15 | 4026 | 3133 | 2360 | 4971 | 3862 | 2790 | 6016 | 4670 | 3400 |
| 20 | 4548 | 3552 | 2640 | 5573 | 4352 | 3120 | 6749 | 5261 | 3800 |
| 30 | 5303 | 4193 | 3110 | 6539 | 5157 | 3680 | 7940 | 6247 | 4480 |
| 50 | 6567 | 5240 | 3800 | 8116 | 6458 | 4500 | 9837 | 7813 | 5475 |
| 100 | 8597 | 6986 | 5000 | 10 681 | 8648 | 5920 | 13 004 | 10 499 | 7200 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.2(2)**
**TYPE B DOUBLE-WALL VENT [NFPA 54: TABLE 13.2(b)]***

| | | 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* (inch) | | | | | | | | | | | | | |
| | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | |
| | | APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | | | |
| VENT HEIGHT *H* (feet) | CONNECTOR RISE *R* (feet) | 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 |
| 6 | 1 | NA | NA | 26 | NA | NA | 46 | NA | NA | 71 | NA | NA | 102 | 207 | 223 | 140 |
| | 2 | NA | NA | 31 | NA | NA | 55 | NA | NA | 85 | 168 | 182 | 123 | 215 | 251 | 167 |
| | 3 | NA | NA | 34 | NA | NA | 62 | 121 | 131 | 95 | 175 | 198 | 138 | 222 | 273 | 188 |
| 8 | 1 | NA | NA | 27 | NA | NA | 48 | NA | NA | 75 | NA | NA | 106 | 226 | 240 | 145 |
| | 2 | NA | NA | 32 | NA | NA | 57 | 125 | 126 | 89 | 184 | 193 | 127 | 234 | 266 | 173 |
| | 3 | NA | NA | 35 | NA | NA | 64 | 130 | 138 | 100 | 191 | 208 | 144 | 241 | 287 | 197 |
| 10 | 1 | NA | NA | 28 | NA | NA | 50 | 119 | 121 | 77 | 182 | 186 | 110 | 240 | 253 | 150 |
| | 2 | NA | NA | 33 | 84 | 85 | 59 | 124 | 134 | 91 | 189 | 203 | 132 | 248 | 278 | 183 |
| | 3 | NA | NA | 36 | 89 | 91 | 67 | 129 | 144 | 102 | 197 | 217 | 148 | 257 | 299 | 203 |
| 15 | 1 | NA | NA | 29 | 79 | 87 | 52 | 116 | 138 | 81 | 177 | 214 | 116 | 238 | 291 | 158 |
| | 2 | NA | NA | 34 | 83 | 94 | 62 | 121 | 150 | 97 | 185 | 230 | 138 | 246 | 314 | 189 |
| | 3 | NA | NA | 39 | 87 | 100 | 70 | 127 | 160 | 109 | 193 | 243 | 157 | 255 | 333 | 215 |
| 20 | 1 | 49 | 56 | 30 | 78 | 97 | 54 | 115 | 152 | 84 | 175 | 238 | 120 | 233 | 325 | 165 |
| | 2 | 52 | 59 | 36 | 82 | 103 | 64 | 120 | 163 | 101 | 182 | 252 | 144 | 243 | 346 | 197 |
| | 3 | 55 | 62 | 40 | 87 | 107 | 72 | 125 | 172 | 113 | 190 | 264 | 164 | 252 | 363 | 223 |
| 30 | 1 | 47 | 60 | 31 | 77 | 110 | 57 | 112 | 175 | 89 | 169 | 278 | 129 | 226 | 380 | 175 |
| | 2 | 51 | 62 | 37 | 81 | 115 | 67 | 117 | 185 | 106 | 177 | 290 | 152 | 236 | 397 | 208 |
| | 3 | 54 | 64 | 42 | 85 | 119 | 76 | 122 | 193 | 120 | 185 | 300 | 172 | 244 | 412 | 235 |
| 50 | 1 | 46 | 69 | 34 | 75 | 128 | 60 | 109 | 207 | 96 | 162 | 336 | 137 | 217 | 460 | 188 |
| | 2 | 49 | 71 | 40 | 79 | 132 | 72 | 114 | 215 | 113 | 170 | 345 | 164 | 226 | 473 | 223 |
| | 3 | 52 | 72 | 45 | 83 | 136 | 82 | 119 | 221 | 123 | 178 | 353 | 186 | 235 | 486 | 252 |
| 100 | 1 | 45 | 79 | 34 | 71 | 150 | 61 | 104 | 249 | 98 | 153 | 424 | 140 | 205 | 585 | 192 |
| | 2 | 48 | 80 | 41 | 75 | 153 | 73 | 110 | 255 | 115 | 160 | 428 | 167 | 212 | 593 | 228 |
| | 3 | 51 | 81 | 46 | 79 | 157 | 85 | 114 | 260 | 129 | 168 | 433 | 190 | 222 | 603 | 256 |

| | COMMON VENT CAPACITY | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TYPE B DOUBLE-WALL COMMON VENT DIAMETER – *D* (inch) | | | | | | | | | | | |
| | 4 | | | 5 | | | 6 | | | 7 | | |
| | COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | |
| VENT HEIGHT *H* (feet) | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT |
| 6 | NA | 78 | 64 | NA | 113 | 99 | 200 | 158 | 144 | 304 | 244 | 196 |
| 8 | NA | 87 | 71 | NA | 126 | 111 | 218 | 173 | 159 | 331 | 269 | 218 |
| 10 | NA | 94 | 76 | 163 | 137 | 120 | 237 | 189 | 174 | 357 | 292 | 236 |
| 15 | 121 | 108 | 88 | 189 | 159 | 140 | 275 | 221 | 200 | 416 | 343 | 274 |
| 20 | 131 | 118 | 98 | 208 | 177 | 156 | 305 | 247 | 223 | 463 | 383 | 302 |
| 30 | 145 | 132 | 113 | 236 | 202 | 180 | 350 | 286 | 257 | 533 | 446 | 349 |
| 50 | 159 | 145 | 128 | 268 | 233 | 208 | 406 | 337 | 296 | 622 | 529 | 410 |
| 100 | 166 | 153 | NA | 297 | 263 | NA | 469 | 398 | NA | 726 | 633 | 464 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.2(2)**
**TYPE B DOUBLE-WALL VENT [NFPA 54: TABLE 13.2(b)] (continued)**

| | | 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* (inch) | | | | | | | | |
| | | 8 | | | 9 | | | 10 | | |
| | | APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| VENT HEIGHT *H* (feet) | CONNECTOR RISE *R* (feet) | FAN | | NAT | FAN | | NAT | FAN | | NAT |
| | | Min | Max | Max | Min | Max | Max | Min | Max | Max |
| 6 | 1 | 262 | 293 | 183 | 325 | 373 | 234 | 447 | 463 | 286 |
| | 2 | 271 | 331 | 219 | 334 | 422 | 281 | 458 | 524 | 344 |
| | 3 | 279 | 361 | 247 | 344 | 462 | 316 | 468 | 574 | 385 |
| 8 | 1 | 285 | 316 | 191 | 352 | 403 | 244 | 481 | 502 | 299 |
| | 2 | 293 | 353 | 228 | 360 | 450 | 292 | 492 | 560 | 355 |
| | 3 | 302 | 381 | 256 | 370 | 489 | 328 | 501 | 609 | 400 |
| 10 | 1 | 302 | 335 | 196 | 372 | 429 | 252 | 506 | 534 | 308 |
| | 2 | 311 | 369 | 235 | 381 | 473 | 302 | 517 | 589 | 368 |
| | 3 | 320 | 398 | 265 | 391 | 511 | 339 | 528 | 637 | 413 |
| 15 | 1 | 312 | 380 | 208 | 397 | 482 | 266 | 556 | 596 | 324 |
| | 2 | 321 | 411 | 248 | 407 | 522 | 317 | 568 | 646 | 387 |
| | 3 | 331 | 438 | 281 | 418 | 557 | 360 | 579 | 690 | 437 |
| 20 | 1 | 306 | 425 | 217 | 390 | 538 | 276 | 546 | 664 | 336 |
| | 2 | 317 | 453 | 259 | 400 | 574 | 331 | 558 | 709 | 403 |
| | 3 | 326 | 476 | 294 | 412 | 607 | 375 | 570 | 750 | 457 |
| 30 | 1 | 296 | 497 | 230 | 378 | 630 | 294 | 528 | 779 | 358 |
| | 2 | 307 | 521 | 274 | 389 | 662 | 349 | 541 | 819 | 425 |
| | 3 | 316 | 542 | 309 | 400 | 690 | 394 | 555 | 855 | 482 |
| 50 | 1 | 284 | 604 | 245 | 364 | 768 | 314 | 507 | 951 | 384 |
| | 2 | 294 | 623 | 293 | 376 | 793 | 375 | 520 | 983 | 458 |
| | 3 | 304 | 640 | 331 | 387 | 816 | 423 | 535 | 1013 | 518 |
| 100 | 1 | 269 | 774 | 249 | 345 | 993 | 321 | 476 | 1236 | 393 |
| | 2 | 279 | 788 | 299 | 358 | 1011 | 383 | 490 | 1259 | 469 |
| | 3 | 289 | 801 | 339 | 368 | 1027 | 431 | 506 | 1280 | 527 |

| | COMMON VENT CAPACITY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | TYPE B DOUBLE-WALL COMMON VENT DIAMETER – *D* (inch) | | | | | | | | |
| | 8 | | | 9 | | | 10 | | |
| | COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| VENT HEIGHT *H* (feet) | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT |
| 6 | 398 | 310 | 257 | 541 | 429 | 332 | 665 | 515 | 407 |
| 8 | 436 | 342 | 285 | 592 | 473 | 373 | 730 | 569 | 460 |
| 10 | 467 | 369 | 309 | 638 | 512 | 398 | 787 | 617 | 487 |
| 15 | 544 | 434 | 357 | 738 | 599 | 456 | 905 | 718 | 553 |
| 20 | 606 | 487 | 395 | 824 | 673 | 512 | 1013 | 808 | 626 |
| 30 | 703 | 570 | 459 | 958 | 790 | 593 | 1183 | 952 | 723 |
| 50 | 833 | 686 | 535 | 1139 | 954 | 689 | 1418 | 1157 | 838 |
| 100 | 999 | 846 | 606 | 1378 | 1185 | 780 | 1741 | 1459 | 948 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

TABLE 510.2(3)
MASONRY CHIMNEY [NFPA 54: TABLE 13.2(c)]*

| | | NUMBER OF APPLIANCES: | TWO OR MORE | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | CATEGORY I | | | | | | | | | | | | |
| | | APPLIANCE VENT CONNECTION: | TYPE B DOUBLE-WALL CONNECTOR | | | | | | | | | | | | |
| | | VENT CONNECTOR CAPACITY | | | | | | | | | | | | | |
| | | TYPE B DOUBLE-WALL VENT CONNECTOR DIAMETER – *D* (inch) | | | | | | | | | | | | | |
| | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | |
| | | APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | | | |
| VENT HEIGHT *H* (feet) | CONNECTOR RISE *R* (feet) | 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 |
| 6 | 1 | 24 | 33 | 21 | 39 | 62 | 40 | 52 | 106 | 67 | 65 | 194 | 101 | 87 | 274 | 141 |
| | 2 | 26 | 43 | 28 | 41 | 79 | 52 | 53 | 133 | 85 | 67 | 230 | 124 | 89 | 324 | 173 |
| | 3 | 27 | 49 | 34 | 42 | 92 | 61 | 55 | 155 | 97 | 69 | 262 | 143 | 91 | 369 | 203 |
| 8 | 1 | 24 | 39 | 22 | 39 | 72 | 41 | 55 | 117 | 69 | 71 | 213 | 105 | 94 | 304 | 148 |
| | 2 | 26 | 47 | 29 | 40 | 87 | 53 | 57 | 140 | 86 | 73 | 246 | 127 | 97 | 350 | 179 |
| | 3 | 27 | 52 | 34 | 42 | 97 | 62 | 59 | 159 | 98 | 75 | 269 | 145 | 99 | 383 | 206 |
| 10 | 1 | 24 | 42 | 22 | 38 | 80 | 42 | 55 | 130 | 71 | 74 | 232 | 108 | 101 | 324 | 153 |
| | 2 | 26 | 50 | 29 | 40 | 93 | 54 | 57 | 153 | 87 | 76 | 261 | 129 | 103 | 366 | 184 |
| | 3 | 27 | 55 | 35 | 41 | 105 | 63 | 58 | 170 | 100 | 78 | 284 | 148 | 106 | 397 | 209 |
| 15 | 1 | 24 | 48 | 23 | 38 | 93 | 44 | 54 | 154 | 74 | 72 | 277 | 114 | 100 | 384 | 164 |
| | 2 | 25 | 55 | 31 | 39 | 105 | 55 | 56 | 174 | 89 | 74 | 299 | 134 | 103 | 419 | 192 |
| | 3 | 26 | 59 | 35 | 41 | 115 | 64 | 57 | 189 | 102 | 76 | 319 | 153 | 105 | 448 | 215 |
| 20 | 1 | 24 | 52 | 24 | 37 | 102 | 46 | 53 | 172 | 77 | 71 | 313 | 119 | 98 | 437 | 173 |
| | 2 | 25 | 58 | 31 | 39 | 114 | 56 | 55 | 190 | 91 | 73 | 335 | 138 | 101 | 467 | 199 |
| | 3 | 26 | 63 | 35 | 40 | 123 | 65 | 57 | 204 | 104 | 75 | 353 | 157 | 104 | 493 | 222 |
| 30 | 1 | 24 | 54 | 25 | 37 | 111 | 48 | 52 | 192 | 82 | 69 | 357 | 127 | 96 | 504 | 187 |
| | 2 | 25 | 60 | 32 | 38 | 122 | 58 | 54 | 208 | 95 | 72 | 376 | 145 | 99 | 531 | 209 |
| | 3 | 26 | 64 | 36 | 40 | 131 | 66 | 56 | 221 | 107 | 74 | 392 | 163 | 101 | 554 | 233 |
| 50 | 1 | 23 | 51 | 25 | 36 | 116 | 51 | 51 | 209 | 89 | 67 | 405 | 143 | 92 | 582 | 213 |
| | 2 | 24 | 59 | 32 | 37 | 127 | 61 | 53 | 225 | 102 | 70 | 421 | 161 | 95 | 604 | 235 |
| | 3 | 26 | 64 | 36 | 39 | 135 | 69 | 55 | 237 | 115 | 72 | 435 | 180 | 98 | 624 | 260 |
| 100 | 1 | 23 | 46 | 24 | 35 | 108 | 50 | 49 | 208 | 92 | 65 | 428 | 155 | 88 | 640 | 237 |
| | 2 | 24 | 53 | 31 | 37 | 120 | 60 | 51 | 224 | 105 | 67 | 444 | 174 | 92 | 660 | 260 |
| | 3 | 25 | 59 | 35 | 38 | 130 | 68 | 53 | 237 | 118 | 69 | 458 | 193 | 94 | 679 | 285 |

| | COMMON VENT CAPACITY | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MINIMUM INTERNAL AREA OF MASONRY CHIMNEY FLUE (square inches) | | | | | | | | | | | | | | |
| | 12 | | | 19 | | | 28 | | | 38 | | | 50 | | |
| | COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | | | | |
| VENT HEIGHT *H* (feet) | 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 |
| 8 | NA | 80 | 28 | NA | 130 | 53 | NA | 193 | 82 | NA | 279 | 119 | NA | 384 | 163 |
| 10 | NA | 84 | 31 | NA | 138 | 56 | NA | 207 | 90 | NA | 299 | 131 | NA | 409 | 177 |
| 15 | NA | NA | 36 | NA | 152 | 67 | NA | 233 | 106 | NA | 334 | 152 | 523 | 467 | 212 |
| 20 | NA | NA | 41 | NA | NA | 75 | NA | 250 | 122 | NA | 368 | 172 | 565 | 508 | 243 |
| 30 | NA | NA | NA | NA | NA | NA | NA | 270 | 137 | NA | 404 | 198 | 615 | 564 | 278 |
| 50 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 620 | 328 |
| 100 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 348 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.2(3)**
**MASONRY CHIMNEY [NFPA 54: TABLE 13.2(c)] (continued)***

| | | NUMBER OF APPLIANCES: | TWO OR MORE | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | CATEGORY I | | | | | | | |
| | | APPLIANCE VENT CONNECTION: | TYPE B DOUBLE-WALL CONNECTOR | | | | | | | |
| | | VENT CONNECTOR CAPACITY | | | | | | | | |
| | | TYPE B DOUBLE-WALL VENT CONNECTOR DIAMETER – *D* (inch) | | | | | | | | |
| | | 8 | | | 9 | | | 10 | | |
| | | APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| VENT HEIGHT *H* (feet) | CONNECTOR RISE *R* (feet) | FAN | | NAT | FAN | | NAT | FAN | | NAT |
| | | Min | Max | Max | Min | Max | Max | Min | Max | Max |
| 6 | 1 | 104 | 370 | 201 | 124 | 479 | 253 | 145 | 599 | 319 |
| | 2 | 107 | 436 | 232 | 127 | 562 | 300 | 148 | 694 | 378 |
| | 3 | 109 | 491 | 270 | 129 | 633 | 349 | 151 | 795 | 439 |
| 8 | 1 | 113 | 414 | 210 | 134 | 539 | 267 | 156 | 682 | 335 |
| | 2 | 116 | 473 | 240 | 137 | 615 | 311 | 160 | 776 | 394 |
| | 3 | 119 | 517 | 276 | 139 | 672 | 358 | 163 | 848 | 452 |
| 10 | 1 | 120 | 444 | 216 | 142 | 582 | 277 | 165 | 739 | 348 |
| | 2 | 123 | 498 | 247 | 145 | 652 | 321 | 168 | 825 | 407 |
| | 3 | 126 | 540 | 281 | 147 | 705 | 366 | 171 | 893 | 463 |
| 15 | 1 | 125 | 511 | 229 | 153 | 658 | 297 | 184 | 824 | 375 |
| | 2 | 128 | 558 | 260 | 156 | 718 | 339 | 187 | 900 | 432 |
| | 3 | 131 | 597 | 292 | 159 | 760 | 382 | 190 | 960 | 486 |
| 20 | 1 | 123 | 584 | 239 | 150 | 752 | 312 | 180 | 943 | 397 |
| | 2 | 126 | 625 | 270 | 153 | 805 | 354 | 184 | 1011 | 452 |
| | 3 | 129 | 661 | 301 | 156 | 851 | 396 | 187 | 1067 | 505 |
| 30 | 1 | 119 | 680 | 255 | 145 | 883 | 337 | 175 | 1115 | 432 |
| | 2 | 122 | 715 | 287 | 149 | 928 | 378 | 179 | 1171 | 484 |
| | 3 | 125 | 746 | 317 | 152 | 968 | 418 | 182 | 1220 | 535 |
| 50 | 1 | 115 | 798 | 294 | 140 | 1049 | 392 | 168 | 1334 | 506 |
| | 2 | 118 | 827 | 326 | 143 | 1085 | 433 | 172 | 1379 | 558 |
| | 3 | 121 | 854 | 357 | 147 | 1118 | 474 | 176 | 1421 | 611 |
| 100 | 1 | 109 | 907 | 334 | 134 | 1222 | 454 | 161 | 1589 | 596 |
| | 2 | 113 | 933 | 368 | 138 | 1253 | 497 | 165 | 1626 | 651 |
| | 3 | 116 | 956 | 399 | 141 | 1282 | 540 | 169 | 1661 | 705 |

| | COMMON VENT CAPACITY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | MINIMUM INTERNAL AREA OF MASONRY CHIMNEY FLUE (square inches) | | | | | | | | |
| | 63 | | | 78 | | | 113 | | |
| | COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| VENT HEIGHT *H* (feet) | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT |
| 6 | NA | 458 | 188 | NA | 582 | 246 | 1041 | 853 | NA |
| 8 | NA | 501 | 218 | 724 | 636 | 278 | 1144 | 937 | 408 |
| 10 | 606 | 538 | 236 | 776 | 686 | 302 | 1226 | 1010 | 454 |
| 15 | 682 | 611 | 283 | 874 | 781 | 365 | 1374 | 1156 | 546 |
| 20 | 742 | 668 | 325 | 955 | 858 | 419 | 1513 | 1286 | 648 |
| 30 | 816 | 747 | 381 | 1062 | 969 | 496 | 1702 | 1473 | 749 |
| 50 | 879 | 831 | 461 | 1165 | 1089 | 606 | 1905 | 1692 | 922 |
| 100 | NA | NA | 499 | NA | NA | 669 | 2053 | 1921 | 1058 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.2(4)**
**MASONRY CHIMNEY [NFPA 54: TABLE 13.2(d)]***

| | | 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* (inch) | | | | | | | | | | | | | |
| | | 3 | | | 4 | | | 5 | | | 6 | | | 7 | | |
| | | APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | | | |
| VENT HEIGHT *H* (feet) | CONNECTOR RISE *R* (feet) | 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 |
| 6 | 1 | NA | NA | 21 | NA | NA | 39 | NA | NA | 66 | 179 | 191 | 100 | 231 | 271 | 140 |
| | 2 | NA | NA | 28 | NA | NA | 52 | NA | NA | 84 | 186 | 227 | 123 | 239 | 321 | 172 |
| | 3 | NA | NA | 34 | NA | NA | 61 | 134 | 153 | 97 | 193 | 258 | 142 | 247 | 365 | 202 |
| 8 | 1 | NA | NA | 21 | NA | NA | 40 | NA | NA | 68 | 195 | 208 | 103 | 250 | 298 | 146 |
| | 2 | NA | NA | 28 | NA | NA | 52 | 137 | 139 | 85 | 202 | 240 | 125 | 258 | 343 | 177 |
| | 3 | NA | NA | 34 | NA | NA | 62 | 143 | 156 | 98 | 210 | 264 | 145 | 266 | 376 | 205 |
| 10 | 1 | NA | NA | 22 | NA | NA | 41 | 130 | 151 | 70 | 202 | 225 | 106 | 267 | 316 | 151 |
| | 2 | NA | NA | 29 | NA | NA | 53 | 136 | 150 | 86 | 210 | 255 | 128 | 276 | 358 | 181 |
| | 3 | NA | NA | 34 | 97 | 102 | 62 | 143 | 166 | 99 | 217 | 277 | 147 | 284 | 389 | 207 |
| 15 | 1 | NA | NA | 23 | NA | NA | 43 | 129 | 151 | 73 | 199 | 271 | 112 | 268 | 376 | 161 |
| | 2 | NA | NA | 30 | 92 | 103 | 54 | 135 | 170 | 88 | 207 | 295 | 132 | 277 | 411 | 189 |
| | 3 | NA | NA | 34 | 96 | 112 | 63 | 141 | 185 | 101 | 215 | 315 | 151 | 286 | 439 | 213 |
| 20 | 1 | NA | NA | 23 | 87 | 99 | 45 | 128 | 167 | 76 | 197 | 303 | 117 | 265 | 425 | 169 |
| | 2 | NA | NA | 30 | 91 | 111 | 55 | 134 | 185 | 90 | 205 | 325 | 136 | 274 | 455 | 195 |
| | 3 | NA | NA | 35 | 96 | 119 | 64 | 140 | 199 | 103 | 213 | 343 | 154 | 282 | 481 | 219 |
| 30 | 1 | NA | NA | 24 | 86 | 108 | 47 | 126 | 187 | 80 | 193 | 347 | 124 | 259 | 492 | 183 |
| | 2 | NA | NA | 31 | 91 | 119 | 57 | 132 | 203 | 93 | 201 | 366 | 142 | 269 | 518 | 205 |
| | 3 | NA | NA | 35 | 95 | 127 | 65 | 138 | 216 | 105 | 209 | 381 | 160 | 277 | 540 | 229 |
| 50 | 1 | NA | NA | 24 | 85 | 113 | 50 | 124 | 204 | 87 | 188 | 392 | 139 | 252 | 567 | 208 |
| | 2 | NA | NA | 31 | 89 | 123 | 60 | 130 | 218 | 100 | 196 | 408 | 158 | 262 | 588 | 230 |
| | 3 | NA | NA | 35 | 94 | 131 | 68 | 136 | 231 | 112 | 205 | 422 | 176 | 271 | 607 | 255 |
| 100 | 1 | NA | NA | 23 | 84 | 104 | 49 | 122 | 200 | 89 | 182 | 410 | 151 | 243 | 617 | 232 |
| | 2 | NA | NA | 30 | 88 | 115 | 59 | 127 | 215 | 102 | 190 | 425 | 169 | 253 | 636 | 254 |
| | 3 | NA | NA | 34 | 93 | 124 | 67 | 133 | 228 | 115 | 199 | 438 | 188 | 262 | 654 | 279 |

| | COMMON VENT CAPACITY | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MINIMUM INTERNAL AREA OF MASONRY CHIMNEY FLUE (square inches) | | | | | | | | | | | | | | |
| | 12 | | | 19 | | | 28 | | | 38 | | | 50 | | |
| | COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | | | | |
| VENT HEIGHT *H* (feet) | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT |
| 6 | NA | NA | 25 | NA | 118 | 45 | NA | 176 | 71 | NA | 255 | 102 | NA | 348 | 142 |
| 8 | NA | NA | 28 | NA | 128 | 52 | NA | 190 | 81 | NA | 276 | 118 | NA | 380 | 162 |
| 10 | NA | NA | 31 | NA | 136 | 56 | NA | 205 | 89 | NA | 295 | 129 | NA | 405 | 175 |
| 15 | NA | NA | 36 | NA | NA | 66 | NA | 230 | 105 | NA | 335 | 150 | NA | 400 | 210 |
| 20 | NA | NA | NA | NA | NA | 74 | NA | 247 | 120 | NA | 362 | 170 | NA | 503 | 240 |
| 30 | NA | NA | NA | NA | NA | NA | NA | NA | 135 | NA | 398 | 195 | NA | 558 | 275 |
| 50 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | 612 | 325 |
| 100 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.2(4)**
**MASONRY CHIMNEY [NFPA 54: TABLE 13.2(d)] (continued)***

| | | 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* (inch) | | | | | | | | |
| | | 8 | | | 9 | | | 10 | | |
| | | APPLIANCE INPUT RATING LIMITS IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| VENT HEIGHT *H* (feet) | CONNECTOR RISE *R* (feet) | FAN | | NAT | FAN | | NAT | FAN | | NAT |
| | | Min | Max | Max | Min | Max | Max | Min | Max | Max |
| 6 | 1 | 292 | 366 | 200 | 362 | 474 | 252 | 499 | 594 | 316 |
| | 2 | 301 | 432 | 231 | 373 | 557 | 299 | 509 | 696 | 376 |
| | 3 | 309 | 491 | 269 | 381 | 634 | 348 | 519 | 793 | 437 |
| 8 | 1 | 313 | 407 | 207 | 387 | 530 | 263 | 529 | 672 | 331 |
| | 2 | 323 | 465 | 238 | 397 | 607 | 309 | 540 | 766 | 391 |
| | 3 | 332 | 509 | 274 | 407 | 663 | 356 | 551 | 838 | 450 |
| 10 | 1 | 333 | 434 | 213 | 410 | 571 | 273 | 558 | 727 | 343 |
| | 2 | 343 | 489 | 244 | 420 | 640 | 317 | 569 | 813 | 403 |
| | 3 | 352 | 530 | 279 | 430 | 694 | 363 | 580 | 880 | 459 |
| 15 | 1 | 349 | 502 | 225 | 445 | 646 | 291 | 623 | 808 | 366 |
| | 2 | 359 | 548 | 256 | 456 | 706 | 334 | 634 | 884 | 424 |
| | 3 | 368 | 586 | 289 | 466 | 755 | 378 | 646 | 945 | 479 |
| 20 | 1 | 345 | 569 | 235 | 439 | 734 | 306 | 614 | 921 | 387 |
| | 2 | 355 | 610 | 266 | 450 | 787 | 348 | 627 | 986 | 443 |
| | 3 | 365 | 644 | 298 | 461 | 831 | 391 | 639 | 1042 | 496 |
| 30 | 1 | 338 | 665 | 250 | 430 | 864 | 330 | 600 | 1089 | 421 |
| | 2 | 348 | 699 | 282 | 442 | 908 | 372 | 613 | 1145 | 473 |
| | 3 | 358 | 729 | 312 | 452 | 946 | 412 | 626 | 1193 | 524 |
| 50 | 1 | 328 | 778 | 287 | 417 | 1022 | 383 | 582 | 1302 | 492 |
| | 2 | 339 | 806 | 320 | 429 | 1058 | 425 | 596 | 1346 | 545 |
| | 3 | 349 | 831 | 351 | 440 | 1090 | 466 | 610 | 1386 | 597 |
| 100 | 1 | 315 | 875 | 328 | 402 | 1181 | 444 | 560 | 1537 | 580 |
| | 2 | 326 | 899 | 361 | 415 | 1210 | 488 | 575 | 1570 | 634 |
| | 3 | 337 | 921 | 392 | 427 | 1238 | 529 | 589 | 1604 | 687 |

| | COMMON VENT CAPACITY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | MINIMUM INTERNAL AREA OF MASONRY CHIMNEY FLUE (square inches) | | | | | | | | |
| | 63 | | | 78 | | | 113 | | |
| | COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| VENT HEIGHT *H* (feet) | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT | FAN +FAN | FAN +NAT | NAT +NAT |
| 6 | NA | 455 | 187 | NA | 579 | 245 | NA | 846 | NA |
| 8 | NA | 497 | 217 | NA | 633 | 277 | 1136 | 928 | 405 |
| 10 | NA | 532 | 234 | 771 | 680 | 300 | 1216 | 1000 | 450 |
| 15 | 677 | 602 | 280 | 866 | 772 | 360 | 1359 | 1139 | 540 |
| 20 | 765 | 661 | 321 | 947 | 849 | 415 | 1495 | 1264 | 640 |
| 30 | 808 | 739 | 377 | 1052 | 957 | 490 | 1682 | 1447 | 740 |
| 50 | NA | 821 | 456 | 1152 | 1076 | 600 | 1879 | 1672 | 910 |
| 100 | NA | NA | 494 | NA | NA | 663 | 2006 | 1885 | 1046 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.2(5)**
**SINGLE-WALL METAL PIPE OR TYPE B ASBESTOS-CEMENT VENT [NFPA 54: TABLE 13.2(e)]***

| | | NUMBER OF APPLIANCES: | TWO OR MORE | | | | |
|---|---|---|---|---|---|---|---|
| | | APPLIANCE TYPE: | DRAFT HOOD-EQUIPMENT | | | | |
| | | APPLIANCE VENT CONNECTION: | DIRECT TO PIPE OR VENT | | | | |
| | | VENT CONNECTOR CAPACITY | | | | | |
| | | VENT CONNECTOR DIAMETER – *D* (inch) | | | | | |
| TOTAL VENT HEIGHT *H* (feet) | CONNECTOR RISE *R* (feet) | 3 | 4 | 5 | 6 | 7 | 8 |
| | | 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 |
| | 3 | 34 | 61 | 98 | 147 | 204 | 275 |
| 15 | 1 | 23 | 44 | 77 | 117 | 179 | 240 |
| | 2 | 30 | 56 | 92 | 134 | 194 | 265 |
| | 3 | 35 | 64 | 102 | 155 | 216 | 298 |
| 30 and up | 1 | 25 | 49 | 84 | 129 | 190 | 270 |
| | 2 | 31 | 58 | 97 | 145 | 211 | 295 |
| | 3 | 36 | 68 | 107 | 164 | 232 | 321 |

| | COMMON VENT CAPACITY | | | | | | |
|---|---|---|---|---|---|---|---|
| | COMMON VENT DIAMETER – *D* (inch) | | | | | | |
| TOTAL VENT HEIGHT *H* (feet) | 4 | 5 | 6 | 7 | 8 | 10 | 12 |
| | COMBINED APPLIANCE INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | |
| 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 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.2(6)**
**EXTERIOR MASONRY CHIMNEY [NFPA 54-12: TABLE 13.2(f)]***

| | NUMBER OF APPLIANCES: | TWO OR MORE | | | | | |
|---|---|---|---|---|---|---|---|
| | APPLIANCE TYPE: | NAT + NAT | | | | | |
| | APPLIANCE VENT CONNECTION: | TYPE B DOUBLE-WALL CONNECTOR | | | | | |
| COMBINED APPLIANCE MAXIMUM INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | |
| VENT HEIGHT *H* (feet) | INTERNAL AREA OF CHIMNEY (square inches) | | | | | | |
| | 12 | 19 | 28 | 38 | 50 | 63 | 78 | 113 |
| 6 | 25 | 46 | 71 | 103 | 143 | 188 | 246 | NA |
| 8 | 28 | 53 | 82 | 119 | 163 | 218 | 278 | 408 |
| 10 | 31 | 56 | 90 | 131 | 177 | 236 | 302 | 454 |
| 15 | NA | 67 | 106 | 152 | 212 | 283 | 365 | 546 |
| 20 | NA | NA | NA | NA | NA | 325 | 419 | 648 |
| 30 | NA | NA | NA | NA | NA | NA | 496 | 749 |
| 50 | NA | NA | NA | NA | NA | NA | NA | 922 |
| 100 | NA | NA | NA | NA | NA | NA | NA | NA |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.2(7)**
**EXTERIOR MASONRY CHIMNEY [NFPA 54-12: TABLE 13.2(g)][1, 2]**

| | NUMBER OF APPLIANCES: | TWO OR MORE | | | | | |
|---|---|---|---|---|---|---|---|
| | APPLIANCE TYPE: | NAT + NAT | | | | | |
| | APPLIANCE VENT CONNECTION: | TYPE B DOUBLE-WALL CONNECTOR | | | | | |
| MINIMUM ALLOWABLE INPUT RATING OF SPACE-HEATING APPLIANCE IN THOUSANDS OF BTU PER HOUR | | | | | | | |
| VENT HEIGHT *H* (feet) | INTERNAL AREA OF CHIMNEY (square inches) | | | | | | |
| 12 | 19 | 28 | 38 | 50 | 63 | 78 | 113 |
| 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 |
| 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 |
| Local 99% winter design temperature: 17°F 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 |
| Local 99% winter design temperature: 5°F 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 |
| Local 99% winter design temperature: 4°F or lower<br>Not recommended for any vent configurations | | | | | | | |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$, °C = (°F-32)/1.8

**Notes:**

[1] See Figure 510.1.2(6) for a map showing local 99 percent winter design temperatures in the United States.

[2] NA: Not applicable.

**TABLE 510.2(8)**
**EXTERIOR MASONRY CHIMNEY [NFPA 54-12: TABLE 13.2(h)]***

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | NUMBER OF APPLIANCES: | TWO OR MORE | | | |
| | | | | APPLIANCE TYPE: | FAN + NAT | | | |
| | | | | APPLIANCE VENT CONNECTION: | TYPE B DOUBLE-WALL CONNECTOR | | | |
| COMBINED APPLIANCE MAXIMUM INPUT RATING IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| VENT HEIGHT *H* (feet) | INTERNAL AREA OF CHIMNEY (square inches) | | | | | | | |
| | 12 | 19 | 28 | 38 | 50 | 63 | 78 | 113 |
| 6 | 74 | 119 | 178 | 257 | 351 | 458 | 582 | 853 |
| 8 | 80 | 130 | 193 | 279 | 384 | 501 | 636 | 937 |
| 10 | 84 | 138 | 207 | 299 | 409 | 538 | 686 | 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 |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 $m^2$

* NA: Not applicable.

**TABLE 510.2(9)**
**EXTERIOR MASONRY CHIMNEY [NFPA 54-12: TABLE 13.2(i)][1, 2]**

| | NUMBER OF APPLIANCES: | TWO OR MORE | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | APPLIANCE TYPE: | FAN + NAT | | | | | | |
| | APPLIANCE VENT CONNECTION: | TYPE B DOUBLE-WALL CONNECTOR | | | | | | |
| MINIMUM ALLOWABLE INPUT RATING OF SPACE-HEATING APPLIANCE IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| VENT HEIGHT *H* (feet) | INTERNAL AREA OF CHIMNEY (square inches) | | | | | | | |
| | 12 | 19 | 28 | 38 | 50 | 63 | 78 | 113 |
| 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 |
| 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 | 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 |
| 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 |
| 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 | 547 |
| 30 | NA | NA | NA | 377 | 450 | 531 | 580 | 682 |
| 50 | NA | NA | NA | NA | NA | 797 | 853 | 972 |
| 100 | NA | NA | NA | NA | NA | NA | NA | 1833 |
| 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 |
| Local 99% winter design temperature: -11°F or lower<br>Not recommended for any vent configurations | | | | | | | | |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 square inch = 0.000645 m², °C = (°F-32)/1.8

**Notes:**

[1] See Figure 510.1.2(6) for a map showing local 99 percent winter design temperatures in the United States.

[2] NA: Not applicable.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 6 - WATER SUPPLY AND DISTRIBUTION

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | X | | X | X | | | X | X | X | X | X | X | | | X | | | | |
| Adopt only those sections that are listed below | | X | | | | | | | | | | | | X | | | X | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| 601.1 Exceptions | | | X | X | | | | | | | | | | | | X | | | |
| 601.2.2 | | | X | X | | | | | | | | | | | | | | | |
| 601.3 | | | | | | | | | | | | | | | | | X | | |
| 601.4 | | | | | | | | | | | | | | | X | | | | |
| 601.5 | | | | | | | | | | | | | | | X | | | | |
| 601.6 | | | | | | | | | | | | | | | X | | | | |
| 601.7 | | | | | | | | | | | | | | | X | | | | |
| 603.5.11 | | | X | X | | | | | | | | | | | | | | | |
| 603.5.15, Note | | X | | | | | | | | | | | | | | | | | |
| 604.1 Exception | | | | | | | | | X | X | X | X | | | | | | | |
| Table 604.1 | X | | X | X | | | X | X | | | | | | X | X | | | | |
| 604.1.1 | | | X | X | | | | | | | | | | | | | | | |
| 604.1.2 | | | X | X | | | | | | | | | | | | | | | |
| 604.11 Note | | | X | X | | | | | | | | | | | | | | | |
| 604.13 | X | | X | X | | | | | | | | | | | | | | | |
| 605.3.3.2 | | | | | | | | | X | X | X | X | | | | | | | |
| 605.4.2 | | | X | X | | | | | | | | | | | | | | | |
| 605.10 & subsections | | | | | | | | | X | X | X | X | | | | | | | |
| 605.11 | X | | X | X | | | | | | | | | | | | | | | |
| 605.13.2 | | | X | | | | | | | | | | | | | | | | |
| 605.16 | | | X | X | | | | | X | X | X | X | | | | | | | |
| 605.17.4 | | | | | | | | | X | X | X | X | | | | | | | |
| 606.8 | | | | | | | | | X | X | X | X | | | | | | | |
| 609.9 | | | | | | | | | X | X | X | X | | | | | | | |
| 609.10 | | | † | † | | | | | | | | | | | | | | | |
| Table 610.3 | | | | X | | | | | | | | | | | | | | | |
| 613.0 & subsections | | | | | | | | | X | X | X | X | | | | | | | |
| Table 613.1 | | | | | | | | | X | X | X | X | | | | | | | |
| 614.0 & subsections | | | | | | | | | X | X | X | X | | | | | | | |
| 615.1 subsection | | | | | | | | | X | X | X | X | | | | | | | |
| 615.2 | | | | | | | | | X | X | X | X | | | | | | | |
| 615.3 | | | | | | | | | X | X | X | X | | | | | | | |
| 615.4 | | | | | | | | | X | | | | | | | | | | |

The state agency does not adopt sections identified by the following symbol: †

# CHAPTER 6

## WATER SUPPLY AND DISTRIBUTION

**601.0 Hot and Cold Water Required.**

**601.1 General.** Except where not deemed necessary for safety or sanitation by the Authority Having Jurisdiction, each plumbing fixture shall be provided with an adequate supply of potable running water piped thereto in an approved manner, so arranged as to flush and keep it in a clean and sanitary condition without danger of backflow or cross-connection. Water closets and urinals shall be flushed by means of an approved flush tank or flushometer valve.

**Exceptions:**

(1) *[HCD 1, HCD 2 and DWR]* Listed fixtures that do not require water for their operation and are not connected to the water supply.

(2) *[HCD 1 & HCD 2] For limited-density owner-built rural dwellings, potable water shall be available to the dwelling site, although such water need not be pressurized. Where water is not piped from a well, spring, cistern or other source, there shall be a minimum reserve of 50 gallons (189 L) of potable water available. Where water delivery is pressurized, piping shall be installed in accordance with the provisions of this chapter.*

(3) *[HCD 1 & HCD 2] Where deemed not necessary for safety or sanitation by the Enforcing Agency.*

(4) *[HCD 1 & HCD 2] Recycled water or treated graywater may be allowed as specified in Chapter 16A Part II of this code.*

(5) *[DWR] Where a public agency requires a building to use recycled water to flush water closets and urinals in accordance with California Water Code 13554.*

In occupancies where plumbing fixtures are installed for private use, hot water shall be required for bathing, washing, laundry, cooking purposes, dishwashing or maintenance. In occupancies where plumbing fixtures are installed for public use, hot water shall be required for bathing and washing purposes. This requirement shall not supersede the requirements for individual temperature control limitations for public lavatories, bidets, bathtubs, whirlpool bathtubs and shower control valves.

**601.2 Identification of a Potable and Nonpotable Water System.** In buildings where potable water and nonpotable water systems are installed, each system shall be clearly identified in accordance with Section 601.2.1 through Section 601.2.4.

**601.2.1 Potable Water.** Green background with white lettering.

**601.2.2 Color and Information.** Each system shall be identified with a colored pipe or band and coded with paints, wraps, and materials compatible with the piping.

Except as required in Section 601.2.2.1, nonpotable water systems shall have a yellow background with black uppercase lettering, with the words "CAUTION: NONPOTABLE WATER, DO NOT DRINK." Each nonpotable system shall be identified to designate the liquid being conveyed, and the direction of normal flow shall be clearly shown. The minimum size of the letters and length of the color field shall comply with Table 601.2.2. *[HCD 1 & HCD 2] An international symbol of a glass in a circle with a slash through it shall be provided similar to that shown in Figure 601 for all nonpotable water systems.*

The background color and required information shall be indicated every 20 feet (6096 mm) but not less than once per room, and shall be visible from the floor level.



**FIGURE 601**
**INTERNATIONAL SYMBOL**

**601.2.2.1 Alternate Water Sources.** Alternate water source systems shall have a purple (Pantone color No. 512, 522C, or equivalent) background with uppercase lettering and shall be field or factory marked as follows:

(1) Gray water systems shall be marked in accordance with this section with the words "CAUTION: NONPOTABLE GRAY WATER, DO NOT DRINK" in yellow letters (Pantone 108 or equivalent).

(2) Reclaimed (recycled) water systems shall be marked in accordance with this section with the words: "CAUTION: NONPOTABLE RECLAIMED (RECYCLED) WATER, DO NOT DRINK" in black letters.

(3) On-site treated water systems shall be marked in accordance with this section with the words: "CAUTION: ON-SITE TREATED NONPOTABLE WATER, DO NOT DRINK" in yellow letters (Pantone 108 or equivalent).

(4) Rainwater catchment systems shall be marked in accordance with this section with the words: "CAUTION: NONPOTABLE RAINWATER, DO NOT DRINK" in yellow letters (Pantone 108 or equivalent).

TABLE 601.2.2
MINIMUM LENGTH OF COLOR FIELD AND SIZE OF LETTERS

| OUTSIDE DIAMETER OF PIPE OR COVERING (inches) | MINIMUM LENGTH OF COLOR FIELD (inches) | MINIMUM SIZE OF LETTERS (inches) |
|---|---|---|
| ½ to 1¼ | 8 | ½ |
| 1½ to 2 | 8 | ¾ |
| 2½ to 6 | 12 | 1¼ |
| 8 to 10 | 24 | 2½ |
| Over 10 | 32 | 3½ |

For SI units: 1 inch = 25.4 mm

**601.2.3 Fixtures.** Where vacuum breakers or backflow preventers are installed with fixtures listed in Table 1401.1, identification of the discharge side shall be permitted to be omitted.

**601.2.4 Outlets.** Each outlet on the nonpotable water line that is used for special purposes shall be posted with black uppercase lettering as follows: "CAUTION: NONPOTABLE WATER, DO NOT DRINK."

***601.3 [CA] Schools of Cosmetology and Cosmetological Establishments.***

***601.3.1 Hot-and Cold running Water.*** *At least one sink with hot-and cold-running water shall be provided in each work area or workroom where hairdressing is performed in each school and establishment.*

***601.3.2 Handwashing Facilities.*** *Each school and establishment shall provide adequate handwashing facilities, including hot-and cold-running water, located within or adjacent to the toilet room or rooms in accordance with Table 422.1.*

***601.3.3 Drinking Water.*** *Each school and establishment shall supply potable drinking water convenient to students, patrons and employees. Approved sanitary drinking fountains shall be installed and so regulated that a jet of at least 2 inches (51 mm) shall be constantly available.*

***601.4 [AGR] Meat and Poultry Processing Plants.*** *Except as provided in Section 601.4.4, the water supply shall be ample and potable, with adequate pressure and facilities for its distribution in the plant, and its protection against contamination and pollution.*

***Note:*** *A water report, issued under the authority of the state health agency, certifying to the potability of the water supply, shall be obtained by the applicant and furnished to the administrator whenever such report is required by the administrator.*

***601.4.1*** *A supply of hot water shall be available.*

***601.4.2*** *Hose connections with steam and water-mixing valves or hot-water hose connections shall be provided at locations throughout the plant.*

***601.4.3*** *The refuse rooms shall be provided with facilities for washing refuse cans and other equipment in the rooms.*

***601.4.4*** *Non-potable water is permitted only in those parts of official plants where no product is handled or prepared, and then only for limited purposes, such as on condensers not connected with the potable water supply, in vapor lines serving inedible product rendering tanks, and in sewer lines for moving heavy solids in the sewage. In all cases, non-potable water lines shall be clearly identified and shall not be cross connected with the potable water supply.*

***Exception:*** *Cross connection is permitted if this is necessary for fire protection and such connection is of a type with a break to ensure against accidental contamination, and to be approved by local authorities and by the Department.*

***601.4.5*** *Equipment using potable water shall be so installed as to prevent back-siphonage into the potable water system.*

***601.4.6*** *All pipelines, reservoirs, tanks, cooling towers and like equipment employed in handling reused water shall be constructed and installed so as to facilitate their cleaning and inspection.*

***601.4.7*** *Hot water of such temperature as to accomplish a thorough cleanup shall be delivered under pressure to outlets.*

***601.4.7.1*** *An ample supply of water at not less than 180°F (82°C) shall be available when used for sanitizing purposes.*

***601.4.8*** *Pens, alleys, and runways shall have hose connections for cleanup purposes.*

***601.5 [AGR] Collection Centers and Facilities.***

***601.5.1*** *The water supply shall be ample with facilities for its distribution. An ample supply of water at not less than 180°F (82°C), or other suitable method.*

***601.5.2*** *The vehicle cleaning and sanitizing area shall be provided with adequate line steam, producing a temperature of at least 180°F (82°C), or other suitable method.*

***601.5.3*** *Hose connections with steam and water-mixing valves of hot-and cold-water hose connections shall be provided at locations throughout the building and at unloading and vehicle cleaning slabs.*

***601.6 [AGR] Renderers.*** *This area shall be provided with live steam or other method of sanitizing vehicles.*

***601.7 [AGR] Horse Meat and Pet Food Establishments.***

***601.7.1*** *The water supply shall be ample, clean and potable, with facilities for its distribution in the plant, and its protection against contamination and pollution.*

***601.7.1.1*** *Equipment using potable water shall be so installed as to prevent back-siphonage into the potable water system.*

***601.7.1.2*** *Non-potable water is permitted only in those parts of official plants where no edible product is handled or prepared, and then only for limited purposes, such as on ammonia condensers not connected with the potable water supply, in vapor lines serving inedible product rendering tanks, in connec-*

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*tion with equipment used for washing and washing inedible products preparatory to tanking, and in sewer lines for moving heavy solids in sewage. In all cases, non-potable water lines shall be clearly identified and shall not be cross connected with the potable water supply.*

***Exception:*** *Cross connection is permitted if this is necessary for fire protection, and such connection is of a type with a break to ensure against accidental contamination, and is approved by local authorities or by the Department.*

***601.7.2*** *All pipelines, reservoirs, tanks, cooling towers, and like equipment employed in handling reused water shall be constructed and installed so as to facilitate their cleaning and inspection.*

***601.7.3*** *Hot water for cleaning rooms and equipment shall be delivered under pressure to outlets and shall be of such temperature as to accomplish a thorough cleanup.*

***601.7.3.1*** *An ample supply of water at not less than 180°F (82°C) shall be available when used for sanitizing purposes.*

***601.7.4*** *Pens, alleys, and runways shall have hose connections for cleanups purposes.*

**602.0 Unlawful Connections.**

**602.1 Prohibited Installation.** No installation of potable water supply piping, or part thereof, shall be made in such a manner that it will be possible for used, unclean, polluted, or contaminated water, mixtures, or substances to enter a portion of such piping from a tank, receptor, equipment, or plumbing fixture by reason of backsiphonage, suction, or other cause, either during normal use and operation thereof, or where such tank, receptor, equipment, or plumbing fixture is flooded or subject to pressure exceeding the operating pressure in the hot or cold water piping.

**602.2 Cross-Contamination.** No person shall make a connection or allow one to exist between pipes or conduits carrying domestic water supplied by a public or private building supply system, and pipes, conduits, or fixtures containing or carrying water from any other source or containing or carrying water that has been used for a purpose whatsoever, or piping carrying chemicals, liquids, gases, or substances whatsoever, unless there is provided a backflow prevention device approved for the potential hazard and maintained in accordance with this code. Each point of use shall be separately protected where potential cross-contamination of individual units exists.

**602.3 Backflow Prevention.** No plumbing fixture, device, or construction shall be installed or maintained, or shall be connected to a domestic water supply, where such installation or connection provides a possibility of polluting such water supply or cross-connection between a distributing system of water for drinking and domestic purposes and water that becomes contaminated by such plumbing fixture, device, or construction unless there is provided a backflow prevention device approved for the potential hazard.

**602.4 Approval by Authority.** No water piping supplied by a private water supply system shall be connected to any other source of supply without the approval of the Authority Having Jurisdiction, Health Department, or other department having jurisdiction.

**603.0 Cross-Connection Control.**

**603.1 General.** Cross-connection control shall be provided in accordance with the provisions of this chapter.

No person shall install a water-operated equipment or mechanism, or use a water-treating chemical or substance, where it is found that such equipment, mechanism, chemical, or substance causes pollution or contamination of the domestic water supply. Such equipment or mechanism shall be permitted where equipped with an approved backflow prevention device or assembly.

**603.2 Approval of Devices or Assemblies.** Before a device or an assembly is installed for the prevention of backflow, it shall have first been approved by the Authority Having Jurisdiction. Devices or assemblies shall be tested in accordance with recognized standards or other standards acceptable to the Authority Having Jurisdiction. Backflow prevention devices and assemblies shall comply with Table 603.2, except for specific applications and provisions as stated in Section 603.5.1 through Section 603.5.21.

Devices or assemblies installed in a potable water supply system for protection against backflow shall be maintained in good working condition by the person or persons having control of such devices or assemblies. Such devices or assemblies shall be tested at the time of installation, repair, or relocation and not less than on an annual schedule thereafter, or more often where required by the Authority Having Jurisdiction. Where found to be defective or inoperative, the device or assembly shall be repaired or replaced. No device or assembly shall be removed from use or relocated or other device or assembly substituted, without the approval of the Authority Having Jurisdiction.

Testing shall be performed by a certified backflow assembly tester in accordance with ASSE Series 5000 or otherwise approved by the Authority Having Jurisdiction.

**603.3 Backflow Prevention Devices, Assemblies, and Methods.**

**603.3.1 Air Gap.** The minimum air gap to afford backflow protection shall be in accordance with Table 603.3.1.

**603.3.2 Atmospheric Vacuum Breaker (AVB).** An atmospheric vacuum breaker consists of a body, a checking member, and an atmospheric port.

**603.3.3 Hose Connection Backflow Preventer.** A hose connection backflow preventer consists of two independent check valves with an independent atmospheric vent between and a means of field testing and draining.

**603.3.4 Double Check Valve Backflow Prevention Assembly (DC).** A double check valve backflow prevention assembly consists of two independently acting internally loaded check valves, four properly located test cocks, and two isolation valves.

**TABLE 603.2**
**BACKFLOW PREVENTION DEVICES, ASSEMBLIES, AND METHODS**

| DEGREE OF HAZARD | | | | | | |
|---|---|---|---|---|---|---|
| DEVICE, ASSEMBLY, OR METHOD[1] | APPLICABLE STANDARDS | POLLUTION (LOW HAZARD) | | CONTAMINATION (HIGH HAZARD) | | INSTALLATION[2,3] |
| | | BACK-SIPHONAGE | BACK-PRESSURE | BACK-SIPHONAGE | BACK-PRESSURE | |
| Air gap | ASME A112.1.2 | X | — | X | — | See Table 603.3.1 in this chapter. |
| Air gap fittings for use with plumbing fixtures, appliances and appurtenances | ASME A112.1.3 | X | — | X | — | Air gap fitting is a device with an internal air gap and typical installation includes plumbing fixtures, appliances and appurtenances. The critical level shall not be installed below the flood level rim. |
| Atmospheric vacuum breaker (consists of a body, checking member and atmospheric port) | ASSE 1001 or CSA B64.1.1 | X | — | X | — | Upright position. No valve downstream. Minimum of 6 inches or listed distance above all downstream piping and flood-level rim of receptor.[4,5] |
| Antisiphon fill valve (ballcocks) for gravity water closet flush tanks and urinal tanks | ASSE 1002 or CSA B125.3 | X | — | X | — | Installation on gravity water closet flush tank and urinal tanks with the fill valve installed with the critical level not less than 1 inch above the opening of the overflow pipe.[4,5] |
| Vacuum breaker wall hydrants, hose bibbs, frost resistant, automatic draining type | ASSE 1019 or CSA B64.2.1.1 | X | — | X | — | Installation includes wall hydrants and hose bibbs. Such devices are not for use under continuous pressure conditions (means of shutoff downstream of device is prohibited).[4,5] |
| Backflow preventer for Carbonated Beverage Dispensers (two independent check valves with a vent to the atmosphere) | ASSE 1022 | X | — | — | — | Installation includes carbonated beverage machines or dispensers. These devices operate under intermittent or continuous pressure conditions. |
| Spill-Resistant Pressure Vacuum Breaker (single check valve with air inlet vent and means of field testing) | ASSE 1056 | X | — | X | — | Upright position. Minimum of 12 inches or listed distance above all downstream piping and flood-level rim of receptor.[5] |
| Double Check Valve Backflow Prevention Assembly (two independent check valves and means of field testing) | ASSE 1015; AWWA C510; CSA B64.5 or CSA B64.5.1 | X | X | — | — | Horizontal unless otherwise listed. Access and clearance shall be in accordance with the manufacturer's instructions, and not less than a 12 inch clearance at bottom for maintenance. May need platform/ladder for test and repair. Does not discharge water. |
| Double Check Detector Fire Protection Backflow Prevention Assembly (two independent check valves with a parallel detector assembly consisting of a water meter and a double check valve backflow prevention assembly and means of field testing) | ASSE 1048 | X | X | — | — | Horizontal unless otherwise listed. Access and clearance shall be in accordance with the manufacturer's instructions, and not less than a 12 inch clearance at bottom for maintenance. May need platform/ladder for test and repair. Does not discharge water. Installation includes a fire protection system and is designed to operate under continuous pressure conditions. |

**TABLE 603.2**
**BACKFLOW PREVENTION DEVICES, ASSEMBLIES, AND METHODS (continued)**

| DEVICE, ASSEMBLY, OR METHOD[1] | APPLICABLE STANDARDS | DEGREE OF HAZARD | | | | INSTALLATION[2,3] |
|---|---|---|---|---|---|---|
| | | POLLUTION (LOW HAZARD) | | CONTAMINATION (HIGH HAZARD) | | |
| | | BACK-SIPHONAGE | BACK-PRESSURE | BACK-SIPHONAGE | BACK-PRESSURE | |
| Pressure Vacuum Breaker Backflow Prevention Assembly (loaded air inlet valve, internally loaded check valve and means of field testing) | ASSE 1020 or CSA B64.1.2 | X | — | X | — | Upright position. May have valves downstream. Minimum of 12 inches above all downstream piping and flood-level rim of receptor. May discharge water. |
| Reduced Pressure Principle Backflow Prevention Assembly (two independently acting loaded check valves, a differential pressure relief valve and means of field testing) | ASSE 1013; AWWA C511; CSA B64.4 or CSA B64.4.1 | X | X | X | X | Horizontal unless otherwise listed. Access and clearance shall be in accordance with the manufacturer's instructions, and not less than a 12 inch clearance at bottom for maintenance. May need platform/ladder for test and repair. May discharge water. |
| Reduced Pressure Detector Fire Protection Backflow Prevention Assembly (two independently acting loaded check valves, a differential pressure relief valve, with a parallel detector assembly consisting of a water meter and a reduced-pressure principle backflow prevention assembly, and means of field testing) | ASSE 1047 | X | X | X | X | Horizontal unless otherwise listed. Access and clearance shall be in accordance with the manufacturer's instructions, and not less than a 12 inch clearance at bottom for maintenance. May need platform/ladder for test and repair. May discharge water. Installation includes a fire protection system and is designed to operate under continuous pressure conditions. |

For SI units: 1 inch = 25.4 mm

**Notes:**

1 See description of devices and assemblies in this chapter.

2 Installation in pit or vault requires previous approval by the Authority Having Jurisdiction.

3 Refer to general and specific requirement for installation.

4 Not to be subjected to operating pressure for more than 12 hours in a 24 hour period.

5 For deck-mounted and equipment-mounted vacuum breaker, see Section 603.5.14.

**603.3.5 Pressure Vacuum Breaker Backflow Prevention Assembly (PVB).** A pressure vacuum breaker backflow prevention assembly consists of a loaded air inlet valve, an internally loaded check valve, two properly located test cocks, and two isolation valves. This device shall be permitted to be installed indoors where provisions for spillage are provided.

**603.3.6 Spill-Resistant Pressure Vacuum Breaker (SVB).** A pressure-type vacuum breaker backflow prevention assembly consists of one check valve force-loaded closed and an air inlet vent valve force-loaded open to atmosphere, positioned downstream of the check valve, and located between and including two tightly closing shutoff valves and test cocks.

**603.3.7 Reduced-Pressure Principle Backflow Prevention Assembly (RP).** A reduced-pressure principle backflow prevention assembly consists of two independently acting internally loaded check valves, a differential pressure-relief valve, four properly located test cocks, and two isolation valves.

**603.3.8 Double Check Detector Fire Protection Backflow Prevention Assembly.** A double check valve backflow prevention assembly with a parallel detector assembly consisting of a water meter and a double check valve backflow prevention assembly (DC).

**603.3.9 Reduced Pressure Detector Fire Protection Backflow Prevention Assembly.** A reduced-pressure principle backflow prevention assembly with a parallel detector assembly consisting of a water meter and a reduced-pressure principle backflow prevention assembly (RP).

TABLE 603.3.1
MINIMUM AIR GAPS FOR WATER DISTRIBUTION[4]

| FIXTURES | WHERE NOT AFFECTED BY SIDEWALLS[1] (inches) | WHERE AFFECTED BY SIDEWALLS[2] (inches) |
|---|---|---|
| Effective openings[3] not greater than ½ of an inch in diameter | 1 | 1½ |
| Effective openings[3] not greater than ¾ of an inch in diameter | 1½ | 2¼ |
| Effective openings[3] not greater than 1 inch in diameter | 2 | 3 |
| Effective openings[3] greater than 1 inch in diameter | Two times diameter of effective opening | Three times diameter of effective opening |

For SI units: 1 inch = 25.4 mm

**Notes:**

[1] Sidewalls, ribs, or similar obstructions do not affect air gaps where spaced from the inside edge of the spout opening a distance exceeding three times the diameter of the effective opening for a single wall, or a distance exceeding four times the effective opening for two intersecting walls.

[2] Vertical walls, ribs, or similar obstructions extending from the water surface to or above the horizontal plane of the spout opening other than specified in Footnote 1 above. The effect of three or more such vertical walls or ribs has not been determined. In such cases, the air gap shall be measured from the top of the wall.

[3] The effective opening shall be the minimum cross-sectional area at the seat of the control valve or the supply pipe or tubing that feeds the device or outlet. Where two or more lines supply one outlet, the effective opening shall be the sum of the cross-sectional areas of the individual supply lines or the area of the single outlet, whichever is smaller.

[4] Air gaps less than 1 inch (25.4 mm) shall be approved as a permanent part of a listed assembly that has been tested under actual backflow conditions with vacuums of 0 to 25 inches of mercury (85 kPa).

**603.4 General Requirements.** Assemblies shall comply with listed standards and be acceptable to the Authority Having Jurisdiction, with jurisdiction over the selection and installation of backflow prevention assemblies.

**603.4.1 Backflow Prevention Valve.** Where more than one backflow prevention valve is installed on a single premise, and the valves are installed in one location, each separate valve shall be permanently identified by the permittee in a manner satisfactory to the Authority Having Jurisdiction.

**603.4.2 Testing.** The premise owner or responsible person shall have the backflow prevention assembly tested by a certified backflow assembly tester at the time of installation, repair, or relocation and not less than on an annual schedule thereafter, or more often where required by the Authority Having Jurisdiction. The periodic testing shall be performed in accordance with the procedures referenced in Table 1401.1 by a tester qualified in accordance with those standards.

**603.4.3 Access and Clearance.** Access and clearance shall be provided for the required testing, maintenance, and repair. Access and clearance shall be in accordance with the manufacturer's instructions, and not less than 12 inches (305 mm) between the lowest portion of the assembly and grade, floor, or platform. Installations elevated that exceed 5 feet (1524 mm) above the floor or grade shall be provided with a permanent platform capable of supporting a tester or maintenance person.

**603.4.4 Connections.** Direct connections between potable water piping and sewer-connected wastes shall not be permitted to exist under any condition with or without backflow protection. Where potable water is discharged to the drainage system, it shall be by means of an approved air gap of two pipe diameters of the supply inlet, but in no case shall the gap be less than 1 inch (25.4 mm). Connection shall be permitted to be made to the inlet side of a trap provided that an approved vacuum breaker is installed not less than 6 inches (152 mm), or the distance according to the device's listing, above the flood-level rim of such trapped fixture, so that at no time will such device be subjected to backpressure.

**603.4.5 Hot Water Backflow Preventers.** Backflow preventers for hot water exceeding 110°F (43°C) shall be a type designed to operate at temperatures exceeding 110°F (43°C) without rendering a portion of the assembly inoperative.

**603.4.6 Integral Backflow Preventers.** Fixtures, appliances, or appurtenances with integral backflow preventers or integral air gaps manufactured as a unit shall be installed in accordance with their listing requirements and the manufacturer's installation instructions.

**603.4.7 Freeze Protection.** In cold climate areas, backflow assemblies and devices shall be protected from freezing with an outdoor enclosure or by a method acceptable to the Authority Having Jurisdiction.

**603.4.8 Drain Lines.** Drain lines serving backflow devices or assemblies shall be sized in accordance with the discharge rates of the manufacturer's flow charts of such devices or assemblies.

**603.4.9 Prohibited Locations.** Backflow prevention devices with atmospheric vents or ports shall not be installed in pits, underground, or submerged locations.

**603.5 Specific Requirements.**

**603.5.1 Atmospheric Vacuum Breaker.** Water closet and urinal flushometer valves shall be protected against backflow by an approved backflow prevention assembly, device, or method. Where the valves are equipped with an atmospheric vacuum breaker, the vacuum breaker shall be installed on the discharge side of the flushometer valve with the critical level not less than 6 inches (152 mm), or the distance according to its listing, above the overflow rim of a water closet bowl or the highest part of a urinal.

**603.5.2 Ballcock.** Water closet and urinal tanks shall be equipped with a ballcock. The ballcock shall be installed with the critical level not less than 1 inch (25.4 mm) above the full opening of the overflow pipe. In cases where the ballcock has no hush tube, the bottom of the water supply inlet shall be installed 1 inch (25.4 mm) above the full opening of the overflow pipe.

**603.5.3 Backflow Prevention.** Water closet flushometer tanks shall be protected against backflow by an approved backflow prevention assembly, device, or method.

**603.5.4 Heat Exchangers.** Heat exchangers used for heat transfer, heat recovery, or solar heating shall protect the potable water system from being contaminated by the heat-transfer medium. Single-wall heat exchangers used in indirect-fired water heaters shall meet the requirements of Section 505.4.1. Double-wall heat exchangers shall separate the potable water from the heat-transfer medium by providing a space between the two walls that are vented to the atmosphere.

**603.5.5 Water Supply Inlets.** Water supply inlets to tanks, vats, sumps, swimming pools, and other receptors shall be protected by one of the following means:

(1) An approved air gap.

(2) A listed vacuum breaker installed on the discharge side of the last valve with the critical level not less than 6 inches (152 mm) or in accordance with its listing.

(3) A backflow preventer suitable for the contamination or pollution, installed in accordance with the requirements for that type of device or assembly as set forth in this chapter.

**603.5.6 Protection from Lawn Sprinklers and Irrigation Systems.** Potable water supplies to systems having no pumps or connections for pumping equipment, and no chemical injection or provisions for chemical injection, shall be protected from backflow by one of the following devices:

(1) Atmospheric vacuum breaker (AVB)

(2) Pressure vacuum breaker backflow prevention assembly (PVB)

(3) Spill-resistant pressure vacuum breaker (SVB)

(4) Reduced-pressure principle backflow prevention assembly (RP)

**603.5.6.1 Systems with Pumps.** Where sprinkler and irrigation systems have pumps, connections for pumping equipment, or auxiliary air tanks, or are otherwise capable of creating backpressure, the potable water supply shall be protected by the following type of device where the backflow device is located upstream from the source of backpressure:

(1) Reduced-pressure principle backflow prevention assembly (RP)

**603.5.6.2 Systems with Backflow Devices.** Where systems have a backflow device installed downstream from a potable water supply pump or a potable water supply pump connection, the device shall be one of the following:

(1) Atmospheric vacuum breaker (AVB)

(2) Pressure vacuum breaker backflow prevention assembly (PVB)

(3) Spill-resistant pressure vacuum breaker (SVB)

(4) Reduced-pressure principle backflow prevention assembly (RP)

**603.5.6.3 Systems with Chemical Injectors.** Where systems include a chemical injector or provisions for chemical injection, the potable water supply shall be protected by the following:

(1) Reduced-pressure principle backflow prevention assembly (RP)

**603.5.7 Outlets with Hose Attachments.** Potable water outlets with hose attachments, other than water heater drains, boiler drains, and clothes washer connections, shall be protected by a nonremovable hose bibb-type backflow preventer, a nonremovable hose bibb-type vacuum breaker, or by an atmospheric vacuum breaker installed not less than 6 inches (152 mm) above the highest point of usage located on the discharge side of the last valve. In climates where freezing temperatures occur, a listed self-draining frostproof hose bibb with an integral backflow preventer or vacuum breaker shall be used.

**603.5.8 Water-Cooled Equipment.** Water-cooled compressors, degreasers, or other water-cooled equipment shall be protected by a backflow preventer installed in accordance with the requirements of this chapter. Water-cooled equipment that produces backpressure shall be equipped with the appropriate protection.

**603.5.9 Aspirators.** Water inlets to water-supplied aspirators shall be equipped with a vacuum breaker installed in accordance with its listing requirements and this chapter. The discharge shall drain through an air gap. Where the tailpiece of a fixture to receive the discharge of an aspirator is used, the air gap shall be located above the flood-level rim of the fixture.

**603.5.10 Steam or Hot Water Boilers.** Potable water connections to steam or hot water boilers shall be protected from backflow by a double check valve backflow prevention assembly or reduced pressure principle backflow prevention assembly in accordance with Table 603.2. Where chemicals are introduced into the system a reduced pressure principle backflow prevention assembly shall be provided in accordance with Table 603.2.

**603.5.11 Nonpotable Water Piping.** In cases where it is impractical to correct individual cross-connections on the domestic waterline, the line supplying such outlets shall be considered a nonpotable water line. No drinking or domestic water outlets shall be connected to the nonpotable waterline. Where possible, portions of the nonpotable waterline shall be exposed, and exposed portions shall be properly identified in a manner satisfactory to the Authority Having Jurisdiction. Each outlet on the nonpotable waterline that is permitted to be used for drinking or domestic purposes shall be posted: "CAUTION: NONPOTABLE WATER, DO NOT DRINK."

*[HCD 1 & HCD 2] An international symbol of a glass in a circle with a slash through it shall be provided similar to that shown in Figure 601.*

**603.5.12 Beverage Dispensers.** Potable water supply to beverage dispensers, carbonated beverage dispensers, or coffee machines shall be protected by an air gap or a vented backflow preventer in accordance with ASSE 1022. For carbonated beverage dispensers, piping material installed downstream of the backflow preventer shall not be affected by carbon dioxide gas.

**603.5.13 Prohibited Location.** Backflow preventers shall not be located in an area containing fumes that are toxic, poisonous, or corrosive.

**603.5.14 Deck-Mounted and Equipment-Mounted Vacuum Breakers.** Deck-mounted or equipment-mounted vacuum breakers shall be installed in accordance with their listing and the manufacturer's installation instructions, with the critical level not less than 1 inch (25.4 mm) above the flood-level rim.

**603.5.15 Protection from Fire Systems.**

*Note: Fire Protection Systems has not been adopted by the State Fire Marshal. This section cannot be adopted or enforced pursuant to California Health and Safety Code 13114.7(a), which is being cited for reference. California Health and Safety Code 13114.7*

*(a) For the purposes of this section the following are definitions of class I and class II systems:*

*(1) American Water Works Association [A.W.W.A] Manual No. M-14 class 1 – Automatic fire sprinkler systems with direct connection from public water mains only; no pumps, tanks, or reservoirs; no physical connection from other water supplies; no antifreeze or additives of any kind; and all sprinkler drains discharging to the atmosphere or other safe outlets.*

*(2) American Water Works Association [A.W.W.A] Manual No. M-14 class 2 – Automatic fire sprinkler systems which are the same as class 1, except that booster pumps may be installed in the connections from the street mains.*

*(b) Automatic fire sprinkler systems described in subdivision (a) shall not require any backflow protection equipment at the service connection other than required by standards for those systems contained in the publication of the National Fire Protection Association entitled "Installation of Sprinkler Systems" [NFPA Pamphlet No. 13, 1980 edition]*

**603.5.16 Health Care or Laboratory Areas.** Vacuum breakers for washer-hose bedpans shall be located not less than 5 feet (1524 mm) above the floor. Hose connections in health care or laboratory areas shall be not less than 6 feet (1829 mm) above the floor.

**603.5.17 Special Equipment.** Portable cleaning equipment, dental vacuum pumps, and chemical dispensers shall be protected from backflow by an air gap, an atmospheric vacuum breaker, a spill-resistant vacuum breaker, or a reduced pressure principle backflow preventer.

**603.5.18 Potable Water Outlets and Valves.** Potable water outlets, freeze-proof yard hydrants, combination stop-and-waste valves, or other fixtures that incorporate a stop and waste feature that drains into the ground shall not be installed underground.

**603.5.19 Pure Water Process Systems.** The water supply to a pure water process system, such as dialysis water systems, semiconductor washing systems, and similar process piping systems, shall be protected from backpressure and backsiphonage by a reduced-pressure principle backflow preventer.

**603.5.19.1 Dialysis Water Systems.** The individual connections of the dialysis related equipment to the dialysis pure water system shall not require additional backflow protection.

**603.5.20 Plumbing Fixture Fittings.** Plumbing fixture fittings with integral backflow protection shall comply with ASME A112.18.1/CSA B 125.1.

**603.5.21 Swimming Pools, Spas, and Hot Tubs.** Potable water supply to swimming pools, spas, and hot tubs shall be protected by an air gap or a reduced pressure principle backflow preventer in accordance with the following:

(1) The unit is equipped with a submerged fill line.

(2) The potable water supply is directly connected to the unit circulation system.

**604.0 Materials.**

**604.1 Pipe, Tube, and Fittings.** Pipe, tube, fittings, solvent cements, thread sealants, solders, and flux used in potable

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water systems intended to supply drinking water shall be in accordance with the requirements of NSF 61.

Materials used in the water supply system, except valves and similar devices, shall be of a like material, except where otherwise approved by the Authority Having Jurisdiction.

Materials for building water piping and building supply piping shall comply with the applicable standards referenced in Table 604.1.

***Exception: [OSHPD 1, 2 & 4]*** *Use of CPVC is not permitted for applications under authority of the Office of Statewide Health Planning and Development.*

***604.1.1 Local Authority to Approve CPVC Pipe Within Residential Buildings Under Specified Conditions. [HCD 1 & HCD 2]*** *The local responsible building official of any city, county, or city and county, shall authorize by permit the use of CPVC for hot and cold water distribution systems within the interior of residential buildings provided all of the following conditions are satisfied:*

*(a)* ***Permit Conditions.*** *Any building permit issued pursuant to Section 604.1.1 shall be conditioned on compliance with the mitigation measures set forth in this section.*

*(b)* ***Approved Materials.*** *Only CPVC plumbing material listed as an approved material and installed in accordance with this code may be used.*

*(c)* ***Installation and Use.*** *Any installation and use of CPVC plumbing material pursuant to this section shall comply with all applicable requirements of this code and Section 1.2 of Appendix I of this code, Installation Standard for CPVC Solvent Cemented Hot and Cold Water Distribution Systems, IAPMO IS 20-2010.*

*(d)* ***Certification of Compliance.*** *Prior to issuing a building permit pursuant to Section 604.1.1, the building official shall require as part of the permitting process that the contractor, or the appropriate plumbing subcontractors, provide written certification: (1) that is required in subdivision (e), and (2) that he or she will comply with the flushing procedures and worker safety measures set forth in Section 1.2 of Appendix I of this code, Installation Standard for CPVC Solvent Cemented Hot and Cold Water Distribution Systems, (IAPMO IS 20-2010).*

*(e)* ***Worker Safety.*** *Any contractor applying for a building permit that includes the use of CPVC plumbing materials authorized pursuant to this section shall include in the permit application a signed written certification stating that:*

*(1) They are aware of the health and safety hazards associated with CPVC plumbing installations;*

*(2) They have included in their Injury and Illness Prevention Plan the hazards associated with CPVC plumbing pipe installations; and*

*(3) The worker safety training elements of their Injury and Illness Prevention Plan meet the Department of Industrial Relation's guidelines.*

*(f)* ***Findings of Compliance.*** *The building official shall not give final permit approval of any CPVC plumbing materials installed pursuant to Section 604.1.1 unless he or she finds that the material has been installed in compliance with the requirements of this code and that the installer has complied with the requirements in Section 1.2.1 of Appendix I of this code, Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems, (IAPMO IS 20-2010).*

*(g)* ***Penalties.*** *Any contractor or subcontractor found to have failed to comply with the flushing requirements of Section 1.2.1 of Appendix I of this code or the ventilation, and glove requirements of Section 1.2.2 of Appendix I of this code, Installation Standards for CPVC Solvent Cemented Hot and Cold Water Distribution Systems, (IAPMO IS 20-2010) shall be subject to the penalties in Health and Safety Code, Division 13, Part 1.5, Chapter 6 (Section 17995 et seq.). In addition, if during the conduct of any building inspection the building official finds that the ventilation and glove requirements of Section 2.7.1 of Appendix I of this code, "Special Requirements for CPVC Installation within Residential Buildings," are being violated, such building officials shall cite the contractor or subcontractor for that violation.*

***604.1.2 PEX.*** *All installations of PEX pipe where it is the initial plumbing piping installed in new construction shall be flushed twice over a period of at least one week. The pipe system shall be first flushed for at least 10 minutes and then filled and allowed to stand for no less than 1 week, after which all the branches of the pipe system must be flushed long enough to fully empty the contained volume. This provision shall not apply to the installation of PEX pipe where it replaces an existing pipe system of any material.*

*(1) At the time of fill, each fixture shall have a removable tag applied stating:*

*(a) "This new plumbing system was first filled and flushed on _____ (date) by _____ (name). The State of California requires that the system be flushed after standing at least one week after the fill date specified above. If this system is used earlier than one week after the fill date, the water must be allowed to run for at least two minutes prior to use for human consumption. This tag may not be removed prior to the completion of the required second flushing, except by the building owner or occupant."*

*(2) Prior to issuing a building permit to install PEX pipe, the building official shall require as part of the permitting process that the contractor, or the appropriate plumbing subcontractors, provide*

**TABLE 604.1**
**MATERIALS FOR BUILDING SUPPLY AND WATER DISTRIBUTION PIPING AND FITTINGS**

| MATERIAL | BUILDING SUPPLY PIPE AND FITTINGS | WATER DISTRIBUTION PIPE AND FITTINGS | REFERENCED STANDARD(S) PIPE | REFERENCED STANDARD(S) FITTINGS |
|---|---|---|---|---|
| Asbestos-Cement | X[1] | — | ASTM C 296 | — |
| Brass | X | X | ASTM B 43, ASTM B 135 | — |
| Copper | X | X | ASTM B 42, ASTM B 75, ASTM B 88, ASTM B 251, ASTM B 302, ASTM B 447 | ASME B16.15, ASME B16.18, ASME B16.22, ASME B16.26 |
| CPVC | X | X | ASTM D 2846, ASTM F 441, ASTM F 442 | ASTM D 2846, ASTM F 437, ASTM F 438, ASTM F 439, ASTM F 1970 |
| Ductile-Iron | X | X | AWWA C151 | ASME B16.4, AWWA C110, AWWA C153 |
| Galvanized Steel | X | X | ASTM A 53 | — |
| Malleable Iron | X | X | — | ASME B16.3 |
| PE | X[1] | — | ASTM D 2239, ASTM D 2737, ASTM D 3035, AWWA C901, CSA B137.1 | ASTM D 2609, ASTM D 2683, ASTM D 3261, ASTM F 1055, CSA B137.1 |
| PE-AL-PE | X | X | ASTM F 1282, CSA B137.9 | ASTM F 1282, ASTM F 1974, CSA B137.9 |
| PE-RT | X | X | ASTM F 2769 | ASTM F 1807, ASTM F 2098, ASTM F 2159; ASTM F 2735, ASTM F 2769 |
| PEX[2, 3] | X | X | ASTM F 876, ASTM F 877, CSA B137.5, AWWA C904[1] | ASSE 1061, ASTM F 877, ASTM F 1807, ASTM F 1960, ASTM F 1961, ASTM F 2080, ASTM F 2159, ASTM F 2735, CSA B137.5 |
| PEX-AL-PEX[4] | X | X | ASTM F 1281, CSA B137.10, ASTM F 2262 | ASTM F 1281, ASTM F 1974, ASTM F 2434, CSA B137.10 |
| PP | X | X | ASTM F 2389, CSA B137.11 | ASTM F 2389, CSA B137.11 |
| PVC | X[1] | — | ASTM D 1785, ASTM D 2241, AWWA C900 | ASTM D 2464, ASTM D 2466, ASTM D 2467, ASTM F 1970 |
| Stainless Steel | X | X | ASTM A 269, ASTM A 312 | — |

[1] For Building Supply or cold-water applications.

[2] *When PEX tubing is placed in soil and is used in potable water systems intended to supply drinking water to fixtures or appliances, the tubing or piping shall be sleeved with a material approved for potable water use in soil or other material that is impermeable to solvents or petroleum products.*

[3] *PEX tubing shall meet or exceed the requirements of ASTM F876-08 or an equivalent or more stringent standard when used in continuously recirculating hot water systems and the PEX tubing is exposed to the hot water 100% of the time.*

[4] ***[For BSC, DSA-SS, DSA-SS/CC & HCD]*** *The use of PEX-AL-PEX in potable water supply systems is not adopted.*

*written certification that he or she will comply with the flushing procedures set forth in the code.*

*(3) The building official shall not give final permit approval of any PEX plumbing installation unless he or she finds that the material has been installed in compliance with the requirements of the code, including the requirements to flush and tag the systems.*

*(4) Any contractor or subcontractor found to have failed to comply with the PEX flushing requirements shall be subject to the penalties in Health and Safety Code, Division 13, Part 1.5, Chapter 6 (Section 17995, et seq.).*

**604.2 Copper Tube.** Copper tube for water piping shall have a weight of not less than Type L.

**Exception:** Type M copper tubing shall be permitted to be used for water piping where piping is aboveground in, or on, a building or underground outside of structures.

**604.3 Hard-Drawn Copper Tubing.** Hard-drawn copper tubing for water supply and distribution in addition to the required incised marking, shall be marked in accordance with ASTM B 88. The colors shall be: Type K, green; Type L, blue; and Type M, red.

**604.4 Flexible Copper Connectors.** Listed flexible copper water connectors shall be installed in readily accessible locations, unless otherwise listed.

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**604.5 Cast-Iron Fittings.** Cast-iron fittings up to and including 2 inches (50 mm) in size, where used in connection with potable water piping, shall be galvanized.

**604.6 Malleable Iron Fittings.** Malleable iron water fittings shall be galvanized.

**604.7 Previously Used Piping and Tubing.** Piping and tubing that has previously been used for a purpose other than for potable water systems shall not be used.

**604.8 Epoxy Coating.** Epoxy coating used on existing building supply or water distribution piping systems shall be in accordance with NSF 61 and AWWA C210.

**604.9 Plastic Materials.** Approved plastic materials shall be permitted to be used in building supply piping, provided that where metal building supply piping is used for electrical grounding purposes, replacement piping therefore shall be of like materials.

**Exception:** Where a grounding system acceptable to the Authority Having Jurisdiction is installed, inspected, and approved, metallic pipe shall be permitted to be replaced with nonmetallic pipe. Plastic materials for building supply piping outside underground shall have a blue insulated copper tracer wire or other approved conductor installed adjacent to the piping. Access shall be provided to the tracer wire or the tracer wire shall terminate aboveground at each end of the nonmetallic piping. The tracer wire size shall be not less than 18 AWG and the insulation type shall be suitable for direct burial.

**604.10 Solder.** Solder shall comply with the requirements of Section 605.3.4.

**604.11 Lead Content.** Water pipe and fittings with a lead content which exceeds 8 percent shall be prohibited in piping systems used to convey potable water.

*Note: On or after January 1, 2010, see Section 116875 of the Health and Safety Code for the lead content of pipes, pipe or plumbing fittings, or fixtures intended to convey or dispense water for human consumption.*

**604.12 Flexible Corrugated Connectors.** Flexible corrugated connectors of copper or stainless steel shall be limited to the following connector lengths:

(1) Fixture Connectors – 30 inches (762 mm)
(2) Washing Machine Connectors – 72 inches (1829 mm)
(3) Dishwasher and Icemaker Connectors – 120 inches (3048 mm)

**604.13 Water Heater Connectors.** Flexible metallic water heater connectors or reinforced flexible water heater connectors connecting water heating to the piping system shall be in accordance with the applicable standards referenced in Table 1401.1. Copper or stainless steel flexible connectors shall not exceed 24 inches (610 mm). PEX, PEX-AL-PEX, PE-AL-PE, or PE-RT tubing shall not be installed within the first 18 inches (457 mm) of piping connected to a water heater.

*[BSC, HCD 1 & HCD 2] PEX-AL-PEX is not adopted for use in potable water supply and distribution systems.*

**605.0 Joints and Connections.**

**605.1 Asbestos-Cement Pipe and Joints.** Joining methods for asbestos-cement pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.1.1.

**605.1.1 Mechanical Joints.** Mechanical joints shall be of the same composition as the pipe and sealed with an approved elastomeric gasket or joined by a listed compression type coupling. Elastomeric gaskets shall comply with ASTM D 1869. The coupling grooves, pipe ends, and elastomeric gaskets shall be cleaned. Elastomeric gaskets shall be positioned in the grooves. Lubricant recommended for potable water application by the pipe manufacturer shall be applied to the machined end of the pipe. Lubricant shall not be applied to the elastomeric gasket or groove, unless specifically recommended by the manufacturer.

**605.2 Brass Pipe and Joints.** Joining methods for brass pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.2.1 through Section 605.2.3.

**605.2.1 Brazed Joints.** Brazed joints between brass pipe and fittings shall be made with brazing alloys having a liquid temperature above 1000°F (538°C). The joint surfaces to be brazed shall be cleaned bright by either manual or mechanical means. Pipe shall be cut square and reamed to full inside diameter. Brazing flux shall be applied to the joint surfaces where required by manufacturer's recommendation. Brazing filler metal in accordance with AWS A5.8 shall be applied at the point where the pipe or tubing enters the socket of the fitting.

**605.2.2 Mechanical Joints.** Mechanical joints shall be of the compression, pressed, or grooved type using an approved elastomeric gasket to form a seal.

**605.2.3 Threaded Joints.** Threaded joints shall be made with pipe threads in accordance with ASME B1.20.1. Thread sealant tape or compound shall be applied only on male threads, and such material shall be of approved types, insoluble in water, and nontoxic.

**605.3 Copper Pipe, Tubing, and Joints.** Joining methods for copper pipe, tubing, and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.3.1 through Section 605.3.5.

**605.3.1 Brazed Joints.** Brazed joints between copper pipe or tubing and fittings shall be made with brazing alloys having a liquid temperature above 1000°F (538°C). The joint surfaces to be brazed shall be cleaned bright by either manual or mechanical means. Tubing shall be cut square and reamed to full inside diameter. Brazing flux shall be applied to the joint surfaces where required by manufacturer's recommendation. Brazing filler metal in accordance with AWS A5.8 shall be applied at the point where the pipe or tubing enters the socket of the fitting.

**605.3.2 Flared Joints.** Flared joints for soft copper water tubing shall be made with fittings that are in accordance with the applicable standards referenced in Table 604.1. Pipe or tubing shall be cut square using an appropriate tubing cutter. The tubing shall be reamed to full inside diameter, resized to round, and expanded with a proper flaring tool.

**605.3.3 Mechanical Joints.** Mechanical joints shall include, but are not limited to, compression, flanged, grooved, pressed, and push fit fittings.

**605.3.3.1 Mechanically Formed Tee Fittings.** Mechanically formed tee fittings shall have extracted collars that shall be formed in a continuous operation consisting of drilling a pilot hole and drawing out the pipe or tube surface to form a collar having a height not less than three times the thickness of the branch tube wall. The branch pipe or tube shall be notched to conform to the inner curve of the run pipe or tube and shall have two dimple depth stops to ensure that penetration of the branch pipe or tube into the collar is of a depth for brazing and that the branch pipe or tube does not obstruct the flow in the main line pipe or tube. Dimple depth stops shall be in line with the run of the pipe or tube. The second dimple shall be ¼ of an inch (6.4 mm) above the first and shall serve as a visual point of inspection. Fittings and joints shall be made by brazing. Soldered joints shall not be permitted.

**605.3.3.2** ***[Not permitted for OSHPD 1, 2, 3, & 4]*** **Pressed Fittings.** Pressed fittings for copper pipe or tubing shall have an elastomeric O-ring that forms the joint. The pipe or tubing shall be fully inserted into the fitting, and the pipe or tubing marked at the shoulder of the fitting. Pipe or tubing shall be cut square, chamfered, and reamed to full inside diameter. The fitting alignment shall be checked against the mark on the pipe or tubing to ensure the pipe or tubing is inserted into the fitting. The joint shall be pressed using the tool recommended by the manufacturer.

**605.3.3.3 Push Fit Fittings.** Removable and nonremovable push fit fittings for copper tubing or pipe that employ quick assembly push fit connectors shall be in accordance with ASSE 1061. Push fit fittings for copper pipe or tubing shall have an approved elastomeric O-ring that forms the joint. Pipe or tubing shall be cut square, chamfered, and reamed to full inside diameter. The tubing shall be fully inserted into the fitting, and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to ensure the tubing is inserted into the fitting and gripping mechanism has engaged on the pipe.

**605.3.4 Soldered Joints.** Soldered joints between copper pipe or tubing and fittings shall be made in accordance with ASTM B 828 with the following sequence of joint preparation and operation as follows: measuring and cutting, reaming, cleaning, fluxing, assembly and support, heating, applying the solder, cooling and cleaning. Pipe or tubing shall be cut square and reamed to the full inside diameter including the removal of burrs on the outside of the pipe or tubing. Surfaces to be joined shall be cleaned bright by manual or mechanical means. Flux shall be applied to pipe or tubing and fittings and shall be in accordance with ASTM B 813, and shall become noncorrosive and nontoxic after soldering. Insert pipe or tubing into the base of the fitting and remove excess flux. Pipe or tubing and fitting shall be supported to ensure a uniform capillary space around the joint. Heat shall be applied using an air or fuel torch with the flame perpendicular to the pipe or tubing using acetylene or an LP gas. Preheating shall depend on the size of the joint. The flame shall be moved to the fitting cup and alternate between the pipe or tubing and fitting. Solder in accordance with ASTM B 32 shall be applied to the joint surfaces until capillary action draws the molten solder into the cup. Solder and fluxes with a lead content that exceeds 0.2 percent shall be prohibited in piping systems conveying potable water. Joint surfaces shall not be disturbed until cool and any remaining flux residue shall be cleaned.

**605.3.5 Threaded Joints.** Threaded joints for copper pipe shall be made with pipe threads in accordance with ASME B1.20.1. Thread sealant tape or compound shall be applied only on male threads, and such material shall be of approved types, insoluble in water, and nontoxic.

**605.4 CPVC Plastic Pipe and Joints.** CPVC plastic pipe and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.4.1 through Section 605.4.3.

**605.4.1 Mechanical Joints.** Removable and nonremovable push fit fittings that employ a quick assembly push fit connector shall be in accordance with ASSE 1061.

**605.4.2 Solvent Cement Joints.** Solvent cement joints for CPVC pipe and fittings shall be clean from dirt and moisture. Solvent cements in accordance with ASTM F 493, requiring the use of a primer shall be orange in color. The primer shall be colored and be in accordance with ASTM F 656. Listed solvent cement in accordance with ASTM F 493 that does not require the use of primers, yellow or red in color, shall be permitted for pipe and fittings manufactured in accordance with ASTM D 2846, ½ of an inch (15 mm) through 2 inches (50 mm) in diameter. Apply primer where required inside the fitting and to the depth of the fitting on pipe. Apply liberal coat of cement to the outside surface of pipe to depth of fitting and inside of fitting. Place pipe inside fitting to forcefully bottom the pipe in the socket and hold together until joint is set.

***[HCD 1 & HCD 2]*** *Low VOC One-Step Cement that does not require the use of primer shall be utilized with CPVC pipe and fittings, manufactured in accordance with ASTM D 2846.*

**605.4.3 Threaded Joints.** Threads shall comply with ASME B1.20.1. A minimum of Schedule 80 shall be permitted to be threaded; however, the pressure rating shall be reduced by 50 percent. The use of molded fittings shall not result in a 50 percent reduction in the pressure rating of the pipe provided that the molded fit-

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tings shall be fabricated so that the wall thickness of the material is maintained at the threads. Thread sealant compound that is compatible with the pipe and fitting, insoluble in water, and nontoxic shall be applied to male threads. Caution shall be used during assembly to prevent over tightening of the CPVC components once the thread sealant has been applied. Female CPVC threaded fittings shall be used with plastic male threads only.

**605.5 Ductile Iron Pipe and Joints.** Ductile iron pipe and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.5.1 and Section 605.5.2.

**605.5.1 Mechanical Joints.** Mechanical joints for ductile iron pipe and fittings shall consist of a bell that is cast integrally with the pipe or fitting and provided with an exterior flange having bolt holes and a socket with annular recesses for the sealing gasket and the plain end of the pipe or fitting. The elastomeric gasket shall comply with AWWA C111. Lubricant recommended for potable water application by the pipe manufacturer shall be applied to the gasket and plain end of the pipe.

**605.5.2 Push-On Joints.** Push-on joints for ductile iron pipe and fittings shall consist of a single elastomeric gasket that shall be assembled by positioning the elastomeric gasket in an annular recess in the pipe or fitting socket and forcing the plain end of the pipe or fitting into the socket. The plain end shall compress the elastomeric gasket to form a positive seal and shall be designed so that the elastomeric gasket shall be locked in place against displacement. The elastomeric gasket shall comply with AWWA C111. Lubricant recommended for potable water application by the pipe manufacturer shall be applied to the gasket and plain end of the pipe.

**605.6 Galvanized Steel Pipe and Joints.** Galvanized steel pipe and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.6.1 and Section 605.6.2.

**605.6.1 Mechanical Joints.** Mechanical joints shall be made with an approved and listed elastomeric gasket.

**605.6.2 Threaded Joints.** Threaded joints shall be made with pipe threads that are in accordance with ASME B1.20.1. Thread sealant tape or compound shall be applied only on male threads, and such material shall be of approved types, insoluble in water, and nontoxic.

**605.7 PE Plastic Pipe/Tubing and Joints.** PE plastic pipe or tubing and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.7.1 and Section 605.7.2.

**605.7.1 Heat-Fusion Joints.** Heat-fusion joints between PE pipe or tubing and fittings shall be assembled in accordance with Section 605.7.1.1 through Section 605.7.1.3 using butt, socket, and electro-fusion heat methods in accordance with ASTM D 2657.

**605.7.1.1 Butt-Fusion Joints.** Butt-fusion joints shall be made by heating the squared ends of two pipes, pipe and fitting, or two fittings by holding ends against a heated element. The heated element shall be removed where the proper melt is obtained and joined ends shall be placed together with applied force.

**605.7.1.2 Electro-Fusion Joints.** Electro-fusion joints shall be made by embedding the resistance wire in the fitting and supplying with a heat source. Pipe shall be clamped in place and power applied through a controlled processor. The material surrounding the wire shall be melted along with the pipe and shall provide the pressure required for fusion.

**605.7.1.3 Socket-Fusion Joints.** Socket-fusion joints shall be made by simultaneously heating the outside surface of a pipe end and the inside of a fitting socket. Where the proper melt is obtained, the pipe and fitting shall be joined by inserting one into the other with applied force. The joint shall fuse together and remain undisturbed until cool.

**605.7.2 Mechanical Joints.** Mechanical joints between PE pipe or tubing and fittings shall include insert and mechanical compression fittings that provide a pressure seal resistance to pullout. Joints for insert fittings shall be made by cutting the pipe square, using a cutter designed for plastic piping, and removal of sharp edges. Two stainless steel clamps shall be placed over the end of the pipe. Fittings shall be checked for proper size based on the diameter of the pipe. The end of pipe shall be placed over the barbed insert fitting, making contact with the fitting shoulder. Clamps shall be positioned equal to 180 degrees (3.14 rad) apart and shall be tightened to provide a leak tight joint. Compression type couplings and fittings shall be permitted for use in joining PE piping and tubing. Stiffeners that extend beyond the clamp or nut shall be prohibited. Bends shall be not less than 30 pipe diameters, or the coil radius where bending with the coil. Bends shall not be permitted closer than 10 pipe diameters of a fitting or valve. Mechanical joints shall be designed for their intended use.

**605.8 PE-AL-PE Plastic Pipe/Tubing and Joints.** PE-AL-PE plastic pipe or tubing and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.8.1 and Section 605.8.1.1.

**605.8.1 Mechanical Joints.** Mechanical joints for PE-AL-PE pipe or tubing and fittings shall be either of the metal insert fittings with a split ring and compression nut or metal insert fittings with copper crimp rings. Metal insert fittings shall comply with ASTM F 1974. Crimp insert fittings shall be joined to the pipe by placing the copper crimp ring around the outer circumference of the pipe, forcing the pipe material into the space formed by the ribs on the fitting until the pipe contacts the shoulder of the fitting. The crimp ring shall then be positioned on the pipe so the edge of the crimp ring is ⅛ of an inch (3.2 mm) to ¼ of an inch (6.4 mm) from the end of the pipe. The jaws of the crimping tool shall be centered over the crimp ring and tool perpendicular to the barb. The jaws shall be closed around the crimp ring and shall not be crimped more than once.

**605.8.1.1 Compression Joints.** Compression joints for PE-AL-PE pipe or tubing and fittings shall be joined through the compression of a split ring, by a compression nut around the circumference of the pipe. The compression nut and split ring shall be placed around the pipe. The ribbed end of the fitting shall be inserted onto the pipe until the pipe contacts the shoulder of the fitting. Position and compress the split ring by tightening the compression nut onto the insert fitting.

**605.9 PE-RT.** Polyethylene of raised temperature (PE-RT) tubing shall be marked with the appropriate standard designation(s) listed in Table 604.1 for which the tubing has been approved. PE-RT tubing shall be installed in accordance with the manufacturer's installation instructions.

**605.9.1 Fittings.** Metal insert fittings, metal compression fittings, and plastic fittings shall be manufactured to and marked in accordance with the standards for fittings in Table 604.1.

**605.10 PEX Plastic Tubing and Joints.** PEX plastic tubing and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.10.1 and Section 605.10.2. *All PEX pipe installed in California must provide at least 30-day UV protection. **[OSHPD 1, 2, 3, & 4]** Installation and use of PEX tubing shall be in accordance with manufacturer's standards. PEX piping shall not be used for any application that would result in noncompliance with any provisions of the California Building Standards Code.*

**605.10.1 Fittings.** Fittings for PEX tubing shall comply with the applicable standards referenced in Table 604.1. PEX tubing in accordance with ASTM F 876 shall be marked with the applicable standard designation for the fittings specified for use with the tubing. *Brass fittings used with PEX tubing shall meet or exceed NSF 14-2009 standards to prevent dezincification and stress crack corrosion. **[OSHPD 1, 2, 3, & 4]** Installation and use of PEX tubing shall be in accordance with manufacturer's standards. PEX piping shall not be used for any application that would result in noncompliance with any provisions of the California Building Standards Code.*

**605.10.2 Mechanical Joints.** Mechanical joints shall be installed in accordance with the manufacturer's installation instructions.

**605.11 PEX-AL-PEX Plastic Tubing and Joints.** PEX-AL-PEX plastic pipe or tubing and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.11.1 and Section 605.11.1.1.

*[BSC, HCD 1 & HCD 2] PEX-AL-PEX is not adopted for use in potable water supply and distribution systems.*

**605.11.1 Mechanical Joints.** Mechanical joints between PEX-AL-PEX tubing and fittings shall include mechanical and compression type fittings and insert fittings with a crimping ring. Insert fittings utilizing a crimping ring shall be in accordance with ASTM F 1974 or ASTM F 2434. Crimp joints for crimp insert fittings shall be joined to PEX-AL-PEX pipe by the compression of a crimp ring around the outer circumference of the pipe, forcing the pipe material into annular spaces formed by ribs on the fitting.

*[BSC] PEX-AL-PEX is not adopted for use in potable water supply and distribution systems.*

**605.11.1.1 Compression Joints.** Compression joints shall include compression insert fittings and shall be joined to PEX-AL-PEX pipe through the compression of a split ring or compression nut around the outer circumference of the pipe, forcing the pipe material into the annular space formed by the ribs on the fitting.

*[BSC] PEX-AL-PEX is not adopted for use in potable water supply and distribution systems.*

**605.12 Polypropylene (PP) Piping and Joints.** PP pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.12.1 through Section 605.12.3.

**605.12.1 Heat-Fusion Joints.** Heat-fusion joints for polypropylene (PP) pipe and fitting joints shall be installed with socket-type heat-fused polypropylene fittings, fusion outlets, butt-fusion polypropylene fittings or pipe, or electro-fusion polypropylene fittings. Joint surfaces shall be clean and free from moisture. The joint shall be undisturbed until cool. Joints shall be made in accordance with ASTM F 2389 or CSA B137.11.

**605.12.2 Mechanical and Compression Sleeve Joints.** Mechanical and compression sleeve joints shall be installed in accordance with the manufacturer's installation instructions.

**605.12.3 Threaded Joints.** PP pipe shall not be threaded. PP transition fittings for connection to other piping materials shall only be threaded by use of brass or stainless steel inserts molded in the fitting.

**605.13 PVC Plastic Pipe and Joints.** PVC plastic pipe and fitting joining methods shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.13.1 through Section 605.13.3.

**605.13.1 Mechanical Joints.** Mechanical joints shall be designed to provide a permanent seal and shall be of the mechanical or push-on joint. The mechanical joint shall include a pipe spigot that has a wall thickness to withstand without deformation or collapse; the compressive force exerted where the fitting is tightened. The push-on joint shall have a minimum wall thickness of the bell at any point between the ring and the pipe barrel. The elastomeric gasket shall comply with ASTM D 3139, and be of such size and shape as to provide a compressive force against the spigot and socket after assembly to provide a positive seal.

**605.13.2 Solvent Cement Joints.** Solvent cement joints for PVC pipe and fittings shall be clean from dirt and moisture. Pipe shall be cut square and pipe shall be deburred. Where surfaces to be joined are cleaned and free of dirt, moisture, oil, and other foreign material, apply primer purple in color in accordance with ASTM F 656. Primer shall be applied until the surface of the pipe and fitting is softened. Solvent cements in accor-

dance with ASTM D 2564 shall be applied to all joint surfaces. Joints shall be made while both the inside socket surface and outside surface of pipe are wet with solvent cement. Hold joint in place and undisturbed for 1 minute after assembly.

*[HCD 1 & HCD 2] Plastic pipe and fittings joined with solvent cement shall utilize Low VOC primer(s), if a primer is required, and Low VOC solvent cement(s) as defined in Section 214.*

**605.13.3 Threaded Joints.** Threads shall comply with ASME B1.20.1. A minimum of Schedule 80 shall be permitted to be threaded; however, the pressure rating shall be reduced by 50 percent. The use of molded fittings shall not result in a 50 percent reduction in the pressure rating of the pipe provided that the molded fittings shall be fabricated so that the wall thickness of the material is maintained at the threads. Thread sealant compound that is compatible with the pipe and fitting, insoluble in water, and nontoxic shall be applied to male threads. Caution shall be used during assembly to prevent over tightening of the PVC components once the thread sealant has been applied. Female PVC threaded fittings shall be used with plastic male threads only.

**605.14 Stainless Steel Pipe and Joints.** Joining methods for stainless steel pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.14.1 and Section 605.14.2.

**605.14.1 Mechanical Joints.** Mechanical joints shall be designed for their intended use. Such joints shall include compression, flanged, grooved, pressed, and threaded.

**605.14.2 Welded Joints.** Welded joints shall be either fusion or resistance welded based on the selection of the base metal. Chemical composition of the filler metal shall comply with AWS A5.9 based on the alloy content of the piping material.

**605.15 Slip Joints.** In water piping, slip joints shall be permitted to be used only on the exposed fixture supply.

**605.16 Dielectric Unions.** Dielectric unions where installed at points of connection where there is a dissimilarity of metals shall be in accordance with ASSE 1079. *[HCD 1 & HCD 2, OSHPD 1, 2, 3 & 4] Dielectric unions shall be used at all points of connection where there is a dissimilarity of metals.*

**605.17 Joints Between Various Materials.** Joints between various materials shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 605.17.1 through Section 605.17.3.

**605.17.1 Copper Pipe or Tubing to Threaded Pipe Joints.** Joints from copper pipe or tubing to threaded pipe shall be made by the use of brass adapter, brass nipple [minimum 6 inches (152 mm)], dielectric fitting, or dielectric union in accordance with ASSE 1079. The joint between the copper pipe or tubing and the fitting shall be a soldered, brazed, flared, or pressed joint and the connection between the threaded pipe and the fitting shall be made with a standard pipe size threaded joint.

**605.17.2 Plastic Pipe to Other Materials.** Where connecting plastic pipe to other types of piping, approved types of adapter or transition fittings designed for the specific transition intended shall be used.

**605.17.3 Stainless Steel to Other Materials.** Where connecting stainless steel pipe to other types of piping, mechanical joints of the compression type, dielectric fitting, or dielectric union in accordance with ASSE 1079 and designed for the specific transition intended shall be used.

**606.0 Valves.**

**606.1 General.** Valves up to and including 2 inches (50 mm) in size shall be brass or other approved material. Sizes exceeding 2 inches (50 mm) shall be permitted to have cast-iron or brass bodies. Each gate or ball valve shall be a fullway type with working parts of non-corrosive material. Valves carrying water used in potable water systems intended to supply drinking water shall be in accordance with the requirements of NSF 61 as referenced in Table 1401.1.

**606.2 Fullway Valve.** A fullway valve controlling outlets shall be installed on the discharge side of each water meter and on each unmetered water supply. Water piping supplying more than one building on one premises shall be equipped with a separate fullway valve to each building, so arranged that the water supply can be turned on or off to an individual or separate building provided; however, that supply piping to a single-family residence and building accessory thereto shall be permitted to be controlled on one valve. Such shutoff valves shall be accessible. A fullway valve shall be installed on the discharge piping from water supply tanks at or near the tank. A fullway valve shall be installed on the cold water supply pipe to each water heater at or near the water heater.

**606.3 Multidwelling Units.** In multidwelling units, one or more shutoff valves shall be provided in each dwelling unit so that the water supply to a plumbing fixture or group of fixtures in that dwelling unit can be shut off without stopping water supply to fixtures in other dwelling units. These valves shall be accessible in the dwelling unit that they control.

**606.4 Multiple Openings.** Valves used to control two or more openings shall be fullway gate valves, ball valves, or other approved valves designed and approved for the service intended.

**606.5 Control Valve.** A control valve shall be installed immediately ahead of each water-supplied appliance and immediately ahead of each slip joint or appliance supply.

Parallel water distribution systems shall provide a control valve either immediately ahead of each fixture being supplied or installed at the manifold, and shall be identified with the fixture being supplied.

**606.6 Accessible.** Required shutoff or control valves shall be accessible.

**606.7 Multiple Fixtures.** A single control valve shall be installed on a water supply line ahead of an automatic metering valve that supplies a battery of fixtures.

***606.8 [OSHPD 1, 2, 3, & 4]*** *Each riser or branch shall be provided with an accessible sectionalizing valve in hot-and*

*cold-water systems to permit servicing or replacement of piping or equipment. Stop valves shall be provided at each fixture.*

**607.0 Gravity Supply Tanks.**

**607.1 General.** Gravity tanks for potable water shall be tightly covered, and have not less than a 16 square inch (0.01 $m^2$) overflow screened with copper screen having not less than 14 nor exceeding 18 openings per linear inch (25.4 mm).

**607.2 Potable Water Tanks.** Potable water tanks, interior tank coatings, or tank liners intended to supply drinking water shall be in accordance with NSF 61.

**608.0 Water Pressure, Pressure Regulators, Pressure Relief Valves, and Vacuum Relief Valves.**

**608.1 Inadequate Water Pressure.** Where the water pressure in the main or other source of supply will not provide a residual water pressure of not less than 15 pounds force per square inch (psi) (103 kPa), after allowing for friction and other pressure losses, a tank and a pump or other means that will provide said 15 psi (103 kPa) pressure shall be installed. Where fixtures, fixture fittings, or both are installed that require residual pressure exceeding 15 psi (103 kPa), that minimum residual pressure shall be provided.

**608.2 Excessive Water Pressure.** Where static water pressure in the water supply piping is exceeding 80 psi (552 kPa), an approved-type pressure regulator preceded by an adequate strainer shall be installed and the static pressure reduced to 80 psi (552 kPa) or less. Pressure regulator(s) equal to or exceeding 1½ inches (38 mm) shall not require a strainer. Such regulator(s) shall control the pressure to water outlets in the building unless otherwise approved by the Authority Having Jurisdiction. Each such regulator and strainer shall be accessibly located aboveground or in a vault equipped with a properly sized and sloped bore-sighted drain to daylight, shall be protected from freezing, and shall have the strainer readily accessible for cleaning without removing the regulator or strainer body or disconnecting the supply piping. Pipe size determinations shall be based on 80 percent of the reduced pressure where using Table 610.4. An approved expansion tank shall be installed in the cold water distribution piping downstream of each such regulator to prevent excessive pressure from developing due to thermal expansion and to maintain the pressure setting of the regulator. Expansion tanks used in potable water systems intended to supply drinking water shall be in accordance with NSF 61. The expansion tank shall be properly sized and installed in accordance with the manufacturer's installation instructions and listing. Systems designed by registered engineers shall be permitted to use approved pressure relief valves in lieu of expansion tanks provided such relief valves have a maximum pressure relief setting of 100 psi (689 kPa) or less.

**608.3 Expansion Tanks, Combination Pressure, and Temperature Relief Valves.** A water system provided with a check valve, backflow preventer, or other normally closed device that prevents dissipation of building pressure back into the water main shall be provided with an approved, listed, and adequately sized expansion tank or other approved device having a similar function to control thermal expansion. Such expansion tank or other approved device shall be installed on the building side of the check valve, backflow preventer, or other device and shall be sized and installed in accordance with the manufacturer's installation instructions.

A water system containing storage water heating equipment shall be provided with an approved, listed, adequately sized combination pressure and temperature relief valve, except for listed nonstorage instantaneous heaters having an inside diameter of not more than 3 inches (80 mm). Each such approved combination temperature and pressure relief valve shall be installed on the water-heating device in an approved location based on its listing requirements and the manufacturer's installation instructions. Each such combination temperature and pressure relief valve shall be provided with a drain in accordance with Section 608.5.

**608.4 Pressure Relief Valves.** Each pressure relief valve shall be an approved automatic type with drain, and each such relief valve shall be set at a pressure of not more than 150 psi (1034 kPa). No shutoff valve shall be installed between the relief valve and the system or in the drain line.

**608.5 Drains.** 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, PP, 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 2 feet (610 mm) nor less than 6 inches (152 mm) aboveground or the flood level of the area receiving the discharge and pointing downward. Such drains shall be permitted to terminate at other approved locations. Relief valve drains shall not terminate in a building's crawl space. No part of such drain pipe shall be trapped or subject to freezing. The terminal end of the drain pipe shall not be threaded.

**608.6 Water-Heating Devices.** A water-heating device connected to a separate storage tank and having valves between said heater and tank shall be provided with an approved water pressure relief valve.

**608.7 Vacuum Relief Valves.** Where a hot-water storage tank or an indirect water heater is located at an elevation above the fixture outlets in the hot-water system, a vacuum relief valve shall be installed on the storage tank or heater.

**609.0 Installation, Testing, Unions, and Location.**

**609.1 Installation.** Water piping shall be adequately supported in accordance with Table 313.1. Burred ends shall be reamed to the full bore of the pipe or tube. Changes in direction shall be made by the appropriate use of fittings, except that changes in direction in copper tubing shall be permitted to 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. Changes in direction are allowed with flexible pipe and tubing without fittings in accordance with the manufacturer's instructions. Provisions shall be made for expansion in hot-

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water piping. Piping, equipment, appurtenances, and devices shall be installed in a workmanlike manner in accordance with the provisions and intent of the code. Building supply yard piping shall be not less than 12 inches (305 mm) below the average local frost depth. The cover shall be not less than 12 inches (305 mm) below finish grade.

**609.2 Trenches.** Water pipes shall not be run or laid in the same trench as building sewer or drainage piping constructed of clay or materials that are not approved for use within a building unless both of the following conditions are met:

(1) The bottom of the water pipe, shall be not less than 12 inches (305 mm) above the top of the sewer or drain line.

(2) The water pipe shall be placed on a solid shelf excavated at one side of the common trench with a clear horizontal distance of not less than 12 inches (305 mm) from the sewer or drain line.

Water pipes crossing sewer or drainage piping constructed of clay or materials that are not approved for use within a building shall be laid not less than 12 inches (305 mm) above the sewer or drain pipe.

**609.3 Under Concrete Slab.** Water piping installed within a building and in or under a concrete floor slab resting on the ground shall be installed in accordance with the following requirements:

(1) Ferrous piping shall have a protective coating of an approved type, machine applied and in accordance with recognized standards. Field wrapping shall provide equivalent protection and shall be restricted to those short sections and fittings necessarily stripped for threading. Zinc coating (galvanizing) shall not be deemed adequate protection for piping or fittings. Approved nonferrous piping shall not be required to be wrapped.

(2) Copper tubing shall be installed without joints where possible. Where joints are permitted, they shall be brazed, and fittings shall be wrought copper.

For the purpose of this section, "within a building" shall mean within the fixed limits of the building foundation.

**609.4 Testing.** Upon completion of a section or of the entire hot and cold water supply system, it shall be tested and proved tight under a water pressure not less than the working pressure under which it is to be used. The water used for tests shall be obtained from a potable source of supply. Except for plastic piping, a 50 psi (345 kPa) air pressure shall be permitted to be substituted for the water test. In either method of test, the piping shall withstand the test without leaking for a period of not less than 15 minutes.

**609.5 Unions.** Unions shall be installed in the water supply piping not more than 12 inches (305 mm) of regulating equipment, water heating, conditioning tanks, and similar equipment that requires service by removal or replacement in a manner that will facilitate its ready removal.

**609.6 Location.** Except as provided in Section 609.7, no building supply shall be located in a lot other than the lot that is the site of the building or structure served by such building supply.

**609.7 Abutting Lot.** Nothing contained in this code shall be construed to prohibit the use of an abutting lot to:

(1) Provide access to connect a building supply to an available public water service where proper cause and legal easement not in violation of other requirements have been first established to the satisfaction of the Authority Having Jurisdiction.

(2) Provide additional space for a building supply where proper cause, transfer of ownership, or change of boundary not in violation of other requirements have been first established to the satisfaction of the Authority Having Jurisdiction. The instrument recording such action shall constitute an agreement with the Authority Having Jurisdiction, which shall clearly state and show that the areas so joined or used shall be maintained as a unit during the time they are so used. Such an agreement shall be recorded in the office of the County Recorder as a part of the conditions of ownership of said properties, and shall be binding on heirs, successors, and assigns to such properties. A copy of the instrument recording such proceedings shall be filed with the Authority Having Jurisdiction.

**609.8 Low-Pressure Cutoff Required on Booster Pumps for Water Distribution Systems.** Where a booster pump (excluding a fire pump) is connected to a building supply or underground water pipe, a low-pressure cutoff switch on the inlet side of the pump shall be installed not more than 5 feet (1524 mm) of the inlet. The cutoff switch shall be set for not less than 10 psi (69 kPa). A pressure gauge shall be installed between the shutoff valve and the pump.

**609.9 Disinfection of Potable Water System.** New or repaired potable water systems shall be disinfected prior to use where required by the Authority Having Jurisdiction. ***[OSHPD 1, 2, 3 & 4]*** *Not required for* ***[OSHPD 3SE]****. Prior to utilization of newly constructed or altered potable water piping systems, all affected potable water piping shall be disinfected using procedures prescribed in California Plumbing Code Sections 609.9(1) through 609.9(4).* The method to be followed shall be that prescribed by the Health Authority or, in case no method is prescribed by it, the following:

(1) The pipe system shall be flushed with clean, potable water until potable water appears at the points of outlet.

(2) The system or parts thereof shall be filled with a water-chlorine solution containing not less than 50 parts per million of chlorine, and the system or part thereof shall be valved-off and allowed to stand for 24 hours; or, the system or part thereof shall be filled with a water-chlorine solution containing not less than 200 parts per million of chlorine and allowed to stand for 3 hours.

(3) Following the allowed standing time, the system shall be flushed with clean, potable water until the chlorine residual in the water coming from the system does not exceed the chlorine residual in the flushing water.

(4) The procedure shall be repeated where it is shown by bacteriological examination made by an approved agency that contamination persists in the system.

**609.10 Water Hammer.** *[Not adopted by HCD]* Building water supply systems where quick-acting valves are installed shall be provided with water hammer arrester(s) to absorb high pressures resulting from the quick closing of these valves. Water hammer arresters shall be approved mechanical devices in accordance with the applicable standard(s) referenced in Table 1401.1 and shall be installed as close as possible to quick-acting valves.

**609.10.1 Mechanical Devices.** Where listed mechanical devices are used, the manufacturer's specifications as to location and method of installation shall be followed.

**610.0 Size of Potable Water Piping.**

**610.1 Size.** The size of each water meter and each potable water supply pipe from the meter or other source of supply to the fixture supply branches, risers, fixtures, connections, outlets, or other uses shall be based on the total demand and shall be determined according to the methods and procedures outlined in this section. Water piping systems shall be designed to ensure that the maximum velocities allowed by the code and the applicable standard are not exceeded.

**610.2 Pressure Loss.** Where a water filter, water softener, backflow prevention device, tankless water heater, or similar device is installed in a water supply line, the pressure loss through such devices shall be included in the pressure loss calculations of the system, and the water supply pipe and meter shall be adequately sized to provide for such a pressure loss.

No water filter, water softener, backflow prevention device, or similar device regulated by this code shall be installed in a potable water supply piping where the installation of such device produces an excessive pressure drop in such water supply piping. In the absence of specific pressure drop information, the diameter of the inlet or outlet of such device or its connecting piping shall be not less than the diameter of such water distribution piping to the fixtures served by the device.

Such devices shall be of a type approved by the Authority Having Jurisdiction and shall be tested for flow rating and pressure loss by an approved laboratory or recognized testing agency to standards consistent with the intent of this chapter.

**610.3 Quantity of Water.** The quantity of water required to be supplied to every plumbing fixture shall be represented by fixture units, as shown in Table 610.3. Equivalent fixture values shown in Table 610.3 include both hot and cold water demand.

**610.4 Parallel Distribution Systems.** Systems within the range of Table 610.4 shall be permitted to be sized from that table or by the method in accordance with Section 610.5.

Listed parallel water distribution systems shall be installed in accordance with their listing, but at no time shall a portion of the system exceed the maximum velocities allowed by the code.

**610.5 Sizing per Appendices A and C.** Except as provided in Section 610.4, the size of each water piping system shall be determined in accordance with the procedure set forth in Appendix A. For alternate methods of sizing water supply systems, see Appendix C.

**610.6 Friction and Pressure Loss.** Except where the type of pipe used and the water characteristics are such that no decrease in capacity due to length of service (age of system) is expected, friction-loss data shall be obtained from the "Fairly Rough" or "Rough" charts in Appendix A of this code. Friction or pressure losses in water meter, valve, and fittings shall be obtained from the same sources. Pressure losses through water-treating equipment, backflow prevention devices, or other flow-restricting devices shall be computed in accordance with Section 610.2.

**610.7 Conditions for Using Table 610.4.** On a proposed water piping installation sized using Table 610.4, the following conditions shall be determined:

(1) Total number of fixture units as determined from Table 610.3, Equivalent Fixture Units, for the fixtures to be installed.

(2) Developed length of supply pipe from meter to most remote outlet.

(3) Difference in elevation between the meter or other source of supply and the highest fixture or outlet.

(4) Pressure in the street main or other source of supply at the locality where the installation is to be made.

(5) In localities where there is a fluctuation of pressure in the main throughout the day, the water piping system shall be designed on the basis of the minimum pressure available.

**610.8 Size of Meter and Building Supply Pipe Using Table 610.4.** The size of the meter and the building supply pipe shall be determined as follows:

(1) Determine the available pressure at the water meter or other source of supply.

(2) Add or subtract depending on positive or negative elevation change, ½ psi (3.4 kPa) for each foot (305 mm) of difference in elevation between such source of supply and the highest water supply outlet in the building or on the premises.

(3) Use the "pressure range" group within which this pressure will fall using Table 610.4.

(4) Select the "length" column that is equal to or longer than the required length.

(5) Follow down the column to a fixture unit value equal to or exceeding the total number of fixture units required by the installation.

(6) Having located the proper fixture unit value for the required length, sizes of meter and building supply pipe as found in the two left-hand columns shall be applied.

No building supply pipe shall be less than ¾ of an inch (20 mm) in diameter.

**610.9 Size of Branches.** Where Table 610.4 is used, the minimum size of each branch shall be determined by the number of fixture units to be served by that branch, the total developed length of the system, and the meter and street service size in accordance with Section 610.8. No branch piping is required to be larger in size than that required by Table 610.4 for the building supply pipe.

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## TABLE 610.3
## WATER SUPPLY FIXTURE UNITS (WSFU) AND MINIMUM FIXTURE BRANCH PIPE SIZES[3]

| APPLIANCES, APPURTENANCES OR FIXTURES[2] | MINIMUM FIXTURE BRANCH PIPE SIZE[1,4] (inches) | PRIVATE | PUBLIC | ASSEMBLY[6] |
|---|---|---|---|---|
| Bathtub or Combination Bath/Shower (fill) | ½ | 4.0 | 4.0 | — |
| ¾ inch Bathtub Fill Valve | ¾ | 10.0 | 10.0 | — |
| Bidet | ½ | 1.0 | — | — |
| Clothes Washer | ½ | 4.0 | 4.0 | — |
| Dental Unit, cuspidor | ½ | — | 1.0 | — |
| Dishwasher, domestic | ½ | 1.5 | 1.5 | — |
| Drinking Fountain or Water Cooler | ½ | 0.5 | 0.5 | 0.75 |
| Hose Bibb | ½ | 2.5 | 2.5 | — |
| Hose Bibb, each additional[8] | ½ | 1.0 | 1.0 | — |
| Lavatory | ½ | 1.0 | 1.0 | 1.0 |
| Lawn Sprinkler, each head[5] | — | 1.0 | 1.0 | — |
| Mobile Home, each (minimum)[9] | — | 12.0 | — | — |
| Sinks | — | — | — | — |
| Bar | ½ | 1.0 | 2.0 | — |
| Clinic Faucet | ½ | — | 3.0 | — |
| Clinic Flushometer Valve with or without faucet | 1 | — | 8.0 | — |
| Kitchen, domestic with or without dishwasher | ½ | 1.5 | 1.5 | — |
| Laundry | ½ | 1.5 | 1.5 | — |
| Service or Mop Basin | ½ | 1.5 | 3.0 | — |
| Washup, each set of faucets | ½ | — | 2.0 | — |
| Shower, per head | ½ | 2.0 | 2.0 | — |
| Urinal, 1.0 GPF Flushometer Valve | ¾ | See Footnote[7] | | — |
| Urinal, greater than 1.0 GPF Flushometer Valve | ¾ | See Footnote[7] | | — |
| Urinal, flush tank | ½ | 2.0 | 2.0 | 3.0 |
| Wash Fountain, circular spray | ¾ | — | 4.0 | — |
| Water Closet, 1.6 GPF Gravity Tank | ½ | 2.5 | 2.5 | 3.5 |
| Water Closet, 1.6 GPF Flushometer Tank | ½ | 2.5 | 2.5 | 3.5 |
| Water Closet, 1.6 GPF Flushometer Valve | 1 | See Footnote[7] | | — |
| Water Closet, greater than 1.6 GPF Gravity Tank | ½ | 3.0 | 5.5 | 7.0 |
| Water Closet, greater than 1.6 GPF Flushometer Valve | 1 | See Footnote[7] | | — |

For SI units: 1 inch = 25 mm

**Notes:**

1 Size of the cold branch pipe, or both the hot and cold branch pipes.

2 Appliances, appurtenances, or fixtures not referenced in this table shall be permitted to be sized by reference to fixtures having a similar flow rate and frequency of use.

3 The listed fixture unit values represent their load on the cold water building supply. The separate cold water and hot water fixture unit value for fixtures having both hot and cold water connections shall be permitted to be each taken as three-quarter of the listed total value of the fixture.

4 The listed minimum supply branch pipe sizes for individual fixtures are the nominal (I.D.) pipe size.

5 For fixtures or supply connections likely to impose continuous flow demands, determine the required flow in gallons per minute (gpm) (L/s), and add it separately to the demand in gpm (L/s) for the distribution system or portions thereof.

6 Assembly [Public Use (See Table 422.1)].

7 Where sizing flushometer systems, see Section 610.10.

8 Reduced fixture unit loading for additional hose bibbs is to be used where sizing total building demand and for pipe sizing where more than one hose bibb is supplied by a segment of water distribution pipe. The fixture branch to each hose bibb shall be sized on the basis of 2.5 fixture units.

9 *[HCD 2] For water supply fixture unit values related to mobilehome parks in all parts of the State of California, see California Code of Regulations, Title 25, Division 1, Chapter 2, Article 5, Section 1278. For water supply fixture unit values related to special occupancy parks in all parts of the State of California, see California Code of Regulations, Title 25, Division 1, Chapter 2.2, Article 5, Section 2278.*

## TABLE 610.4
## FIXTURE UNIT TABLE FOR DETERMINING WATER PIPE AND METER SIZES

| METER AND STREET SERVICE (inches) | BUILDING SUPPLY AND BRANCHES (inches) | MAXIMUM ALLOWABLE LENGTH (feet) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 40 | 60 | 80 | 100 | 150 | 200 | 250 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | 1000 |
| PRESSURE RANGE – 30 to 45 psi[1] | | | | | | | | | | | | | | | | |
| ¾ | ½[2] | 6 | 5 | 4 | 3 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ¾ | ¾ | 16 | 16 | 14 | 12 | 9 | 6 | 5 | 5 | 4 | 4 | 3 | 2 | 2 | 2 | 1 |
| ¾ | 1 | 29 | 25 | 23 | 21 | 17 | 15 | 13 | 12 | 10 | 8 | 6 | 6 | 6 | 6 | 6 |
| 1 | 1 | 36 | 31 | 27 | 25 | 20 | 17 | 15 | 13 | 12 | 10 | 8 | 6 | 6 | 6 | 6 |
| ¾ | 1¼ | 36 | 33 | 31 | 28 | 24 | 23 | 21 | 19 | 17 | 16 | 13 | 12 | 12 | 11 | 11 |
| 1 | 1¼ | 54 | 47 | 42 | 38 | 32 | 28 | 25 | 23 | 19 | 17 | 14 | 12 | 12 | 11 | 11 |
| 1½ | 1¼ | 78 | 68 | 57 | 48 | 38 | 32 | 28 | 25 | 21 | 18 | 15 | 12 | 12 | 11 | 11 |
| 1 | 1½ | 85 | 84 | 79 | 65 | 56 | 48 | 43 | 38 | 32 | 28 | 26 | 22 | 21 | 20 | 20 |
| 1½ | 1½ | 150 | 124 | 105 | 91 | 70 | 57 | 49 | 45 | 36 | 31 | 26 | 23 | 21 | 20 | 20 |
| 2 | 1½ | 151 | 129 | 129 | 110 | 80 | 64 | 53 | 46 | 38 | 32 | 27 | 23 | 21 | 20 | 20 |
| 1 | 2 | 85 | 85 | 85 | 85 | 85 | 85 | 82 | 80 | 66 | 61 | 57 | 52 | 49 | 46 | 43 |
| 1½ | 2 | 220 | 205 | 190 | 176 | 155 | 138 | 127 | 120 | 104 | 85 | 70 | 61 | 57 | 54 | 51 |
| 2 | 2 | 370 | 327 | 292 | 265 | 217 | 185 | 164 | 147 | 124 | 96 | 70 | 61 | 57 | 54 | 51 |
| 2 | 2½ | 445 | 418 | 390 | 370 | 330 | 300 | 280 | 265 | 240 | 220 | 198 | 175 | 158 | 143 | 133 |
| PRESSURE RANGE – 46 to 60 psi[1] | | | | | | | | | | | | | | | | |
| ¾ | ½[2] | 7 | 7 | 6 | 5 | 4 | 3 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| ¾ | ¾ | 20 | 20 | 19 | 17 | 14 | 11 | 9 | 8 | 6 | 5 | 4 | 4 | 3 | 3 | 3 |
| ¾ | 1 | 39 | 39 | 36 | 33 | 28 | 23 | 21 | 19 | 17 | 14 | 12 | 10 | 9 | 8 | 8 |
| 1 | 1 | 39 | 39 | 39 | 36 | 30 | 25 | 23 | 20 | 18 | 15 | 12 | 10 | 9 | 8 | 8 |
| ¾ | 1¼ | 39 | 39 | 39 | 39 | 39 | 39 | 34 | 32 | 27 | 25 | 22 | 19 | 19 | 17 | 16 |
| 1 | 1¼ | 78 | 78 | 76 | 67 | 52 | 44 | 39 | 36 | 30 | 27 | 24 | 20 | 19 | 17 | 16 |
| 1½ | 1¼ | 78 | 78 | 78 | 78 | 66 | 52 | 44 | 39 | 33 | 29 | 24 | 20 | 19 | 17 | 16 |
| 1 | 1½ | 85 | 85 | 85 | 85 | 85 | 85 | 80 | 67 | 55 | 49 | 41 | 37 | 34 | 32 | 30 |
| 1½ | 1½ | 151 | 151 | 151 | 151 | 128 | 105 | 90 | 78 | 62 | 52 | 42 | 38 | 35 | 32 | 30 |
| 2 | 1½ | 151 | 151 | 151 | 151 | 150 | 117 | 98 | 84 | 67 | 55 | 42 | 38 | 35 | 32 | 30 |
| 1 | 2 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 83 | 80 |
| 1½ | 2 | 370 | 370 | 340 | 318 | 272 | 240 | 220 | 198 | 170 | 150 | 135 | 123 | 110 | 102 | 94 |
| 2 | 2 | 370 | 370 | 370 | 370 | 368 | 318 | 280 | 250 | 205 | 165 | 142 | 123 | 110 | 102 | 94 |
| 2 | 2½ | 654 | 640 | 610 | 580 | 535 | 500 | 470 | 440 | 400 | 365 | 335 | 315 | 285 | 267 | 250 |
| PRESSURE RANGE – Over 60 psi[1] | | | | | | | | | | | | | | | | |
| ¾ | ½[2] | 7 | 7 | 7 | 6 | 5 | 4 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 0 |
| ¾ | ¾ | 20 | 20 | 20 | 20 | 17 | 13 | 11 | 10 | 8 | 7 | 6 | 6 | 5 | 4 | 4 |
| ¾ | 1 | 39 | 39 | 39 | 39 | 35 | 30 | 27 | 24 | 21 | 17 | 14 | 13 | 12 | 12 | 11 |
| 1 | 1 | 39 | 39 | 39 | 39 | 38 | 32 | 29 | 26 | 22 | 18 | 14 | 13 | 12 | 12 | 11 |
| ¾ | 1¼ | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 34 | 28 | 26 | 25 | 23 | 22 | 21 |
| 1 | 1¼ | 78 | 78 | 78 | 78 | 74 | 62 | 53 | 47 | 39 | 31 | 26 | 25 | 23 | 22 | 21 |
| 1½ | 1¼ | 78 | 78 | 78 | 78 | 78 | 74 | 65 | 54 | 43 | 34 | 26 | 25 | 23 | 22 | 21 |
| 1 | 1½ | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 81 | 64 | 51 | 48 | 46 | 43 | 40 |
| 1½ | 1½ | 151 | 151 | 151 | 151 | 151 | 151 | 130 | 113 | 88 | 73 | 51 | 51 | 46 | 43 | 40 |
| 2 | 1½ | 151 | 151 | 151 | 151 | 151 | 151 | 142 | 122 | 98 | 82 | 64 | 51 | 46 | 43 | 40 |
| 1 | 2 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 | 85 |
| 1½ | 2 | 370 | 370 | 370 | 370 | 360 | 335 | 305 | 282 | 244 | 212 | 187 | 172 | 153 | 141 | 129 |
| 2 | 2 | 370 | 370 | 370 | 370 | 370 | 370 | 370 | 340 | 288 | 245 | 204 | 172 | 153 | 141 | 129 |
| 2 | 2½ | 654 | 654 | 654 | 654 | 654 | 650 | 610 | 570 | 510 | 460 | 430 | 404 | 380 | 356 | 329 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 pound-force per square inch = 6.8947 kPa

**Notes:**

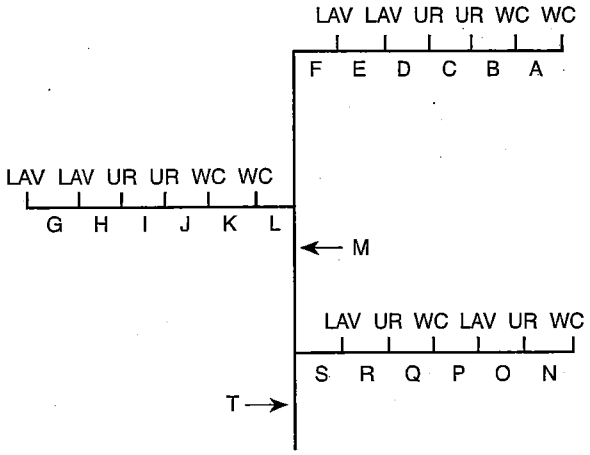
[1] Available static pressure after head loss.

[2] Building supply, not less than ¾ of an inch (20 mm) nominal size.

**610.10 Sizing for Flushometer Valves.** Where using Table 610.4 to size water supply systems serving flushometer valves, the number of flushometer fixture units assigned to every section of pipe, whether branch or main, shall be determined by the number and category of flushometer valves served by that section of pipe, in accordance with Table 610.10. Piping supplying a flushometer valve shall be not less in size than the valve inlet.

Where using Table 610.10 to size water piping, care shall be exercised to assign flushometer fixture units based on the number and category of fixtures served.

In the example below, fixture units assigned to each section of pipe are computed. Each capital letter refers to the section of pipe above it, unless otherwise shown.




A: 1 WC = 40 F.U.
B: 2 WC = 70 F.U.
C: 2 WC (70) + 1 UR (20) = 90 F.U.
D: 2 WC (70) + 2 UR (35) = 105 F.U.
E: 2 WC (70) + 2 UR (35) + 1 LAV (1) = 106 F.U.
F: 2 WC (70) + 2 UR (35) + 2 LAV (2) = 107 F.U.
G: 1 LAV = 1 F.U.
H: 2 LAV = 2 F.U.
I: 2 LAV (2) + 1 UR (20) = 22 F.U.
J: 2 LAV (2)+ 2 UR (35) = 37 F.U.
K: 2 LAV (2) + 2 UR (35) + 1 WC (40) = 77 F.U.
L: 2 LAV (2) + 2 UR (35) + 2 WC (70) = 107 F.U.
M: 4 WC (105) + 4 UR (53) + 4 LAV (4) = 162 F.U.
N: 1 WC = 40 F.U.
O: 1 WC (40) + 1 UR (20) = 60 F.U.
P: 1 WC (40) + 1 UR (20) + 1 LAV (1) = 61 F.U.
Q: 2 WC (70) + 1 UR (20) + 1 LAV (1) = 91 F.U.
R: 2 WC (70) + 2 UR (35) + 1 LAV (1) = 106 F.U.
S: 2 WC (70) + 2 UR (35) + 2 LAV (2) = 107 F.U.
T: 6 WC (125) + 6 UR (63) + 6 LAV (6) = 194 F.U.

**EXAMPLE 610.10**
**SIZING METHOD FOR PUBLIC USE FIXTURES USING TABLE 610.10**

**TABLE 610.10**
**FLUSHOMETER FIXTURE UNITS FOR WATER SIZING USING TABLE 610.3**

| FIXTURE CATEGORY: WATER CLOSET WITH FLUSHOMETER VALVES | | |
|---|---|---|
| NUMBER OF FLUSHOMETER VALVES | INDIVIDUAL FIXTURE UNITS ASSIGNED IN DECREASING VALUE | FIXTURE UNITS ASSIGNED FOR WATER CLOSETS AND SIMILAR 10-UNIT FIXTURES IN ACCUMULATIVE VALUES |
| 1 | 40 | 40 |
| 2 | 30 | 70 |
| 3 | 20 | 90 |
| 4 | 15 | 105 |
| 5 or more | 10 each | 115 plus 10 for each additional fixture in excess of 5 |
| **FIXTURE CATEGORY: URINALS WITH FLUSHOMETER VALVES** | | |
| NUMBER OF FLUSHOMETER VALVES | INDIVIDUAL FIXTURE UNITS ASSIGNED IN DECREASING VALUE | FIXTURE UNITS ASSIGNED FOR URINALS AND SIMILAR 5-UNIT FIXTURES IN ACCUMULATIVE VALUES |
| 1 | 20 | 20 |
| 2 | 15 | 35 |
| 3 | 10 | 45 |
| 4 | 8 | 53 |
| 5 or more | 5 each | 58 plus 5 for each additional fixture in excess of 5 |

**610.11 Sizing Systems for Flushometer Tanks.** The size of branches and mains serving flushometer tanks shall be consistent with the sizing procedures for flush tank water closets.

**610.12 Sizing for Velocity.** Water piping systems shall not exceed the maximum velocities listed in this section or Appendix A.

**610.12.1 Copper Tube Systems.** Maximum velocities in copper and copper alloy tube and fitting systems shall not exceed 8 feet per second (ft/s) (2.4 m/s) in cold water and 5 ft/s in hot water (1.5 m/s).

**610.12.2 Tubing Systems Using Copper Alloy Fittings.** Maximum velocities through copper alloy fittings in tubing other than copper shall not exceed 8 ft/s (2.4 m/s) in cold water and 5 ft/s in hot water (1.5 m/s).

**610.13 Exceptions.** The provisions of this section relative to size of water piping shall not apply to the following:

(1) Water supply piping systems designed in accordance with recognized engineering procedures acceptable to the Authority Having Jurisdiction.

(2) Alteration of or minor additions to existing installations, provided the Authority Having Jurisdiction finds that there will be an adequate supply of water to operate fixtures.

(3) Replacement of existing fixtures or appliances.

(4) Piping that is part of fixture equipment.

(5) Unusual conditions where, in the judgment of the Authority Having Jurisdiction, an adequate supply of water is provided to operate fixtures and equipment.

(6) Nonpotable waterlines as defined in Section 601.2.

(7) The size and material of irrigation water piping installed outside of a building or structure and separated from the potable water supply by means of an approved air gap or backflow prevention device is not regulated by this code. The potable water piping system supplying each such irrigation system shall be adequately sized as required elsewhere in this chapter to deliver the full connected demand of both the domestic use and the irrigation systems.

## 611.0 Drinking Water Treatment Units.

**611.1 Application.** Drinking water treatment units shall comply with NSF 42 or NSF 53. Water softeners shall comply with NSF 44. Ultraviolet water treatment systems shall comply with NSF 55. Reverse osmosis drinking water treatment systems shall comply with NSF 58. Drinking water distillation systems shall comply with NSF 62.

**611.2 Air Gap Discharge.** Discharge from drinking water treatment units shall enter the drainage system through an air gap in accordance with Table 603.3.1 or an air gap device in accordance with Table 603.2, NSF 58, or IAPMO PS 65.

**611.3 Connection Tubing.** The tubing to and from drinking water treatment units shall be of a size and material as recommended by the manufacturer. The tubing shall comply with the requirements of NSF 14, NSF 42, NSF 44, NSF 53, NSF 55, NSF 58, NSF 62 or the appropriate material standards referenced in Table 1401.1.

**611.4 Sizing of Residential Softeners.** Residential-use water softeners shall be sized in accordance with Table 611.4.

**TABLE 611.4**
**SIZING OF RESIDENTIAL WATER SOFTENERS[4]**

| REQUIRED SIZE OF SOFTENER CONNECTION (inches) | NUMBER OF BATHROOM GROUPS SERVED[1] |
|---|---|
| ¾ | up to 2[2] |
| 1 | up to 4[3] |

For SI units: 1 inch = 25 mm

**Notes:**

1 Installation of a kitchen sink and dishwasher, laundry tray, and automatic clothes washer permitted without additional size increase.

2 An additional water closet and lavatory permitted.

3 Over four bathroom groups, the softener size shall be engineered for the specific installation.

4 See also Appendix A, Recommended Rules for Sizing the Water Supply System, and Appendix C, Alternate Plumbing Systems, for alternate methods of sizing water supply systems.

## 612.0 Residential Fire Sprinkler Systems.

**612.1 General.** Where residential fire sprinkler systems are installed, they shall be installed in accordance with the standards listed in Table 1401.1.

## *613.0 [OSHPD 1, 2, 3 & 4] Domestic Hot-Water Distribution Systems for Health Facilities and Clinics.*

*613.1 The domestic water-heating equipment and distribution systems shall supply water at the temperature and amounts shown in Table 613.1. Where the system is designed by a mechanical engineer, appropriate diversity factors may be utilized.*

***TABLE 613.1***
***[OSHPD 1, 2, 3 & 4] HOT WATER USE***

| | CLINICAL | DIETARY[1] | LAUNDRY[2] |
|---|---|---|---|
| Liter/Hour/Bed | 11.9 | 7.2 | 7.6 |
| Gallons/Hour/Bed | 3 | 2 | 2 |
| Temperature °C | 41-49.0 | 49.0 | 71.0 |
| Temperature °F | 105-120.0 | 120.0 | 160.0 |

*1 Rinse water temperature at automatic dishwashing equipment and pot sinks shall be 180°F(82°C).*

***Exception:** The rinse water supply to pot rinse sinks may be deleted if a method of chemical disinfection using a three-compartment sink is proposed.*

*2 The required temperature of 160°F (71°C) in the laundry is that measure in the washing machine and shall be supplied so that the temperature may be maintained over the entire wash and rinse period.*

***Exception:** A lower water temperature of 140°F (60°C) may be utilized, provided linens are subsequently passed through a tumbler dryer at 180°F (82°C) or a flatwork ironer at 300°F (149°C).*

*613.2 At least two pieces of hot-water-heating equipment shall be provided to supply hot water for dishwashing and minimum patient services such as handwashing and bathing. Booster heaters for 125°F to 180°F (52°C to 82°C) water are acceptable as a second piece of equipment for dishwashing. Where storage tanks are separate from the water heater, at least two independent storage tanks shall be provided. Not required for **[OSHPD 3SE]**.*

*613.3 Instantaneous heaters are permitted for supplying hot water to handwashing and bathing fixtures if a continuous mechanical recirculation system is also provided.*

*613.4 Water storage tanks shall be fabricated of corrosion-resistant materials or lined with corrosion-resistant materials.*

*613.5 Temperature control valves shall be provided to automatically regulate the temperature of hot water delivered to plumbing fixtures used by patients to a range of 105°F (41°C) minimum to 120°F (49°C) maximum. High temperature alarm set at 125°F (52°C) shall be provided. The audible/visual device for the high temperature alarm shall annunciate at a continuously occupied location.*

*613.6 Hot-water distribution system serving patient care areas shall be under constant mechanical recirculation to provide continuous hot water at each hot water outlet. Non-recirculated fixture branch piping shall not exceed 25 feet (7.62 meters) in length. Dead-end piping (risers with no flow, branches with no fixture) shall not be installed. In renovation projects, dead-end piping shall be removed in the area of renovation. Empty risers, mains, and branches installed for future use shall be permitted.*

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*613.7 At fixtures where water exceeding 125°F (52°C) is accessible to patients or personnel, warning signs in letters at least 2 inches (51 mm) high shall be posted above the fixtures.*

*613.8 Sectionalizing valves shall be provided as required by Section 606.8.*

***614.0 Dialysis Water-Distribution Systems.***

***614.1 [OSHPD 1, 2, 3, & 4]*** *Dialysis water feedlines shall be PVC (polyvinyl chloride), glass, stainless steel, or PVDF (polyvinylidene fluoride) and sized to provide a minimum velocity of 1.5 feet per second (0.46 m/s). The piping shall be a singleloop system with or without recirculation. Branches to dialysis machines shall be ¼ inch (6.4 mm) inside dimension and take off from the bottom of the main feedline.*

*614.2 All piping for multistation or central dialysis units shall be rigid where possible. All piping and tubing shall be in a neat arrangement. The placement of piping or tubing on the floor is not permitted.*

*614.3 All valves shall be located in accessible locations.*

*614.4 Piping and valves shall be identified according to their function.*

*614.5 A means of preventing backwashing or flushing of the system when one or more stations are in operation shall be provided.*

*614.6 A continuous audible alarm shall sound at the nurses' station and remote equipment rooms when the minimum velocity is not maintained, or if backwashing or flushing is attempted while one or more stations are in operation.*

*614.7 Water used for dialysis treatment shall meet the latest edition of ANSI/American Association of Medical Instrumentations (AAMI) RD62, Water treatment equipment for hemodialysis applications.*

*614.8 A diagram of all piping as installed shall be posted at the nurses' station and equipment room of all multistation or central dialysis units.*

***615.0 Identification of Potable and Nonpotable Water Lines.***

***615.1 Uses Not Permitted.***

***615.1.1 [OSHPD 1, 2, 3 & 4]*** *Nonpotable water shall not be piped for drinking, washing or bathing, washing of clothing, cooking, washing of food, washing of cooking or eating utensils, washing of food preparation or processing premises, or other personal service rooms.*

***615.2 [OSHPD 1, 2, 3 & 4]*** *Non-potable water systems or systems carrying any other non-potable substance shall be installed so as to prevent backflow or back-siphonage into a potable water system.*

***615.3 [OSHPD 1, 2, 3 & 4]*** *Outlets for non-potable water, such as water for industrial or fire-fighting purposes, shall be posted in a manner understandable to all employees to indicate that the water is unsafe and shall not be used for drinking, washing, cooking or other personal service purposes.*

***615.4 [OSHPD 1] Emergency Water Supply.***

***615.4.1*** *For new acute care hospital buildings submitted after the effective date of this code, the hospital shall have an on-site water supply sufficient to operate essential hospital utilities and equipment in the acute care hospital building, to support 72 hours of continuing operation in the event of an emergency. Any general acute care hospital in operation after January 1, 2030 shall have an on-site water supply sufficient to operate essential hospital utilities and equipment in the acute care hospital buildings on the campus with an SPC-3, SPC-4, or SPC-5 rating, to support 72 hours of continuing operation in the event of an emergency. See also California Building Code, Part 2, Section 1616A.1.42.*

*The emergency water storage capacity shall be computed based on an approved Water Conservation/Water Rationing Plan to provide for 72 hours of operation, accepted by the licensing agency. For acute care hospital facilities or buildings required to meet NPC-5, on-site water supply of not less than 150 gallons [567.9 L] [based on 50 gallons/day/bed for 72 hours] of potable water per licensed bed shall be provided. In no event shall the campus on-site water storage capacity be less than one tank with at least 5,000 gallons capacity.*

*The emergency supply shall have fittings to allow for replenishment of the water supply from transportable water sources and a means to dispense water to portable containers in the event that normal water supply becomes unavailable.*

***Exception:*** *With the approval of the Office and the licensing agency, hook-ups that allow for the use of transportable sources of potable water may be provided in lieu of 72 hours of on-site storage if a minimum onsite water supply of potable and industrial water is provided, sufficient to support 24 hours of operation, without replenishment based on the hospital's approved Water Conservation/Water Rationing plan. In no event shall the on-site water storage capacity be less than one tank with at least 5,000 gallons capacity. This emergency supply tank shall have fittings to allow for replenishment of the water supply from transportable water sources and a means to dispense water to portable containers in the event that normal water supply becomes unavailable.*

***615.4.2*** *The emergency supply of water shall be provided at adequate pressure using gravity, pressure tanks, or booster pumps. Pumps used for this purpose shall be provided with electrical power from the on-site emergency power supply system.*

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 7 - SANITARY DRAINAGE

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | X | | | | | | X | X | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | X | X | | | | | X | X | X | X | | | X | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| 701.1(2) (a) | | | X | X | | | | | | | | | | | | | | | |
| 701.1(2) (b) | | | | | | | | | X | X | X | X | | | | | | | |
| Table 702.1 | | | | X | | | | | | | | | | | | | | | |
| 705.10.4 | | | X | X | | | | | | | | | | | | | | | |
| 710.3.1 | | | X | X | | | | | | | | | | | | | | | |
| 713.4 | | | X | | | | | | | | | | | | | | | | |
| 717.2 | | | | | | | | | | | | | | | X | | | | |
| 724.0 | | | | | | | | | | | | | | | X | | | | |
| 725.0 | | | | | | | | | | | | | | | X | | | | |
| 726.0 | | | | | | | | | | | | | | | X | | | | |
| 727.0 | | | | | | | | | X | | | | | | | | | | |

# CHAPTER 7
## SANITARY DRAINAGE

### Part I – Drainage Systems.

**701.0 Materials.**

**701.1 Drainage Piping.** Materials for drainage piping shall be in accordance with one of the referenced standards in Table 701.1 except that:

(1) No galvanized wrought-iron or galvanized steel pipe shall be used underground and shall be kept not less than 6 inches (152 mm) aboveground.

(2) ABS and PVC DWV piping installations shall be installed in accordance with applicable standards referenced in Table 1401.1. Except for individual single-family dwelling units, materials exposed within ducts or plenums shall have a flame-spread index of a maximum of 25 and a smoke-developed index of a maximum 50, where tested in accordance with ASTM E 84 and UL 723.

(a) *[HCD 1 & HCD 2] ABS and PVC installations are limited to not more than two stories of areas of residential accommodation.*

(b) *[OSHPD 1, 2, & 4] ABS and PVC installations are not allowed.*

(3) No vitrified clay pipe or fittings shall be used aboveground or where pressurized by a pump or ejector. They shall be kept not less than 12 inches (305 mm) belowground.

(4) Copper tube for drainage and vent piping shall have a weight of not less than that of copper drainage tube type DWV.

(5) Stainless steel 304 pipe and fittings shall not be installed underground and shall be kept not less than 6 inches (152 mm) aboveground.

(6) Cast-iron soil pipe and fittings shall be listed and tested in accordance with standards referenced in Table 1401.1. Such pipe and fittings shall be marked with country of origin and identification of the original manufacturer in addition to markings required by referenced standards.

**701.2 Drainage Fittings.** Materials for drainage fittings shall comply with the applicable standards referenced in Table 701.1 of the same diameter as the piping served, and such fittings shall be compatible with the type of pipe used.

**701.2.1 Screwed Pipe.** Fittings on screwed pipe shall be of the recessed drainage type. Burred ends shall be reamed to the full bore of the pipe.

**701.2.2 Threads.** The threads of drainage fittings shall be tapped so as to allow ¼ inch per foot (20.8 mm/m) grade.

**701.2.3 Type.** Fittings used for drainage shall be of the drainage type, have a smooth interior water-way, and be constructed so as to allow ¼ inch per foot (20.8 mm/m) grade.

**701.3 Lead.** (See Table 1401.1) Sheet lead shall be not less than the following:

(1) For safe pans – not less than 4 pounds per square foot lb/ft² (19 kg/m²) or 1/16 of an inch (1.6 mm) thick.

(2) For flashings or vent terminals – not less than 3 lb/ft² (15 kg/m²) or 0.0472 of an inch (1.1989 mm) thick.

(3) Lead bends and lead traps shall be not less than ⅛ of an inch (3.2 mm) wall thickness.

**701.4 Caulking Ferrules.** Caulking ferrules shall be manufactured from bronze or copper and shall be in accordance with Table 701.4.

**701.5 Soldering Bushings.** Soldering bushings shall be of bronze or copper in accordance with Table 701.5.

**702.0 Fixture Unit Equivalents.**

**702.1 Trap Size.** The unit equivalent of plumbing fixtures shown in Table 702.1 shall be based on the size of the trap required, and the unit equivalent of fixtures and devices not shown in Table 702.1 shall be based on the size of trap or trap arm.

Maximum drainage fixture units for a fixture trap and trap arm loadings for sizes up to 4 inches (100 mm) shall be in accordance with Table 702.2(a).

**702.2 Intermittent Flow.** Drainage fixture units for intermittent flow into the drainage system shall be computed on the rated discharge capacity in gallons per minute (gpm) (L/s) in accordance with Table 702.2(b).

**702.3 Continuous Flow.** For a continuous flow into a drainage system, such as from a pump, sump ejector, air conditioning equipment, or similar device, 2 fixture units shall be equal to each gallon per minute (gpm) (0.06 L/s) of flow.

**TABLE 701.4**
**CAULKING FERRULES**

| PIPE SIZE (inches) | INSIDE DIAMETER (inches) | LENGTH (inches) | MINIMUM WEIGHT EACH | |
|---|---|---|---|---|
| | | | pounds | ounces |
| 2 | 2¼ | 4½ | 1 | 0 |
| 3 | 3¼ | 4½ | 1 | 12 |
| 4 | 4¼ | 4½ | 2 | 8 |

For SI units: 1 inch = 25 mm, 1 pound = 0.453 kg, 1 ounce = 0.02834 kg

**TABLE 701.5**
**SOLDERING BUSHINGS**

| PIPE SIZE (inches) | MINIMUM WEIGHT EACH | | PIPE SIZE (inches) | MINIMUM WEIGHT EACH | |
|---|---|---|---|---|---|
| | pounds | ounces | | pounds | ounces |
| 1¼ | 0 | 6 | 2½ | 1 | 6 |
| 1½ | 0 | 8 | 3 | 2 | 0 |
| 2 | 0 | 14 | 4 | 3 | 8 |

For SI units: 1 inch = 25 mm, 1 pound = 0.453 kg, 1 ounce = 0.02834 kg

**TABLE 701.1**
**MATERIALS FOR DRAIN, WASTE, VENT PIPE AND FITTINGS**

| MATERIAL | UNDERGROUND DRAIN, WASTE, VENT PIPE AND FITTINGS | ABOVEGROUND DRAIN, WASTE, VENT PIPE AND FITTINGS | BUILDING SEWER PIPE AND FITTINGS | REFERENCED STANDARD(S) PIPE | REFERENCED STANDARD(S) FITTINGS |
|---|---|---|---|---|---|
| ABS (Schedule 40) | X | X | X | ASTM D 1527, ASTM D 2661, ASTM D 2680*, ASTM F 628 | ASTM D 2661, ASTM D 2680* |
| Asbestos-Cement | — | — | X | ASTM C 14*, ASTM C 428* | — |
| Brass | — | X | — | ASTM B 43 | — |
| Cast-Iron | X | X | X | ASTM A 74, ASTM A 888, CISPI 301 | ASME B16.12, ASTM A 74, ASTM A 888, CISPI 301 |
| Co-Extruded ABS (Schedule 40) | X | X | X | ASTM F 1488 | ASTM D 2661, ASTM D 2680* |
| Co-Extruded PVC (Schedule 40) | X | X | X | ASTM F 891, ASTM F 1488 | ASTM D 2665, ASTM F 794*, ASTM F 1866 |
| Copper (Type DWV) | X | X | X | ASTM B 75, ASTM B 251, ASTM B 302, ASTM B 306 | ASME B16.23, ASME B16.29 |
| Galvanized Malleable Iron | — | X | — | — | ASME B16.3 |
| Galvanized Steel | — | X | — | ASTM A 53 | — |
| Polyethylene | — | — | X | ASTM F 714 | ASTM D 2683, ASTM D 3261, ASTM F 1055, ASTM F 2206 |
| PVC (Schedule 40) | X | X | X | ASTM D 1785, ASTM D 2665, ASTM F 794* | ASTM D 2665, ASTM F 794*, ASTM F 1866 |
| Stainless Steel 304 | — | X | — | ASME A112.3.1 | ASME A112.3.1 |
| Stainless Steel 316L | X | X | X | ASME A112.3.1 | ASME A112.3.1 |
| Vitrified Clay (Extra strength) | — | — | X | ASTM C 700 | ASTM C 700 |

* For building sewer applications.

**TABLE 702.1**
**DRAINAGE FIXTURE UNIT VALUES (DFU)**

| PLUMBING APPLIANCES, APPURTENANCES, OR FIXTURES | MINIMUM SIZE TRAP AND TRAP ARM[7] (inches) | PRIVATE | PUBLIC | ASSEMBLY[8] |
|---|---|---|---|---|
| Bathtub or Combination Bath/Shower | 1½ | 2.0 | 2.0 | — |
| Bidet | 1¼ | 1.0 | — | — |
| Bidet | 1½ | 2.0 | — | — |
| Clothes Washer, domestic, standpipe[5] | 2 | 3.0 | 3.0 | 3.0 |
| Dental Unit, cuspidor | 1¼ | — | 1.0 | 1.0 |
| Dishwasher, domestic, with independent drain[2] | 1½ | 2.0 | 2.0 | 2.0 |
| Drinking Fountain or Water Cooler | 1¼ | 0.5 | 0.5 | 1.0 |
| Food Waste Grinder, commercial | 2 | — | 3.0 | 3.0 |
| Floor Drain, emergency | 2 | — | 0.0 | 0.0 |
| Floor Drain (for additional sizes see Section 702.0) | 2 | 2.0 | 2.0 | 2.0 |
| Shower, single-head trap | 2 | 2.0 | 2.0 | 2.0 |
| Multi-head, each additional | 2 | 1.0 | 1.0 | 1.0 |
| Lavatory, single | 1¼ | 1.0 | 1.0 | 1.0 |
| Lavatory, in sets of two or three | 1½ | 2.0 | 2.0 | 2.0 |
| Washfountain | 1½ | — | 2.0 | 2.0 |
| Washfountain | 2 | — | 3.0 | 3.0 |
| Mobile Home, trap[9] | 3 | 12.0 | — | — |
| Receptor, indirect waste[1,3] | 1½ | See footnote[1,3] | | |
| Receptor, indirect waste[1,4] | 2 | See footnote[1,4] | | |
| Receptor, indirect waste[1] | 3 | See footnote[1] | | |
| Sinks | — | — | — | — |
| Bar | 1½ | 1.0 | — | — |
| Bar[2] | 1½ | — | 2.0 | 2.0 |
| Clinical | 3 | — | 6.0 | 6.0 |
| Commercial with food waste[2] | 1½ | — | 3.0 | 3.0 |
| Special Purpose[2] | 1½ | 2.0 | 3.0 | 3.0 |
| Special Purpose | 2 | 3.0 | 4.0 | 4.0 |
| Special Purpose | 3 | — | 6.0 | 6.0 |
| Kitchen, domestic[2] (with or without food waste grinder, dishwasher, or both) | 1½ | 2.0 | 2.0 | — |
| Laundry[2] (with or without discharge from a clothes washer) | 1½ | 2.0 | 2.0 | 2.0 |
| Service or Mop Basin | 2 | — | 3.0 | 3.0 |
| Service or Mop Basin | 3 | — | 3.0 | 3.0 |
| Service, flushing rim | 3 | — | 6.0 | 6.0 |
| Wash, each set of faucets | — | — | 2.0 | 2.0 |
| Urinal, integral trap 1.0 GPF[2] | 2 | 2.0 | 2.0 | 5.0 |
| Urinal, integral trap greater than 1.0 GPF | 2 | 2.0 | 2.0 | 6.0 |
| Urinal, exposed trap[2] | 1½ | 2.0 | 2.0 | 5.0 |
| Water Closet, 1.6 GPF Gravity Tank[6] | 3 | 3.0 | 4.0 | 6.0 |
| Water Closet, 1.6 GPF Flushometer Tank[6] | 3 | 3.0 | 4.0 | 6.0 |
| Water Closet, 1.6 GPF Flushometer Valve[6] | 3 | 3.0 | 4.0 | 6.0 |
| Water Closet, greater than 1.6 GPF Gravity Tank[6] | 3 | 4.0 | 6.0 | 8.0 |
| Water Closet, greater than 1.6 GPF Flushometer Valve[6] | 3 | 4.0 | 6.0 | 8.0 |

For SI units: 1 inch = 25 mm

**Notes:**

1 Indirect waste receptors shall be sized based on the total drainage capacity of the fixtures that drain therein to, in accordance with Table 702.2(b).

2 Provide a 2 inch (50 mm) minimum drain.

3 For refrigerators, coffee urns, water stations, and similar low demands.

4 For commercial sinks, dishwashers, and similar moderate or heavy demands.

5 Buildings having a clothes-washing area with clothes washers in a battery of three or more clothes washers shall be rated at 6 fixture units each for purposes of sizing common horizontal and vertical drainage piping.

6 Water closets shall be computed as 6 fixture units where determining septic tank sizes based on Appendix H of this code.

7 Trap sizes shall not be increased to the point where the fixture discharge is capable of being inadequate to maintain their self-scouring properties.

8 Assembly [Public Use (see Table 422.1)].

9 *[HCD 2] For drainage fixture unit values related to mobilehome parks in all parts of the State of California, see California Code of Regulations, Title 25, Division 1, Chapter 2, Article 5, Section 1268. For drainage fixture unit values related to special occupancy parks in all parts of the State of California, see California Code of Regulations, Title 25, Division 1, Chapter 2.2, Article 5, Section 2268.*

TABLE 702.2(a)
MAXIMUM DRAINAGE FIXTURE UNITS FOR A TRAP AND TRAP ARM*

| SIZE OF TRAP AND TRAP ARM (inches) | DRAINAGE FIXTURE UNIT VALUES (DFU) |
|---|---|
| 1¼ | 1 unit |
| 1½ | 3 units |
| 2 | 4 units |
| 3 | 6 units |
| 4 | 8 units |

For SI Units: 1 inch = 25 mm
* **Exception:** On self-service laundries.

TABLE 702.2(b)
DISCHARGE CAPACITY IN GALLONS PER MINUTE FOR INTERMITTENT FLOW ONLY*

| GPM | FIXTURE UNITS |
|---|---|
| Up to 7½ | Equals 1 Fixture Unit |
| Greater than 7½ to 15 | Equals 2 Fixture Units |
| Greater than 15 to 30 | Equals 4 Fixture Units |
| Greater than 30 to 50 | Equals 6 Fixture Units |

For SI units: 1 gallon per minute = 0.06 L/s
* Discharge capacity exceeding 50 gallons per minute (3.15 L/s) shall be determined by the Authority Having Jurisdiction.

**703.0 Size of Drainage Piping.**

**703.1 Minimum Size.** The minimum sizes of vertical, horizontal, or both drainage piping shall be determined from the total of fixture units connected thereto, and additionally, in the case of vertical drainage pipes, in accordance with their length.

**703.2 Maximum Number of Fixture Units.** Table 703.2 shows the maximum number of fixture units allowed on a vertical or horizontal drainage pipe, building drain, or building sewer of a given size; the maximum number of fixture units allowed on a branch interval of a given size; and the maximum length (in feet and meters) of a vertical drainage pipe of a given size.

**703.3 Sizing per Appendix C.** For alternate method of sizing drainage piping, see Appendix C.

**704.0 Fixture Connections (Drainage).**

**704.1 Inlet Fittings.** Drainage piping shall be provided with approved inlet fittings for fixture connections, correctly located according to the size and type of fixture proposed to be connected.

**704.2 Single Vertical Drainage Pipe.** Two fixtures set back-to-back, or side-by-side, within the distance allowed between a trap and its vent shall be permitted to be served by a single vertical drainage pipe provided that each fixture wastes separately into an approved double-fixture fitting having inlet openings at the same level.

**704.3 Commercial Dishwashing Machines and Sinks.** Pot sinks, scullery sinks, dishwashing sinks, silverware sinks, commercial dishwashing machines, silverware-washing machines, and other similar fixtures shall be connected directly to the drainage system. A floor drain shall be provided adjacent to the fixture, and the fixture shall be connected on the sewer side of the floor drain trap, provided that no other drainage line is connected between the floor drain waste connection and the fixture drain. The fixture and floor drain shall be trapped and vented in accordance with this code.

**705.0 Joints and Connections.**

**705.1 ABS and ABS Co-Extruded Plastic Pipe and Joints.** Joining methods for ABS plastic pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 705.1.1 through Section 705.1.3.

**705.1.1 Mechanical Joints.** Mechanical joints shall be designed to provide a permanent seal and shall be of the mechanical or push-on joint. The push-on joint shall include an elastomeric gasket in accordance with ASTM D 3212 and shall provide a compressive force against the spigot and socket after assembly to provide a permanent seal.

**705.1.2 Solvent Cement Joints.** Solvent cement joints for ABS pipe and fittings shall be clean from dirt and moisture. Pipe shall be cut square and shall be deburred. Where surfaces to be joined are cleaned and free of dirt, moisture, oil, and other foreign material, solvent cement in accordance with ASTM D 2235 shall be applied to all joint surfaces. Joints shall be made while both the inside socket surface and outside surface of pipe are wet with solvent cement. Hold joint in place and undisturbed for 1 minute after assembly.

**705.1.3 Threaded Joints.** Threads shall comply with ASME B1.20.1. A minimum of Schedule 80 shall be permitted to be threaded. Molded threads on adapter fittings for transition to threaded joints shall be permitted. Thread sealant compound shall be applied to male threads, insoluble in water, and nontoxic. The joint between the pipe and transition fitting shall be of the solvent cement type. Caution shall be used during assembly to prevent over tightening of the ABS components once the thread sealant compound has been applied.

**705.2 Asbestos-Cement Pipe and Joints.** Joining methods for asbestos-cement pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 705.2.1.

**705.2.1 Mechanical Joints.** Mechanical joints shall be of the same composition as the pipe and sealed with an approved elastomeric gasket or joined by a listed compression type coupling. Elastomeric gaskets shall comply with ASTM D 1869. The coupling grooves, pipe ends, and elastomeric gaskets shall be cleaned. Elastomeric gaskets shall be positioned in the grooves. Lubricant recommended by the manufacturer shall be applied to the machined end of the pipe. Lubricant shall not be applied to the elastomeric gasket or groove, unless specifically recommended by the manufacturer.

TABLE 703.2
MAXIMUM UNIT LOADING AND MAXIMUM LENGTH OF DRAINAGE AND VENT PIPING

| SIZE OF PIPE (inches) | 1¼ | 1½ | 2 | 2½ | 3 | 4 | 5 | 6 | 8 | 10 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Maximum Units** | | | | | | | | | | | |
| Drainage Piping[1] | | | | | | | | | | | |
| Vertical | 1 | 2[2] | 16[3] | 32[3] | 48[4] | 256 | 600 | 1380 | 3600 | 5600 | 8400 |
| Horizontal | 1 | 1 | 8[3] | 14[3] | 35[4] | 216[5] | 428[5] | 720[5] | 2640[5] | 4680[5] | 8200[5] |
| **Maximum Length** | | | | | | | | | | | |
| Drainage Piping | | | | | | | | | | — | — |
| Vertical, (feet) | 45 | 65 | 85 | 148 | 212 | 300 | 390 | 510 | 750 | | |
| Horizontal (unlimited) | | | | | | | | | | | |
| **Vent Piping** | | | | | | | | | | | |
| Horizontal and Vertical[6] | | | | | | | | | | — | — |
| Maximum Units | 1 | 8[3] | 24 | 48 | 84 | 256 | 600 | 1380 | 3600 | | |
| Maximum Lengths, (feet) | 45 | 60 | 120 | 180 | 212 | 300 | 390 | 510 | 750 | | |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm

**Notes:**

1. Excluding trap arm.
2. Except sinks, urinals, and dishwashers – exceeding 1 fixture unit.
3. Except six-unit traps or water closets.
4. Only four water closets or six-unit traps allowed on a vertical pipe or stack; and not to exceed three water closets or six-unit traps on a horizontal branch or drain.
5. Based on ¼ inch per foot (20.8 mm/m) slope. For ⅛ of an inch per foot (10.4 mm/m) slope, multiply horizontal fixture units by a factor of 0.8.
6. The diameter of an individual vent shall be not less than 1¼ inches (32 mm) nor less than one-half the diameter of the drain to which it is connected. Fixture unit load values for drainage and vent piping shall be computed from Table 702.1 and Table 702.2(b). Not to exceed one-third of the total permitted length of a vent shall be permitted to be installed in a horizontal position. Where vents are increased one pipe size for their entire length, the maximum length limitations specified in this table do not apply. This table is in accordance with the requirements of Section 901.2.

**705.3 Brass Pipe and Joints.** Joining methods for brass pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 705.3.1 through Section 705.3.3.

**705.3.1 Brazed Joints.** Brazed joints between brass pipe and fittings shall be made with brazing alloys having a liquid temperature above 1000°F (538°C). The joint surfaces to be brazed shall be cleaned bright by either manual or mechanical means. Pipe shall be cut square and reamed to full inside diameter. Brazing flux shall be applied to the joint surfaces where required by manufacturer's recommendation. Brazing filler metal in accordance with AWS A5.8 shall be applied at the point where the pipe or tubing enters the socket of the fitting.

**705.3.2 Mechanical Joints.** Mechanical joints shall be of the compression type using an elastomeric gasket to form a seal.

**705.3.3 Threaded Joints.** Threaded joints shall be made with pipe threads in accordance with ASME B1.20.1. Thread sealant tape or compound shall be applied only on male threads, and such material shall be of approved types, insoluble in water, and nontoxic.

**705.4 Cast-Iron Pipe and Joints.** Joining methods for cast-iron pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 705.4.1 and Section 705.4.2.

**705.4.1 Caulked Joints.** Caulked joints shall be firmly packed with oakum or hemp and filled with molten lead to a depth of not less than 1 inch (25.4 mm) in one continuous pour. The lead shall be caulked thoroughly at the inside and outside edges of the joint. After caulking, the finished joint shall not exceed ⅛ of an 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.

**705.4.2 Mechanical Joints.** Mechanical joints for cast-iron pipe and fittings shall be of the compression or mechanical joint coupling type. Compression type joints with an elastomeric gasket for cast-iron hub and spigot pipe shall comply with ASTM C 564. Hub and spigot shall be clean and free of dirt, mud, sand, and foreign materials. Cut pipe shall be free from sharp edges. Fold and insert gasket into hub. Lubricate the joint following manufacturer's instructions. Insert spigot into hub until the spigot end of the pipe bottom out in the hub. Use the same procedure for the installation of fittings.

A mechanical joint shielded coupling type for hubless cast-iron pipe and fittings shall have a metallic shield where installed aboveground, and shall comply with ASTM A 1056, ASTM C 1277, ASTM C 1540, or CISPI 310. The elastomeric gasket shall comply with ASTM C 564. Hubless cast-iron pipe and fittings shall be clean and free of dirt, mud, sand, and foreign materials. Cut pipe shall be free from sharp edges. Gasket shall be placed on the end of the pipe or fitting and the stainless steel shield and clamp assembly on the end of the other pipe or fitting. Pipe or fittings shall be seated against the center stop inside the elastomeric sleeve. Slide the stainless steel shield and clamp

assembly into position centered over the gasket and tighten. Bands shall be tightened using an approved calibrated torque wrench specifically set by the manufacturer of the couplings.

**705.5 Copper Pipe (DWV) and Joints.** Joining methods for copper pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 705.5.1 through Section 705.5.4.

**705.5.1 Brazed Joints.** Brazed joints between copper pipe and fittings shall be made with brazing alloys having a liquid temperature above 1000°F (538°C). The joint surfaces to be brazed shall be cleaned bright by either manual or mechanical means. Piping shall be cut square and reamed to full inside diameter. Brazing flux shall be applied to the joint surfaces where required by manufacturer's recommendation. Brazing filler metal in accordance with AWS A5.8 shall be applied at the point where the pipe or tubing enters the socket of the fitting.

**705.5.2 Mechanical Joints.** Mechanical joints in copper piping shall be made with a mechanical coupling with grooved end piping or approved joint designed for the specific application.

**705.5.3 Soldered Joints.** Soldered joints between copper pipe and fittings shall be made in accordance with ASTM B 828 with the following sequence of joint preparation and operation as follows: measuring and cutting, reaming, cleaning, fluxing, assembly and support, heating, applying the solder, cooling, and cleaning. Pipe shall be cut square and reamed to the full inside diameter including the removal of burrs on the outside of the pipe. Surfaces to be joined shall be cleaned bright by manual or mechanical means. Flux shall be applied to pipe and fittings and shall be in accordance with ASTM B 813, and shall become noncorrosive and nontoxic after soldering. Insert pipe into the base of the fitting and remove excess flux. Pipe and fitting shall be supported to ensure a uniform capillary space around the joint. Heat shall be applied using an air or fuel torch with the flame perpendicular to the pipe using acetylene or an LP gas. Preheating shall depend on the size of the joint. The flame shall be moved to the fitting cup and alternate between the pipe and fitting. Solder in accordance with ASTM B 32 shall be applied to the joint surfaces until capillary action draws the molten solder into the cup. Joint surfaces shall not be disturbed until cool and any remaining flux residue shall be cleaned.

**705.5.4 Threaded Joints.** Threaded joints for copper pipe shall be made with pipe threads in accordance with ASME B1.20.1. Thread sealant tape or compound shall be applied only on male threads, and such material shall be approved types, insoluble in water, and nontoxic.

**705.6 Galvanized Steel Pipe and Joints.** Joining methods for galvanized steel pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 705.6.1 and Section 705.6.2.

**705.6.1 Mechanical Joints.** Mechanical joints shall be made with an elastomeric gasket.

**705.6.2 Threaded Joints.** Threaded joints shall be made with pipe threads in accordance with ASME B1.20.1. Thread sealant tape or compound shall be applied only on male threads, and such material shall be of approved types, insoluble in water, and nontoxic.

**705.7 PVC and PVC Co-Extruded Plastic Pipe and Joining Methods.** Joining methods for PVC plastic pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 705.7.1 through Section 705.7.3.

**705.7.1 Mechanical Joints.** Mechanical joints shall be designed to provide a permanent seal and shall be of the mechanical or push-on joint type. The push-on joint shall include an elastomeric gasket in accordance with ASTM D 3212 and shall provide a compressive force against the spigot and socket after assembly to provide a permanent seal.

**705.7.2 Solvent Cement Joints.** Solvent cement joints for PVC pipe and fittings shall be clean from dirt and moisture. Pipe shall be cut square and pipe shall be deburred. Where surfaces to be joined are cleaned and free of dirt, moisture, oil, and other foreign material, apply primer purple in color in accordance with ASTM F 656. Primer shall be applied until the surface of the pipe and fitting is softened. Solvent cements in accordance with ASTM D 2564 shall be applied to all joint surfaces. Joints shall be made while both the inside socket surface and outside surface of pipe are wet with solvent cement. Hold joint in place and undisturbed for 1 minute after assembly.

**705.7.3 Threaded Joints.** Threads shall comply with ASME B1.20.1. A minimum of Schedule 80 shall be permitted to be threaded. Molded threads on adapter fittings for transition to threaded joints shall be permitted. Thread sealant compound that is compatible with the pipe and fitting, insoluble in water, and nontoxic shall be applied to male threads. The joint between the pipe and transition fitting shall be of the solvent cement type. Caution shall be used during assembly to prevent over tightening of the PVC components once the thread sealant has been applied. Female PVC threaded fittings shall be used with plastic male threads only.

**705.8 Stainless Steel Pipe and Joints.** Joining methods for stainless steel pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 705.8.1 and Section 705.8.2.

**705.8.1 Mechanical Joints.** Mechanical joints between stainless steel pipe and fittings shall be of the compression, grooved coupling, hydraulic pressed fittings, or flanged.

**705.8.2 Welded Joints.** Welded joints between stainless steel pipe and fittings shall comply with ASME A112.3.1 and shall be welded autogenously. Pipe shall be cleaned, free of scale and contaminating particles. Pipe shall be cut with a combination cutting and

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beveling tool that provides a square cut, and free of burrs. Mineral oil lubricant shall be used during the cutting and beveling process.

**705.9 Vitrified Clay Pipe and Joints.** Joining methods for vitrified clay pipe and fittings shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 705.9.1.

**705.9.1 Mechanical Joints.** Mechanical joints shall be designed to provide a permanent seal and shall be of the mechanical or push-on joint type. The push-on joint shall include an elastomeric gasket in accordance with ASTM C 425 and shall provide a compressive force against the spigot and socket after assembly to provide a permanent seal.

**705.10 Special Joints.**

**705.10.1 Slip Joints.** In fixture drains and traps, slip joints of approved materials shall be permitted to be used in accordance with their approvals.

**705.10.2 Expansion Joints.** Expansion joints shall be accessible, except where in vent piping or drainage stacks, and shall be permitted to be used where necessary to provide for expansion and contraction of the pipes.

**705.10.3 Ground Joint, Flared, or Ferrule Connections.** Brass or copper ground joint, flared, or ferrule-type connections that allow adjustment of tubing, but provide a rigid joint where made up, shall not be considered as slip joints.

**705.10.4 Transition Joint.** A solvent cement transition joint between ABS and PVC building drain and building sewer shall be made using listed transition solvent cement. *[HCD 1 & HCD 2] Plastic pipe and fittings joined with solvent cement shall utilize Low VOC primer(s), if a primer is required, and Low VOC solvent cement(s) as defined in Section 214.0.*

**705.11 Joints Between Various Materials.** Joints between various materials shall be installed in accordance with the manufacturer's installation instructions and shall comply with Section 705.11.1 through Section 705.11.4.

**705.11.1 Copper Pipe to Cast-Iron Pipe.** Joints from copper pipe or tubing to cast-iron pipe shall be made with a listed compression type joint or brass ferrule. The copper pipe or tubing shall be soldered or brazed to the ferrule and the ferrule shall be joined to the cast-iron hub by a compression or caulked joint.

**705.11.2 Copper Pipe to Threaded Pipe Joints.** Joints from copper pipe or tubing to threaded pipe shall be made by the use of a listed brass adapter or dielectric fitting. The joint between the copper pipe and the fitting shall be a soldered or brazed, and the connection between the threaded and the fittings shall be made with a standard pipe size threaded joint.

**705.11.3 Plastic Pipe to Other Materials.** Where connecting plastic pipe to other types of plastic or other types of piping material; approved listed adapter or transition fittings and listed for the specific transition intended shall be used.

**705.11.4 Stainless Steel Pipe to Other Materials.** Where connecting stainless steel pipe to other types of piping, listed mechanical joints of the compression type and listed for the specific transition intended shall be used.

**706.0 Changes in Direction of Drainage Flow.**

**706.1 Approved Fittings.** Changes in direction of drainage piping shall be made by the appropriate use of approved fittings and shall be of the angles presented by a one-sixteenth bend, one-eighth bend, or one-sixth bend, or other approved fittings of equivalent sweep.

**706.2 Horizontal to Vertical.** Horizontal drainage lines, connecting with a vertical stack, shall enter through 45 degree (0.79 rad) wye branches, 60 degree (1.05 rad) wye branches, combination wye and one-eighth bend branches, sanitary tee or sanitary tapped tee branches, or other approved fittings of equivalent sweep. No fitting having more than one inlet at the same level shall be used unless such fitting is constructed so that the discharge from one inlet cannot readily enter any other inlet. Double sanitary tees shall be permitted to be used where the barrel of the fitting is not less than two pipe sizes larger than the largest inlet, (pipe sizes recognized for this purpose are 2 inches, 2½ inches, 3 inches, 3½ inches, 4 inches, 4½ inches, 5 inches, 6 inches, etc.) (50, 65, 80, 90, 100, 115, 125, 150 mm, etc.).

**706.3 Horizontal to Horizontal.** Horizontal drainage lines connecting with other horizontal drainage lines shall enter through 45 degree (0.79 rad) wye branches, combination wye and one-eighth bend branches, or other approved fittings of equivalent sweep.

**706.4 Vertical to Horizontal.** Vertical drainage lines connecting with horizontal drainage lines shall enter through 45 degree (0.79 rad) wye branches, combination wye and one-eighth bend branches, or other approved fittings of equivalent sweep. Branches or offsets of 60 degrees (1.05 rad) shall be permitted to be used where installed in a true vertical position.

**707.0 Cleanouts.**

**707.1 Plug.** Each cleanout fitting for cast-iron pipe shall consist of a cast-iron or brass body and an approved plug. Each cleanout for galvanized wrought-iron, galvanized steel, copper, or brass pipe shall consist of a brass plug as specified in Table 707.1, or a standard weight brass cap, or an approved ABS or PVC plastic plug, or an approved stainless steel cleanout or plug. Plugs shall have raised square heads or approved countersunk rectangular slots.

**707.2 Approved.** Each cleanout fitting and each cleanout plug or cap shall be of an approved type.

**707.3 Gas and Watertight.** Cleanouts shall be designed to be gas- and watertight.

**707.4 Location.** Each horizontal drainage pipe shall be provided with a cleanout at its upper terminal, and each run of piping, that is more than 100 feet (30 480 mm) in total developed length, shall be provided with a cleanout for

**TABLE 707.1**
**CLEANOUTS**

| SIZE OF PIPE (inches) | SIZE OF CLEANOUT (inches) | THREADS (per inches) |
|---|---|---|
| 1½ | 1½ | 11½ |
| 2 | 1½ | 11½ |
| 2½ | 2½ | 8 |
| 3 | 2½ | 8 |
| 4 & larger | 3½ | 8 |

For SI units: 1 inch = 25 mm

each 100 feet (30 480 mm), or fraction thereof, in length of such piping. An additional cleanout shall be provided in a drainage line for each aggregate horizontal change of direction exceeding 135 degrees (2.36 rad).

**Exceptions:**

(1) Cleanouts shall be permitted to be omitted on a horizontal drain line less than 5 feet (1524 mm) in length unless such line is serving sinks or urinals.

(2) Cleanouts shall be permitted to be omitted on a horizontal drainage pipe installed on a slope of 72 degrees (1.26 rad) or less from the vertical angle (one-fifth bend).

(3) Excepting the building drain and its horizontal branches, a cleanout shall not be required on a pipe or piping that is above the floor level of the lowest floor of the building.

(4) An approved type of two-way cleanout fitting, installed inside the building wall near the connection between the building drain and the building sewer or installed outside of a building at the lower end of a building drain and extended to grade, shall be permitted to be substituted for an upper terminal cleanout.

**707.5 Cleaning.** Each cleanout shall be installed so that it opens to allow cleaning in the direction of flow of the soil or waste or at right angles thereto and, except in the case of wye branch and end-of-line cleanouts, shall be installed vertically above the flow line of the pipe.

**707.6 Extension.** Each cleanout extension shall be considered as drainage piping and each 90 degree (1.57 rad) cleanout extension shall be extended from a wye-type fitting or other approved fitting of equivalent sweep.

**707.7 Interceptor.** Each cleanout for an interceptor shall be outside of such interceptor.

**707.8 Access.** Each cleanout, unless installed under an approved cover plate, shall be above grade, readily accessible, and so located as to serve the purpose for which it is intended. Cleanouts located under cover plates shall be so installed as to provide the clearances and accessibility required by this section.

**707.9 Clearance.** Each cleanout in piping 2 inches (50 mm) or less in size shall be so installed that there is a clearance of not less than 12 inches (305 mm) in front of the cleanout. Cleanouts in piping exceeding 2 inches (50 mm) shall have a clearance of not less than 18 inches (457 mm) in front of the cleanout. Cleanouts in under-floor piping shall be extended to or above the finished floor or shall be extended outside the building where there is less than 18 inches (457 mm) vertical overall, allowing for obstructions such as ducts, beams, and piping, and 30 inches of (762 mm) horizontal clearance from the means of access to such cleanout. No under-floor cleanout shall be located exceeding 20 feet (6096 mm) from an access door, trap door, or crawl hole.

**707.10 Fittings.** Cleanout fittings shall be not less in size than those given in Table 707.1.

**707.11 Pressure Drainage Systems.** Cleanouts shall be provided for pressure drainage systems as classified under Section 710.7.

**707.12 Countersunk Cleanout Plugs.** Countersunk cleanout plugs shall be installed where raised heads cause a hazard.

**707.13 Hubless Blind Plugs.** Where a hubless blind plug is used for a required cleanout, the complete coupling and plug shall be accessible for removal or replacement.

**707.14 Trap Arms.** Cleanouts for trap arms shall be installed in accordance with Section 1002.3.

### 708.0 Grade of Horizontal Drainage Piping.

**708.1 General.** Horizontal drainage piping shall be run in practical alignment and a uniform slope of not less than ¼ inch per foot (20.8 mm/m) or 2 percent toward the point of disposal provided that, where it is impractical due to the depth of the street sewer, to the structural features, or to the arrangement of a building or structure to obtain a slope of ¼ inch per foot (20.8 mm/m) or 2 percent, such pipe or piping 4 inches (100 mm) or larger in diameter shall be permitted to have a slope of not less than ⅛ inch per foot (10.4 mm/m) or 1 percent, where first approved by the Authority Having Jurisdiction.

### 709.0 Gravity Drainage Required.

**709.1 General.** Where practicable, plumbing fixtures shall be drained to the public sewer or private sewage disposal system by gravity.

### 710.0 Drainage of Fixtures Located Below the Next Upstream Manhole or Below the Main Sewer Level.

**710.1 Backflow Protection.** Fixtures installed on a floor level that is lower than the next upstream manhole cover of the public or private sewer shall be protected from backflow of sewage by installing an approved type of backwater valve. Fixtures on such floor level that are not below the next upstream manhole cover shall not be required to be protected by a backwater valve. Fixtures on floor levels above such elevation shall not discharge through the backwater valve. Cleanouts for drains that pass through a backwater valve shall be clearly identified with a permanent label stating "backwater valve downstream".

**710.2 Sewage Discharge.** Drainage piping serving fixtures that are located below the crown level of the main sewer

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shall discharge into an approved watertight sump or receiving tank, so located as to receive the sewage or wastes by gravity. From such sump or receiving tank, the sewage or other liquid wastes shall be lifted and discharged into the building drain or building sewer by approved ejectors, pumps, or other equally efficient approved mechanical devices.

**710.3 Sewage Ejector and Pumps.** A sewage ejector or sewage pump receiving the discharge of water closets or urinals:

(1) Shall have a discharge capacity of not less than 20 gpm (1.26 L/s).

(2) In single dwelling units, the ejector or pump shall be capable of passing a 1½ inch (38 mm) diameter solid ball, and the discharge piping of each ejector or pump shall have a backwater valve and gate valve, and be not less than 2 inches (50 mm) in diameter.

(3) In other than single-dwelling units, the ejector or pump shall be capable of passing a 2 inch (51 mm) diameter solid ball, and the discharge piping of each ejector or pump shall have a backwater valve and gate valve, and be not less than 3 inches (80 mm) in diameter.

*710.3.1 [HCD 1 & HCD 2] The minimum size of any pump or any discharge pipe from a sump having a water closet connected thereto shall be not less than (2) inches (50 mm).*

**710.4 Discharge Line.** The discharge line from such ejector, pump, or other mechanical device shall be provided with an accessible backwater or swing check valve and gate or ball valve. Where the gravity drainage line to which such discharge line connects is horizontal, the method of connection shall be from the top through a wye branch fitting. The gate or ball valve shall be located on the discharge side of the backwater or check valve.

Gate or ball valves, where installed in drainage piping, shall be fullway type with working parts of corrosion-resistant metal. Sizes 4 inches (100 mm) or more in diameter shall have cast-iron bodies, and sizes less than 4 inches (100 mm), cast-iron or brass bodies.

**710.5 Size of Building Drains and Sewers.** Building drains or building sewers receiving discharge from a pump or ejector shall be adequately sized to prevent overloading. Two fixture units shall be allowed for each gallon per minute (0.06 L/s) of flow.

**710.6 Backwater Valves.** Backwater valves, gate valves, fullway ball valves, unions, motors, compressors, air tanks, and other mechanical devices required by this section shall be located where they will be accessible for inspection and repair and, unless continuously exposed, shall be enclosed in a masonry pit fitted with an adequately sized removable cover.

Backwater valves shall have bodies of cast-iron, plastic, brass, or other approved materials; shall have noncorrosive bearings, seats, and self-aligning discs; and shall be constructed so as to ensure a positive mechanical seal. Such backwater valves shall remain open during periods of low flows to avoid screening of solids and shall not restrict capacities or cause excessive turbulence during peak loads. Unless otherwise listed, valve access covers shall be bolted type with gasket, and each valve shall bear the manufacturer's name cast into the body and the cover.

**710.7 Drainage and Venting Systems.** The drainage and venting systems, in connection with fixtures, sumps, receiving tanks, and mechanical waste-lifting devices, shall be installed under the same requirements as provided for in this code for gravity systems.

**710.8 Sump and Receiving Tank Construction.** Sumps and receiving tanks shall be watertight and shall be constructed of concrete, metal, or other approved materials. Where constructed of poured concrete, the walls and bottom shall be adequately reinforced and designed to recognized acceptable standards. Metal sumps or tanks shall be of such thickness as to serve their intended purpose and shall be treated internally and externally to resist corrosion.

**710.9 Alarm.** Such sumps and receiving tanks shall be automatically discharged and, where in a "public use" occupancy, shall be provided with dual pumps or ejectors arranged to function alternately in normal use and independently in case of overload or mechanical failure. The pumps shall have an audio and visual alarm, readily accessible, that signals pump failure or an overload condition. The lowest inlet shall have a clearance of not less than 2 inches (51 mm) from the high-water or "starting" level of the sump.

**710.10 Sump and Receiving Tank Covers and Vents.** Sumps and receiving tanks shall be provided with substantial covers having a bolt-and-gasket- type manhole or equivalent opening to permit access for inspection, repairs, and cleaning. The top shall be provided with a vent pipe that shall extend separately through the roof or, where permitted, be combined with other vent pipes. Such vent shall be large enough to maintain atmospheric pressure within the sump under normal operating conditions and, in no case, shall be less in size than that required by Table 703.2 for the number and type of fixtures discharging into the sump, nor less than 1½ inches (40 mm) in diameter. Where the foregoing requirements are met and the vent, after leaving the sump, is combined with vents from fixtures discharging into the sump, the size of the combined vent need not exceed that required for the total number of fixtures discharging into the sump. No vent from an air-operating sewage ejector shall combine with other vents.

**710.11 Air Tanks.** Air tanks shall be so proportioned as to be of equal cubical capacity to the ejectors connected therewith in which there shall be maintained an air pressure of not less than 2 pounds per foot (lb/ft) (3 kg/m) of height the sewage is to be raised. No water-operated ejectors shall be permitted.

**710.12 Grinder Pump Ejector.** Grinder pumps shall be permitted to be used.

**710.12.1 Discharge Piping.** The discharge piping shall be sized in accordance with the manufacturer's installation instructions and shall be not less than 1¼ inches (32 mm) in diameter. A check valve and fullway-type shutoff valve shall be located within the discharge line.

**710.13 Macerating Toilet Systems.** Listed macerating toilet systems shall be permitted as an alternate to a sewage pump system where approved by the Authority Having Jurisdiction.

**710.13.1 Sumps.** The sump shall be water- and gastight.

**710.13.2 Discharge Piping.** The discharge piping shall be sized in accordance with manufacturer's instructions and shall be not less than ¾ of an inch (20 mm) in diameter. The developed length of the discharge piping shall not exceed the manufacturer's instructions. A check valve and fullway-type shutoff valve shall be located within the discharge line or internally within the device.

**710.13.3 Venting.** The plumbing fixtures that discharge into the macerating device shall be vented in accordance with this code. The sump shall be vented in accordance with the manufacturer's instructions and such vent shall be permitted to connect to the fixture venting.

**711.0 Suds Relief.**

**711.1 General.** Drainage connections shall not be made into a drainage piping system within 8 feet (2438 mm) of a vertical to horizontal change of direction of a stack containing suds-producing fixtures. Bathtubs, laundries, washing machine standpipes, kitchen sinks, and dishwashers shall be considered suds-producing fixtures. Where parallel vent stacks are required, they shall connect to the drainage stack at a point 8 feet (2438 mm) above the lowest point of the drainage stack.

**Exceptions:**

(1) Single-family residences

(2) Stacks receiving the discharge from less than three stories of plumbing fixtures

**712.0 Testing.**

**712.1 Media.** The piping of the plumbing, drainage, and venting systems shall be tested with water or air except that plastic pipe shall not be tested with air. The Authority Having Jurisdiction shall be permitted to require the removal of cleanouts, etc., to ascertain whether the pressure has reached all parts of the system. After the plumbing fixtures have been set and their traps filled with water, they shall be submitted to a final test.

**712.2 Water Test.** The water test shall be applied to the drainage and vent systems either in its entirety or in sections. Where the test is applied to the entire system, openings in the piping shall be tightly closed, except the highest opening, and the system filled with water to point of overflow. Where the system is tested in sections, each opening shall be tightly plugged, except the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than a 10 foot (3048 mm) head of water. In testing successive sections, not less than the upper 10 feet (3048 mm) of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost 10 feet (3048 mm) of the system) shall have been submitted to a test of less than a 10 foot (3048 mm) head of water. The water shall be kept in the system, or in the portion under test, for not less than 15 minutes before inspection starts. The system shall then be tight at points.

**712.3 Air Test.** The air test shall be made by attaching an air compressor testing apparatus to a suitable opening and, after closing all other inlets and outlets to the system, forcing air into the system until there is a uniform gauge pressure of 5 pounds-force per square inch (psi) (34 kPa) or sufficient to balance a column of mercury 10 inches (34 kPa) in height. The pressure shall be held without introduction of additional air for a period of not less than 15 minutes.

## Part II – Building Sewers.

**713.0 Sewer Required.**

**713.1 Where Required.** A building in which plumbing fixtures are installed and premises having drainage piping thereon shall have a connection to a public or private sewer, except as provided in Section 101.8, Section 713.2, and Section 713.4.

**713.2 Private Sewage Disposal System.** Where no public sewer intended to serve a lot or premises is available in a thoroughfare or right of way abutting such lot or premises, drainage piping from a building or works shall be connected to an approved private sewage disposal system.

**713.3 Public Sewer.** Within the limits prescribed by Section 713.4 hereof, the rearrangement or subdivision into smaller parcels of a lot that abuts and is served by a public sewer shall not be deemed cause to permit the construction of a private sewage disposal system, and plumbing or drainage systems on a smaller parcel or parcels shall connect to the public sewer.

**713.4 Public Sewer Availability.** The public sewer shall be permitted to be considered as not being available where such public sewer or a building or an exterior drainage facility connected thereto is located more than 200 feet (60 960 mm) from a proposed building or exterior drainage facility on a lot or premises that abuts and is served by such public sewer.

*[HCD 1] For residential occupancies, the public sewer may be considered as not being available by the Authority Having Jurisdiction.*

**713.5 Permit.** No permit shall be issued for the installation, alteration, or repair of a private sewage disposal system, or part thereof, on a lot for which a connection with a public sewer is available.

**713.6 Lot.** On every lot or premises hereafter connected to a public sewer, plumbing and drainage systems or parts thereof on such lot or premises shall be connected with such public sewer.

**713.7 Installation.** In cities, counties, or both where the installation of building sewers is under the jurisdiction of a department other than the Authority Having Jurisdiction,

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the provisions of this code relating to building sewers need not apply.

**Exception:** Single-family dwellings and buildings or structures accessory thereto, existing and connected to an approved private sewage disposal system prior to the time of connecting the premises to the public sewer shall be permitted, where no hazard, nuisance, or insanitary condition is evidenced and written permission has been obtained from the Authority Having Jurisdiction, remain connected to such properly maintained private sewage disposal system where there is insufficient grade or fall to permit drainage to the sewer by gravity.

### 714.0 Damage to Public Sewer or Private Sewage Disposal System.

**714.1 Unlawful Practices.** It shall be unlawful for a person to deposit, by means whatsoever, into a plumbing fixture, floor drain, interceptor, sump, receptor, or device which is connected to a drainage system, public sewer, private sewer, septic tank, or cesspool, ashes; cinders; solids; rags; flammable, poisonous, or explosive liquids or gases; oils; grease; and whatsoever that is capable of causing damage to the public sewer, private sewer, or private sewage disposal system.

**714.2 Prohibited Water Discharge.** No rain, surface, or subsurface water shall be connected to or discharged into a drainage system, unless first approved by the Authority Having Jurisdiction.

**714.3 Prohibited Sewer Connection.** No cesspool, septic tank, seepage pit, or drain field shall be connected to a public sewer or to a building sewer leading to such public sewer.

**714.4 Commercial Food Waste Grinder.** The Authority Having Jurisdiction shall review before approval, the installation of a commercial food waste grinder connecting to a private sewage disposal system.

**714.5 Tanks.** An approved-type, watertight sewage or wastewater holding tank, the contents of which, due to their character, shall be periodically removed and disposed of at some approved off-site location, shall be installed where required by the Authority Having Jurisdiction or the Health Officer to prevent anticipated surface or subsurface contamination or pollution, damage to the public sewer, or other hazardous or nuisance conditions.

### 715.0 Building Sewer Materials.

**715.1 Materials.** The building sewer, beginning 2 feet (610 mm) from a building or structure, shall be of such materials as prescribed in this code.

**715.2 Joining Methods and Materials.** Joining methods and materials shall be as prescribed in this code.

**715.3 Existing Sewers.** Replacement of existing building sewer and building storm sewers using trenchless methodology and materials shall be installed in accordance with ASTM F 1216.

### 716.0 Markings.

**716.1 General.** Pipe, brick, block, prefabricated septic tanks, prefabricated septic tank or seepage pit covers, or other parts or appurtenances incidental to the installation of building sewers or private sewage disposal systems shall be in accordance with the approval requirements of Chapter 3 of this code.

### 717.0 Size of Building Sewers.

**717.1 General.** The minimum size of a building sewer shall be determined on the basis of the total number of fixture units drained by such sewer, in accordance with Table 717.1. No building sewer shall be smaller than the building drain.

For alternate methods of sizing building sewers, see Appendix C.

*717.2 [AGR] Meat and Poultry Processing Plants. The sewer system shall have the capacity to remove all waste from the various processing and cleaning operations and to minimize or prevent stoppage and surcharging at the system.*

**TABLE 717.1**
**MAXIMUM/MINIMUM FIXTURE UNIT LOADING ON BUILDING SEWER PIPING***

| SIZE OF PIPE (inches) | SLOPE, (inches per foot) | | |
|---|---|---|---|
| | 1/16 | 1/8 | 1/4 |
| 6 and smaller | (As specified in Table 703.2/ No minimum loading) | | |
| 8 | 1950/1500 | 2800/625 | 3900/275 |
| 10 | 3400/1600 | 4900/675 | 6800/300 |
| 12 | 5600/1700 | 8000/725 | 11 200/325 |

For SI units: 1 inch = 25 mm, 1 inch per foot = 83.3 mm/m

* See also Appendix H, Private Sewage Disposal Systems. For alternate methods of sizing drainage piping, see Appendix C.

### 718.0 Grade, Support, and Protection of Building Sewers.

**718.1 Slope.** Building sewers shall be run in practical alignment and at a uniform slope of not less than ¼ inch per foot (20.8 mm/m) toward the point of disposal.

**Exception:** Where approved by the Authority Having Jurisdiction and where it is impractical, due to the depth of the street sewer or to the structural features or to the arrangement of a building or structure, to obtain a slope of ¼ inch per foot (20.8 mm/m), such pipe or piping 4 inches (100 mm) through 6 inches (150 mm) shall be permitted to have a slope of not less than ⅛ inch per foot (10.4 mm/m) and such piping 8 inches (200 mm) and larger shall be permitted to have a slope of not less than 1/16 inch per foot (5.2 mm/m).

**718.2 Support.** Building sewer piping shall be laid on a firm bed throughout its entire length, and such piping laid in made or filled-in ground shall be laid on a bed of

approved materials and shall be properly supported as required by the Authority Having Jurisdiction.

**718.3 Protection from Damage.** No building sewer or other drainage piping or part thereof, which is constructed of materials other than those approved for use under or within a building, shall be installed under or within 2 feet (610 mm) of a building or structure, or part thereof, nor less than 1 foot (305 mm) below the surface of the ground. The provisions of this subsection include structures such as porches and steps, whether covered or uncovered; breezeways; roofed porte cocheres; roofed patios; carports; covered walks; covered driveways; and similar structures or appurtenances.

**719.0 Cleanouts.**

**719.1 Locations.** Cleanouts shall be placed inside the building near the connection between the building drain and the building sewer or installed outside the building at the lower end of the building drain and extended to grade.

Additional building sewer cleanouts shall be installed at intervals not to exceed 100 feet (30 480 mm) in straight runs and for each aggregate horizontal change in direction exceeding 135 degrees (2.36 rad).

**719.2 No Additional Cleanouts.** Where a building sewer or a branch thereof does not exceed 10 feet (3048 mm) in length and is a straight-line projection from a building drain that is provided with a cleanout, no cleanout will be required at its point of connection to the building drain.

**719.3 Building Sewer Cleanouts.** Required building sewer cleanouts shall be extended to grade and shall be in accordance with the appropriate sections of Cleanouts, Section 707.0, for sizing, construction, and materials. Where building sewers are located under buildings, the cleanout requirements of Section 707.0 shall apply.

**719.4 Cleaning.** Each cleanout shall be installed so that it opens to allow cleaning in the direction of flow of the soil or waste or at right angles thereto and, except in the case of wye branch and end-of-line cleanouts, shall be installed vertically above the flow line of the pipe.

**719.5 Access.** Cleanouts installed under concrete or asphalt paving shall be made accessible by yard boxes or by extending flush with paving with approved materials and shall be adequately protected.

**719.6 Manholes.** Approved manholes shall be permitted to be installed in lieu of cleanouts, where first approved by the Authority Having Jurisdiction. The maximum distance between manholes shall not exceed 300 feet (91 440 mm).

The inlet and outlet connections shall be made by the use of a flexible compression joint not less than 12 inches (305 mm) and not exceeding 3 feet (914 mm) from the manhole. No flexible compression joints shall be embedded in the manhole base.

**720.0 Sewer and Water Pipes.**

**720.1 General.** Building sewers or drainage piping of clay or materials that are not approved for use within a building shall not be run or laid in the same trench as the water pipes unless the following requirements are met:

(1) The bottom of the water pipe, at points, shall be not less than 12 inches (305 mm) above the top of the sewer or drain line.

(2) The water pipe shall be placed on a solid shelf excavated at one side of the common trench with a clear horizontal distance of not less than 12 inches (305 mm) from the sewer or drain line.

(3) Water pipes crossing sewer or drainage piping constructed of clay or materials that are not approved for use within a building shall be laid not less than 12 inches (305 mm) above the sewer or drain pipe.

For the purpose of this section, "within a building" shall mean within the fixed limits of the building foundation.

**721.0 Location.**

**721.1 Building Sewer.** Except as provided in Section 721.2, no building sewer shall be located in a lot other than the lot that is the site of the building or structure served by such sewer nor shall a building sewer be located at a point having less than the minimum distances referenced in Table 721.1.

**721.2 Abutting Lot.** Nothing contained in this code shall be construed to prohibit the use of all or part of an abutting lot to:

(1) Provide access to connect a building sewer to an available public sewer where proper cause and legal easement, not in violation of other requirements, has been first established to the satisfaction of the Authority Having Jurisdiction.

(2) Provide additional space for a building sewer where proper cause, transfer of ownership, or change of boundary, not in violation of other requirements, has been first established to the satisfaction of the Authority Having Jurisdiction. The instrument recording such action shall constitute an agreement with the Authority Having Jurisdiction and shall clearly state and show that the areas so joined or used shall be maintained as a unit during the time they are so used. Such an agreement shall be recorded in the office of the County Recorder as part of the conditions of ownership of said properties, and shall be binding on heirs, successors, and assigns to such properties. A copy of the instrument recording such proceedings shall be filed with the Authority Having Jurisdiction.

**722.0 Abandoned Sewers and Sewage Disposal Facilities.**

**722.1 Building (House) Sewer.** An abandoned building (house) sewer, or part thereof, shall be plugged or capped in an approved manner within 5 feet (1524 mm) of the property line.

**722.2 Cesspools, Septic Tanks, and Seepage Pits.** A cesspool, septic tank, and seepage pit that has been abandoned or has been discontinued otherwise from further use, or to which no waste or soil pipe from a plumbing fixture is

**TABLE 721.1**
**MINIMUM HORIZONTAL DISTANCE REQUIRED FROM BUILDING SEWER (feet)**

| | |
|---|---|
| Buildings or structures[1] | 2 |
| Property line adjoining private property | Clear[2] |
| Water supply wells | 50[3] |
| Streams | 50 |
| On-site domestic water service line | 1[4] |
| Public water main | 10[5, 6] |

For SI units: 1 foot = 304.8 mm

**Notes:**

[1] Including porches and steps, whether covered or uncovered; breezeways; roofed portecocheres; roofed patios; carports; covered walks; covered driveways; and similar structures or appurtenances.

[2] See also Section 312.3.

[3] Drainage piping shall clear domestic water supply wells by not less than 50 feet (15 240 mm). This distance shall be permitted to be reduced to not less than 25 feet (7620 mm) where the drainage piping is constructed of materials approved for use within a building.

[4] See Section 720.0.

[5] For parallel construction.

[6] For crossings, approval by the Health Department or the Authority Having Jurisdiction shall be required.

connected, shall have the sewage removed therefrom and be completely filled with earth, sand, gravel, concrete, or other approved material.

**722.3 Filling.** The top cover or arch over the cesspool, septic tank, or seepage pit shall be removed before filling, and the filling shall not extend above the top of the vertical portions of the sidewalls or above the level of the outlet pipe until inspection has been called and the cesspool, septic tank, or seepage pit has been inspected. After such inspection, the cesspool, septic tank, or seepage pit shall be filled to the level of the top of the ground.

**722.4 Ownership.** No person owning or controlling a cesspool, septic tank, or seepage pit on the premises of such person or in that portion of a public street, alley, or other public property abutting such premises, shall fail, refuse, or neglect to comply with the provisions of this section or upon receipt of notice so to comply from the Authority Having Jurisdiction.

**722.5 Disposal Facilities.** Where disposal facilities are abandoned consequent to connecting a premises with the public sewer, the permittee making the connection shall fill abandoned facilities in accordance with the Authority Having Jurisdiction within 30 days from the time of connecting to the public sewer.

### 723.0 Building Sewer Test.

**723.1 General.** Building sewers shall be tested by plugging the end of the building sewer at its points of connection with the public sewer or private sewage disposal system and completely filling the building sewer with water from the lowest to the highest point thereof, or by approved equivalent low-pressure air test. Plastic DWV piping systems shall not be tested by the air test method. The building sewer shall be watertight.

### *724.0 [AGR] Meat and Poultry Processing Plant Drainage.*

*724.1 The drainage and plumbing systems must permit the quick runoff of all water from plant buildings, and of surface water around the plant buildings, and of surface water around the plant and on the premises; and all such water shall be disposed of in such a manner as to prevent a nuisance or health hazard.*

*724.2 Toilet soil lines shall be separated from house drainage lines to a point outside the building unless an automatic backwater check valve is installed to prevent backflow. Drainage from toilet bowls and urinals shall not be discharged into a grease catch basin, nor shall such drainage be permitted to enter the sewer lines at a point where there might be a possibility of such drainage backing up and flooding the floor of the building.*

### *725.0 [AGR] Collection Center and Facilities Drainage.*

*Drainage and plumbing systems shall meet the requirements of Section 724.1.*

### *726.0 [AGR] Drainage and Plumbing, General.*

*726.1 The outer premises of every official establishment, including docks, areas where cars and other vehicles are loaded, driveways, approaches, yards, pens and alleys, shall be drained.*

*726.2 Toilet soil lines shall be separated from house drainage lines to a point outside the building, and drainage from toilet bowls and urinals shall not be discharged into a grease catch basin.*

### *727.0 [OSHPD 1] Emergency Sanitary Drainage.*

*727.1 For new acute care hospital buildings submitted after the effective date of this code, the hospital shall have an on-site holding tank[s] to store sewage and liquid waste sufficient to operate essential hospital utilities and equipment in the acute care hospital building, to support 72 hours of continuing operation in the event of an emergency. Any general acute care hospital in operation after January 1, 2030 shall have an on-site holding tank[s] to store sewage and liquid waste sufficient to operate essential hospital utilities and equipment in the acute care hospital buildings on the campus with an SPC-3, SPC-4, or SPC-5 rating, to support 72 hours of continuing operation in the event of an emergency. The emergency waste holding capacity shall be based on the Water Conservation/Water Rationing Plan required in Section 615.4.1. See also California Building Code, Part 2, Section 1616A.1.42.*

***Exception:*** *Hook-ups that allow for the use of transportable means of sewage and liquid waste disposal may be provided instead of on-site storage if the hospital has a plan for storage of sewage and liquid waste. This plan may include the use of leak-proof bags if adequate storage of these and other bags of waste are provided. These storage facilities shall comply with the appropriate local health and environmental authorities' requirements, California Department of Public Health requirements for medical waste management, and comply with the following minimum requirements:*

*(a)* ***Location[s].*** *Location[s] shall be provided for waste collection and storage with sufficient space based upon the volume of projected waste and length of anticipated storage.*

*(b)* ***Enclosure[s].*** *Lockable room[s] or lockable screened enclosure[s] of adequate capacity to store the quantity of waste anticipated shall be provided for the washing and cleaning of containers and for the storage of sewage and waste water.*

*The room[s] or screened enclosure[s] shall include the following:*

1. *Floor and curb. A sealed concrete floor or other approved impervious flooring with a curb and with a drain connected to the sewer.*
2. *Water. Steam or hot water and cold water supplies in accordance with the California Plumbing Code.*

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 8 - INDIRECT WASTES

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | X | | X | X | | | X | X | X | X | X | X | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |

# CHAPTER 8
## INDIRECT WASTES

**801.0 Indirect Wastes.**

**801.1 Air Gap or Air Break Required.** Indirect waste piping shall discharge into the building drainage system through an air gap or air break as set forth in this code. Where a drainage air gap is required by this code, the minimum vertical distance as measured from the lowest point of the indirect waste pipe or the fixture outlet to the flood-level rim of the receptor shall be not less than 1 inch (25.4 mm).

**801.2 Food and Beverage Handling Establishments.** Establishments engaged in the storage, preparation, selling, serving, processing, or other handling of food and beverage involving the following equipment that requires drainage shall provide indirect waste piping for refrigerators, refrigeration coils, freezers, walk-in coolers, iceboxes, ice-making machines, steam tables, egg boilers, coffee urns and brewers, hot-and-cold drink dispensers, and similar equipment.

**801.2.1 Size of Indirect Waste Pipes.** Except for refrigeration coils and ice-making machines, the size of the indirect waste pipe shall be not smaller than the drain on the unit, but shall be not smaller than 1 inch (25 mm), and the maximum developed length shall not exceed 15 feet (4572 mm). Indirect waste pipe for ice-making machines shall be not less than the drain on the unit, and in no case less than ¾ of an inch (20 mm).

**801.2.2 Walk-In Coolers.** For walk-in coolers, floor drains shall be permitted to be connected to a separate drainage line discharging into an outside receptor. The flood-level rim of the receptor shall be not less than 6 inches (152 mm) lower than the lowest floor drain. Such floor drains shall be trapped and individually vented. Cleanouts shall be provided at 90 degree (1.57 rad) turns and shall be accessibly located. Such waste shall discharge through an air gap or air break into a trapped and vented receptor, except that a full-size air gap is required where the indirect waste pipe is under vacuum.

**801.2.3 Food-Handling Fixtures.** Food-preparation sinks, steam kettles, potato peelers, ice cream dipper wells, and similar equipment shall be indirectly connected to the drainage system by means of an air gap. Bins, sinks, and other equipment having drainage connections and used for the storage of unpackaged ice used for human ingestion, or used in direct contact with ready-to-eat food, shall be indirectly connected to the drainage system by means of an air gap. Each indirect waste pipe from food-handling fixtures or equipment shall be separately piped to the indirect waste receptor and shall not combine with other indirect waste pipes. The piping from the equipment to the receptor shall be not less than the drain on the unit, and in no case less than ½ of an inch (15 mm).

**801.3 Bar and Fountain Sink Traps.** Where the sink in a bar, soda fountain, or counter is so located that the trap serving the sink cannot be vented, the sink drain shall discharge through an air gap or air break (see Section 801.2.3) into an approved receptor that is vented. The developed length from the fixture outlet to the receptor shall not exceed 5 feet (1524 mm).

**801.4 Connections from Water Distribution System.** Indirect waste connections shall be provided for drains, overflows, or relief pipes from potable water pressure tanks, water heaters, boilers, and similar equipment that is connected to the potable water distribution system. Such indirect waste connections shall be made by means of a water-distribution air gap constructed in accordance with Table 603.3.1.

**801.5 Sterilizers.** Lines, devices, or apparatus such as stills, sterilizers, and similar equipment requiring waste connections and used for sterile materials shall be indirectly connected by means of an air gap. Each such indirect waste pipe shall be separately piped to the receptor and shall not exceed 15 feet (4572 mm). Such receptors shall be located in the same room.

**801.6 Drip or Drainage Outlets.** Appliances, devices, or apparatus not regularly classified as plumbing fixtures, but which have drip or drainage outlets, shall be permitted to be drained by indirect waste pipes discharging into an open receptor through either an air gap or air break (see Section 801.2.1).

**802.0 Approvals.**

**802.1 General.** No plumbing fixtures served by indirect waste pipes or receiving discharge therefrom shall be installed until first approved by the Authority Having Jurisdiction.

**803.0 Indirect Waste Piping.**

**803.1 General.** Except as hereinafter provided, the size and construction of indirect waste piping shall be in accordance with other sections of this code applicable to drainage and vent piping. No vent from indirect waste piping shall combine with a sewer-connected vent, but shall extend separately to the outside air. Indirect waste pipes exceeding 5 feet (1524 mm), but less than 15 feet (4572 mm) in length shall be directly trapped, but such traps need not be vented.

Indirect waste pipes less than 15 feet (4572 mm) in length shall be not less than the diameter of the drain outlet or tailpiece of the fixture, appliance, or equipment served, and in no case less than ½ of an inch (15 mm). Angles and changes of direction in such indirect waste pipes shall be provided with cleanouts so as to permit flushing and cleaning.

**804.0 Indirect Waste Receptors.**

**804.1 Standpipe Receptors.** Plumbing fixtures or other receptors receiving the discharge of indirect waste pipes shall be approved for the use proposed and shall be of such shape and capacity as to prevent splashing or flooding and shall be located where they are readily accessible for inspection and cleaning. No standpipe receptor for a clothes washer shall extend more than 30 inches (762 mm), or not less than 18 inches (457 mm) above its trap. No trap for a clothes washer standpipe receptor shall be installed below the floor, but shall be roughed in not less than 6 inches (152 mm) and not more than 18 inches (457 mm) above the floor. No indirect waste receptor shall be installed in a toilet room, closet, cupboard, or storeroom, nor in a portion of a building not in general use by the occupants thereof; except standpipes for clothes washers shall be permitted to be installed in toilet and bathroom areas where the clothes washer is installed in the same room.

**805.0 Pressure Drainage Connections.**

**805.1 General.** Indirect waste connections shall be provided for drains, overflows, or relief vents from the water supply system, and no piping or equipment carrying wastes or producing wastes or other discharges under pressure shall be directly connected to a part of the drainage system.

The foregoing shall not apply to an approved sump pump or to an approved pressure-wasting plumbing fixture or device where the Authority Having Jurisdiction has been satisfied that the drainage system is adequately sized to accommodate the anticipated discharge thereof.

**806.0 Sterile Equipment.**

**806.1 General.** Appliances, devices, or apparatus such as stills, sterilizers, and similar equipment requiring water and waste and used for sterile materials shall be drained through an air gap.

**807.0 Appliances.**

**807.1 Non-Classed Apparatus.** Appliances, devices, equipment, or other apparatus not regularly classed as plumbing fixtures, which are equipped with pumps, drips, or drainage outlets, shall be permitted to be drained by indirect waste pipes discharging into an approved type of open receptor.

**807.2 Condensate Waste.** Where the condensate waste from air- conditioning coils discharges by direct connection to a lavatory tailpiece or to an approved accessible inlet on a bathtub overflow, the connection shall be located in the area controlled by the same person controlling the air-conditioned space.

**807.3 Undiluted Condensate Waste.** Where undiluted condensate waste from a fuel-burning condensing appliance is discharged into the drainage system, the material in the drainage system shall be cast-iron, galvanized iron, plastic, or other materials approved for this use.

**Exceptions:**

(1) Where the above condensate is discharged to an exposed fixture tailpiece and trap, such tailpiece and trap shall be permitted to be brass.

(2) Materials approved in Section 701.0 shall be permitted to be used where data is provided that the condensate waste is adequately diluted.

**807.4 Domestic Dishwashing Machine.** No domestic dishwashing machine shall be directly connected to a drainage system or food waste disposer without the use of an approved dishwasher air gap fitting on the discharge side of the dishwashing machine. Listed air gaps shall be installed with the flood-level (FL) marking at or above the flood level of the sink or drainboard, whichever is higher.

**808.0 Cooling Water.**

**808.1 General.** Where permitted by the Authority Having Jurisdiction, clean running water used exclusively as a cooling medium in an appliance, device, or apparatus shall be permitted to discharge into the drainage system through the inlet side of a fixture trap in the event that a suitable fixture is not available to receive such discharge. Such trap connection shall be by means of a pipe connected to the inlet side of an approved fixture trap, the upper end terminating in a funnel-shaped receptacle set adjacent, and not less than 6 inches (152 mm) above the overflow rim of the fixture.

**809.0 Drinking Fountains.**

**809.1 General.** Drinking fountains shall be permitted to be installed with indirect wastes.

**810.0 Steam and Hot Water Drainage Condensers and Sumps.**

**810.1 High Temperature Discharge.** No steam pipe shall be directly connected to a plumbing or drainage system, nor shall water having a temperature above 140°F (60°C) be discharged under pressure directly into a drainage system. Pipes from boilers shall discharge by means of indirect waste piping, as determined by the Authority Having Jurisdiction or the boiler manufacturer's recommendations. Such pipes shall be permitted to be indirectly connected by discharging into an open or closed condenser or an intercepting sump of an approved type that will prevent the entrance of steam or such water under pressure into the drainage system. Closed condensers or sumps shall be provided with a vent that shall be taken off the top and extended separately, full size above the roof. Condensers and sumps shall be properly trapped at the outlet with a deep seal trap extending to within 6 inches (152 mm) of the bottom of the tank. The top of the deep seal trap shall have a ¾ of an inch (19.1 mm) opening located at the highest point of the trap to serve as a siphon breaker. Outlets shall be taken off from the side in such a manner as to allow a waterline to be maintained that will permanently occupy not less than one-half the capacity of the condenser or

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sump. Inlets shall enter above the waterline. Wearing plates or baffles shall be installed in the tank to protect the shell. The sizes of the blowoff line inlet, the water outlets, and the vent shall be as shown in Table 810.1. The contents of condensers receiving steam or hot water under pressure shall pass through an open sump before entering the drainage system.

**TABLE 810.1**
**PIPE CONNECTIONS IN BLOWOFF CONDENSERS AND SUMPS (inches)**

| BOILER BLOWOFF | WATER OUTLET | VENT |
|---|---|---|
| ¾* | ¾* | 2 |
| 1 | 1 | 2½ |
| 1¼ | 1¼ | 3 |
| 1½ | 1½ | 4 |
| 2 | 2 | 5 |
| 2½ | 2½ | 6 |

For SI units: 1 inch = 25.4 mm

* To be used only with boilers of 100 square feet (9.29 m²) of heating surface or less.

**810.2 Sumps, Condensers, and Intercepting Tanks.** Sumps, condensers, or intercepting tanks that are constructed of concrete shall have walls and bottom not less than 4 inches (102 mm) in thickness, and the inside shall be cement plastered not less than ½ of an inch (12.7 mm) in thickness. Condensers constructed of metal shall be not less than No. 12 U.S. standard gauge (0.109 inch) (2.77 mm), and such metal condensers shall be protected from external corrosion by an approved bituminous coating.

**810.3 Cleaning.** Sumps and condensers shall be provided with suitable means of access for cleaning and shall contain a volume of not less than twice the volume of water removed from the boiler or boilers connected thereto where the normal water level of such boiler or boilers is reduced not less than 4 inches (102 mm).

**810.4 Strainers.** An indirect waste interceptor receiving discharge-containing particles that would clog the receptor drain shall have a readily removable beehive strainer.

### 811.0 Chemical Wastes.

**811.1 Pretreatment.** Chemical or industrial liquid wastes that are likely to damage or increase maintenance costs on the sanitary sewer system, detrimentally affect sewage treatment, or contaminate surface or subsurface waters shall be pretreated to render them innocuous prior to discharge into a drainage system. Detailed plans and specifications of the pretreatment facilities shall be required by the Authority Having Jurisdiction.

Piping conveying industrial, chemical, or process wastes from their point of origin to sewer-connected pretreatment facilities shall be of such material and design as to adequately perform its intended function to the satisfaction of the Authority Having Jurisdiction. Drainage discharge piping from pretreatment facilities or interceptors shall be in accordance with standard drainage installation procedures.

Copper tube shall not be used for chemical or industrial wastes as defined in this section.

**811.2 Waste and Vent Pipes.** Each waste pipe receiving or intended to receive the discharge of a fixture into which acid or corrosive chemical is placed, and each vent pipe connected thereto, shall be constructed of Chlorinated Poly(vinyl-chloride) (CPVC), Polypropylene (PP), Polyvinylidene Fluoride (PVDF), chemical-resistant glass, high-silicon iron pipe, or lead pipe with a wall thickness of not less than ⅛ of an inch (3.2 mm); an approved type of ceramic glazed or unglazed vitrified clay; or other approved corrosion-resistant materials.

**811.3 Joining Materials.** Joining materials shall be of approved type and quality.

**811.4 Access.** Where practicable, piping shall be readily accessible and installed with the maximum of clearance from other services.

**811.5 Permanent Record.** The owner shall make and keep a permanent record of the location of piping and venting carrying chemical waste.

**811.6 Chemical Vent.** No chemical vent shall intersect vents for other services.

**811.7 Discharge.** Chemical wastes shall be discharged in a manner approved by the Authority Having Jurisdiction.

**811.8 Diluted Chemicals.** The provisions in this section relative to materials and methods of construction shall not apply to installations such as photographic or x-ray dark rooms or research or control laboratories where minor amounts of adequately diluted chemicals are discharged.

### 812.0 Clear Water Wastes.

**812.1 General.** Water lifts, expansion tanks, cooling jackets, sprinkler systems, drip or overflow pans, or similar devices that discharge clear wastewater into the building drainage system shall discharge through an indirect waste.

### 813.0 Swimming Pools.

**813.1 General.** Pipes carrying wastewater from swimming or wading pools, including pool drainage and backwash from filters, shall be installed as an indirect waste. Where a pump is used to discharge waste pool water to the drainage system, the pump discharge shall be installed as an indirect waste.

### 814.0 Condensate Wastes and Control.

**814.1 Condensate Disposal.** Condensate from air washers, air-cooling coils, fuel-burning condensing appliances, the overflow from evaporative coolers, and similar water-supplied equipment or similar air-conditioning equipment

shall be collected and discharged to an approved plumbing fixture or disposal area. Where discharged into the drainage system, equipment shall drain by means of an indirect waste pipe. The waste pipe shall have a slope of not less than ⅛ inch per foot (10.4 mm/m) or 1 percent slope and shall be of approved corrosion-resistant material not smaller than the outlet size in accordance with Table 814.1 for condensing fuel-burning appliances, respectively. Condensate or wastewater shall not drain over a public way.

**TABLE 814.1**
**MINIMUM CONDENSATE PIPE SIZE**

| EQUIPMENT CAPACITY IN TONS OF REFRIGERATION | MINIMUM CONDENSATE PIPE DIAMETER (inches) |
|---|---|
| Up to 20 | ¾ |
| 21–40 | 1 |
| 41–90 | 1¼ |
| 91–125 | 1½ |
| 126–250 | 2 |

For SI units: 1 ton = 3.52 kW, 1 inch = 25 mm

**814.2 Size.** The size of condensate waste pipes is for one unit or a combination of units, or as recommended by the manufacturer. The capacity of waste pipes assumes a ⅛ inch per foot (10.4 mm/m) or 1 percent slope, with the pipe running three-quarters full at the following pipe conditions:

| Outside Air – 20% | | Room Air – 80% | |
|---|---|---|---|
| DB | WB | DB | WB |
| 90°F | 73°F | 75°F | 62.5°F |

For SI units: °C = (°F-32)/1.8

Condensate drain sizing for other slopes or other conditions shall be approved by the Authority Having Jurisdiction.

Air-conditioning waste pipes shall be constructed of materials specified in Chapter 7.

**814.3 Point of Discharge.** Air-conditioning condensate waste pipes shall connect indirectly to the drainage system through an air gap or air break to properly trapped and vented receptors, dry wells, leach pits, or the tailpiece of plumbing fixtures.

Condensate waste shall not drain over a public way.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 9 - VENTS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | X | | | | | | X | X | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | X | X | | | | | X | X | X | X | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| 903.1.1 | | | X | X | | | | | | | | | | | | | | | |
| 903.1.2 | | | X | | | | | | | | | | | | | | | | |
| 903.1.3 | | | | | | | | | X | X | X | X | | | | | | | |
| 906.2.1 | | | | | | | | | X | X | X | X | | | | | | | |

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# CHAPTER 9
## VENTS

**901.0 General.**

**901.1 Vents Required.** Each plumbing fixture trap, except as otherwise provided in this code, shall be protected against siphonage and backpressure, and air circulation shall be ensured throughout all parts of the drainage system by means of vent pipes installed in accordance with the requirements of this chapter and as otherwise required by this code.

**901.2 Trap Seal Protection.** The vent system shall be designed to prevent a trap seal from being exposed to a pressure differential that exceeds 1 inch water column (0.24 kPa) on the outlet side of the trap.

**902.0 Vents Not Required.**

**902.1 Interceptor.** Vent piping shall be permitted to be omitted on an interceptor where such interceptor acts as a primary settling tank and discharges through a horizontal indirect waste pipe into a secondary interceptor. The second interceptor shall be properly trapped and vented.

**902.2 Bars, Soda Fountains, and Counter.** Traps serving sinks that are part of the equipment of bars, soda fountains, and counters need not be vented where the location and construction of such bars, soda fountains, and counters is such as to make it impossible to do so. Where such conditions exist, said sinks shall discharge by means of approved indirect waste pipes into a floor sink or other approved type of receptor.

**903.0 Materials.**

**903.1 Applicable Standards.** Vent pipe and fittings shall comply with the applicable standards referenced in Table 701.1, except that:

(1) No galvanized steel or 304 stainless steel pipe shall be installed underground and shall be not less than 6 inches (152 mm) aboveground.

(2) ABS and PVC DWV piping installations shall be in accordance with the applicable standards referenced in Table 1401.1. Except for individual single-family dwelling units, materials exposed within ducts or plenums shall have a flame-spread index of a maximum of 25 and a smoke-developed index of not more than 50 where tested in accordance with ASTM E 84 or UL 723.

*903.1.1 [HCD 1 & HCD 2] ABS or PVC installations are limited to not more than two stories of areas of residential accommodation.*

*903.1.2 [HCD 1] All malleable iron vents shall be galvanized.*

*903.1.3 [OSHPD 1, 2, 3 & 4] ABS and PVC installations are not allowed.*

**903.2 Use of Copper Tubing.**

**903.2.1 Underground.** Copper tube for underground drainage and vent piping shall have a weight of not less than that of copper drainage tube type DWV.

**903.2.2 Aboveground.** Copper tube for aboveground drainage and vent piping shall have a weight of not less than that of copper drainage tube type DWV.

**903.2.3 Prohibited Use.** Copper tube shall not be used for chemical or industrial wastes as defined in Section 811.0.

**903.2.4 Marking.** Hard-drawn copper tubing, in addition to the required incised marking, shall be marked in accordance with either ASTM B 306 or ASTM B 88 as listed in Table 1401.1. The colors shall be: Type K, green; Type L, blue; Type M, red; and Type DWV, yellow.

**903.3 Changes in Direction.** Changes in direction of vent piping shall be made by the appropriate use of approved fittings, and no such pipe shall be strained or bent. Burred ends shall be reamed to the full bore of the pipe.

**904.0 Size of Vents.**

**904.1 Size.** The size of vent piping shall be determined from its length and the total number of fixture units connected thereto, in accordance with Table 703.2. The diameter of an individual vent shall be not less than 1¼ inches (32 mm) nor less than one-half the diameter of the drain to which it is connected. In addition, the drainage piping of each building and each connection to a public sewer or a private sewage disposal system shall be vented by means of one or more vent pipes, the aggregate cross-sectional area of which shall be not less than that of the largest required building sewer, as determined from Table 703.2. Vent pipes from fixtures located upstream from pumps, ejectors, backwater valves, or other devices that obstruct the free flow of air and other gases between the building sewer and the outside atmosphere shall not be used for meeting the cross-sectional area venting requirements of this section.

**Exception:** Where connected to a common building sewer, the drainage piping of two or more buildings located on the same lot and under one ownership shall be permitted to be vented by means of piping sized in accordance with Table 703.2, provided the aggregate cross-sectional area of vents is not less than that of the largest required common building sewer.

**904.2 Length.** Not more than one-third of the total permitted length, in accordance with Table 703.2, of a minimum-sized vent shall be installed in a horizontal position.

**Exception:** Where a minimum-sized vent is increased one pipe size for its entire length, the maximum length limitation shall not apply.

**905.0 Vent Pipe Grades and Connections.**

**905.1 Grade.** Vent and branch vent pipes shall be free from drops or sags, and each such vent shall be level or shall be so graded and connected as to drip back by gravity to the drainage pipe it serves.

**905.2 Horizontal Drainage Pipe.** Where vents connect to a horizontal drainage pipe, each vent pipe shall have its invert taken off above the drainage centerline of such pipe downstream of the trap being served.

**905.3 Vent Pipe Rise.** Unless prohibited by structural conditions, each vent shall rise vertically to a point not less than 6 inches (152 mm) above the flood-level rim of the fixture served before offsetting horizontally, and where two or more vent pipes converge, each such vent pipe shall rise to a point not less than 6 inches (152 mm) in height above the flood-level rim of the plumbing fixture it serves before being connected to any other vent. Vents less than 6 inches (152 mm) above the flood-level rim of the fixture shall be installed with approved drainage fittings, material, and grade to the drain.

**905.4 Roof Termination.** Vent pipes shall extend undiminished in size above the roof, or shall be reconnected with a soil or waste vent of proper size.

**905.5 Location of Opening.** The vent pipe opening from a soil or waste pipe, except for water closets and similar fixtures, shall not be below the weir of the trap.

**905.6 Common Vertical Pipe.** Two fixtures shall be permitted to be served by a common vertical pipe where each such fixture wastes separately into an approved double fitting having inlet openings at the same level.

**906.0 Vent Termination.**

**906.1 Roof Termination.** Each vent pipe or stack shall extend through its flashing and shall terminate vertically not less than 6 inches (152 mm) above the roof nor less than 1 foot (305 mm) from a vertical surface.

**906.2 Clearance.** Each vent shall terminate not less than 10 feet (3048 mm) from, or not less than 3 feet (914 mm) above, an openable window, door, opening, air intake, or vent shaft, or not less than 3 feet (914 mm) in every direction from a lot line, alley and street excepted.

II ***906.2.1 [OSHPD 1, 2, 3 & 4, except OSHPD 3SE]*** *Each vent pipe shall terminate not less than twenty-five (25) feet (7620 mm) from any air intake or vent shaft.*

**906.3 Use of Roof.** Vent pipes shall be extended separately or combined, of full required size, not less than 6 inches (152 mm) above the roof or fire wall. Flagpoling of vents shall be prohibited except where the roof is used for purposes other than weather protection. Vents within 10 feet (3048 mm) of a part of the roof that is used for such other purposes shall extend not less than 7 feet (2134 mm) above such roof and shall be securely stayed.

**906.4 Outdoor Installations.** Vent pipes for outdoor installations shall extend not less than 10 feet (3048 mm) above the surrounding ground and shall be securely supported.

**906.5 Joints.** Joints at the roof around vent pipes shall be made watertight by the use of approved flashings or flashing material.

**906.6 Lead.** (See Table 1401.1) Sheet lead shall be not less than the following:

(1) For safe pans – not less than 4 pounds per square foot ($lb/ft^2$) (19 $kg/m^2$) or 1/16 of an inch (1.6 mm) thick.

(2) For flashings or vent terminals – not less than 3 $lb/ft^2$ (15 $kg/m^2$).

(3) Lead bends and lead traps shall be not less than 1/8 of an inch (3.2 mm) wall thickness.

**906.7 Frost or Snow Closure.** Where frost or snow closure is likely to occur in locations having minimum design temperature below 0°F (-17.8°C), vent terminals shall be not less than 2 inches (50 mm) in diameter, but in no event smaller than the required vent pipe. The change in diameter shall be made inside the building not less than 1 foot (305 mm) below the roof in an insulated space and terminate not less than 10 inches (254 mm) above the roof, or in accordance with the Authority Having Jurisdiction.

**907.0 Vent Stacks and Relief Vents.**

**907.1 Drainage Stack.** Each drainage stack that extends 10 or more stories above the building drain or other horizontal drain, shall be served by a parallel vent stack, which shall extend undiminished in size from its upper terminal and connect to the drainage stack at or immediately below the lowest fixture drain. Each such vent stack shall also be connected to the drainage stack at each fifth floor, counting down from the uppermost fixture drain, by means of a yoke vent, the size of which shall be not less in diameter than either the drainage or the vent stack, whichever is smaller.

**907.2 Yoke Vent.** The yoke vent connection to the vent stack shall be placed not less than 42 inches (1067 mm) above the floor level, and the yoke vent connection to the drainage stack shall be by means of a wye-branch fitting placed below the lowest drainage branch connection serving that floor.

**908.0 Wet Venting.**

**908.1 Vertical Wet Venting.** Wet venting is limited to vertical drainage piping receiving the discharge from the trap arm of one and two fixture unit fixtures that also serves as a vent not exceeding four fixtures. Wet-vented fixtures shall be within the same story; provided, further, that fixtures with a continuous vent discharging into a wet vent shall be within the same story as the wet-vented fixtures. No wet vent shall exceed 6 feet (1829 mm) in developed length.

**908.1.1 Size.** The vertical piping between two consecutive inlet levels shall be considered a wet-vented section. Each wet-vented section shall be not less than one pipe size exceeding the required minimum waste pipe size of the upper fixture or shall be one pipe size exceeding the required minimum pipe size for the sum of the fixture units served by such wet-vented section, whichever is larger, but in no case less than 2 inches (50 mm).

**908.1.2 Vent Connection.** Common vent sizing shall be the sum of the fixture units served but, in no case, smaller than the minimum vent pipe size required for a fixture served, or by Section 904.0.

**908.2 Horizontal Wet Venting for Bathroom Groups.** Water closets, bathtubs, showers, and floor drains within one or two bathroom groups located on the same floor level and for private use shall be permitted to be vented by a wet vent. The wet vent shall be considered the vent for the fixtures and shall extend from the connection of the dry vent along the direction of the flow in the drain pipe to the most downstream fixture drain or trap arm connection to the horizontal branch drain. Each wet-vented fixture drain or trap arm shall connect independently to the wet-vented horizontal branch drain. Each individual fixture drain or trap arm shall connect horizontally to the wet-vented horizontal branch drain or shall be provided with a dry vent. The trap to vent distance shall be in accordance with Table 1002.2. Only the fixtures within the bathroom groups shall connect to the wet-vented horizontal branch drain. The water closet fixture drain or trap arm connection to the wet vent shall be downstream of the fixture drain or trap arm connections. Additional fixtures shall discharge downstream of the wet vent system and be conventionally vented.

**908.2.1 Vent Connection.** The dry vent connection to the wet vent shall be an individual vent or common vent for the lavatory, urinal, bidet, shower, or bathtub. Only one wet-vented fixture drain or trap arm shall discharge upstream of the dry-vented fixture drain connection.

**908.2.2 Size.** The wet vent shall be sized based on the fixture unit discharge into the wet vent. The wet vent shall be not less than 2 inches (50 mm) in diameter for 4 drainage fixture units (dfu) or less, and not less than 3 inches (80 mm) in diameter for 5 dfu or more. The dry vent shall be sized in accordance with Table 702.1 and Table 703.2 based on the total fixture units discharging into the wet vent.

**909.0 Special Venting for Island Fixtures.**

**909.1 General.** Traps for island sinks and similar equipment shall be roughed in above the floor and shall be permitted to be vented by extending the vent as high as possible, but not less than the drainboard height and then returning it downward and connecting it to the horizontal sink drain immediately downstream from the vertical fixture drain. The return vent shall be connected to the horizontal drain through a wye-branch fitting and shall, in addition, be provided with a foot vent taken off the vertical fixture vent by means of a wye branch immediately below the floor and extending to the nearest partition and then through the roof to the open air, or shall be permitted to be connected to other vents at a point not less than 6 inches (152 mm) above the flood-level rim of the fixtures served. Drainage fittings shall be used on the vent below the floor level, and a slope of not less than ¼ inch per foot (20.8 mm/m) back to the drain shall be maintained. The return bend used under the drainboard shall be a one piece fitting or an assembly of a 45 degree (0.79 rad), a 90 degree (1.57 rad), and a 45 degree (0.79 rad) elbow in the order named. Pipe sizing shall be as elsewhere required in this code. The island sink drain, upstream of the returned vent, shall serve no other fixtures. An accessible cleanout shall be installed in the vertical portion of the foot vent.

**910.0 Combination Waste and Vent Systems.**

**910.1 Where Permitted.** Combination waste and vent systems shall be permitted where structural conditions preclude the installation of conventional systems as otherwise prescribed by this code.

**910.2 Approval.** Plans and specifications for each combination waste and vent system shall first be approved by the Authority Having Jurisdiction before a portion of such system is installed.

**910.3 Vents.** Each combination waste and vent system, as defined in Chapter 2, shall be provided with a vent or vents adequate to ensure free circulation of air. A branch exceeding 15 feet (4572 mm) in length shall be separately vented in an approved manner. The area of a vent installed in a combination waste and vent system shall be not less than one-half the inside cross-sectional area of the drain pipe served. The vent connection shall be downstream of the uppermost fixture.

**910.4 Size.** Each waste pipe and each trap in such a system shall be not less than two pipe sizes exceeding the sizes required by Chapter 7 of this code, and not less than two pipe sizes exceeding a fixture tailpiece or connection.

**910.5 Vertical Waste Pipe.** No vertical waste pipe shall be used in such a system, except the tailpiece or connection between the outlet of a plumbing fixture and the trap. Such tailpieces or connections shall be as short as possible, and in no case shall exceed 2 feet (610 mm).

**Exception:** Branch lines shall be permitted to have 45 degree (0.79 rad) vertical offsets.

**910.6 Cleanouts.** An accessible cleanout shall be installed in each vent for the combination waste and vent system. Cleanouts shall not be required on a wet-vented branch serving a single trap where the fixture tailpiece or connection is not less than 2 inches (50 mm) in diameter and provides ready access for cleaning through the trap.

**910.7 Fixtures.** No water closet or urinal shall be installed on such a system. Other one, two, or three unit fixtures remotely located from the sanitary system and adjacent to a combination waste and vent system shall be permitted to be connected to such system in the conventional manner by means of waste and vent pipes of regular sizes, providing that the two pipe size increase required in Section 910.4 is based on the total fixture unit load connected to the system.

See Appendix B of this code for explanatory notes on the design of combination waste and vent systems.

**911.0 Engineered Vent System.**

**911.1 General.** The design and sizing of a vent system shall be permitted to be determined by accepted engineering practices. The system shall be designed by a registered design professional and approved in accordance with Section 301.4.

**911.2 Minimum Requirements.** An engineered vent system shall provide protection of the trap seal in accordance with Section 901.2.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 10 - TRAPS AND INTERCEPTORS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | X | | | | | | X | X | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | X | X | | | | | X | X | X | X | | | X | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| 1003.1 Exception 2 | | | X | X | | | | | | | | | | | | | | | |
| 1010.2 & subsections | | | | | | | | | | | | | | | X | | | | |
| 1010.3 | | | | | | | | | | | | | | | X | | | | |
| 1010.4 | | | | | | | | | | | | | | | X | | | | |
| 1010.5 & subsections | | | | | | | | | | | | | | | X | | | | |
| 1014.1A | | | | | | | | | X | X | X | X | | | | | | | |
| 1014.1B | | | | | | | | | X | X | X | X | | | | | | | |
| 1014.1C | | | | | | | | | X | X | X | X | | | | | | | |
| 1015.6 | | | | | | | | | X | X | X | X | | | | | | | |
| 1015.7 | | | | | | | | | X | X | X | X | | | | | | | |

# CHAPTER 10
## TRAPS AND INTERCEPTORS

**1001.0 Traps Required.**

**1001.1 Where Required.** Each plumbing fixture, shall be separately trapped by an approved type of liquid seal trap. This section shall not apply to fixtures with integral traps. Not more than one trap shall be permitted on a trap arm. Food waste disposal units installed with a set of restaurant, commercial, or industrial sinks shall be connected to a separate trap. Each domestic clothes washer and each laundry tub shall be connected to a separate and independent trap, except that a trap serving a laundry tub shall be permitted to also receive the waste from a clothes washer set adjacent thereto. The vertical distance between a fixture outlet and the trap weir shall be as short as practicable, but in no case shall the tailpiece from a fixture exceed 24 inches (610 mm) in length. One trap shall be permitted to serve a set of not more than three single compartment sinks or laundry tubs of the same depth or three lavatories immediately adjacent to each other and in the same room where the waste outlets are not more than 30 inches (762 mm) apart and the trap is centrally located where three compartments are installed.

**1002.0 Traps Protected by Vent Pipes.**

**1002.1 Vent Pipes.** Each plumbing fixture trap, except as otherwise provided in this code, shall be protected against siphonage, backpressure, and air circulation shall be assured throughout the drainage system by means of a vent pipe installed in accordance with the requirements of this code.

**1002.2 Fixture Traps.** Each fixture trap shall have a protecting vent so located that the developed length of the trap arm from the trap weir to the inner edge of the vent shall be within the distance given in Table 1002.2, but in no case less than two times the diameter of the trap arm.

**1002.3 Change of Direction.** A trap arm shall be permitted to change direction without the use of a cleanout where such change of direction does not exceed 90 degrees (1.57 rad). Horizontal changes in direction of trap arms shall be in accordance with Section 706.3.

**Exception:** For trap arms 3 inches (80 mm) in diameter and larger, the change of direction shall not exceed 135 degrees (2.36 rad) without the use of a cleanout.

**1002.4 Vent Pipe Opening.** The vent pipe opening from a soil or waste pipe, except for water closets and similar fixtures, shall not be below the weir of the trap.

**1003.0 Traps — Described.**

**1003.1 General Requirements.** Each trap, except for traps within an interceptor or similar device shall be self-cleaning. Traps for bathtubs, showers, lavatories, sinks, laundry tubs, floor drains, urinals, drinking fountains, dental units, and similar fixtures shall be of standard design, weight and shall be of ABS, cast-brass, cast-iron, lead, PP, PVC, or other approved material. An exposed and readily accessible drawn-brass tubing trap, not less than 17 B & S Gauge (0.045 inch) (0.114 mm), shall be permitted to be used on fixtures discharging domestic sewage.

**Exceptions:**

(1) Drawn-brass tubing traps shall not be used for urinals. Each trap shall have the manufacturer's name stamped legibly in the metal of the trap, and each tubing trap shall have the gauge of the tubing in addition to the manufacturer's name. A trap shall have a smooth and uniform interior waterway.

*(2) [HCD 1 & HCD 2] Non-water supplied urinals conforming to ASME A112.19.19-2006, Standard for Vitreous China Nonwater Urinals, or reference standards in Table 1401.1 for non-vitreous ceramic or plastic urinal fixtures.*

**1003.2 Slip Joint Fittings.** A maximum of one approved slip joint fitting shall be permitted to be used on the outlet side of a trap, and no tubing trap shall be installed without a listed tubing trap adapter. Listed plastic trap adapters shall be permitted to be used to connect listed metal tubing traps.

**TABLE 1002.2**
**HORIZONTAL LENGTHS OF TRAP ARMS**
**(EXCEPT FOR WATER CLOSETS AND SIMILAR FIXTURES)[1, 2]**

| TRAP ARM PIPE DIAMETER (inches) | DISTANCE TRAP TO VENT MINIMUM (inches) | LENGTH MAXIMUM (inches) |
|---|---|---|
| 1¼ | 2½ | 30 |
| 1½ | 3 | 42 |
| 2 | 4 | 60 |
| 3 | 6 | 72 |
| 4 | 8 | 120 |
| Exceeding 4 | 2 x Diameter | 120 |

For SI units: 1 inch = 25.4 mm

**Notes:**

[1] Maintain ¼ inch per foot slope (20.8 mm/m).

[2] The developed length between the trap of a water closet or similar fixture (measured from the top of the closet flange to the inner edge of the vent) and its vent shall not exceed 6 feet (1829 mm).

**1003.3 Size.** The size (nominal diameter) of a trap for a given fixture shall be sufficient to drain the fixture rapidly, but in no case less than nor more than one pipe size larger than given in Table 702.1. The trap shall be the same size as the trap arm to which it is connected.

**1004.0 Traps.**

**1004.1 Prohibited.** No form of trap that depends for its seal upon the action of movable parts shall be used. No trap that has concealed interior partitions, except those of plastic, glass, or similar corrosion-resisting material, shall be used. "S" traps, bell traps, and crown-vented traps shall be prohibited. No fixture shall be double trapped. Drum and bottle traps shall be installed for special conditions. No trap shall be installed without a vent, except as otherwise provided in this code.

**1004.2 Movable Parts.** Bladders, check valves or other type of devices with moveable parts shall be prohibited to serve as a trap.

**1005.0 Trap Seals.**

**1005.1 General.** Each fixture trap shall have a liquid seal of not less than 2 inches (51 mm) and not more than 4 inches (102 mm), except where a deeper seal is found necessary by the Authority Having Jurisdiction. Traps shall be set true with respect to their liquid seals and, where necessary, they shall be protected from freezing.

**1006.0 Floor Drain Traps.**

**1006.1 General.** Floor drains shall connect into a trap so constructed that it can be readily cleaned and of a size to serve efficiently the purpose for which it is intended. The drain inlet shall be so located that it is in full view. Where subject to reverse flow of sewage or liquid waste, such drains shall be equipped with an approved backwater valve.

**1007.0 Trap Seal Protection.**

**1007.1 General.** Floor drain or similar traps directly connected to the drainage system and subject to infrequent use shall be protected with a trap seal primer, except where not deemed necessary for safety or sanitation by the Authority Having Jurisdiction. Trap seal primers shall be accessible for maintenance.

**1008.0 Building Traps.**

**1008.1 General.** Building traps shall not be installed except where required by the Authority Having Jurisdiction. Each building trap where installed shall be provided with a cleanout and with a relieving vent or fresh-air intake on the inlet side of the trap, which need not be larger than one-half the diameter of the drain to which it connects. Such relieving vent or fresh-air intake shall be carried above grade and terminate in a screened outlet located outside the building.

**1009.0 Industrial Interceptors (Clarifiers) and Separators.**

**1009.1 Where Required.** Interceptors (clarifiers) (including grease, oil, sand interceptors [clarifiers], etc.) shall be required by the Authority Having Jurisdiction where they are necessary for the proper handling of liquid wastes containing grease, flammable wastes, sand, solids, acid or alkaline substances, or other ingredients harmful to the building drainage system, the public or private sewer, or to public or private sewage disposal.

**1009.2 Approval.** The size, type, and location of each interceptor (clarifier) or separator shall be approved by the Authority Having Jurisdiction. Except where otherwise specifically permitted, no wastes other than those requiring treatment or separation shall be discharged into an interceptor (clarifier).

**1009.3 Design.** Interceptors (clarifiers) for sand and similar heavy solids shall be so designed and located as to be readily accessible for cleaning and shall have a water seal of not less than 6 inches (152 mm).

**1009.4 Relief Vent.** Interceptors (clarifiers) shall be so designed that they will not become air-bound where closed covers are used. Each interceptor (clarifier) shall be properly vented.

**1009.5 Location.** Each interceptor (clarifier) cover shall be readily accessible for servicing and maintaining the interceptor (clarifier) in working and operating condition. The use of ladders or the removal of bulky equipment in order to service interceptors (clarifiers) shall constitute a violation of accessibility. Location of interceptors (clarifiers) shall be shown on the approved building plan.

**1009.6 Maintenance of Interceptors.** Interceptors shall be maintained in efficient operating condition by periodic removal of accumulated grease, scum, oil, or other floating substances and solids deposited in the interceptor.

**1009.7 Discharge.** The waste pipe from oil and sand interceptors shall discharge as approved by the Authority Having Jurisdiction.

**1010.0 Slaughterhouses, Packing Establishments, etc.**

**1010.1 General.** A fish, fowl, and animal slaughterhouse or establishment; a fish, fowl, and meat packing or curing establishment; a soap factory, tallow-rendering, fat-rendering, and a hide-curing establishment shall be connected to and shall drain or discharge into an approved grease interceptor (clarifier).

***1010.2 [AGR] Meat and Poultry Processing Plants.***

*1010.2.1 Drainage and Plumbing Systems. Drainage and plumbing systems shall meet the requirements of Section 724.0.*

*1010.2.1.1 Each floor drain shall be equipped with a deep-seal trap.*

*1010.2.2 The plumbing shall be installed so as to prevent sewage from backing up and flooding the floor.*

*Exception: Floor drains in areas not regularly washed down will be acceptable with deep-seal traps, provided*

*that such drains are connected to secondary drainage systems discharging into a safe sink or basin (air gap) that is properly trapped and vented, and that such drains accomplish the objectives and intent of this section.*

*1010.2.3 Interceptor traps which are connected with the sewer system shall not be near any edible products department or in any area where products are unloaded from or loaded into vehicles. To facilitate cleaning, such traps shall have inclined bottoms and be provided with suitable covers.*

***1010.3 [AGR] Collection Centers and Facilities.*** *All drains shall be properly installed with adequate deep-sealed traps of the conventional "P," "U" or "S" type and vents.*

***1010.4 [AGR] Horse Meat and Pet Food Establishments.*** *There shall be an efficient drainage and plumbing system for the establishment and premises. All drains and gutters shall be installed with traps and vents approved by the Department.*

***1010.5 [AGR] Draining and Plumbing.*** *There shall be an efficient drainage and plumbing system for the plant and premises.*

***1010.5.1 Drainage and Gutters.*** *All drains and gutters shall be properly installed with approved traps and vents. The drainage and plumbing system must permit the quick runoff of all water from plant buildings, and of surface water around the plant on the premises, and all such water shall be disposed of in such a manner as to prevent a nuisance or health hazard.*

***1010.5.2 Sewage and Plant Waste.*** *The sewer system have adequate slope and capacity to remove readily all waste from the various processing operations and to minimize, or if possible, prevent stoppage and surcharging of the system. When the sewage disposal system is a private system which is required to be approved by a state or local health authority, the applicant shall furnish the administrator a letter from the proper health authority indicating that the sewage disposal system is acceptable to such authority.*

**1011.0 Minimum Requirements for Auto Wash Racks.**

**1011.1 General.** A private or public wash rack, or floor or slab used for cleaning machinery or machine parts shall be adequately protected against storm or surface water and shall drain or discharge into an approved interceptor (clarifier).

**1012.0 Commercial and Industrial Laundries.**

**1012.1 General.** Laundry equipment in commercial and industrial buildings that does not have integral strainers shall discharge into an interceptor having a wire basket or similar device that is removable for cleaning and that will prevent passage into the drainage system of solids ½ of an inch (12.7 mm) or larger in maximum dimension, such as string, rags, buttons, or other solid materials detrimental to the public sewerage system.

**1013.0 Bottling Establishments.**

**1013.1 General.** Bottling plants shall discharge their process wastes into an interceptor that will provide for the separation of broken glass or other solids, before discharging liquid wastes into the drainage system.

**1014.0 Grease Interceptors.**

**1014.1 Where Required.** Where it is determined by the Authority Having Jurisdiction that waste pretreatment is required, an approved type of grease interceptor(s) in accordance with the provisions of this section shall be correctly sized and properly installed in grease waste line(s) leading from sinks and drains, such as floor drains, floor sinks, and other fixtures or equipment in serving establishments such as restaurants, cafes, lunch counters, cafeterias, bars and clubs, hotels, hospitals, sanitariums, factory or school kitchens, or other establishments where grease is introduced into the drainage or sewage system in quantities that can effect line stoppage or hinder sewage treatment or private sewage disposal. A combination of hydromechanical, gravity grease interceptors, and engineered systems shall be allowed in order to meet this code and other applicable requirements of the Authority Having Jurisdiction where space or existing physical constraints of existing buildings necessitate such installations. A grease interceptor shall not be required for individual dwelling units or for private living quarters. Water closets, urinals, and other plumbing fixtures conveying human waste shall not drain into or through the grease interceptor.

*1014.1A [OSHPD 1, 2, 3 & 4] The Authority Having Jurisdiction is the individual official, board, department or agency authorized to administer and enforce the sewage treatment system in the area of the location of the health facility.*

*1014.1B [OSHPD 1, 2, 3 & 4] Grease interceptors shall not be installed in food preparation area of the kitchens.* ||

*1014.1C [OSHPD 1, 2, 3 & 4] Grease interceptors shall be installed outside of the kitchen area in location affording ease of maintenance and servicing.*

**1014.1.1 Trapped and Vented.** Each fixture discharging into a grease interceptor shall be individually trapped and vented in an approved manner.

**1014.1.2 Maintenance.** Grease interceptors shall be maintained in efficient operating condition by periodic removal of the accumulated grease and latent material. No such collected grease shall be introduced into drainage piping or a public or private sewer. Where the Authority Having Jurisdiction determines that a grease interceptor is not being properly cleaned or maintained, the Authority Having Jurisdiction shall have the authority to mandate the installation of additional equipment or devices and to mandate a maintenance program.

**1014.1.3 Food Waste Disposal Units and Dishwashers.** Unless specifically required or permitted by the Authority Having Jurisdiction, no food waste disposal unit or dishwasher shall be connected to or

discharge into a grease interceptor. Commercial food waste disposers shall be permitted to discharge directly into the building's drainage system.

**1014.2 Hydromechanical Grease Interceptors.** Plumbing fixtures or equipment connected to a Type A and B hydromechanical grease interceptor shall discharge through an approved type of vented flow control installed in a readily accessible and visible location. Flow control devices shall be designed and installed so that the total flow through such device or devices shall at no time be greater than the rated flow of the connected grease interceptor. No flow control device having adjustable or removable parts shall be approved. The vented flow control device shall be located such that no system vent shall be between the flow control and the grease interceptor inlet. The vent or air inlet of the flow control device shall connect with the sanitary drainage vent system, as elsewhere required by this code, or shall terminate through the roof of the building, and shall not terminate to the free atmosphere inside the building.

**Exception:** Listed grease interceptors with integral flow controls or restricting devices shall be installed in an accessible location in accordance with the manufacturer's installation instructions.

**1014.2.1 Capacity.** The total capacity in gallons (gal) (L) of fixtures discharging into a hydromechanical grease interceptor shall not exceed two and one-half times the certified gallon per minute (gpm) (L/s) flow rate of the interceptor in accordance with Table 1014.2.1.

For the purpose of this section, the term "fixture" shall mean and include each plumbing fixture, appliance, apparatus, or other equipment required to be connected to or discharged into a grease interceptor by a provision of this section.

**1014.2.2 Vent.** A vent shall be installed downstream of hydromechanical grease interceptors in accordance with the requirements of this code.

**1014.3 Gravity Grease Interceptors.** Required gravity grease interceptors shall comply with the provisions of Section 1014.3.1 through Section 1014.3.7.

**1014.3.1 General.** The provisions of this section shall apply to the design, construction, installation, and testing of commercial kitchen gravity grease interceptors.

**1014.3.2 Waste Discharge Requirements.** Waste discharge in establishments from fixtures and equipment which contain grease, including but not limited to, scullery sinks, pot and pan sinks, dishwashers, soup kettles, and floor drains located in areas where grease-containing materials exist, shall be permitted to be

**TABLE 1014.2.1**
**HYDROMECHANICAL GREASE INTERCEPTOR SIZING USING GRAVITY FLOW RATES[1]**

| DIAMETER OF GREASE WASTE PIPE (inches) | MAXIMUM FULL PIPE FLOW (gpm)[2] | SIZE OF GREASE INTERCEPTOR | |
|---|---|---|---|
| | | ONE-MINUTE DRAINAGE PERIOD (gpm) | TWO-MINUTE DRAINAGE PERIOD (gpm) |
| 2 | 20 | 20 | 10 |
| 3 | 60 | 75 | 35 |
| 4 | 125 | 150 | 75 |
| 5 | 230 | 250 | 125 |
| 6 | 375 | 500 | 250 |

For SI units: 1 inch = 25 mm, 1 gallon per minute = 0.06 L/s

Notes:

[1] For interceptor sizing by fixture capacity see the example below.

[2] ¼ inch slope per foot (20.8 mm/m) based on Manning's formula with friction factor $N = .012$.

**EXAMPLE 1014.2.1**
**SIZING HYDROMECHANICAL GREASE INTERCEPTOR(S) USING FIXTURE CAPACITY**

**Step 1: Determine the flow rate from each fixture.**

[Length] X [Width] X [Depth] / [231] = Gallons X [.75 fill factor] / [Drain Period (1 minute or 2 minutes)]

**Step 2: Calculate the total load from fixtures that discharge into the interceptor.**

| FIXTURES | COMPARTMENTS | LOAD (gallons) | SIZE OF GREASE INTERCEPTOR ONE-MINUTE DRAINAGE PERIOD (gpm) | TWO-MINUTE DRAINAGE PERIOD (gpm) |
|---|---|---|---|---|
| Compartment size | — | — | — | — |
| 24 inches x 24 inches x 12 inches | 2 | 44.9 | — | — |
| Hydrant | — | 3 | — | — |
| Rated Appliance | — | 2 | — | — |
| — | — | 49.9 | 50 | 25 |

For SI units: 1 inch = 25.4 mm, 1 gallon per minute = 0.06 L/s, 1 gallon = 3.785 L

drained into the sanitary waste through the interceptor where approved by the Authority Having Jurisdiction.

**1014.3.2.1 Toilets and Urinals.** Toilets, urinals, and other similar fixtures shall not drain through the interceptor.

**1014.3.2.2 Inlet Pipe.** Waste shall enter the interceptor through the inlet pipe.

**1014.3.3 Design.** Gravity interceptors shall be constructed in accordance with the applicable standard in Table 1401.1 or the design approved by the Authority Having Jurisdiction.

**1014.3.4 Location.** Each grease interceptor shall be so installed and connected that it shall be easily accessible for inspection, cleaning, and removal of the intercepted grease. A gravity grease interceptor in accordance with IAPMO Z1001, shall not be installed in a building where food is handled. Location of the grease interceptor shall meet the approval of the Authority Having Jurisdiction.

**1014.3.4.1 Interceptors.** Interceptors shall be placed as close as practical to the fixtures they serve.

**1014.3.4.2 Business Establishment.** Each business establishment for which a gravity grease interceptor is required shall have an interceptor which shall serve that establishment unless otherwise approved by the Authority Having Jurisdiction.

**1014.3.4.3 Access.** Each gravity grease interceptor shall be located so as to be readily accessible to the equipment required for maintenance.

**1014.3.5 Construction Requirements.** Gravity grease interceptors shall be designed to remove grease from effluent and shall be sized in accordance with this section. Gravity grease interceptors shall also be designed to retain grease until accumulations can be removed by pumping the interceptor. It is recommended that a sample box be located at the outlet end of gravity grease interceptors so that the Authority Having Jurisdiction can periodically sample effluent quality.

**1014.3.6 Sizing Criteria.** The volume of the interceptor shall be determined by using Table 1014.3.6. Where drainage fixture units (DFUs) are not known, the interceptor shall be sized based on the maximum DFUs allowed for the pipe size connected to the inlet of the interceptor. Refer to Table 703.2, Drainage Piping, Horizontal.

**1014.3.7 Abandoned Gravity Grease Interceptors.** Abandoned grease interceptors shall be pumped and filled as required for abandoned sewers and sewage disposal facilities in Section 722.0.

**TABLE 1014.3.6**
**GRAVITY GREASE INTERCEPTOR SIZING**

| DRAINAGE FIXTURE UNITS[1, 3] (DFUs) | INTERCEPTOR VOLUME[2] (gallons) |
|---|---|
| 8 | 500 |
| 21 | 750 |
| 35 | 1000 |
| 90 | 1250 |
| 172 | 1500 |
| 216 | 2000 |
| 307 | 2500 |
| 342 | 3000 |
| 428 | 4000 |
| 576 | 5000 |
| 720 | 7500 |
| 2112 | 10 000 |
| 2640 | 15 000 |

For SI units: 1 gallon = 3.785 L

**Notes:**

1 The maximum allowable DFUs plumbed to the kitchen drain lines that will be connected to the grease interceptor.

2 This size is based on: DFUs, the pipe size from this code; Table 703.2; Useful Tables for flow in half-full pipes (ref: *Mohinder Nayyar Piping Handbook*, 3rd Edition, 1992). Based on 30-minute retention time (ref.: George Tchobanoglous and Metcalf & Eddy. *Wastewater Engineering Treatment, Disposal and Reuse*, 3rd Ed. 1991 & Ronald Crites and George Tchobanoglous. *Small and Decentralized Wastewater Management Systems*, 1998). Rounded up to nominal interceptor volume.

3 Where the flow rate of directly connected fixture(s) or appliance(s) have no assigned DFU values, the additional grease interceptor volume shall be based on the known flow rate (gpm) (L/s) multiplied by 30 minutes.

## 1015.0 FOG (Fats, Oils, and Greases) Disposal System.

**1015.1 Purpose.** The purpose of this section is to provide the necessary criteria for the sizing, application, and installation of FOG disposal systems designated as a pretreatment or discharge water quality compliance strategy.

**1015.2 Scope.** FOG disposal systems shall be considered engineered systems and shall be in accordance with the requirements of Section 301.4 of this code.

**1015.3 Components, Materials, and Equipment.** FOG disposal systems, including components, materials, and equipment necessary for the proper function of the system, shall be in accordance with Section 301.1.2 or Section 301.2 of this code.

**1015.4 Sizing Application and Installation.** FOG disposal systems shall be engineered, sized, and installed in accordance with the manufacturer's installation instructions and as specified in ASME A112.14.6, as listed in Table 1401.1 of this code.

**1015.5 Performance.** FOG disposal systems shall be tested and certified as listed in Table 1401.1 of this code, and other national consensus standards applicable to FOG disposal systems as discharging a maximum of 5.84 grains per gallon (gr/gal) (100 mg/L) FOG.

***1015.6 [OSHPD 1, 2, 3 & 4]*** *Grease interceptors shall not be installed in food preparation area of kitchens.*

***1015.7 [OSHPD 1, 2, 3 & 4]*** *Grease interceptors shall be installed outside of the kitchen area in location affording ease of maintenance and servicing.*

EXAMPLE 1014.3.6
GRAVITY GREASE INTERCEPTOR SIZING EXAMPLE

Given: A restaurant with the following fixtures and equipment.

One food preparation sink; three floor drains - one in the food prep area, one in the grill area, and one receiving the indirect waste from the ice machine and a mop sink.

Kitchen Drain Line DFU Count (from Table 702.1):

| | |
|---|---|
| 3 floor drains at 2 DFUs each = | 6 DFUs |
| Mop sink at 3 DFUs each = | 3 DFUs |
| Food prep sink at 3 DFUs each = | 3 DFUs |
| Total = 12 DFUs | |

Using Table 1014.3.6, the grease interceptor will be sized at 750 gallons (2389 L).

**1016.0 Sand Interceptors.**

**1016.1 Discharge.** Where the discharge of a fixture or drain contain solids or semi-solids heavier than water that would be harmful to a drainage system or cause a stoppage within the system, the discharge shall be through a sand interceptor. Multiple floor drains shall be permitted to discharge into one sand interceptor.

**1016.2 Authority Having Jurisdiction.** Sand interceptors are required where the Authority Having Jurisdiction deems it advisable to have a sand interceptor to protect the drainage system.

**1016.3 Construction and Size.** Sand interceptors shall be built of brick or concrete, prefabricated coated steel, or other watertight material. The interceptor shall have an interior baffle for full separation of the interceptor into two sections. The outlet pipe shall be the same size as the inlet pipe of the sand interceptor, the minimum being 3 inches (80 mm), and the baffle shall have two openings of the same diameter as the outlet pipe and at the same invert as the outlet pipe. These openings shall be staggered so that there cannot be a straight line flow between the inlet pipe and the outlet pipe. The invert of the inlet pipe shall be no lower than the invert of the outlet pipe.

The sand interceptor shall have a minimum dimension of 2 square feet (0.2 $m^2$) for the net free opening of the inlet section and a minimum depth under the invert of the outlet pipe of 2 feet (610 mm).

For each 5 gpm (0.3 L/s) flow or fraction thereof over 20 gpm (1.26 L/s), the area of the sand interceptor inlet section is to be increased by 1 square foot (0.09 $m^2$). The outlet section shall at all times have a minimum area of 50 percent of the inlet section.

The outlet section shall be covered by a solid removable cover, set flush with the finished floor, and the inlet section shall have an open grating, set flush with the finished floor and suitable for the traffic in the area in which it is located.

**1016.4 Separate Use.** Sand and similar interceptors for every solid shall be so designed and located as to be readily accessible for cleaning, shall have a water seal of not less than 6 inches (152 mm), and shall be vented.

**1017.0 Oil and Flammable Liquid Interceptors.**

**1017.1 Interceptors Required.** Repair garages and gasoline stations with grease racks or grease pits, and factories that have oily, flammable, or both types of wastes as a result of manufacturing, storage, maintenance, repair, or testing processes, shall be provided with an oil or flammable liquid interceptor that shall be connected to necessary floor drains. The separation or vapor compartment shall be independently vented to the outer air. Where two or more separation or vapor compartments are used, each shall be vented to the outer air or shall be permitted to connect to a header that is installed at a minimum of 6 inches (152 mm) above the spill line of the lowest floor drain and vented independently to the outer air. The minimum size of a flammable vapor vent shall be not less than 2 inches (51 mm), and, where vented through a sidewall, the vent shall be not less than 10 feet (3048 mm) above the adjacent level at an approved location. The interceptor shall be vented on the sewer side and shall not connect to a flammable vapor vent. Oil and flammable interceptors shall be provided with gastight cleanout covers that shall be readily accessible. The waste line shall be not less than 3 inches (80 mm) in diameter with a full-size cleanout to grade. Where an interceptor is provided with an overflow, it shall be provided with an overflow line [not less than 2 inches (50 mm) in diameter] to an approved waste oil tank having a minimum capacity of 550 gallons (2082 L) and meeting the requirements of the Authority Having Jurisdiction. The waste oil from the separator shall flow by gravity or shall be pumped to a higher elevation by an automatic pump. Pumps shall be adequately sized and accessible. Waste oil tanks shall have a 2 inch (50 mm) minimum pump-out connection at grade and a 1½ inch (38 mm) minimum vent to atmosphere at an approved location not less than 10 feet (3048 mm) above grade.

**1017.2 Design of Interceptors.** Each manufactured interceptor that is rated shall be stamped or labeled by the manufacturer with an indication of its full discharge rate in gpm (L/s). The full discharge rate to such an interceptor shall be determined at full flow. Each interceptor shall be rated equal to or greater than the incoming flow and shall be provided with an overflow line to an underground tank.

Interceptors not rated by the manufacturer shall have a depth of not less than 2 feet (610 mm) below the invert of the discharge drain. The outlet opening shall have not less than an 18 inch (457 mm) water seal and shall have a minimum capacity as follows: Where not more than three motor vehicles are serviced, stored, or both, interceptors shall have a minimum capacity of 6 cubic feet (0.2 $m^3$), and 1 cubic foot (0.03 $m^3$) of capacity shall be added for each vehicle up to 10 vehicles. Above 10 vehicles, the Authority

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Having Jurisdiction shall determine the size of the interceptor required. Where vehicles are serviced and not stored, interceptor capacity shall be based on a net capacity of 1 cubic foot (0.03 $m^3$) for each 100 square feet (9.29 $m^2$) of surface to be drained into the interceptor, with a minimum of 6 cubic feet (0.2 $m^3$).

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 11 - STORM DRAINAGE

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | | | | | | X | X | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | X | | X | X | | | | | X | X | X | X | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| 1101.3 | X | | X | X | | | | | | | | | | | | | | | |
| 1101.3.2 | | | | | | | | | X | X | X | X | | | | | | | |
| 1101.5 Exception | | | X | X | | | | | | | | | | | | | | | |
| 1102.1.1 | | | X | X | | | | | | | | | | | | | | | |
| 1102.1.3 | | | | | | | | | X | X | X | X | | | | | | | |

# CHAPTER 11
## STORM DRAINAGE

**1101.0 General.**

**1101.1 Where Required.** Roofs, paved areas, yards, courts, courtyards, vent shafts, light wells, or similar areas having rainwater, shall be drained into a separate storm sewer system, or into a combined sewer system where a separate storm sewer system is not available, or to some other place of disposal satisfactory to the Authority Having Jurisdiction. In the case of one- and two-family dwellings, storm water shall be permitted to be discharged on flat areas, such as streets or lawns, so long as the storm water shall flow away from the building and away from adjoining property, and shall not create a nuisance.

**1101.2 Storm Water Drainage to Sanitary Sewer Prohibited.** Storm water shall not be drained into sewers intended for sanitary drainage.

**1101.3 Material Uses.** Rainwater piping placed within the interior of a building or run within a vent or shaft shall be of cast-iron, galvanized steel, wrought iron, brass, copper, lead, Schedule 40 ABS DWV, Schedule 40 PVC DWV, stainless steel 304 or 316L [stainless steel 304 pipe and fittings shall not be installed underground and shall be kept not less than 6 inches (152 mm) aboveground], or other approved materials, and changes in direction shall be in accordance with the requirements of Section 706.0. ABS and PVC DWV piping installations shall be installed in accordance with IS 5 *and* IS 9. Except for individual single-family dwelling units, materials exposed within ducts or plenums shall have a flame-spread index of a maximum of 25 and a smoke-developed index of a maximum of 50, where tested in accordance with ASTM E 84 and UL 723.

*1101.3.1 [HCD 1 & HCD 2] ABS or PVC installations are limited to not more than two stories of areas of residential accommodation.*

*1101.3.2 [OSHPD 1, 2 , 3, & 4] ABS and PVC installations are not allowed.*

**1101.4 Expansion Joints Required.** Expansion joints or sleeves shall be provided where warranted by temperature variations or physical conditions.

**1101.5 Subsoil Drains.** Subsoil drains shall be provided around the perimeter of buildings having basements, cellars, crawl spaces, or floors below grade. Such subsoil drains shall be permitted to be positioned inside or outside of the footing, shall be of perforated or open-jointed approved drain tile or pipe, not less than 3 inches (80 mm) in diameter, and shall be laid in gravel, slag, crushed rock, approved ¾ of an inch (19.1 mm) crushed, recycled glass aggregate, or other approved porous material with not less than 4 inches (102 mm) surrounding the pipe. Filter media shall be provided for exterior subsoil piping.

***Exception: [HCD 1 & HCD 2] Subsoil drains are mandatory only when required by the Authority Having Jurisdiction due to geological conditions.***

**1101.5.1 Discharge.** Subsoil drains shall be piped to a storm drain, to an approved water course, to the front street curb or gutter, to an alley, or the discharge from the subsoil drains shall be conveyed to the alley by a concrete gutter. Where a continuously flowing spring or groundwater is encountered, subsoil drains shall be piped to a storm drain or an approved water course.

**1101.5.2 Sump.** Where it is not possible to convey the drainage by gravity, subsoil drains shall discharge to an accessible sump provided with an approved automatic electric pump. The sump shall be not less than 15 inches (381 mm) in diameter, 18 inches (457 mm) in depth, and provided with a fitted cover. The sump pump shall have an adequate capacity to discharge water coming into the sump as it accumulates to the required discharge point, and the capacity of the pump shall be not less than 15 gallons per minute (gpm) (0.95 L/s). The discharge piping from the sump pump shall be not less than 1½ inches (40 mm) in diameter and have a union or other approved quick-disconnect assembly to make the pump accessible for servicing.

**1101.5.3 Splash Blocks.** For separate dwellings not serving continuously flowing springs or groundwater, the sump discharge pipe shall be permitted to discharge onto a concrete splash block with a minimum length of 24 inches (610 mm). This pipe shall be within 4 inches (102 mm) of the splash block and positioned to direct the flow parallel to the recessed line of the splash block.

**1101.5.4 Backflow Protection.** Subsoil drains subject to backflow where discharging into a storm drain shall be provided with a backwater valve in the drain line so located as to be accessible for inspection and maintenance.

**1101.5.5 Open Area.** Nothing in Section 1101.5 shall prevent drains that serve either subsoil drains or areaways of a detached building from discharging to a properly graded open area, provided that:

(1) They do not serve continuously flowing springs or groundwater.

(2) The point of discharge is not less than 10 feet (3048 mm) from a property line.

(3) It is impracticable to discharge such drains to a storm drain, to an approved water course, to the front street curb or gutter, or to an alley.

**1101.6 Building Subdrains.** Building subdrains located below the public sewer level shall discharge into a sump or receiving tank, the contents of which shall be automatically lifted and discharged into the drainage system as required for building sumps.

**1101.7 Areaway Drains.** Open subsurface space adjacent to a building, serving as an entrance to the basement or cellar of a building, shall be provided with a drain or drains. Such areaway drains shall be not less than 2 inches (50 mm) in diameter for areaways at a maximum of 100 square feet (9.29 $m^2$) in area, and shall be discharged in the manner provided for subsoil drains not serving continu-

ously flowing springs or groundwater (see Section 1101.5.1). Areaways in excess of 100 square feet (9.29 $m^2$) shall not drain into subsoil drains. Areaway drains for areaways exceeding 100 square feet (9.29 $m^2$) shall be sized in accordance with Table 1101.7.

**1101.8 Window Areaway Drains.** Window areaways at a maximum of 10 square feet (0.93 $m^2$) in area shall be permitted to discharge to the subsoil drains through a 2 inch (50 mm) pipe. However, window areaways exceeding 10 square feet (0.93 $m^2$) in area shall be handled in the manner provided for entrance areaways (see Section 1101.7).

**1101.9 Filling Stations and Motor Vehicle Washing Establishments.** Public filling stations and motor vehicle washing establishments shall have the paved area sloped toward sumps or gratings within the property lines. Curbs not less than 6 inches (152 mm) high shall be placed where required to direct water to gratings or sumps.

**1101.10 Paved Areas.** Where the occupant creates surface water drainage, the sumps, gratings, or floor drains shall be piped to a storm drain or an approved water course.

**1101.11 Roof Drainage.**

**1101.11.1 Primary Roof Drainage.** Roof areas of a building shall be drained by roof drains or gutters. The location and sizing of drains and gutters shall be coordinated with the structural design and pitch of the roof. Unless otherwise required by the Authority Having Jurisdiction, roof drains, gutters, vertical conductors or leaders, and horizontal storm drains for primary drainage shall be sized based on a storm of 60 minutes duration and 100 year return period. Refer to Table D 1.1 (in Appendix D) for 100 year, 60 minute storms at various locations.

**1101.11.2 Secondary Drainage.** Secondary (emergency) roof drainage shall be provided by one of the methods specified in Section 1101.11.2.1 or Section 1101.11.2.2.

**1101.11.2.1 Roof Scuppers or Open Side.** Secondary roof drainage shall be provided by an open-sided roof or scuppers where the roof perimeter construction extends above the roof in such a manner that water will be entrapped. An open-sided roof or scuppers shall be sized to prevent the depth of ponding water from exceeding that for which the roof was designed as determined by Section 1101.11.1. Scupper openings shall be not less than 4 inches (102 mm) high and have a width equal to the circumference of the roof drain required for the area served, sized in accordance with Table 1101.11.

**1101.11.2.2 Secondary Roof Drain.** Secondary roof drains shall be provided. The secondary roof drains shall be located not less than 2 inches (51 mm) above the roof surface. The maximum height of the roof drains shall be a height to prevent the depth of ponding water from exceeding that for which the roof was designed as determined by Section 1101.11.1. The secondary roof drains shall connect to a piping system in accordance with Section 1101.11.2.2(A) or Section 1101.11.2.2(B).

**1101.11.2.2(A) Separate Piping System.** The secondary roof drainage system shall be a separate system of piping, independent of the primary roof drainage system. The discharge shall be above grade, in a location observable by the building occupants or maintenance personnel. Secondary roof drain systems shall be sized in accordance with Section 1101.11.1 based on the rainfall rate for which the primary system is sized.

**1101.11.2.2(B) Combined System.** The secondary roof drains shall connect to the vertical piping of the primary storm drainage conductor downstream of a horizontal offset below the roof. The primary storm drainage system shall connect to the building storm water that connects to an underground public storm sewer. The combined secondary and primary roof drain systems shall be sized in accordance with Section 1106.0 based on double the rainfall rate for the local area.

**1101.12 Cleanouts.** Cleanouts for building storm drains shall comply with the requirements of Section 719.0 of this code.

**1101.12.1 Rain Leaders and Conductors.** Rain leaders and conductors connected to a building storm sewer shall have a cleanout installed at the base of the outside leader or outside conductor before it connects to the horizontal drain.

**1101.13 Rainwater Sumps.** Rainwater sumps serving "public use" occupancy buildings shall be provided with dual pumps arranged to function alternately in case of overload or mechanical failure.

**1102.0 Materials.**

**1102.1 Conductors.** Conductors installed aboveground in buildings shall be in accordance with the applicable standards referenced in Table 701.1 for aboveground drain, waste, and vent pipe.

**1102.1.1 Inside of Conductors.** The inside of conductors installed aboveground level shall be of seamless copper water tube, Type K, L, or M; Schedule 40 copper pipe or Schedule 40 copper alloy pipe; Type DWV copper drainage tube; service weight cast-iron soil pipe or hubless cast-iron soil pipe; standard weight galvanized steel pipe; stainless steel 304 or 316L [stainless steel 304 pipe and fittings shall not be installed underground and shall be kept not less than 6 inches (152 mm) aboveground]; or Schedule 40 ABS or Schedule 40 PVC plastic pipe.

***1102.1.2 [HCD 1] ABS or PVC installations are limited to not more than two stories of areas of residential accommodation.***

***1102.1.3 [OSHPD 1, 2, 3 & 4] ABS and PVC installations are not allowed.***

**1102.2 Leaders.** Leaders installed outside shall be in accordance with the applicable standards referenced in Table 701.1 for aboveground drain, waste, and vent pipe; aluminum sheet metal; galvanized steel sheet metal; or copper sheet metal.

**1102.3 Underground Building Storm Drains.** Underground building storm drains shall comply with the applicable standards referenced in Table 701.1 for underground drain, waste, and vent pipe.

**1102.4 Building Storm Sewers.** Building storm sewers shall comply with the applicable standards referenced in Table 701.1 for building sewer pipe.

**1102.5 Subsoil Drains.** Subsoil drains shall be open jointed, perforated, or both and constructed of materials in accordance with Table 1102.5.

**TABLE 1102.5**
**MATERIALS FOR SUBSOIL DRAIN PIPE AND FITTINGS**

| MATERIAL | REFERENCED STANDARD(S) |
|---|---|
| Asbestos Cement | ASTM C 444, ASTM C 508 ASTM C 966 |
| PE | ASTM F 405 |
| PVC | ASTM D 2729 |
| Vitrified Clay (Extra strength) | ASTM C 4, ASTM C 700 |

**1103.0 Traps on Storm Drains and Leaders.**

**1103.1 Where Required.** Leaders and storm drains, where connected to a combined sewer, shall be trapped. Floor and area drains connected to a storm drain shall be trapped.

**Exception:** Traps shall not be required where roof drains, rain leaders, and other inlets are at locations allowed under Section 906.0, Vent Termination.

**1103.2 Where Not Required.** No trap shall be required for leaders or conductors that are connected to a sewer carrying storm water exclusively.

**1103.3 Trap Size.** Traps, where installed for individual conductors, shall be the same size as the horizontal drain to which they are connected.

**1103.4 Method of Installation of Combined Sewer.** Individual storm-water traps shall be installed on the storm-water drain branch serving each storm-water inlet, or a single trap shall be installed in the main storm drain just before its connection with the combined building sewer. Such traps shall be provided with an accessible cleanout on the outlet side of the trap.

**1104.0 Leaders, Conductors, and Connections.**

**1104.1 Improper Use.** Leaders or conductors shall not be used as soil, waste, or vent pipes nor shall soil, waste, or vent pipes be used as leaders or conductors.

**1104.2 Protection of Leaders.** Leaders installed along alleyways, driveways, or other locations where exposed to damage shall be protected by metal guards, recessed into the wall, or constructed from ferrous pipe.

**1104.3 Combining Storm with Sanitary Drainage.** The sanitary and storm drainage system of a building shall be entirely separate, except where a combined sewer is used, in which case the building storm drain shall be connected in the same horizontal plane through a single wye fitting to the combined building sewer not less than 10 feet (3048 mm) downstream from a soil stack.

**1105.0 Roof Drains.**

**1105.1 Materials.** Requirements for roof drain materials shall comply with Section 1105.1.1 and Section 1105.1.2.

**1105.1.1 Lead.** Roof drains shall be constructed of materials in accordance with Table 1401.1.

**1105.1.2 Copper.** Roof drains shall be of cast-iron, copper or copper alloy, lead, or plastic.

**1105.2 Dome or Strainer for General Use.** Roof drains and overflow drains, except those draining to hanging gutters, shall be equipped with strainers extending not less than 4 inches (102 mm) above the surface of the roof immediately adjacent to the drain. Strainers shall have a minimum inlet area above the roof level not less than one and one-half times the area of the conductor or leader to which the drain is connected.

**1105.3 Strainers for Flat Decks.** Roof drain strainers for use on sun decks, parking decks, and similar areas that are normally serviced and maintained, shall be permitted to be of the flat surface type. Such roof drain strainers shall be level with the deck and shall have an available inlet area of not less than two times the area of the conductor or leader to which the drain is connected.

**1105.4 Roof Drain Flashings.** Connection between the roof and roof drains that pass through the roof and into the interior of the building shall be made watertight by the use of proper flashing material.

**1105.4.1 Lead Flashing.** Where lead flashing material is used, it shall be not less than 4 pounds per square foot ($lb/ft^2$) (19 $kg/m^2$).

**1105.4.2 Copper Flashing.** Where copper flashing material is used, it shall be not less than 12 ounces per square foot ($oz/ft^2$) (3.7 $kg/m^2$).

**1106.0 Size of Leaders, Conductors, and Storm Drains.**

**1106.1 Vertical Conductors and Leaders.** Vertical conductors and leaders shall be sized on the basis of the maximum projected roof area and Table 1101.11.

**1106.2 Size of Horizontal Storm Drains and Sewers.** The size of building storm drains or building storm sewers or their horizontal branches shall be based upon the maximum projected roof or paved area to be handled and Table 1101.7.

**1106.3 Size of Roof Gutters.** The size of semi-circular gutters shall be based on the maximum projected roof area and Table 1106.3.

**1106.4 Side Walls Draining onto a Roof.** Where vertical walls project above a roof so as to permit storm water to

drain to the roof area below, the adjacent roof area shall be permitted to be computed from Table 1101.11 as follows:

(1) For one wall – add 50 percent of the wall area to the roof area figures.

(2) For two adjacent walls of equal height – add 35 percent of the total wall areas.

(3) For two adjacent walls of unequal height – add 35 percent of the total common height and add 50 percent of the remaining height of the highest wall.

(4) Two opposite walls of same height – add no additional area.

(5) Two opposite walls of differing heights – add 50 percent of the wall area above the top of lower wall.

(6) Walls on three sides – add 50 percent of the area of the inner wall below the top of the lowest wall, plus allowance for the area of the wall above the top of the lowest wall, in accordance with Section 1106.4(3) and Section 1106.4(5) above.

(7) Walls on four sides – no allowance for wall areas below the top of the lowest wall – add for areas above the top of the lowest wall in accordance with Section 1106.4(1), Section 1106.4(3), Section 1106.4(5), and Section 1106.4(6) above.

### 1107.0 Values for Continuous Flow.

**1107.1 General.** Where there is a continuous or semi-continuous discharge into the building storm drain or building storm sewer, as from a pump, ejector, air-conditioning plant, or similar device, 1 gpm (0.06 L/s) of such discharge shall be computed as being equivalent to 24 square feet (2.2 $m^2$) of roof area, based upon a rate of rainfall of 4 inches per hour (in/h) (102 mm/h).

### 1108.0 Controlled-Flow Roof Drainage.

**1108.1 Application.** In lieu of sizing the storm drainage system in accordance with Section 1106.0, the roof drainage shall be permitted to be sized on the basis of controlled flow and storage of the storm water on the roof, provided the following conditions are met:

(1) The water from a 25 year-frequency storm shall not be stored on the roof exceeding 24 hours.

(2) During the storm, the water depth on the roof shall not exceed the depths specified in Table 1108.1(2).

(3) Not less than two drains shall be installed in roof areas of 10 000 square feet (929 $m^2$) or less, and not less than one additional drain shall be installed for each 10 000 square feet (929 $m^2$) of roof area exceeding 10 000 square feet (929 $m^2$).

(4) Each roof drain shall have a precalibrated, fixed (nonadjustable), and proportional weir (notched) in a standing water collar inside the strainer. No mechanical devices or valves shall be allowed.

**TABLE 1108.1(2)**
**CONTROLLED-FLOW MAXIMUM ROOF WATER DEPTH**

| ROOF RISE* (inches) | MAXIMUM WATER DEPTH AT DRAIN (inches) |
|---|---|
| Flat | 3 |
| 2 | 4 |
| 4 | 5 |
| 6 | 6 |

For SI units: 1 inch = 25.4 mm

* Vertical measurement from the roof surface at the drain to the highest point of the roof surface served by the drain, ignoring a local depression immediately adjacent to the drain.

(5) Pipe sizing shall be based on the pre-calibrated rate of flow (gpm) (L/s) of the pre-calibrated weir for the maximum allowable water depth, and Table 1101.7 and Table 1101.11.

(6) The height of stones or other granular material above the waterproofed surface shall not be considered in water depth measurement, and the roof surface in the vicinity of the drain shall not be recessed to create a reservoir.

(7) Roof design, where controlled-flow roof drainage is used, shall be such that the design roof live load is not less than 30 $lb/ft^2$ (146 $kg/m^2$) to provide a safety factor exceeding the 15 $lb/ft^2$ (73 $kg/m^2$) represented by the depth of water stored on the roof in accordance with Table 1108.1(2).

(8) Scuppers shall be provided in parapet walls. The distance of scupper bottoms above the roof level at the drains shall not exceed the maximum distances specified in Table 1108.1(8).

**TABLE 1108.1(8)**
**DISTANCE OF SCUPPER BOTTOMS ABOVE ROOF**

| ROOF RISE* (inches) | ABOVE ROOF LEVEL AT DRAIN (inches) |
|---|---|
| Flat | 3 |
| 2 | 4 |
| 4 | 5 |
| 6 | 6 |

For SI units: 1 inch = 25.4 mm

* Vertical measurement from the roof surface at the drain to the highest point of the roof surface served by the drain, ignoring a local depression immediately adjacent to the drain.

(9) Scupper openings shall be not less than 4 inches (102 mm) high and have a width equal to the circumference of the roof drain required for the area served, sized in accordance with Table 1101.11.

(10) Flashings shall extend above the top of the scuppers.

(11) At a wall or parapet, 45 degree (0.79 rad) cants shall be installed.

(12) Separate storm and sanitary drainage systems shall be provided within the building.

(13) Calculations for the roof drainage system shall be submitted along with the plans to the Authority Having Jurisdiction for approval.

**1108.2 Setback Roofs.** Drains on setback roofs shall be permitted to be connected to the controlled-flow drainage systems provided:

(1) The setback is designed for storing water, or

(2) The square footage of the setback drainage area is converted as outlined in Section 1108.0 to gpm, and the storm-water pipe sizes in the controlled-flow system are based on the sum of the loads.

(3) The branch from each of the roof drains that are not provided with controlled flow shall be sized in accordance with Table 1101.11.

**1109.0 Testing.**

**1109.1 Testing Required.** New building storm drainage systems and parts of existing systems that have been altered, extended, or repaired shall be tested in accordance with Section 1109.2.1 or Section 1109.2.2 to disclose leaks and defects.

**1109.2 Methods of Testing Storm Drainage Systems.** Except for outside leaders and perforated or open-jointed drain tile, the piping of storm drain systems shall be tested upon completion of the rough piping installation by water or air, except that plastic pipe shall not be tested with air, and proved tight. The Authority Having Jurisdiction shall be permitted to require the removal of cleanout plugs to ascertain whether the pressure has reached parts of the system. One of the following test methods shall be used in accordance with Section 1109.2.1 through Section 1109.2.3.

**1109.2.1 Water Test.** After piping has been installed, the water test shall be applied to the drainage system, either to the entire system or to sections. Where the test is applied to the entire system, all openings in the piping shall be tightly closed except for the highest opening, and the system shall be filled with water to the point of overflow. Where the system is tested in sections, each opening shall be tightly plugged except for the highest opening of the section under test, and each section shall be filled with water, but no section shall be tested with less than a 10 foot (3048 mm) head of water. In testing successive sections, not less than the upper 10 feet (3048 mm) of the next preceding section shall be tested so that no joint of pipe in the building except the uppermost 10 feet (3048 mm) of a roof drainage system, which shall be filled with water to the flood level of the uppermost roof drain, shall have been submitted to a test of less than 10 foot (3048 mm) head of water. The water shall be kept in the system or in the portion under test for not less than 15 minutes before inspection starts; the system shall then be tight.

**1109.2.2 Air Test.** The air test shall be made by attaching an air compressor testing apparatus to a suitable opening after closing other inlets and outlets to the system, forcing air into the system until there is a uniform gauge pressure of 5 pounds-force per square inch (psi) (34 kPa) or sufficient pressure to balance a column of mercury 10 inches (34 kPa) in height. This pressure shall be held without introduction of additional air for a period of not less than 15 minutes.

**1109.2.3 Exceptions.** Where circumstances exist that make air and water tests described in Section 1109.2.1 and Section 1109.2.2 impractical, see Section 103.5.6.3.

## TABLE 1101.7
## SIZING OF HORIZONTAL RAINWATER PIPING[1, 2]

| SIZE OF PIPE | FLOW (⅛ inch per foot slope) | MAXIMUM ALLOWABLE HORIZONTAL PROJECTED ROOF AREAS AT VARIOUS RAINFALL RATES (square feet) | | | | | |
|---|---|---|---|---|---|---|---|
| inches | gpm | 1 (in/h) | 2 (in/h) | 3 (in/h) | 4 (in/h) | 5 (in/h) | 6 (in/h) |
| 3 | 34 | 3288 | 1644 | 1096 | 822 | 657 | 548 |
| 4 | 78 | 7520 | 3760 | 2506 | 1880 | 1504 | 1253 |
| 5 | 139 | 13 360 | 6680 | 4453 | 3340 | 2672 | 2227 |
| 6 | 222 | 21 400 | 10 700 | 7133 | 5350 | 4280 | 3566 |
| 8 | 478 | 46 000 | 23 000 | 15 330 | 11 500 | 9200 | 7670 |
| 10 | 860 | 82 800 | 41 400 | 27 600 | 20 700 | 16 580 | 13 800 |
| 12 | 1384 | 133 200 | 66 600 | 44 400 | 33 300 | 26 650 | 22 200 |
| 15 | 2473 | 238 000 | 119 000 | 79 333 | 59 500 | 47 600 | 39 650 |

| SIZE OF PIPE | FLOW (¼ inch per foot slope) | MAXIMUM ALLOWABLE HORIZONTAL PROJECTED ROOF AREAS AT VARIOUS RAINFALL RATES (square feet) | | | | | |
|---|---|---|---|---|---|---|---|
| inches | gpm | 1 (in/h) | 2 (in/h) | 3 (in/h) | 4 (in/h) | 5 (in/h) | 6 (in/h) |
| 3 | 48 | 4640 | 2320 | 1546 | 1160 | 928 | 773 |
| 4 | 110 | 10 600 | 5300 | 3533 | 2650 | 2120 | 1766 |
| 5 | 196 | 18 880 | 9440 | 6293 | 4720 | 3776 | 3146 |
| 6 | 314 | 30 200 | 15 100 | 10 066 | 7550 | 6040 | 5033 |
| 8 | 677 | 65 200 | 32 600 | 21 733 | 16 300 | 13 040 | 10 866 |
| 10 | 1214 | 116 800 | 58 400 | 38 950 | 29 200 | 23 350 | 19 450 |
| 12 | 1953 | 188 000 | 94 000 | 62 600 | 47 000 | 37 600 | 31 350 |
| 15 | 3491 | 336 000 | 168 000 | 112 000 | 84 000 | 67 250 | 56 000 |

| SIZE OF PIPE | FLOW (½ inch per foot slope) | MAXIMUM ALLOWABLE HORIZONTAL PROJECTED ROOF AREAS AT VARIOUS RAINFALL RATES (square feet) | | | | | |
|---|---|---|---|---|---|---|---|
| inches | gpm | 1 (in/h) | 2 (in/h) | 3 (in/h) | 4 (in/h) | 5 (in/h) | 6 (in/h) |
| 3 | 68 | 6576 | 3288 | 2192 | 1644 | 1310 | 1096 |
| 4 | 156 | 15 040 | 7520 | 5010 | 3760 | 3010 | 2500 |
| 5 | 278 | 26 720 | 13 360 | 8900 | 6680 | 5320 | 4450 |
| 6 | 445 | 42 800 | 21 400 | 14 267 | 10 700 | 8580 | 7140 |
| 8 | 956 | 92 000 | 46 000 | 30 650 | 23 000 | 18 400 | 15 320 |
| 10 | 1721 | 165 600 | 82 800 | 55 200 | 41 400 | 33 150 | 27 600 |
| 12 | 2768 | 266 400 | 133 200 | 88 800 | 66 600 | 53 200 | 44 400 |
| 15 | 4946 | 476 000 | 238 000 | 158 700 | 119 000 | 95 200 | 79 300 |

For SI units: 1 inch = 25 mm, 1 gallon per minute = 0.06 L/s, ⅛ inch per foot = 10.4 mm/m, 1 inch per hour = 25.4 mm/h, 1 square foot = 0.0929 $m^2$

**Notes:**

[1] The sizing data for horizontal piping are based on the pipes flowing full.

[2] For rainfall rates other than those listed, determine the allowable roof area by dividing the area given in the 1 inch per hour (25.4 mm/h) column by the desired rainfall rate.

## TABLE 1101.11
## SIZING ROOF DRAINS, LEADERS, AND VERTICAL RAINWATER PIPING[2, 3]

| SIZE OF DRAIN, LEADER, OR PIPE | FLOW | MAXIMUM ALLOWABLE HORIZONTAL PROJECTED ROOF AREAS AT VARIOUS RAINFALL RATES (square feet) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| inches | gpm[1] | 1 (in/h) | 2 (in/h) | 3 (in/h) | 4 (in/h) | 5 (in/h) | 6 (in/h) | 7 (in/h) | 8 (in/h) | 9 (in/h) | 10 (in/h) | 11 (in/h) | 12 (in/h) |
| 2 | 30 | 2880 | 1440 | 960 | 720 | 575 | 480 | 410 | 360 | 320 | 290 | 260 | 240 |
| 3 | 92 | 8800 | 4400 | 2930 | 2200 | 1760 | 1470 | 1260 | 1100 | 980 | 880 | 800 | 730 |
| 4 | 192 | 18 400 | 9200 | 6130 | 4600 | 3680 | 3070 | 2630 | 2300 | 2045 | 1840 | 1675 | 1530 |
| 5 | 360 | 34 600 | 17 300 | 11 530 | 8650 | 6920 | 5765 | 4945 | 4325 | 3845 | 3460 | 3145 | 2880 |
| 6 | 563 | 54 000 | 27 000 | 17 995 | 13 500 | 10 800 | 9000 | 7715 | 6750 | 6000 | 5400 | 4910 | 4500 |
| 8 | 1208 | 116 000 | 58 000 | 38 660 | 29 000 | 23 200 | 19 315 | 16 570 | 14 500 | 12 890 | 11 600 | 10 545 | 9600 |

For SI units: 1 inch = 25 mm, 1 gallon per minute = 0.06 L/s, 1 inch per hour = 25.4 mm/h, 1 square foot = 0.0929 $m^2$

**Notes:**

[1] Maximum discharge capacity, gpm (L/s) with approximately 1¾ inch (44 mm) head of water at the drain.

[2] For rainfall rates other than those listed, determine the allowable roof area by dividing the area given in the 1 inch per hour (25.4 mm/h) column by the desired rainfall rate.

[3] Vertical piping shall be round, square, or rectangular. Square pipe shall be sized to enclose its equivalent roundpipe. Rectangular pipe shall have not less than the same cross-sectional area as its equivalent round pipe, except that the ratio of its side dimensions shall not exceed 3 to 1.

## TABLE 1106.3
## SIZE OF GUTTERS

| DIAMETER OF GUTTER (1/16 inch per foot slope) | MAXIMUM RAINFALL RATES BASED ON ROOF AREA (square feet) | | | | |
|---|---|---|---|---|---|
| inches | 2 (in/h) | 3 (in/h) | 4 (in/h) | 5 (in/h) | 6 (in/h) |
| 3 | 340 | 226 | 170 | 136 | 113 |
| 4 | 720 | 480 | 360 | 288 | 240 |
| 5 | 1250 | 834 | 625 | 500 | 416 |
| 6 | 1920 | 1280 | 960 | 768 | 640 |
| 7 | 2760 | 1840 | 1380 | 1100 | 918 |
| 8 | 3980 | 2655 | 1990 | 1590 | 1325 |
| 10 | 7200 | 4800 | 3600 | 2880 | 2400 |

| DIAMETER OF GUTTER (1/8 inch per foot slope) | MAXIMUM RAINFALL RATES BASED ON ROOF AREA (square feet) | | | | |
|---|---|---|---|---|---|
| inches | 2 (in/h) | 3 (in/h) | 4 (in/h) | 5 (in/h) | 6 (in/h) |
| 3 | 480 | 320 | 240 | 192 | 160 |
| 4 | 1020 | 681 | 510 | 408 | 340 |
| 5 | 1760 | 1172 | 880 | 704 | 587 |
| 6 | 2720 | 1815 | 1360 | 1085 | 905 |
| 7 | 3900 | 2600 | 1950 | 1560 | 1300 |
| 8 | 5600 | 3740 | 2800 | 2240 | 1870 |
| 10 | 10 200 | 6800 | 5100 | 4080 | 3400 |

| DIAMETER OF GUTTER (1/4 inch per foot slope) | MAXIMUM RAINFALL RATES BASED ON ROOF AREA (square feet) | | | | |
|---|---|---|---|---|---|
| inches | 2 (in/h) | 3 (in/h) | 4 (in/h) | 5 (in/h) | 6 (in/h) |
| 3 | 680 | 454 | 340 | 272 | 226 |
| 4 | 1440 | 960 | 720 | 576 | 480 |
| 5 | 2500 | 1668 | 1250 | 1000 | 834 |
| 6 | 3840 | 2560 | 1920 | 1536 | 1280 |
| 7 | 5520 | 3680 | 2760 | 2205 | 1840 |
| 8 | 7960 | 5310 | 3980 | 3180 | 2655 |
| 10 | 14 400 | 9600 | 7200 | 5750 | 4800 |

| DIAMETER OF GUTTER (1/2 inch per foot slope) | MAXIMUM RAINFALL RATES BASED ON ROOF AREA (square feet) | | | | |
|---|---|---|---|---|---|
| inches | 2 (in/h) | 3 (in/h) | 4 (in/h) | 5 (in/h) | 6 (in/h) |
| 3 | 960 | 640 | 480 | 384 | 320 |
| 4 | 2040 | 1360 | 1020 | 816 | 680 |
| 5 | 3540 | 2360 | 1770 | 1415 | 1180 |
| 6 | 5540 | 3695 | 2770 | 2220 | 1850 |
| 7 | 7800 | 5200 | 3900 | 3120 | 2600 |
| 8 | 11 200 | 7460 | 5600 | 4480 | 3730 |
| 10 | 20 000 | 13 330 | 10 000 | 8000 | 6660 |

For SI units: 1 inch = 25 mm, 1/16 inch per foot = 5.2 mm/m, 1 inch per hour = 25.4 mm/h, 1 square foot = 0.0929 $m^2$

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 12 - FUEL GAS PIPING

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | X | X | X | X | | | X | X | X | X | X | X | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| 1210.18 | | | | | | | | | | | | | | | | | | | |

# CHAPTER 12
## FUEL GAS PIPING

**1201.0 Scope of Gas Piping.**

**1201.1 Coverage of Piping System.** Coverage of piping systems shall extend from the point of delivery to the appliance connections. For other than undiluted liquefied petroleum gas systems, the point of delivery shall be the outlet of the service meter assembly or the outlet of the service regulator or service shutoff valve where no meter is provided. For undiluted liquefied petroleum gas systems, the point of delivery shall be considered the outlet of the final pressure regulator, exclusive of the line gas regulators where no meter is installed. Where a meter is installed, the point of delivery shall be the outlet of the meter. [NFPA 54-12:1.1.1.1(A)]

**1201.2 Piping System Requirements.** Piping systems requirements shall include design, materials, components, fabrications, assembly, installation, testing, inspection, operation, and maintenance. [NFPA 54:1.1.1.1(C)]

**1201.3 Application.** This code shall not apply to the following (reference standards for some of which appear in Chapter 14):

(1) Portable LP-Gas appliances that are not connected to a fixed fuel piping system.

(2) Installation of appliances such as brooders, dehydrators, dryers, and irrigation equipment used for agricultural purposes.

(3) Raw material (feedstock) applications, except for piping to special atmosphere generators.

(4) Oxygen-fuel gas cutting and welding systems.

(5) Industrial gas applications using gases such as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen, and nitrogen.

(6) Petroleum refineries, pipeline compressor or pumping stations, loading terminals, compounding plants, refinery tank farms, and natural gas processing plants.

(7) Large integrated chemical plants or portions of such plants where flammable or combustible liquids or gases are produced by chemical reactions or used in chemical reactions.

(8) LP-Gas installations at utility gas plants.

(9) Liquefied natural gas (LNG) installations.

(10) Fuel gas piping in electric utility power plants.

(11) Proprietary items of equipment, apparatus, or instruments such as gas-generating sets, compressors, and calorimeters.

(12) LP-Gas appliances for vaporization, gas mixing, and gas manufacturing.

(13) LP-Gas piping for buildings under construction or renovations that are not to become part of the permanent building piping system—that is, temporary fixed piping for building heat.

(14) Installation of LP-Gas systems for railroad switch heating.

(15) Installation of LP-Gas and compressed natural gas systems on vehicles.

(16) Gas piping, meters, gas-pressure regulators, and other appurtenances used by the serving gas supplier in distribution of gas, other than undiluted LP-Gas. [NFPA 54-12:1.1.1.2]

**1202.0 General.**

**1202.1 Installation.** The regulations of this chapter shall govern the installation of fuel gas piping in or in connection with a building, structure or within the property lines of premises up to 5 pounds-force per square inch (34 kPa), other than service pipe. Fuel oil piping systems shall be installed in accordance with NFPA 31.

**1203.0 Inspection.**

**1203.1 Inspection Notification.** Upon completion of the installation, alteration, or repair of gas piping, and prior to the use thereof, the Authority Having Jurisdiction shall be notified that such gas piping is ready for inspection.

**1203.2 Excavation.** Excavations required for the installation of underground piping shall be kept open until such time as the piping has been inspected and approved. Where such piping is covered or concealed before such approval, it shall be exposed upon the direction of the Authority Having Jurisdiction.

**1203.3 Type of Inspections.** The Authority Having Jurisdiction shall make the following inspections and either shall approve that portion of the work as completed or shall notify the permit holder wherein the same fails to be in accordance with this code.

**1203.3.1 Rough Piping Inspection.** This inspection shall be made after gas piping authorized by the permit has been installed and before such piping has been covered or concealed or fixture or appliance has been attached thereto. This inspection shall include a determination that the gas piping size, material, and installation meet the requirements of this code.

**1203.3.2 Final Piping Inspection.** This inspection shall be made after piping authorized by the permit has been installed and after portions thereof that are to be covered or concealed are so concealed and before fixture, appliance, or shutoff valve has been attached thereto. This inspection shall comply with Section 1213.1. Test gauges used in conducting tests shall be in accordance with Section 318.0.

**1203.4 Inspection Waived.** 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 shall be permitted to be waived at the discretion of the Authority Having Jurisdiction. In this event, the Authority Having Jurisdiction shall 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.

**1204.0 Certificate of Inspection.**

**1204.1 Issuance.** Where upon final piping inspection, the installation is found to be in accordance with the provisions of this code, a certificate of inspection shall be permitted to be issued by the Authority Having Jurisdiction.

**1204.2 Gas Supplier.** A copy of the certificate of such final piping inspection shall be issued to the serving gas supplier supplying gas to the premises.

**1204.3 Unlawful.** It shall be unlawful for a serving gas supplier, or person furnishing gas, to turn on or cause to be turned on, a fuel gas or a gas meter or meters, until such certificate of final inspection, as herein provided, has been issued.

**1205.0 Authority to Render Gas Service.**

**1205.1 Authorized Personnel.** It shall be unlawful for a 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 a premises where and when gas service is, at the time, not being rendered.

**1205.2 Outlets.** It shall be unlawful to turn on or connect gas in or on the premises unless outlets are securely connected to gas appliances or capped or plugged with screw joint fittings.

**1206.0 Authority to Disconnect.**

**1206.1 Disconnection.** The Authority Having Jurisdiction or the serving gas supplier is hereby authorized to disconnect gas piping or appliance or both that shall be found not to be in accordance with the requirements of this code or that are found defective and in such condition as to endanger life or property.

**1206.2 Notice.** 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 thereof.

**1206.3 Capped Outlets.** It shall be unlawful to remove or disconnect gas piping or gas appliance without capping or plugging with a screw joint fitting, the outlet from which said pipe or appliance was removed. Outlets to which gas appliances are not connected shall be left capped, gastight on a piping system that has been installed, altered, or repaired.

**Exception:** Where an approved listed quick-disconnect device is used.

**1207.0 Temporary Use of Gas.**

**1207.1 General.** Where temporary use of gas is desired and the Authority Having Jurisdiction deems the use necessary, a permit shall be permitted to 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 is in accordance with the requirements of this code regarding material, sizing, and safety.

**1208.0 Gas Piping System Design, Materials, and Components.**

**1208.1 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. [NFPA 54:5.1.1]

**1208.1.1 Addition to Existing System.** Where additional appliances are being connected to a gas piping system, the existing piping shall be checked to determine whether it has adequate capacity. Where inadequate, the existing system shall be enlarged as required, or separate gas piping of approved capacity shall be provided. [NFPA 54:5.1.2]

**1208.2 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]

**1208.3 Interconnections Between Gas Piping Systems.**

**1208.3.1 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. [NFPA 54:5.3.1]

**1208.3.2 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. [NFPA 54:5.3.2]

**1208.4 Sizing of Gas Piping Systems.** Gas piping systems shall be of such size and so installed as to provide a supply of gas to meet the maximum demand and supply gas to each appliance inlet at not less than the minimum supply pressure required by the appliance. [NFPA 54:5.4.1]

**1208.4.1 Maximum Gas Demand.** The volumetric flow rate of gas to be provided (in cubic feet per hour) shall be calculated using the manufacturer's input ratings of the appliance served, adjusted for altitude. Where the input rating is not indicated, the gas supplier, appliance manufacturer, or a qualified agency shall be contacted or the rating from Table 1208.4.1 shall be used for estimating the volumetric flow rate of gas to be supplied.

The total connected hourly load shall be used as the basis for piping sizing, assuming the appliances are operating at full capacity simultaneously.

**Exception:** Sizing shall be permitted to be based upon established load diversity factors. [NFPA 54-12:5.4.2]

**1208.4.2 Sizing Methods.** Gas piping shall be sized in accordance with one of the following:

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TABLE 1208.4.1
APPROXIMATE GAS INPUT FOR TYPICAL APPLIANCES
[NFPA 54: TABLE 5.4.2.1]

| APPLIANCE | INPUT (Btu/h approx.) |
|---|---|
| **Space Heating Units** | |
| Warm air furnace | |
| Single family | 100 000 |
| Multifamily, per unit | 60 000 |
| Hydronic boiler | |
| Single family | 100 000 |
| Multifamily, per unit | 60 000 |
| **Space and Water Heating Units** | |
| Hydronic boiler | |
| Single family | 120 000 |
| Multifamily, per unit | 75 000 |
| **Water Heating Appliances** | |
| Water heater, automatic storage 30 to 40 gallon tank | 35 000 |
| Water heater, automatic storage 50 gallon tank | 50 000 |
| Water heater, automatic instantaneous | |
| Capacity at 2 gallons per minute | 142 800 |
| Capacity at 4 gallons per minute | 285 000 |
| Capacity at 6 gallons per minute | 428 400 |
| Water heater, domestic, circulating or side-arm | 35 000 |
| **Cooking Appliances** | |
| Range, freestanding, domestic | 65 000 |
| Built-in oven or broiler unit, domestic | 25 000 |
| Built-in top unit, domestic | 40 000 |
| **Other Appliances** | |
| Refrigerator | 3000 |
| Clothes dryer, Type 1 (domestic) | 35 000 |
| Gas fireplace direct vent | 40 000 |
| Gas log | 80 000 |
| Barbecue | 40 000 |
| Gaslight | 2500 |

For SI units: 1000 British thermal units per hour = 0.293 kW

(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 instructions. [NFPA 54:5.4.3]

**1208.4.3 Allowable Pressure Drop.** The design pressure loss in a piping system under maximum probable flow conditions, from the point of delivery to the inlet connection of the appliance, shall be such that the supply pressure at the appliance is greater than or equal to the minimum pressure required by the appliance. [NFPA 54:5.4.4]

**1208.5 Acceptable Piping Materials and Joining Methods.** Materials used for piping systems shall be in accordance with the requirements of this chapter or shall be acceptable to the Authority Having Jurisdiction. [NFPA 54:5.6.1.1]

**1208.5.1 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 approved for the service intended. [NFPA 54:5.6.1.2]

**1208.5.1.1 Other Materials.** Material not covered by the standards specifications listed herein shall be investigated and tested to determine that it is safe 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]

**1208.5.2 Metallic Pipe.**

**1208.5.2.1 Cast-Iron.** Cast-iron pipe shall not be used. [NFPA 54:5.6.2.1]

**1208.5.2.2 Steel and Wrought-Iron.** Steel and wrought-iron pipe shall be not less than standard weight (Schedule 40) and shall comply with one of the following standards:

(1) ASME B36.10

(2) ASTM A 53

(3) ASTM A 106 [NFPA 54:5.6.2.2]

**1208.5.2.3 Copper and Brass.** Copper and brass pipe shall not be used where the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic feet (scf) of gas (0.7 mg/100 L). [NFPA 54:5.6.2.3]

Threaded copper, brass, or aluminum alloy pipe shall not be used with gases corrosive to such material. [NFPA 54:5.6.2.4]

**1208.5.2.4 Aluminum Alloy.** Aluminum alloy pipe shall comply with ASTM B 241 (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, insulation or is subject to repeated wettings by such liquids as water, detergents, or sewage. [NFPA 54:5.6.2.5]

Aluminum alloy pipe shall not be used in exterior locations or underground. [NFPA 54:5.6.2.6]

**1208.5.3 Metallic Tubing.** Seamless copper, aluminum alloy, or steel tubing shall not be used with gases corrosive to such material. [NFPA 54:5.6.3]

**1208.5.3.1 Steel.** Steel tubing shall comply with ASTM A 254. [NFPA 54:5.6.3.1]

**1208.5.3.2 Copper and Brass.** Copper and brass tubing shall not be used where the gas contains more

than an average of 0.3 grains of hydrogen sulfide per 100 scf of gas (0.7 mg/100 L). Copper tubing shall comply with standard Type K or L of ASTM B 88 or ASTM B 280. [NFPA 54:5.6.3.2]

**1208.5.3.3 Aluminum Alloy.** Aluminum alloy tubing shall comply with ASTM B 210 or ASTM B 241. Aluminum alloy tubing shall be coated to protect against external corrosion where it is in contact with masonry, plaster, insulation, or is subject to repeated wettings by such liquids as water, detergent, or sewage. Aluminum alloy tubing shall not be used in exterior locations or underground. [NFPA 54:5.6.3.3]

**1208.5.3.4 Corrugated Stainless Steel.** Corrugated stainless steel tubing shall be tested and listed in accordance with the construction, installation, and performance requirements of CSA LC-1. [NFPA 54:5.6.3.4]

**1208.5.4 Plastic Pipe, Tubing, and Fittings.** Polyethylene plastic pipe, tubing, and fittings used to supply fuel gas shall be in accordance with ASTM D 2513. Pipe to be used shall be marked "gas" and "ASTM D 2513." [NFPA 54-12:5.6.4.1.1]

**1208.5.4.1 Regulator Vent Piping.** Plastic pipe and fittings used to connect regulator vents to remote vent terminations shall be PVC in accordance with UL 651. PVC vent piping shall not be installed indoors. [NFPA 54-12:5.6.4.2]

**1208.5.4.2 Anodeless Risers.** Anodeless risers shall comply with Section 1208.5.4.2(A) through Section 1208.5.4.2(C). [NFPA 54:5.6.4.3]

**1208.5.4.2(A) Factory-Assembled Anodeless Risers.** 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 54:5.6.4.3(1)]

**1208.5.4.2(B) Service Head Adapters and Field-Assembled Anodeless Risers.** Service head adapters and field-assembled anodeless risers incorporating service head adapters shall be recommended by the manufacturer for the gas used and shall be design-certified to be in accordance with the requirements of Category I of ASTM D 2513. The manufacturer shall provide the user qualified installation instructions. [NFPA 54:5.6.4.3(2)]

**1208.5.4.2(C) Undiluted Liquefied Petroleum Gas Piping.** The use of plastic pipe, tubing, and fittings in undiluted liquefied petroleum gas piping systems shall be in accordance with NFPA 58. [NFPA 54:5.6.4.3(3)]

**1208.5.5 Workmanship and Defects.** Gas pipe, tubing, and fittings shall be clear and free from cutting burrs and defects in structure or threading, and shall be thoroughly brushed and chip and scale blown. Defects in pipe, tubing, and fittings shall not be repaired. Defective pipe, tubing, and fittings shall be replaced. [NFPA 54:5.6.5]

**1208.5.6 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. [NFPA 54:5.6.6]

**1208.5.7 Metallic Pipe Threads.** Metallic pipe and fitting threads shall be taper pipe threads and shall comply with ASME B1.20.1. [NFPA 54:5.6.7.1]

**1208.5.7.1 Damaged Threads.** Pipe with threads that are stripped, chipped, corroded, or otherwise damaged shall not be used. Where a weld opens during the operation of cutting or threading, that portion of the pipe shall not be used. [NFPA 54:5.6.7.2]

**1208.5.7.2 Number of Threads.** Field threading of metallic pipe shall be in accordance with Table 1208.5.7.2. [NFPA 54:5.6.7.3]

**TABLE 1208.5.7.2**
**SPECIFICATIONS FOR THREADING METALLIC PIPE**
**[NFPA 54: TABLE 5.6.7.3]**

| IRON PIPE SIZE (inches) | APPROXIMATE LENGTH OF THREADED PORTION (inches) | APPROXIMATE NUMBER OF THREADS TO BE CUT |
|---|---|---|
| ½ | ¾ | 10 |
| ¾ | ¾ | 10 |
| 1 | ⅞ | 10 |
| 1¼ | 1 | 11 |
| 1½ | 1 | 11 |
| 2 | 1 | 11 |
| 2½ | 1½ | 12 |
| 3 | 1½ | 12 |
| 4 | 1⅝ | 13 |

For SI units: 1 inch = 25.4 mm

**1208.5.7.3 Thread Joint Compounds.** Thread joint compounds shall be resistant to the action of liquefied petroleum gas or to other chemical constituents of the gases to be conducted through the piping. [NFPA 54-12:5.6.7.4]

**1208.5.8 Metallic Piping Joints and Fittings.** The type of piping joint used shall be approved 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 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]

**1208.5.8.1 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 1000°F (538°C). Brazing alloys

shall not contain more than 0.05 percent phosphorus. [NFPA 54:5.6.8.1]

**1208.5.8.2 Tubing Joints.** Tubing joints shall either be made with approved gas tubing fittings, be brazed with a material having a melting point in excess of 1000°F (538°C), or made by press-connect fittings in accordance with CSA LC-4. Brazing alloys shall not contain more than 0.05 percent phosphorus. [NFPA 54:5.6.8.2]

**1208.5.8.3 Flared Joints.** Flared joints shall be used in systems constructed from nonferrous pipe and tubing where experience or tests have demonstrated that the joint is approved for the conditions and where provisions are made in the design to prevent separation of the joints. [NFPA 54:5.6.8.3]

**1208.5.8.4 Metallic Pipe Fittings (Including Valves, Strainers, Filters).** Metallic pipe fittings shall comply with the following:

(1) Threaded fittings in sizes exceeding 4 inches (100 mm) shall not be used unless acceptable to the Authority Having Jurisdiction.

(2) Fittings used with steel or wrought-iron pipe shall be steel, brass, bronze, malleable iron, or cast-iron.

(3) Fittings used with copper or brass pipe shall be copper, brass, or bronze.

(4) Fittings used with aluminum alloy pipe shall be of aluminum alloy.

(5) Cast-iron fittings.
   (a) Flanges shall be permitted.
   (b) Bushings shall not be used.
   (c) Fittings shall not be used in systems containing flammable gas-air mixtures.
   (d) Fittings in sizes 4 inches (100 mm) and larger shall not be used indoors unless approved by the Authority Having Jurisdiction.
   (e) Fittings in sizes 6 inches (150 mm) and larger shall not be used unless approved by the Authority Having Jurisdiction.

(6) Aluminum alloy fitting threads shall not form the joint seal.

(7) Zinc-aluminum alloy fittings shall not be used in systems containing flammable gas-air mixtures.

(8) Special fittings such as couplings; proprietary-type joints; saddle tees; gland-type compression fittings; and flared, flareless, or compression-type tubing fittings shall be:
   (a) Used within the fitting manufacturer's pressure-temperature recommendations.
   (b) Used within the service conditions anticipated with respect to vibration, fatigue, thermal expansion, or contraction.
   (c) Installed or braced to prevent separation of the joint by gas pressure or external physical damage.
   (d) Acceptable to the Authority Having Jurisdiction. [NFPA 54:5.6.8.4]

**1208.5.9 Plastic Piping, Joints, and Fittings.** Plastic pipe, tubing, and fittings shall be installed in accordance with the manufacturer's installation instructions. Section 1208.5.9.1 through Section 1208.5.9.4 shall be observed where making such joints. [NFPA 54:5.6.9]

**1208.5.9.1 Joint Design.** The joint shall be designed and installed so that the longitudinal pullout resistance of the joint shall be equal to the tensile strength of the plastic piping material. [NFPA 54:5.6.9(1)]

**1208.5.9.2 Heat-Fusion Joint.** Heat-fusion joints shall be made in accordance with AWS B2.4. 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)]

**1208.5.9.3 Compression-Type Mechanical Joints.** 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, shall extend not less than the outside end of the pipe or tubing, and shall extend not less than to the outside end of the compression fitting where 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)]

**1208.5.9.4 Liquefied Petroleum Gas Piping Systems.** Plastic piping joints and fittings for use in liquefied petroleum gas piping systems shall be in accordance with NFPA 58. [NFPA 54:5.6.9(4)]

**1208.5.10 Flanges.** Flanges shall comply with ASME B16.1, ASME B16.20, or MSS SP-6. The pressure-temperature ratings shall equal or exceed that required by the application. [NFPA 54:5.6.10]

**1208.5.10.1 Flange Facings.** Standard facings shall be permitted for use under this code. Where 150 psi (1034 kPa) steel flanges are bolted to Class 125 cast-iron flanges, the raised face on the steel flange shall be removed. [NFPA 54:5.6.10.1]

**1208.5.10.2 Lapped Flanges.** Lapped flanges shall be used aboveground or in exposed locations accessible for inspection. [NFPA 54:5.6.10.2]

**1208.5.11 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] Flange gaskets shall comply with the following requirements:

(1) Acceptable materials include the following:
   (a) Metal (plain or corrugated)
   (b) Composition
   (c) Aluminum "O" rings and spiral-wound metal gaskets [NFPA 54-12:5.6.11.1]
(2) Where a flanged joint is opened, the gasket shall be replaced. [NFPA 54:5.6.11.2]
(3) Full-face gaskets shall be used with bronze and cast-iron flanges. [NFPA 54:5.6.11.3]

**1208.6 Gas Meters.** Gas meters shall be selected for the maximum expected pressure and permissible pressure drop. [NFPA 54:5.7.1]

**1208.6.1 Location.** Gas meters shall be located in ventilated spaces readily accessible for examination, reading, replacement, or necessary maintenance. [NFPA 54:5.7.2.1]

**1208.6.1.1 Subject to Damage.** Gas meters shall not be placed where they will be subjected to damage, such as adjacent to a driveway; under a fire escape; in public passages, halls, or coal bins; or where they will be subject to excessive corrosion or vibration. [NFPA 54:5.7.2.2]

**1208.6.1.2 Extreme Temperatures.** Gas meters shall not be located where they will be subjected to extreme temperatures or sudden extreme changes in temperature. Meters shall not be located in areas where they are subjected to temperatures beyond those recommended by the manufacturer. [NFPA 54:5.7.2.3]

**1208.6.2 Supports.** Gas meters shall be supported or connected to rigid piping so as not to exert a strain on the meters. Where flexible connectors are used to connect a gas meter to downstream piping at mobile homes in mobile home parks, the meter shall be supported by a post or bracket placed in a firm footing or by other means providing equivalent support. [NFPA 54:5.7.3]

**1208.6.3 Meter Protection.** Meters shall be protected against overpressure, backpressure, and vacuum. [NFPA 54-12:5.7.4]

**1208.6.4 Identification.** Gas piping at multiple meter installations shall be marked by a metal tag or other permanent means attached by the installing agency, designating the building or the part of the building being supplied. [NFPA 54:5.7.5]

**1208.7 Gas Pressure Regulators.** A line gas pressure regulator shall be installed where the gas supply pressure exceeds that at which the appliance is designed to operate or varies beyond design pressure limits. [NFPA 54-12:5.8.1]

**1208.7.1 Overpressure Protection.** Where the gas supply design pressure in piping systems located indoors exceeds 2 psi (14 kPa) and line pressure regulators are installed to reduce the supply pressure to 14 inches water column (3.5 kPa) or less, the following shall apply:

(1) Regulators shall be provided with factory installed overpressure protection devices.
(2) Overpressure protection devices shall limit the pressure downstream of the line pressure regulator to 2 psi (14 kPa) in the event of failure of the line pressure regulator. [NFPA 54-12:5.8.3]

**1208.7.2 Listing.** Line gas pressure regulators shall be listed in accordance with CSA Z21.80. [NFPA 54:5.8.2]

**1208.7.3 Location.** The gas pressure regulator shall be accessible for servicing. [NFPA 54:5.8.3]

**1208.7.4 Regulator Protection.** Pressure regulators shall be protected against physical damage. [NFPA 54:5.8.4]

**1208.7.5 Venting.**

**1208.7.5.1 Line Gas Pressure Regulators.** Line gas pressure regulators shall be installed in accordance with the following requirements:

(1) An independent vent to the exterior of the building, sized in accordance with the regulator manufacturer's instructions, shall be provided where the location of a regulator is such that a ruptured diaphragm will cause a hazard. Where more than one regulator is at a location, each regulator shall have a separate vent to the outdoors, or where approved by the Authority Having Jurisdiction, the vent lines shall be permitted to be manifolded in accordance with accepted engineering practices to minimize backpressure in the event of diaphragm failure. Materials for vent piping shall comply with Section 1208.5.

   **Exception:** A regulator and vent limiting means combination listed in accordance with CSA Z21.80 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 will cause blockage.
(3) The regulator vent shall terminate not less than 3 feet (914 mm) from a source of ignition.
(4) At locations where regulators will be submerged during floods, a special antiflood-type breather vent fitting shall be installed, or the vent line shall be extended above the height of the expected flood waters.
(5) A regulator shall not be vented to the appliance flue or exhaust system. [NFPA 54:5.8.5.1]

**1208.7.5.2 Venting of Gas Appliance Pressure Regulators.** Venting of gas appliance pressure regulators shall be in accordance with the following requirements:

(1) Appliance pressure regulators requiring access to the atmosphere for successful operation shall be equipped with vent piping leading outdoors or, where the regulator vent is an integral part of the appliance, 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.

(2) Vent limiting means shall be employed on listed appliance pressure regulators.

(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.

(4) Under no circumstances shall a regulator be vented to the appliance flue or exhaust system.

(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.

(6) Vent lines from a gas appliance pressure regulator and 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 54:9.1.19]

**1208.7.5.3 Discharge of Vents.** The discharge of vents shall be in accordance with the following requirements:

(1) The discharge stacks, vents, or outlet parts of pressure-relieving and pressure-limiting devices shall be located so that gas is safely discharged into the outdoors.

(2) Discharge stacks or vents shall be designed to prevent the entry of water, insects, or other foreign material that could cause blockage. The discharge stack or vent line shall be not less than the same size as the outlet of the pressure-relieving device. [NFPA 54:5.9.7]

**1208.7.6 Bypass Piping.** Valved and regulated bypasses shall be permitted to be placed around gas line pressure regulators where continuity of service is imperative. [NFPA 54:5.8.6]

**1208.7.7 Identification.** Line pressure regulators at multiple regulator installations shall be marked by a metal tag or other permanent means designating the building or the part of the building being supplied. [NFPA 54:5.8.7]

**1208.8 Backpressure Protection.** Protective devices shall be installed as close to the appliance as practical where the design of the appliance connected is such that air, oxygen, or standby gases are capable of being forced into the gas supply system. Gas and air combustion mixers incorporating double diaphragm "zero" or "atmosphere" governors or regulators shall require no further protection unless connected directly to compressed air or oxygen at pressures of 5 psi (34 kPa) or more. [NFPA 54:5.10.1]

**1208.8.1 Protective Devices.** Protective devices shall include, but not be limited to the following:

(1) Check valves.

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

(3) Reverse flow indicators controlling positive shutoff valves.

(4) Normally closed air-actuated positive shutoff pressure regulators. [NFPA 54:5.10.2]

**1208.9 Low-Pressure Protection.** A protective device shall be installed between the meter and the appliance or equipment where the operation of the appliance or equipment is such that it is capable of producing a vacuum or a dangerous reduction in gas pressure at the meter. Such protective devices include, but are not limited to, mechanical, diaphragm-operated, or electrically operated low-pressure shutoff valves. [NFPA 54-12:5.11]

**1208.10 Shutoff Valves.** Shutoff valves shall be approved and shall be selected giving consideration to pressure drop, service involved, emergency use, and reliability of operation. Shutoff valves of size 1 inch (25 mm) National Pipe Thread and smaller shall be listed. [NFPA 54:5.12]

**1208.11 Expansion and Flexibility.** Piping systems shall be designed to prevent failure from thermal expansion or contraction. [NFPA 54-12:5.14.1]

**1208.11.1 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 54:5.14.2]

**1209.0 Excess Flow Valve.**

**1209.1 General.** Where automatic excess flow valves are installed, they shall be listed, sized, and installed in accordance with the manufacturer's installation instructions. [NFPA 54:5.13]

**1210.0 Gas Piping Installation.**

**1210.1 Piping Underground.** Underground gas piping shall be installed with approved clearance from other underground structures 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 approved clearance or shall be insulated from sources of heat so as to prevent the heat from impairing the serviceability of the pipe. [NFPA 54:7.1.1]

**1210.1.1 Cover Requirements.** Underground piping systems shall be installed with a cover not less than 18 inches (457 mm). Where external damage to the pipe is not likely to result, the cover shall be not less than 12 inches (305 mm). Where a cover not less than 12 inches (305 mm) cannot be provided, the pipe shall be installed in conduit or bridged (shielded). [NFPA 54:7.1.2.1]

**1210.1.2 Trenches.** The trench shall be graded so that the pipe has a firm, substantially continuous bearing on the bottom of the trench. [NFPA 54:7.1.2.2]

**1210.1.2.1 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 54:7.1.2.3]

**1210.1.3 Protection Against Corrosion.** Gas piping in contact with earth or other material that is capable of corroding the piping shall be protected against corrosion in an approved manner. Where 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 54:7.1.3]

**1210.1.4 Protection Against Freezing.** Where the formation of hydrates or ice is known to occur, piping shall be protected against freezing. [NFPA 54:7.1.4]

**1210.1.5 Piping Through Foundation Wall.** Underground piping installed through the outer foundation or basement wall of a building shall be encased in a protective sleeve or protected by an approved device or method. The space between the gas piping and the sleeve and between the sleeve and the wall shall be sealed to prevent entry of gas and water. [NFPA 54-12:7.1.5]

**1210.1.6 Piping Underground Beneath Buildings.** Where gas piping is installed underground beneath buildings, the piping shall be either:

(1) Encased in an approved conduit designed to withstand the imposed loads and installed in accordance with Section 1210.1.6.1 or Section 1210.1.6.2.

(2) A piping or encasement system listed for installation beneath buildings. [NFPA 54-12:7.1.6]

**1210.1.6.1 Conduit with One End Terminating Outdoors.** 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 a 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 not less than 4 inches (102 mm) outside the building, be vented outdoors above finished ground level, and be installed so as to prevent the entrance of water and insects. [NFPA 54:7.1.6.1]

**1210.1.6.2 Conduit with Both Ends Terminating Indoors.** Where the conduit originates and terminates within the same building, the conduit shall originate and terminate in an accessible portion of the building and shall not be sealed. [NFPA 54:7.1.6.2]

**1210.1.7 Plastic Piping.** Plastic piping shall be installed outdoors, underground only.

**Exceptions**:

(1) Plastic piping shall be permitted to terminate aboveground where an anodeless riser is used.

(2) Plastic piping shall be permitted to terminate with a wall head adapter aboveground in buildings, including basements, where the plastic piping is inserted in a piping material permitted for use in buildings. [NFPA 54-12:7.1.7.1]

**1210.1.7.1 Connections Between Metallic and Plastic Piping.** Connections made between metallic and plastic piping shall be made with fittings that are in accordance with one of the following:

(1) ASTM D 2513

(2) ASTM F 1973

(3) ASTM F 2509 [NFPA 54:7.1.7.2]

**1210.1.7.2 Tracer Wire.** An electrically continuous corrosion-resistant tracer wire (not less than 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 54:7.1.7.3]

**1210.2 Installation of Piping.** Piping installed aboveground shall be securely supported and located where it will be protected from physical damage. Where passing through an exterior wall, the piping shall be protected against corrosion by coating or wrapping with an inert material approved for such applications. The piping shall be sealed around its circumference at the point of the exterior penetration to prevent the entry of water, insects, and rodents. Where piping is encased in a protective pipe sleeve, the annular spaces between the gas piping and the sleeve and between the sleeve and the wall opening shall be sealed. [NFPA 54-12:7.2.1]

**1210.2.1 Building Structure.** The installation of gas piping shall not cause structural stresses within building components to exceed allowable design limits. Approval shall be obtained before beams or joists are cut or notched. [NFPA 54:7.2.2]

Permission shall be obtained from the Authority Having Jurisdiction.

**1210.2.2 Gas Piping to be Sloped.** Piping for other than dry gas conditions shall be sloped not less than ¼ inch in 15 feet (1.4 mm/m) to prevent traps. [NFPA 54:7.2.4]

**1210.2.2.1 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.

**Exception:** Appliance shutoff valves required by this code shall be permitted to be installed in accessible spaces containing vented appliances.

**1210.2.3 Prohibited Locations.** Gas piping inside a building shall not be installed in or through a clothes chute, chimney or gas vent, dumbwaiter, elevator shaft, or air duct, other than combustion air ducts. [NFPA 54:7.2.5]

**Exception:** Ducts used to provide ventilation air in accordance with Section 506.0 or to above-ceiling spaces in accordance with Section 1210.2.2.1.

**1210.2.4 Hangers, Supports, and Anchors.** Piping shall be supported with metal pipe hooks, metal pipe straps, metal bands, metal brackets, metal hangers, or building structural components; approved for the size of piping; of adequate strength and quality; and located at intervals so as to prevent or damp out excessive vibration. Piping shall be anchored to prevent undue strains on connected appliances and equipment and shall not be supported by other piping. Pipe hangers and supports shall comply with the requirements of MSS SP-58. [NFPA 54:7.2.6.1]

**1210.2.4.1 Spacing.** Spacing of supports in gas piping installations shall not exceed the distance shown in Table 1210.2.4.1. Spacing of supports for CSST shall be in accordance with the CSST manufacturer's instructions. [NFPA 54:7.2.6.2]

**TABLE 1210.2.4.1**
**SUPPORT OF PIPING**
**[NFPA 54: TABLE 7.2.6.2]**

| STEEL PIPE, NOMINAL SIZE OF PIPE (inches) | SPACING OF SUPPORTS (feet) | NOMINAL SIZE OF TUBING SMOOTH-WALL (inches O.D.) | SPACING OF SUPPORTS (feet) |
|---|---|---|---|
| ½ | 6 | ½ | 4 |
| ¾ or 1 | 8 | ⅝ or ¾ | 6 |
| 1¼ or larger (horizontal) | 10 | ⅞ or 1 (horizontal) | 8 |
| 1¼ or larger (vertical) | Every floor level | 1 or larger (vertical) | Every floor level |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm

**1210.2.4.2 Expansion and Contraction.** Supports, hangers, and anchors shall be installed so as not to interfere with the free expansion and contraction of the piping between anchors. Parts of the supporting system shall be designed and installed so they are not disengaged by movement of the supported piping. [NFPA 54:7.2.6.3]

**1210.2.5 Removal of Piping.** Where piping containing gas is to be removed, the line shall be first disconnected from sources of gas and then thoroughly purged with air, water, or inert gas before cutting or welding is done. [NFPA 54-12:7.2.6]

**1210.3 Concealed Piping in Buildings.** Gas piping in concealed locations shall be installed in accordance with this section. [NFPA 54:7.3.1]

**1210.3.1 Connections.** Where gas piping is to be concealed, connections shall be of the following type:

(1) Pipe fittings such as elbows, tees, couplings, and right/left nipple/couplings.

(2) Joining tubing by brazing (see Section 1208.5.8.2). [NFPA 54:7.3.2(2)]

(3) Fittings listed for use in concealed spaces or that have been demonstrated to sustain, without leakage, forces due to temperature expansion or contraction, vibration, or fatigue based on their geographic location, application, or operation. [NFPA 54:7.3.2(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 right/left nipple/coupling.

**1210.3.2 Piping in Partitions.** Concealed gas piping shall not be located in solid partitions. [NFPA 54:7.3.3]

**1210.3.3 Tubing in Partitions.** This provision shall not apply to tubing that pierces walls, floors, or partitions. Tubing installed vertically and horizontally inside hollow walls or partitions without protection along its entire concealed length shall be in accordance with the following requirements:

(1) A steel striker barrier not less than 0.0508 of an inch (1.3 mm) thick, or equivalent, shall be installed between the tubing and the finished wall and extend not less than 4 inches (102 mm) beyond concealed penetrations of plates, firestops, wall studs, and similar construction features.

(2) The tubing shall be installed in single runs and shall not be rigidly secured. [NFPA 54:7.3.4]

**1210.3.4 Piping in Floors.** In industrial occupancies, gas piping in solid floors such as concrete shall be laid in channels in the floor and covered to permit access to the piping with minimum damage to the building. Where piping in floor channels is exposed to excessive moisture or corrosive substances, the piping shall be protected in an approved manner. [NFPA 54:7.3.5.1]

**Exception:** 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 not less than 1½ inches (38 mm) of concrete and shall not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Piping, fittings, and risers shall be protected against corrosion in accordance with Section 1208.5.6. Piping shall not be embedded in concrete slabs containing quick-set additives or cinder aggregate. [NFPA 54:7.3.5.2]

**1210.4 Piping in Vertical Chases.** Where gas piping exceeding 5 psi (34 kPa) is located within vertical chases in accordance with Section 1210.5(2), the requirements of Section 1210.4.1 through Section 1210.4.3 shall apply. [NFPA 54:7.4]

**1210.4.1 Pressure Reduction.** Where pressure reduction is required in branch connections in accordance with Section 1210.5, 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 Section 1208.7.1 and Section 1208.7.5. The regulator shall be accessible for service and repair, and vented in accordance with one of the following:

(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 1 foot (305 mm) of the chase.

(2) Where the fuel gas is heavier than air, the regulator vent shall be vented directly to the outdoors. [NFPA 54:7.4.1]

**1210.4.2 Construction.** Chase construction shall comply with local building codes with respect to fire resistance and protection of horizontal and vertical openings. [NFPA 54:7.4.2]

**1210.4.3 Ventilation.** A chase shall be ventilated to the outdoors and at the top. The openings shall have a minimum free area [in square inches ($m^2$)] equal to the product of one-half of the maximum pressure in the piping [in psi (kPa)] times the largest nominal diameter of that piping [in inches (mm)], 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 54:7.4.3]

**1210.5 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:

(1) The piping system is welded.

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

(3) The piping is located inside buildings or separate areas of buildings used exclusively for one of the following:

(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.

(5) The piping serves appliances or equipment used for agricultural purposes.

(6) The piping system is an LP-Gas piping system with a design operating pressure exceeding 20 psi (138 kPa) and in accordance with NFPA 58. LP-Gas systems designed to operate below -5°F (-21°C) or with butane or a propane-butane mix shall be designed to either accommodate liquid LP-Gas or to prevent LP-Gas vapor from condensing back into liquid. [NFPA 54:5.5]

**1210.5.1 Liquefied Petroleum Gas Systems.** The maximum operating pressure of LP-Gas piping systems shall be:

(1) In accordance with Section 1210.4.1.

(2) In accordance with NFPA 58, where the pressure exceeds 20 psi (138 kPa).

(3) Designed to either accommodate liquid LP-Gas or prevent LP-Gas vapor from condensing back into a liquid in buildings having systems designed to operate below -5°F (-21°C) or with butane or a propane–butane mix.

**1210.6 Appliance Overpressure Protection.** The maximum operating pressure for piping systems serving appliances designed to operate at 14 inches water column (3.5 kPa) inlet pressure or less shall be 2 pounds-force per square inch gauge (psig) (14 kPa) unless an over-pressure protection device designed to limit pressure at the appliance to 2 psig (14 kPa) upon failure of the line gas pressure regulator is installed.

**1210.7 Gas Pipe Turns.** Changes in direction of gas pipe shall be made by the use of fittings, factory bends, or field bends. [NFPA 54:7.5]

**1210.7.1 Metallic Pipe.** Metallic pipe bends shall comply with the following:

(1) Bends shall be made with bending equipment and procedures intended for that purpose.

(2) Bends shall be smooth and free from buckling, cracks, or other evidence of mechanical damage.

(3) The longitudinal weld of the pipe shall be near the neutral axis of the bend.

(4) The pipe shall not be bent through an arc of more than 90 degrees (1.57 rad).

(5) The inside radius of a bend shall be not less than six times the outside diameter of the pipe. [NFPA 54:7.5.1]

**1210.7.2 Plastic Pipe.** Plastic pipe bends shall comply with the following:

(1) The pipe shall not be damaged, and the internal diameter of the pipe shall not be effectively reduced.

(2) Joints shall not be located in pipe bends.

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

(4) Where the piping manufacturer specifies the use of special bending equipment or procedures, such equipment or procedures shall be used. [NFPA 54:7.5.2]

**1210.7.3 Elbows.** Factory-made welding elbows or transverse segments cut therefrom shall have an arc length measured along the crotch of not less than 1 inch (25.4 mm) for pipe sizes 2 inches (50 mm) and larger. [NFPA 54:7.5.3]

**1210.8 Drips and Sediment Traps.**

**1210.8.1 Provide Drips Where Necessary.** For other than dry gas conditions, a drip shall be provided at a point in the line of pipe where condensate is capable of collecting. 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 54:7.6.1]

**1210.8.2 Location of Drips.** Drips shall be installed 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 54:7.6.2]

**1210.8.3 Sediment Traps.** The installation of sediment traps shall comply with Section 1211.8. [NFPA 54-12:7.6.3]

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**1210.9 Outlets.** Outlets shall be located and installed in accordance with the following requirements:

(1) The outlet fittings or piping shall be securely fastened in place.

(2) Outlets shall not be located behind doors.

(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.

(4) The unthreaded portion of gas piping outlets shall extend not less than 1 inch (25.4 mm) through finished ceilings or indoor or outdoor walls.

(5) The unthreaded portion of gas piping outlets shall extend not less than 2 inches (51 mm) above the surface of floors or outdoor patios or slabs.

(6) The provisions of Section 1210.9(4) and Section 1210.9(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 manufacturer's installation instructions. [NFPA 54:7.7.1]

**1210.9.1 Cap Outlets.** 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 appliance is connected thereto. Where an appliance is disconnected from an outlet, and the outlet is not to be used again immediately, it shall be closed gastight.

**Exceptions:**

(1) Laboratory equipment installed in accordance with Section 1211.3.1 shall be permitted.

(2) The use of a listed quick-disconnect device with integral shutoff or listed gas convenience outlet shall be permitted. [NFPA 54:7.7.2.1]

**1210.9.1.1 Appliance Shutoff Valves.** Appliance shutoff valves installed in fireplaces shall be removed and the piping capped gastight where the fireplace is used for solid-fuel burning. [NFPA 54:7.7.2.2]

**1210.10 Branch Pipe Connection.** Where 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 54:7.8]

**1210.11 Manual Gas Shutoff Valves.** 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 54:7.9.1]

**1210.11.1 Valves Controlling Multiple Systems.** Main gas shutoff valves controlling several gas piping systems shall be readily accessible for operation and installed so as to be protected from physical damage. They shall be marked with a metal tag or other permanent means attached by the installing agency so that the gas piping systems supplied through them are readily identified. [NFPA 54:7.9.2.1]

**1210.11.1.1 Shutoff Valves for Multiple House Lines.** In multiple-tenant buildings supplied through a master meter, or through one service regulator where a meter is not provided, or where meters or service regulators are not readily accessible from the equipment location, an individual shutoff valve for each apartment or tenant line shall be provided at a convenient point of general accessibility. In a common system serving a number of individual buildings, shutoff valves shall be installed at each building. [NFPA 54:7.9.2.2]

**1210.11.2 Emergency Shutoff Valves.** An exterior shutoff valve to permit turning off the gas supply to each building in an emergency shall be provided. The emergency shutoff valves shall be plainly marked as such and their locations posted as required by the Authority Having Jurisdiction. [NFPA 54:7.9.2.3]

**1210.11.3 Shutoff Valve for Laboratories.** Each laboratory space containing two or more gas outlets installed on tables, benches, or in hoods in educational, research, commercial and industrial occupancies shall have a single shutoff valve through which such gas outlets are supplied. The shutoff valve shall be accessible and shall be located within the laboratory or located adjacent to the laboratory's egress door and shall be identified. [NFPA 54:7.9.2.4]

**1210.12 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 an allowance in the piping system design has been made for such a device and where approved by the Authority Having Jurisdiction. [NFPA 54:7.10]

**1210.13 Systems Containing Gas-Air Mixtures Outside the Flammable Range.** Where gas-air mixing machines are employed to produce mixtures above or below the flammable range, they shall be provided with stops to prevent adjustment of the mixture to within or approaching the flammable range. [NFPA 54:7.11]

**1210.14 Systems Containing Flammable Gas-Air Mixtures.** Systems containing flammable gas-air mixtures shall be in accordance with NFPA 54.

**1210.15 Electrical Bonding and Grounding.**

**1210.15.1 Pipe and Tubing other than CSST.** Each aboveground portion of a gas piping system other than CSST that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping, other than CSST, shall be considered to be bonded where it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance. [NFPA 54:7.13.1]

**1210.15.2 Bonding of CSST Gas Piping.** CSST gas piping systems shall be bonded to the electrical service grounding electrode system. The bonding jumper shall connect to a metallic pipe or fitting between the point of delivery and the first downstream CSST fitting. The bonding jumper shall be not smaller than 6 AWG copper wire or equivalent. Gas piping systems that contain one or more segments of CSST shall be bonded in accordance with this section. [NFPA 54-12:7.13.2]

**1210.15.3 Grounding Conductor or Electrode.** Gas piping shall not be used as a grounding conductor or electrode. [NFPA 54-12:7.13.3]

**1210.15.4 Lightning Protection System.** Where a lightning protection system is installed, the bonding of the gas piping system shall be in accordance with NFPA 780. [NFPA 54:7.13.4]

**1210.16 Electrical Circuits.** Electrical circuits shall not utilize gas piping or components as conductors.

**Exception:** Low-voltage (50V 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. [NFPA 54:7.14]

**1210.17 Electrical Connections.** Electrical connections between wiring and electrically operated control devices in a piping system shall comply with the requirements of *California Electrical Code.*

**1210.17.1 Safety Control.** An 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 54:7.15.2]

***1210.18 Earthquake-Actuated Gas Shutoff Valves.*** *Earthquake-actuated gas shutoff valves, certified by the State Architect as conforming to California Referenced Standards Code (CRSC), Standard 12-12-1, shall be provided for buildings when such installation is required by local ordinance. Earthquake-actuated gas shutoff valves which have not been certified by the State Architect shall be prohibited in buildings open to the public under mandatory installation by local ordinance.*

*An earthquake-actuated gas shutoff valve is a valve for installation in a gas piping system and designed to automatically shut off the gas at the location of the valve in the event of a seismic disturbance.*

## 1211.0 Appliance Connections to Building Piping.

**1211.1 Connecting Gas Appliances.** Appliances shall be connected to the building piping in accordance with Section 1211.5 through Section 1211.7 by one of the following [NFPA 54:9.6.1]:

(1) Rigid metallic pipe and fittings. [NFPA 54:9.6.1(1)]

(2) Semirigid metallic tubing and metallic fittings. Aluminum alloy tubing shall not be used in exterior locations. [NFPA 54:9.6.1(2)]

(3) A listed connector installed in accordance with CSA Z21.24. The connector shall be installed in accordance with the manufacturer's installation instructions and shall be in the same room as the appliance. One connector shall be installed for each appliance. [NFPA 54:9.6.1(3)]

(4) CSST where installed in accordance with the manufacturer's installation instructions. [NFPA 54:9.6.1(5)]

(5) Listed nonmetallic gas hose connectors installed in accordance with Section 1211.3. [NFPA 54:9.6.1(6)]

(6) Commercial cooking appliances that are moved for cleaning and sanitation purposes shall be installed in accordance with the connector manufacturer's installation instructions using a listed appliance connector in accordance with CSA Z21.69. The commercial cooking appliance connector installation shall be configured in accordance with the manufacturer's installation instructions. [NFPA 54:9.6.1.1]

(7) Movement of appliances with casters shall be limited by a restraining device installed in accordance with the connector and appliance manufacturer's installation instructions. [NFPA 54:9.6.1.2]

(8) In Section 1211.1(2), Section 1211.1(3), and Section 1211.1(5), 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, insulation, or are subject to repeated wettings by such liquids as water (except rainwater), detergents, or sewage. [NFPA 54:9.6.1(7)]

**1211.2 Suspended Low-Intensity Infrared Tube Heaters.** Suspended low-intensity infrared tube heaters shall be connected to the building piping system with a connector listed for the application in accordance with CSA Z21.24 and the following requirements:

(1) The connector shall be installed in accordance with the tube heater installation instructions, and shall be in the same room as the appliance.

(2) One connector shall be used per appliance. [NFPA 54:9.6.1.3]

**1211.3 Use of Nonmetallic Gas Hose Connectors.** Listed nonmetallic gas hose connectors shall be installed in accordance with the manufacturer's installation instructions and in accordance with Section 1211.3.1 and Section 1211.3.2. [NFPA 54:9.6.2]

**1211.3.1 Indoor.** Indoor gas hose connectors shall be used to connect laboratory, shop, and ironing equipment requiring mobility during operation. An appliance shutoff valve shall be installed where the connector is attached to the building piping. The connector shall be of minimum length and shall not exceed 6 feet (1829 mm). The connector shall not be concealed and shall not extend from one room to another or pass through wall partitions, ceilings, or floors. [NFPA 54:9.6.2(1)]

**1211.3.2 Outdoor.** Where outdoor gas hose connectors are used to connect portable outdoor appliances, the connector shall be listed in accordance with CSA Z21.54. An appliance shutoff valve, a listed quick-disconnect device, or a listed gas convenience outlet shall be installed where the connector is attached to the supply piping and in such a manner to prevent the accumulation of water or foreign matter. This connection shall be made only in the outdoor area where the appliance is to be used. [NFPA 54-12:9.6.2(2)]

The connector length shall not exceed 15 feet (4572 mm).

**1211.4 Connection of Portable and Mobile Industrial Gas Appliances.**

**1211.4.1 Flexible Hose.** Where portable industrial appliances, or appliances requiring mobility or subject to vibration, are connected to the building gas piping sys-

tem by the use of a flexible hose, the hose shall be approved and safe for the conditions under which it is used. [NFPA 54:9.6.3.1]

**1211.4.2 Swivel Joints or Couplings.** Where industrial appliances requiring mobility are connected to the rigid piping by the use of swivel joints or couplings, the swivel joints or couplings shall be approved for the service required, and only the minimum number required shall be installed. [NFPA 54:9.6.3.2]

**1211.4.3 Metal Flexible Connectors.** Where industrial appliances subject to vibration are connected to the building piping system by the use of metal flexible connectors, the connectors shall be approved for the service required. [NFPA 54:9.6.3.3]

**1211.4.4 Flexible Connectors.** Where flexible connections are used, they shall be of the minimum practical length and shall not extend from one room to another or pass through walls, partitions, ceilings, or floors. Flexible connections shall not be used in a concealed location. They shall be protected against physical or thermal damage and shall be provided with gas shutoff valves in readily accessible locations in rigid piping upstream from the flexible connections. [NFPA 54:9.6.3.4]

**1211.5 Appliance Shutoff Valves and Connections.** Appliances 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 6 feet (1829 mm) of the appliance 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. Shutoff valves serving decorative gas appliances shall be permitted to be installed in fireplaces where listed for such use. [NFPA 54:9.6.4]

**Exceptions:**

(1) Shutoff valves shall be permitted to be accessibly located inside or under an appliance where such appliance is removed without removal of the shutoff valve.

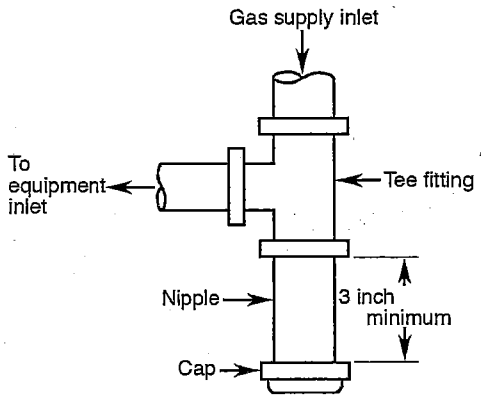
(2) Shutoff valves shall be permitted to be accessibly located inside wall heaters and wall furnaces listed for recessed installation where necessary maintenance is performed without removal of the shutoff valve.

**1211.6 Quick-Disconnect Devices.** Quick-disconnect devices used to connect appliances to the building piping shall be listed. Where installed indoors, an approved manual shutoff valve with a non-displaceable valve member shall be installed upstream of the quick-disconnect device. [NFPA 54:9.6.5]

**1211.7 Gas Convenience Outlets.** Appliances shall be permitted to be connected to the building piping by means of a listed gas convenience outlet, in conjunction with a listed appliance connector, installed in accordance with the manufacturer's installation instructions.

Gas convenience outlets shall be listed in accordance with CSA Z21.90 and installed in accordance with the manufacturer's installation instructions. [NFPA 54:9.6.6]

**1211.8 Sediment Trap.** Where a sediment trap is not incorporated as a part of the appliance, a sediment trap shall be installed downstream of the appliance shutoff valve as close to the inlet of the appliance as practical at the time of appliance installation. The sediment trap shall be either a tee fitting with a capped nipple in the bottom outlet, as illustrated in Figure 1211.8, or other device recognized as an effective sediment trap. Illuminating appliances, ranges, clothes dryers, decorative appliances for installation in vented fireplaces, gas fireplaces, and outdoor grills shall not be required to be so equipped. [NFPA 54:9.6.7]




For SI units: 1 inch = 25.4 mm

**FIGURE 1211.8**
**METHOD OF INSTALLING A TEE FITTING SEDIMENT TRAP**
**[NFPA 54: FIGURE 9.6.7]**

**1211.9 Installation of Piping.** Piping shall be installed in a manner not to interfere with inspection, maintenance, or servicing of the appliance. [NFPA 54:9.6.8]

## 1212.0 Liquefied Petroleum Gas Facilities and Piping.

**1212.1 General.** Liquefied petroleum gas facilities shall comply with NFPA 58.

## 1213.0 Pressure Testing and Inspection.

**1213.1 Piping Installations.** Prior to acceptance and initial operation, piping installations shall be visually inspected and pressure-tested to determine that the materials, design, fabrication, and installation practices are in accordance with the requirements of this code. [NFPA 54-12:8.1.1.1]

**1213.1.1 Inspection Requirements.** Inspection shall consist of visual examination during or after manufacture, fabrication, assembly, or pressure tests. [NFPA 54-12:8.1.1.2]

**1213.1.2 Repairs and Additions.** 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 54:8.1.1.3]

**1213.1.3 New Branches.** Where new branches are installed from the point of delivery to new appliances, 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 54:8.1.1.4]

**1213.1.4 Piping System.** 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 is determined that the valve, including the valve-closing mechanism, is designed to safely withstand the pressure. [NFPA 54:8.1.1.5]

**1213.1.5 Regulators and Valves.** 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 54:8.1.1.6]

**1213.1.6 Test Medium.** The test medium shall be air, nitrogen, carbon dioxide, or an inert gas. OXYGEN SHALL NEVER BE USED. [NFPA 54:8.1.2]

**1213.2 Test Preparation.**

**1213.2.1 Pipe Joints.** Pipe joints, including welds, shall be left exposed for examination during the test.

**Exception:** Covered or concealed pipe end joints that have been previously tested in accordance with this code. [NFPA 54:8.1.3.1]

**1213.2.2 Expansion Joints.** Expansion joints shall be provided with temporary restraints, where required, for the additional thrust load under test. [NFPA 54:8.1.3.2]

**1213.2.3 Appliances and Equipment.** 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 54:8.1.3.3]

**1213.2.4 Designed for (less than) Operating Pressures.** 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 54:8.1.3.4]

**1213.2.5 Designed for (equal to or more than) Operating Pressures.** Where the piping system is connected to appliances or equipment 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 appliance or equipment shutoff valve(s). [NFPA 54:8.1.3.5]

**1213.2.6 Safety.** Testing of piping systems shall be performed in a manner that protects the safety of employees and the public during the test. [NFPA 54-12:8.1.3.6]

**1213.3 Test Pressure.** This inspection shall include an air, $CO_2$, or nitrogen pressure test, at which time the gas piping shall stand a pressure of not less than 10 psi (69 kPa) gauge pressure. Test pressures shall be held for a length of time satisfactory to the Authority Having Jurisdiction, but in no case less than 15 minutes with no perceptible drop in pressure. For welded piping, and for piping carrying gas at pressures in excess of 14 inches water column pressure (3.5 kPa), the test pressure shall be not less than 60 psi (414 kPa) and shall be continued for a length of time satisfactory to the Authority Having Jurisdiction, but in no case for less than 30 minutes. These tests shall be made using air, $CO_2$, or nitrogen pressure and shall be made in the presence of the Authority Having Jurisdiction. Necessary apparatus for conducting tests shall be furnished by the permit holder. Test gauges used in conducting tests shall be in accordance with Section 318.0.

**1213.4 Detection of Leaks and Defects.** The piping system shall withstand the test pressure specified without showing evidence of leakage or other defects. Reduction of test pressures as indicated by pressure gauges shall be deemed to indicate the presence of a leak unless such reduction is readily attributed to some other cause. [NFPA 54:8.1.5.1]

**1213.4.1 Detecting Leaks.** 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 54:8.1.5.2]

**1213.4.2 Repair or Replace.** Where leakage or other defects are located, the affected portion of the piping system shall be repaired or replaced and retested. [NFPA 54-12:8.1.5.3]

**1213.5 Piping System Leak Test.** Leak checks using fuel gas shall be permitted in piping systems that have been pressure-tested in accordance with Section 1213.0. [NFPA 54:8.2.1]

**1213.5.1 Turning Gas On.** During the process of turning gas on into a system of new gas piping, the entire system shall be inspected to determine that there are no open fittings or ends and that valves at unused outlets are closed and plugged or capped. [NFPA 54:8.2.2]

**1213.5.2 Leak Check.** 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 checked for leakage. Where leakage is indicated, the gas supply shall be shut off until the necessary repairs have been made. [NFPA 54:8.2.3]

**1213.5.3 Placing Appliances and Equipment in Operation.** Appliances and equipment shall not be placed in operation until after the piping system has been checked in accordance with Section 1213.5.2; connections to the appliance are checked for leakage; and purged in accordance with Section 1213.6. [NFPA 54-12:8.2.4]

**1213.6 Purging Requirements.** The purging of piping shall be in accordance with Section 1213.6.1 through Section 1213.6.3. [NFPA 54-12:8.3]

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**1213.6.1 Piping Systems Required to be Purged Outdoors.** The purging of piping systems shall be in accordance with the provisions of Section 1213.6.1.1 through Section 1213.6.1.4 where the piping system meets either of the following:

(1) The design operating gas pressure exceeds 2 psig (14 kPa).

(2) The piping being purged contains one or more sections of pipe or tubing meeting the size and length criteria of Table 1213.6.1. [NFPA 54-12:8.3.1]

**TABLE 1213.6.1**
**SIZE AND LENGTH OF PIPING**
**[NFPA 54-12: TABLE 8.3.1]***

| NOMINAL PIPING SIZE (inches) | LENGTH OF PIPING (feet) |
|---|---|
| ≥ 2½ < 3 | > 50 |
| ≥ 3 < 4 | > 30 |
| ≥ 4 < 6 | > 15 |
| ≥ 6 < 8 | > 10 |
| ≥ 8 | Any length |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm

* CSST EHD size of 62 is equivalent to nominal 2 inches (50 mm) pipe or tubing size.

**1213.6.1.1 Removal from Service.** Where existing gas piping is opened, the section that is opened shall be isolated from the gas supply and the line pressure vented in accordance with Section 1213.6.1.3. Where gas piping meeting the criteria of Table 1213.6.1 is removed from service, the residual fuel gas in the piping shall be displaced with an inert gas. [NFPA 54-12:8.3.1.1]

**1213.6.1.2 Placing in Operation.** Where gas piping containing air and meeting the criteria of Table 1213.6.1 is placed in operation, the air in the piping shall first be displaced with an inert gas. The inert gas shall then be displaced with fuel gas in accordance with Section 1213.6.1.3. [NFPA 54-12:8.3.1.2]

**1213.6.1.3 Outdoor Discharge of Purged Gases.** The open end of a piping system being pressure vented or purged shall discharge directly to an outdoor location. Purging operations shall comply with the following requirements:

(1) The point of discharge shall be controlled with a shutoff valve.

(2) The point of discharge shall be located not less than 10 feet (3048 mm) from sources of ignition, not less than 10 feet (3048 mm) from building openings, and not less than 25 feet (7620 mm) from mechanical air intake openings.

(3) During discharge, the open point of discharge shall be continuously attended and monitored with a combustible gas indicator that is in accordance with Section 1213.6.1.4.

(4) Purging operations introducing fuel gas shall be stopped where 90 percent fuel gas by volume is detected within the pipe.

(5) Persons not involved in the purging operations shall be evacuated from areas within 10 feet (3048 mm) of the point of discharge. [NFPA 54-12:8.3.1.3]

**1213.6.1.4 Combustible Gas Indicator.** Combustible gas indicators shall be listed and shall be calibrated in accordance with the manufacturer's instructions. Combustible gas indicators shall numerically display a volume scale from 0 percent to 100 percent in 1 percent or smaller increments. [NFPA 54-12:8.3.1.4]

**1213.6.2 Piping Systems Allowed to be Purged Indoors or Outdoors.** The purging of piping systems shall be in accordance with the provisions of Section 1213.6.2.1 where the piping system meets both of the following:

(1) The design operating pressure is 2 psig (14 kPa) or less.

(2) The piping being purged is constructed entirely from pipe or tubing not meeting the size and length criteria of Table 1213.6.1. [NFPA 54-12:8.3.2]

**1213.6.2.1 Purging Procedure.** The piping system shall be purged in accordance with one or more of the following:

(1) The piping shall be purged with fuel gas and shall discharge to the outdoors.

(2) The piping shall be purged with fuel gas and shall discharge to the indoors or outdoors through an appliance burner not located in a combustion chamber. Such burner shall be provided with a continuous source of ignition.

(3) The piping shall be purged with fuel gas and shall discharge to the indoors or outdoors through a burner that has a continuous source of ignition and that is designed for such purpose.

(4) The piping shall be purged with fuel gas that is discharge to the indoors or outdoors, and the point of discharge shall be monitored with a listed combustible gas deteetor in accordance with Section 1213.6.2.2. Purging shall be stopped where fuel gas is detected.

(5) The piping shall be purged by the gas supplier in accordance with written procedures. [NFPA 54-12:8.3.2.1]

**1213.6.2.2 Combustible Gas Detector.** Combustible gas detectors shall be listed and shall be calibrated or tested in accordance with the manufacturer's instructions. Combustible gas detectors shall be capable of indicating the presence of fuel gas. [NFPA 54-12:8.3.2.2]

**1213.6.3 Purging Appliances and Equipment.** After the piping system has been placed in operation, appli-

ances and equipment shall be purged before being placed into operation. [NFPA 54-12:8.3.3]

**1214.0 Interconnections Between Gas Piping Systems.**

**1214.1 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. [NFPA 54:5.3.1]

**1214.2 Interconnections for Standby Fuels.** Where supplementary gas for standby use is connected downstream from a meter or a service regulator where a meter is not provided, a device to prevent backflow shall be installed. A three-way valve installed to admit the standby supply and at the same time shut off the regular supply shall be permitted to be used for this purpose. [NFPA 54:5.3.2]

**1215.0 Required Gas Supply.**

**1215.1 General.** The following regulations, shall comply with this section and Section 1216.0, shall be the standard for the installation of gas piping. Natural gas regulations and tables are based on the use of gas having a specific gravity of 0.60, supplied at 6 to 8 inches water column (1.5 kPa to 1.9 kPa) pressure at the outlet of the meter or regulator. For undiluted liquefied petroleum gas, gas piping shall be permitted to be sized at 11 inches water column (2.7 kPa) pressure at the outlet of the meter or regulator and specific gravity of 1.50. Where gas of a different specific gravity is to be delivered, the specific gravity conversion factors provided by the serving gas supplier shall be used in sizing piping systems from the pipe sizing tables in this chapter.

**1215.2 Volume.** 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 manufacturer of the appliance or appliances to be connected to each such outlet.

**1215.3 Gas Appliances.** Where the gas appliances to be installed have not been definitely specified, Table 1208.4.1 shall be permitted to be used as a reference to estimate requirements of typical appliances.

To obtain the cubic feet per hour ($m^3/h$) of gas required, divide the input of the appliances by the average Btu (kW•h) heating value per cubic foot ($m^3$) of the gas. The average Btu (kW•h) per cubic foot ($m^3$) of the gas in the area of the installation shall be permitted to be obtained from the serving gas supplier.

**1215.4 Size of Piping Outlets.** The size of the supply piping outlet for a gas appliance shall be not less than ½ of an inch (15 mm).

The size of a piping outlet for a mobile home shall be not less than ¾ of an inch (20 mm).

**1216.0 Required Gas Piping Size.**

**1216.1 Pipe Sizing Methods.** Where the pipe size is to be determined using a method in Section 1216.1.1 through Section 1216.1.3, the diameter of each pipe segment shall be obtained from the pipe sizing tables in Section 1216.2 or from the sizing equations in Section 1216.3. [NFPA 54:6.1]

**1216.1.1 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 (see calculation example in Figure 1216.1.1). [NFPA 54:6.1.1]

**1216.1.2 Branch Length Method.** Pipe shall be sized as follows:

(1) The pipe size of each section of the longest pipe run from the point of delivery to the most remote outlet shall be determined using the longest run of piping and the load of the section.

(2) The pipe size of each section of branch piping not previously sized shall be determined using the length of piping from the point of delivery to the most remote outlet in each branch and the load of the section. [NFPA 54:6.1.2]

**1216.1.3 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 54:6.1.3]

**1216.2 Tables for Sizing Gas Piping Systems.** Table 1216.2(1) through Table 1216.2(36) shall be used to size gas piping in conjunction with one of the methods described in Section 1216.1.1 through Section 1216.1.3. [NFPA 54:6.2]

**1216.3 Sizing Equations.** The inside diameter of smooth-wall pipe or tubing shall be determined by Equation 1216.3(1), Equation 1216.3(2), Table 1216.3, and using the equivalent pipe length determined by Section 1216.1.1 through Section 1216.1.3. [NFPA 54:6.4]

**EQUATION 1216.3(1)**
**LOW-PRESSURE GAS FORMULA (LESS THAN 1.5 psi)**
**[NFPA 54:6.4.1]**

$$D = \frac{Q^{0.381}}{19.17\left(\frac{\Delta H}{Cr \times L}\right)^{0.206}}$$

Where:

$D$ = inside diameter of pipe, inches

$Q$ = input rate appliance(s), cubic feet per hour at 60°F and 30 inch mercury column

$L$ = equivalent length of pipe, feet

$\Delta H$ = pressure drop, inches water column

$Cr$ = in accordance with Table 1216.3

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**EQUATION 1216.3(2)**
**HIGH-PRESSURE GAS FORMULA (1.5 psi AND ABOVE)**
**[NFPA 54:6.4.2]**

$$D = \frac{Q^{0.381}}{18.93\left[\frac{(P_1^2 - P_2^2)\cdot Y}{Cr \times L}\right]^{0.206}}$$

Where:

$D$ = inside diameter of pipe, inches
$Q$ = input rate appliance(s), cubic feet per hour at 60°F and 30 inch mercury column
$P_1$ = upstream pressure, psia ($P_1$ + 14.7)
$P_2$ = downstream pressure, psia ($P_2$ + 14.7)
$L$ = equivalent length of pipe, feet
$Cr$ = in accordance with Table 1216.3
$Y$ = in accordance with Table 1216.3

For SI units: 1 cubic foot = 0.0283 $m^3$, 1000 British thermal units per hour = 0.293 kW, 1 inch = 25 mm, 1 foot = 304.8 mm, 1 pound-force per square inch = 6.8947 kPa, °C = (°F-32)/1.8, 1 inch mercury column = 3.39 kPa, 1 inch water column = 0.249 kPa

**TABLE 1216.3**
***Cr* AND *Y* FOR NATURAL GAS AND UNDILUTED PROPANE AT STANDARD CONDITIONS**
**[NFPA 54: TABLE 6.4.2]**

| GAS | FORMULA FACTORS | |
|---|---|---|
| | *Cr* | *Y* |
| Natural Gas | 0.6094 | 0.9992 |
| Undiluted Propane | 1.2462 | 0.9910 |

**1216.4 Sizing of Piping Sections.** To determine the size of each section of pipe in a system within the range of Table 1216.2(1) through Table 1216.2(36), proceed as follows:

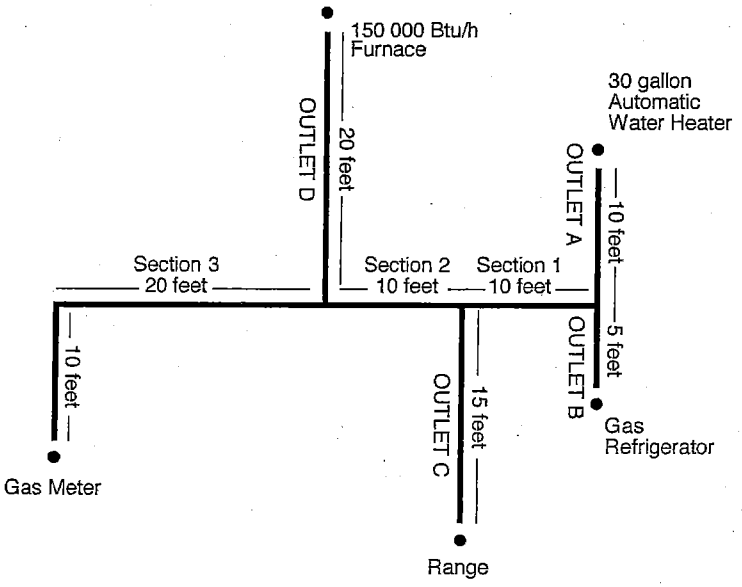
(1) Measure the length of the pipe from the gas meter location to the most remote outlet on the system.
(2) Select the length in feet column and row showing the distance, or the next longer distance where the table does not give the exact length.
(3) Starting at the most remote outlet, find in the row just selected the gas demand for that outlet. Where 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 appliances and the installation prevents both units from operating simultaneously, the larger of the two demand loads needs to 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. Size branch piping in the order of their distance from the meter location, beginning with the most distant outlet not previously sized.

**1216.5 Engineering Methods.** For conditions other than those covered by Section 1216.1, 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 an outlet where full demand is being supplied to all outlets, shall be in accordance with the requirements of Section 1208.4.

**1216.6 Variable Gas Pressure.** Where the gas pressure exceeds 14 inches (3.5 kPa) or less than 6 inches (1.5 kPa) of water column, or where 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 exceeding the serving gas supplier's standard delivery pressure shall have prior verification from the gas supplier of the availability of the design pressure.

**FIGURE 1216.1.1 EXAMPLE ILLUSTRATING USE OF TABLES 1208.4.1 AND 1216.2(1)**

**Problem:** Determine the required pipe size of each section and outlet of the piping system shown in Figure 1216.1.1. Gas to be used has a specific gravity of 0.60 and 1100 British thermal units (Btu) per cubic foot (0.0114 kW•h/L), delivered at 8 inch water column (1.9 kPa) pressure.




For SI units: 1 foot = 304.8 mm, 1 gallon = 3.785 L, 1000 British thermal units per hour = 0.293 kW, 1 cubic foot per hour = 0.0283 $m^3/h$

**Solution:**

(1) Maximum gas demand of Outlet A —
32 cubic feet per hour (0.91 $m^3/h$) (from Table 1208.4.1).
Maximum gas demand of Outlet B —
3 cubic feet per hour (0.08 $m^3/h$) (from Table 1208.4.1).
Maximum gas demand of Outlet C —
59 cubic feet per hour (1.67 $m^3/h$) (from Table 1208.4.1).
Maximum gas demand of Outlet D —
136 cubic feet per hour (3.85 $m^3/h$) [150 000 Btu/hour (44 kW) divided by 1100 Btu per cubic foot (0.0114 kW•h/L)].

(2) The length of pipe from the gas meter to the most remote outlet (Outlet A) is 60 feet (18 288 mm).

(3) Using the length in feet column row marked 60 feet (18 288 mm) in Table 1216.2(1):
Outlet A, supplying 32 cubic feet per hour (0.91 $m^3/h$), requires ½ of an inch (15 mm) pipe.
Section 1, supplying Outlets A and B, or 35 cubic feet per hour (0.99 $m^3/h$) requires ½ of an inch (15 mm) pipe.
Section 2, supplying Outlets A, B, and C, or 94 cubic feet per hour (2.66 $m^3/h$) requires ¾ of an inch (20 mm) pipe.
Section 3, supplying Outlets A, B, C, and D, or 230 cubic feet per hour (6.51 $m^3/h$), requires 1 inch (25 mm) pipe.

(4) Using the column marked 60 feet (18 288 mm) in Table 1216.2(1) [no column for actual length of 55 feet (16 764 mm)]:
Outlet B supplying 3 cubic feet per hour (0.08 $m^3/h$), requires ½ of an inch (15 mm) pipe.
Outlet C, supplying 59 cubic feet per hour (1.67 $m^3/h$), requires ½ of an inch (15 mm) pipe.

(5) Using the column marked 60 feet (18 288 mm) in Table 1216.2(1):
Outlet D, supplying 136 cubic feet per hour (3.85 $m^3/h$), requires ¾ of an inch (20 mm) pipe.

TABLE 1216.2(1)
SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.2(b)][1, 2]

| | | | | | | | | | GAS: | NATURAL | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | INLET PRESSURE: | LESS THAN 2 psi | | | | |
| | | | | | | | | | PRESSURE DROP: | 0.5 in. w.c. | | | | |
| | | | | | | | | | SPECIFIC GRAVITY: | 0.60 | | | | |
| | PIPE SIZE (inch) | | | | | | | | | | | | | |
| NOMINAL: | ½ | ¾ | 1 | 1¼ | 1½ | 2 | 2½ | 3 | 4 | 5 | 6 | 8 | 10 | 12 |
| ACTUAL ID: | 0.622 | 0.824 | 1.049 | 1.380 | 1.610 | 2.067 | 2.469 | 3.068 | 4.026 | 5.047 | 6.065 | 7.981 | 10.020 | 11.938 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | | | | | | |
| 10 | 172 | 360 | 678 | 1390 | 2090 | 4020 | 6400 | 11 300 | 23 100 | 41 800 | 67 600 | 139 000 | 252 000 | 399 000 |
| 20 | 118 | 247 | 466 | 957 | 1430 | 2760 | 4400 | 7780 | 15 900 | 28 700 | 46 500 | 95 500 | 173 000 | 275 000 |
| 30 | 95 | 199 | 374 | 768 | 1150 | 2220 | 3530 | 6250 | 12 700 | 23 000 | 37 300 | 76 700 | 139 000 | 220 000 |
| 40 | 81 | 170 | 320 | 657 | 985 | 1900 | 3020 | 5350 | 10 900 | 19 700 | 31 900 | 65 600 | 119 000 | 189 000 |
| 50 | 72 | 151 | 284 | 583 | 873 | 1680 | 2680 | 4740 | 9660 | 17 500 | 28 300 | 58 200 | 106 000 | 167 000 |
| 60 | 65 | 137 | 257 | 528 | 791 | 1520 | 2430 | 4290 | 8760 | 15 800 | 25 600 | 52 700 | 95 700 | 152 000 |
| 70 | 60 | 126 | 237 | 486 | 728 | 1400 | 2230 | 3950 | 8050 | 14 600 | 23 600 | 48 500 | 88 100 | 139 000 |
| 80 | 56 | 117 | 220 | 452 | 677 | 1300 | 2080 | 3670 | 7490 | 13 600 | 22 000 | 45 100 | 81 900 | 130 000 |
| 90 | 52 | 110 | 207 | 424 | 635 | 1220 | 1950 | 3450 | 7030 | 12 700 | 20 600 | 42 300 | 76 900 | 122 000 |
| 100 | 50 | 104 | 195 | 400 | 600 | 1160 | 1840 | 3260 | 6640 | 12 000 | 19 500 | 40 000 | 72 600 | 115 000 |
| 125 | 44 | 92 | 173 | 355 | 532 | 1020 | 1630 | 2890 | 5890 | 10 600 | 17 200 | 35 400 | 64 300 | 102 000 |
| 150 | 40 | 83 | 157 | 322 | 482 | 928 | 1480 | 2610 | 5330 | 9650 | 15 600 | 32 100 | 58 300 | 92 300 |
| 175 | 37 | 77 | 144 | 296 | 443 | 854 | 1360 | 2410 | 4910 | 8880 | 14 400 | 29 500 | 53 600 | 84 900 |
| 200 | 34 | 71 | 134 | 275 | 412 | 794 | 1270 | 2240 | 4560 | 8260 | 13 400 | 27 500 | 49 900 | 79 000 |
| 250 | 30 | 63 | 119 | 244 | 366 | 704 | 1120 | 1980 | 4050 | 7320 | 11 900 | 24 300 | 44 200 | 70 000 |
| 300 | 27 | 57 | 108 | 221 | 331 | 638 | 1020 | 1800 | 3670 | 6630 | 10 700 | 22 100 | 40 100 | 63 400 |
| 350 | 25 | 53 | 99 | 203 | 305 | 587 | 935 | 1650 | 3370 | 6100 | 9880 | 20 300 | 36 900 | 58 400 |
| 400 | 23 | 49 | 92 | 189 | 283 | 546 | 870 | 1540 | 3140 | 5680 | 9190 | 18 900 | 34 300 | 54 300 |
| 450 | 22 | 46 | 86 | 177 | 266 | 512 | 816 | 1440 | 2940 | 5330 | 8620 | 17 700 | 32 200 | 50 900 |
| 500 | 21 | 43 | 82 | 168 | 251 | 484 | 771 | 1360 | 2780 | 5030 | 8150 | 16 700 | 30 400 | 48 100 |
| 550 | 20 | 41 | 78 | 159 | 239 | 459 | 732 | 1290 | 2640 | 4780 | 7740 | 15 900 | 28 900 | 45 700 |
| 600 | 19 | 39 | 74 | 152 | 228 | 438 | 699 | 1240 | 2520 | 4560 | 7380 | 15 200 | 27 500 | 43 600 |
| 650 | 18 | 38 | 71 | 145 | 218 | 420 | 669 | 1180 | 2410 | 4360 | 7070 | 14 500 | 26 400 | 41 800 |
| 700 | 17 | 36 | 68 | 140 | 209 | 403 | 643 | 1140 | 2320 | 4190 | 6790 | 14 000 | 25 300 | 40 100 |
| 750 | 17 | 35 | 66 | 135 | 202 | 389 | 619 | 1090 | 2230 | 4040 | 6540 | 13 400 | 24 400 | 38 600 |
| 800 | 16 | 34 | 63 | 130 | 195 | 375 | 598 | 1060 | 2160 | 3900 | 6320 | 13 000 | 23 600 | 37 300 |
| 850 | 16 | 33 | 61 | 126 | 189 | 363 | 579 | 1020 | 2090 | 3780 | 6110 | 12 600 | 22 800 | 36 100 |
| 900 | 15 | 32 | 59 | 122 | 183 | 352 | 561 | 992 | 2020 | 3660 | 5930 | 12 200 | 22 100 | 35 000 |
| 950 | 15 | 31 | 58 | 118 | 178 | 342 | 545 | 963 | 1960 | 3550 | 5760 | 11 800 | 21 500 | 34 000 |
| 1000 | 14 | 30 | 56 | 115 | 173 | 333 | 530 | 937 | 1910 | 3460 | 5600 | 11 500 | 20 900 | 33 100 |
| 1100 | 14 | 28 | 53 | 109 | 164 | 316 | 503 | 890 | 1810 | 3280 | 5320 | 10 900 | 19 800 | 31 400 |
| 1200 | 13 | 27 | 51 | 104 | 156 | 301 | 480 | 849 | 1730 | 3130 | 5070 | 10 400 | 18 900 | 30 000 |
| 1300 | 12 | 26 | 49 | 100 | 150 | 289 | 460 | 813 | 1660 | 3000 | 4860 | 9980 | 18 100 | 28 700 |
| 1400 | 12 | 25 | 47 | 96 | 144 | 277 | 442 | 781 | 1590 | 2880 | 4670 | 9590 | 17 400 | 27 600 |
| 1500 | 11 | 24 | 45 | 93 | 139 | 267 | 426 | 752 | 1530 | 2780 | 4500 | 9240 | 16 800 | 26 600 |
| 1600 | 11 | 23 | 44 | 89 | 134 | 258 | 411 | 727 | 1480 | 2680 | 4340 | 8920 | 16 200 | 25 600 |
| 1700 | 11 | 22 | 42 | 86 | 130 | 250 | 398 | 703 | 1430 | 2590 | 4200 | 8630 | 15 700 | 24 800 |
| 1800 | 10 | 22 | 41 | 84 | 126 | 242 | 386 | 682 | 1390 | 2520 | 4070 | 8370 | 15 200 | 24 100 |
| 1900 | 10 | 21 | 40 | 81 | 122 | 235 | 375 | 662 | 1350 | 2440 | 3960 | 8130 | 14 800 | 23 400 |
| 2000 | NA | 20 | 39 | 79 | 119 | 229 | 364 | 644 | 1310 | 2380 | 3850 | 7910 | 14 400 | 22 700 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

**Notes:**

[1] Table entries are rounded to 3 significant digits.

[2] NA means a flow of less than 10 $ft^3/h$ (0.283 $m^3/h$).

**TABLE 1216.2(2)**
**SCHEDULE 40 METALLIC PIPE [NFPA 54-12: TABLE 6.2(c)]***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | GAS: | NATURAL | | |
| | | | | | | INLET PRESSURE: | LESS THAN 2 psi | | |
| | | | | | | PRESSURE DROP: | 3.0 in. w.c. | | |
| | | | | | | SPECIFIC GRAVITY: | 0.60 | | |
| INTENDED USE: INITIAL SUPPLY PRESSURE OF 8.0 IN. W.C. OR GREATER | | | | | | | | | |
| | PIPE SIZE (inch) | | | | | | | | |
| NOMINAL: | ½ | ¾ | 1 | 1¼ | 1½ | 2 | 2½ | 3 | 4 |
| ACTUAL ID: | 0.622 | 0.824 | 1.049 | 1.380 | 1.610 | 2.067 | 2.469 | 3.068 | 4.026 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | |
| 10 | 454 | 949 | 1787 | 3669 | 5497 | 10 588 | 16 875 | 29 832 | 43 678 |
| 20 | 312 | 652 | 1228 | 2522 | 3778 | 7277 | 11 598 | 20 503 | 30 020 |
| 30 | 250 | 524 | 986 | 2025 | 3034 | 5844 | 9314 | 16 465 | 24 107 |
| 40 | 214 | 448 | 844 | 1733 | 2597 | 5001 | 7971 | 14 092 | 20 632 |
| 50 | 190 | 397 | 748 | 1536 | 2302 | 4433 | 7065 | 12 489 | 18 286 |
| 60 | 172 | 360 | 678 | 1392 | 2085 | 4016 | 6401 | 11 316 | 16 569 |
| 70 | 158 | 331 | 624 | 1280 | 1919 | 3695 | 5889 | 10 411 | 15 243 |
| 80 | 147 | 308 | 580 | 1191 | 1785 | 3437 | 5479 | 9685 | 14 181 |
| 90 | 138 | 289 | 544 | 1118 | 1675 | 3225 | 5140 | 9087 | 13 305 |
| 100 | 131 | 273 | 514 | 1056 | 1582 | 3046 | 4856 | 8584 | 12 568 |
| 125 | 116 | 242 | 456 | 936 | 1402 | 2700 | 4303 | 7608 | 11 139 |
| 150 | 105 | 219 | 413 | 848 | 1270 | 2446 | 3899 | 6893 | 10 093 |
| 175 | 96 | 202 | 380 | 780 | 1169 | 2251 | 3587 | 6342 | 9285 |
| 200 | 90 | 188 | 353 | 726 | 1087 | 2094 | 3337 | 5900 | 8638 |
| 250 | 80 | 166 | 313 | 643 | 964 | 1856 | 2958 | 5229 | 7656 |
| 300 | 72 | 151 | 284 | 583 | 873 | 1681 | 2680 | 4738 | 6937 |
| 350 | 66 | 139 | 261 | 536 | 803 | 1547 | 2465 | 4359 | 6382 |
| 400 | 62 | 129 | 243 | 499 | 747 | 1439 | 2294 | 4055 | 5937 |
| 450 | 58 | 121 | 228 | 468 | 701 | 1350 | 2152 | 3804 | 5570 |
| 500 | 55 | 114 | 215 | 442 | 662 | 1275 | 2033 | 3594 | 5262 |
| 550 | 52 | 109 | 204 | 420 | 629 | 1211 | 1931 | 3413 | 4997 |
| 600 | 50 | 104 | 195 | 400 | 600 | 1156 | 1842 | 3256 | 4767 |
| 650 | 47 | 99 | 187 | 384 | 575 | 1107 | 1764 | 3118 | 4565 |
| 700 | 46 | 95 | 179 | 368 | 552 | 1063 | 1695 | 2996 | 4386 |
| 750 | 44 | 92 | 173 | 355 | 532 | 1024 | 1632 | 2886 | 4225 |
| 800 | 42 | 89 | 167 | 343 | 514 | 989 | 1576 | 2787 | 4080 |
| 850 | 41 | 86 | 162 | 332 | 497 | 957 | 1526 | 2697 | 3949 |
| 900 | 40 | 83 | 157 | 322 | 482 | 928 | 1479 | 2615 | 3828 |
| 950 | 39 | 81 | 152 | 312 | 468 | 901 | 1436 | 2539 | 3718 |
| 1000 | 38 | 79 | 148 | 304 | 455 | 877 | 1397 | 2470 | 3616 |
| 1100 | 36 | 75 | 141 | 289 | 432 | 833 | 1327 | 2346 | 3435 |
| 1200 | 34 | 71 | 134 | 275 | 412 | 794 | 1266 | 2238 | 3277 |
| 1300 | 33 | 68 | 128 | 264 | 395 | 761 | 1212 | 2143 | 3138 |
| 1400 | 31 | 65 | 123 | 253 | 379 | 731 | 1165 | 2059 | 3014 |
| 1500 | 30 | 63 | 119 | 244 | 366 | 704 | 1122 | 1983 | 2904 |
| 1600 | 29 | 61 | 115 | 236 | 353 | 680 | 1083 | 1915 | 2804 |
| 1700 | 28 | 59 | 111 | 228 | 342 | 658 | 1048 | 1854 | 2714 |
| 1800 | 27 | 57 | 108 | 221 | 331 | 638 | 1017 | 1797 | 2631 |
| 1900 | 27 | 56 | 105 | 215 | 322 | 619 | 987 | 1745 | 2555 |
| 2000 | 26 | 54 | 102 | 209 | 313 | 602 | 960 | 1698 | 2485 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

* Table entries are rounded to 3 significant digits.

**TABLE 1216.2(3)**
**SCHEDULE 40 METALLIC PIPE [NFPA 54-12: TABLE 6.2(d)]***

| | |
|---|---|
| GAS: | NATURAL |
| INLET PRESSURE: | LESS THAN 2 psi |
| PRESSURE DROP: | 6.0 in. w.c. |
| SPECIFIC GRAVITY: | 0.60 |

INTENDED USE: INITIAL SUPPLY PRESSURE OF 11.0 IN. W.C. OR GREATER

| | PIPE SIZE (inch) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| NOMINAL: | ½ | ¾ | 1 | 1¼ | 1½ | 2 | 2½ | 3 | 4 |
| ACTUAL ID: | 0.622 | 0.824 | 1.049 | 1.380 | 1.610 | 2.067 | 2.469 | 3.068 | 4.026 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | |
| 10 | 660 | 1380 | 2600 | 5338 | 7999 | 15 405 | 24 553 | 43 405 | 63 551 |
| 20 | 454 | 949 | 1787 | 3669 | 5497 | 10 588 | 16 875 | 29 832 | 43 678 |
| 30 | 364 | 762 | 1435 | 2946 | 4415 | 8502 | 13 551 | 23 956 | 35 075 |
| 40 | 312 | 652 | 1228 | 2522 | 3778 | 7277 | 11 598 | 20 503 | 30 020 |
| 50 | 276 | 578 | 1089 | 2235 | 3349 | 6449 | 10 279 | 18 172 | 26 606 |
| 60 | 250 | 524 | 986 | 2025 | 3034 | 5844 | 9314 | 16 465 | 24 107 |
| 70 | 230 | 482 | 907 | 1863 | 2791 | 5376 | 8568 | 15 147 | 22 178 |
| 80 | 214 | 448 | 844 | 1733 | 2597 | 5001 | 7971 | 14 092 | 20 632 |
| 90 | 201 | 420 | 792 | 1626 | 2437 | 4693 | 7479 | 13 222 | 19 359 |
| 100 | 190 | 397 | 748 | 1536 | 2302 | 4433 | 7065 | 12 489 | 18 286 |
| 125 | 168 | 352 | 663 | 1361 | 2040 | 3928 | 6261 | 11 069 | 16 207 |
| 150 | 153 | 319 | 601 | 1234 | 1848 | 3559 | 5673 | 10 029 | 14 684 |
| 175 | 140 | 293 | 553 | 1135 | 1700 | 3275 | 5219 | 9227 | 13 509 |
| 200 | 131 | 273 | 514 | 1056 | 1582 | 3046 | 4856 | 8584 | 12 568 |
| 250 | 116 | 242 | 456 | 936 | 1402 | 2700 | 4303 | 7608 | 11 139 |
| 300 | 105 | 219 | 413 | 848 | 1270 | 2446 | 3899 | 6893 | 10 093 |
| 350 | 96 | 202 | 380 | 780 | 1169 | 2251 | 3587 | 6342 | 9285 |
| 400 | 90 | 188 | 353 | 726 | 1087 | 2094 | 3337 | 5900 | 8638 |
| 450 | 84 | 176 | 332 | 681 | 1020 | 1965 | 3131 | 5535 | 8105 |
| 500 | 80 | 166 | 313 | 643 | 964 | 1856 | 2958 | 5229 | 7656 |
| 550 | 76 | 158 | 297 | 611 | 915 | 1762 | 2809 | 4966 | 7271 |
| 600 | 72 | 151 | 284 | 583 | 873 | 1681 | 2680 | 4738 | 6937 |
| 650 | 69 | 144 | 272 | 558 | 836 | 1610 | 2566 | 4537 | 6643 |
| 700 | 66 | 139 | 261 | 536 | 803 | 1547 | 2465 | 4359 | 6382 |
| 750 | 64 | 134 | 252 | 516 | 774 | 1490 | 2375 | 4199 | 6148 |
| 800 | 62 | 129 | 243 | 499 | 747 | 1439 | 2294 | 4055 | 5937 |
| 850 | 60 | 125 | 235 | 483 | 723 | 1393 | 2220 | 3924 | 5745 |
| 900 | 58 | 121 | 228 | 468 | 701 | 1350 | 2152 | 3804 | 5570 |
| 950 | 56 | 118 | 221 | 454 | 681 | 1311 | 2090 | 3695 | 5410 |
| 1000 | 55 | 114 | 215 | 442 | 662 | 1275 | 2033 | 3594 | 5262 |
| 1100 | 52 | 109 | 204 | 420 | 629 | 1211 | 1931 | 3413 | 4997 |
| 1200 | 50 | 104 | 195 | 400 | 600 | 1156 | 1842 | 3256 | 4767 |
| 1300 | 47 | 99 | 187 | 384 | 575 | 1107 | 1764 | 3118 | 4565 |
| 1400 | 46 | 95 | 179 | 368 | 552 | 1063 | 1695 | 2996 | 4386 |
| 1500 | 44 | 92 | 173 | 355 | 532 | 1024 | 1632 | 2886 | 4225 |
| 1600 | 42 | 89 | 167 | 343 | 514 | 989 | 1576 | 2787 | 4080 |
| 1700 | 41 | 86 | 162 | 332 | 497 | 957 | 1526 | 2697 | 3949 |
| 1800 | 40 | 83 | 157 | 322 | 482 | 928 | 1479 | 2615 | 3828 |
| 1900 | 39 | 81 | 152 | 312 | 468 | 901 | 1436 | 2539 | 3718 |
| 2000 | 38 | 79 | 148 | 304 | 455 | 877 | 1397 | 2470 | 3616 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

* Table entries are rounded to 3 significant digits.

TABLE 1216.2(4)
SCHEDULE 40 METALLIC PIPE [NFPA 54-12; TABLE 6.2(e)]*

| | | | | | | GAS: | NATURAL | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | INLET PRESSURE: | 2.0 psi | | |
| | | | | | | PRESSURE DROP: | 1.0 psi | | |
| | | | | | | SPECIFIC GRAVITY: | 0.60 | | |
| | PIPE SIZE (inch) | | | | | | | | |
| NOMINAL: | ½ | ¾ | 1 | 1¼ | 1½ | 2 | 2½ | 3 | 4 |
| ACTUAL ID: | 0.622 | 0.824 | 1.049 | 1.380 | 1.610 | 2.067 | 2.469 | 3.068 | 4.026 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | |
| 10 | 1510 | 3040 | 5560 | 11 400 | 17 100 | 32 900 | 52 500 | 92 800 | 189 000 |
| 20 | 1070 | 2150 | 3930 | 8070 | 12 100 | 23 300 | 37 100 | 65 600 | 134 000 |
| 30 | 869 | 1760 | 3210 | 6590 | 9880 | 19 000 | 30 300 | 53 600 | 109 000 |
| 40 | 753 | 1520 | 2780 | 5710 | 8550 | 16 500 | 26 300 | 46 400 | 94 700 |
| 50 | 673 | 1360 | 2490 | 5110 | 7650 | 14 700 | 23 500 | 41 500 | 84 700 |
| 60 | 615 | 1240 | 2270 | 4660 | 6980 | 13 500 | 21 400 | 37 900 | 77 300 |
| 70 | 569 | 1150 | 2100 | 4320 | 6470 | 12 500 | 19 900 | 35 100 | 71 600 |
| 80 | 532 | 1080 | 1970 | 4040 | 6050 | 11 700 | 18 600 | 32 800 | 67 000 |
| 90 | 502 | 1010 | 1850 | 3810 | 5700 | 11 000 | 17 500 | 30 900 | 63 100 |
| 100 | 462 | 934 | 1710 | 3510 | 5260 | 10 100 | 16 100 | 28 500 | 58 200 |
| 125 | 414 | 836 | 1530 | 3140 | 4700 | 9060 | 14 400 | 25 500 | 52 100 |
| 150 | 372 | 751 | 1370 | 2820 | 4220 | 8130 | 13 000 | 22 900 | 46 700 |
| 175 | 344 | 695 | 1270 | 2601 | 3910 | 7530 | 12 000 | 21 200 | 43 300 |
| 200 | 318 | 642 | 1170 | 2410 | 3610 | 6960 | 11 100 | 19 600 | 40 000 |
| 250 | 279 | 583 | 1040 | 2140 | 3210 | 6180 | 9850 | 17 400 | 35 500 |
| 300 | 253 | 528 | 945 | 1940 | 2910 | 5600 | 8920 | 15 800 | 32 200 |
| 350 | 232 | 486 | 869 | 1790 | 2670 | 5150 | 8210 | 14 500 | 29 600 |
| 400 | 216 | 452 | 809 | 1660 | 2490 | 4790 | 7640 | 13 500 | 27 500 |
| 450 | 203 | 424 | 759 | 1560 | 2330 | 4500 | 7170 | 12 700 | 25 800 |
| 500 | 192 | 401 | 717 | 1470 | 2210 | 4250 | 6770 | 12 000 | 24 400 |
| 550 | 182 | 381 | 681 | 1400 | 2090 | 4030 | 6430 | 11 400 | 23 200 |
| 600 | 174 | 363 | 650 | 1330 | 2000 | 3850 | 6130 | 10 800 | 22 100 |
| 650 | 166 | 348 | 622 | 1280 | 1910 | 3680 | 5870 | 10 400 | 21 200 |
| 700 | 160 | 334 | 598 | 1230 | 1840 | 3540 | 5640 | 9970 | 20 300 |
| 750 | 154 | 322 | 576 | 1180 | 1770 | 3410 | 5440 | 9610 | 19 600 |
| 800 | 149 | 311 | 556 | 1140 | 1710 | 3290 | 5250 | 9280 | 18 900 |
| 850 | 144 | 301 | 538 | 1100 | 1650 | 3190 | 5080 | 8980 | 18 300 |
| 900 | 139 | 292 | 522 | 1070 | 1600 | 3090 | 4930 | 8710 | 17 800 |
| 950 | 135 | 283 | 507 | 1040 | 1560 | 3000 | 4780 | 8460 | 17 200 |
| 1000 | 132 | 275 | 493 | 1010 | 1520 | 2920 | 4650 | 8220 | 16 800 |
| 1100 | 125 | 262 | 468 | 960 | 1440 | 2770 | 4420 | 7810 | 15 900 |
| 1200 | 119 | 250 | 446 | 917 | 1370 | 2640 | 4220 | 7450 | 15 200 |
| 1300 | 114 | 239 | 427 | 878 | 1320 | 2530 | 4040 | 7140 | 14 600 |
| 1400 | 110 | 230 | 411 | 843 | 1260 | 2430 | 3880 | 6860 | 14 000 |
| 1500 | 106 | 221 | 396 | 812 | 1220 | 2340 | 3740 | 6600 | 13 500 |
| 1600 | 102 | 214 | 382 | 784 | 1180 | 2260 | 3610 | 6380 | 13 000 |
| 1700 | 99 | 207 | 370 | 759 | 1140 | 2190 | 3490 | 6170 | 12 600 |
| 1800 | 96 | 200 | 358 | 736 | 1100 | 2120 | 3390 | 5980 | 12 200 |
| 1900 | 93 | 195 | 348 | 715 | 1070 | 2060 | 3290 | 5810 | 11 900 |
| 2000 | 91 | 189 | 339 | 695 | 1040 | 2010 | 3200 | 5650 | 11 500 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa

* Table entries are rounded to 3 significant digits.

**TABLE 1216.2(5)**
**SCHEDULE 40 METALLIC PIPE [NFPA 54-12: TABLE 6.2(f)]***

| | | | | | | GAS: | NATURAL | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | INLET PRESSURE: | 3.0 psi | | |
| | | | | | | PRESSURE DROP: | 2.0 psi | | |
| | | | | | | SPECIFIC GRAVITY: | 0.60 | | |
| | PIPE SIZE (inch) | | | | | | | | |
| NOMINAL: | ½ | ¾ | 1 | 1¼ | 1½ | 2 | 2½ | 3 | 4 |
| ACTUAL ID: | 0.622 | 0.824 | 1.049 | 1.380 | 1.610 | 2.067 | 2.469 | 3.068 | 4.026 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | |
| 10 | 2350 | 4920 | 9270 | 19 000 | 28 500 | 54 900 | 87 500 | 155 000 | 316 000 |
| 20 | 1620 | 3380 | 6370 | 13 100 | 19 600 | 37 700 | 60 100 | 106 000 | 217 000 |
| 30 | 1300 | 2720 | 5110 | 10 500 | 15 700 | 30 300 | 48 300 | 85 400 | 174 000 |
| 40 | 1110 | 2320 | 4380 | 8990 | 13 500 | 25 900 | 41 300 | 73 100 | 149 000 |
| 50 | 985 | 2060 | 3880 | 7970 | 11 900 | 23 000 | 36 600 | 64 800 | 132 000 |
| 60 | 892 | 1870 | 3520 | 7220 | 10 800 | 20 800 | 33 200 | 58 700 | 120 000 |
| 70 | 821 | 1720 | 3230 | 6640 | 9950 | 19 200 | 30 500 | 54 000 | 110 000 |
| 80 | 764 | 1600 | 3010 | 6180 | 9260 | 17 800 | 28 400 | 50 200 | 102 000 |
| 90 | 717 | 1500 | 2820 | 5800 | 8680 | 16 700 | 26 700 | 47 100 | 96 100 |
| 100 | 677 | 1420 | 2670 | 5470 | 8200 | 15 800 | 25 200 | 44 500 | 90 800 |
| 125 | 600 | 1250 | 2360 | 4850 | 7270 | 14 000 | 22 300 | 39 500 | 80 500 |
| 150 | 544 | 1140 | 2140 | 4400 | 6590 | 12 700 | 20 200 | 35 700 | 72 900 |
| 175 | 500 | 1050 | 1970 | 4040 | 6060 | 11 700 | 18 600 | 32 900 | 67 100 |
| 200 | 465 | 973 | 1830 | 3760 | 5640 | 10 900 | 17 300 | 30 600 | 62 400 |
| 250 | 412 | 862 | 1620 | 3330 | 5000 | 9620 | 15 300 | 27 100 | 55 300 |
| 300 | 374 | 781 | 1470 | 3020 | 4530 | 8720 | 13 900 | 24 600 | 50 100 |
| 350 | 344 | 719 | 1350 | 2780 | 4170 | 8020 | 12 800 | 22 600 | 46 100 |
| 400 | 320 | 669 | 1260 | 2590 | 3870 | 7460 | 11 900 | 21 000 | 42 900 |
| 450 | 300 | 627 | 1180 | 2430 | 3640 | 7000 | 11 200 | 19 700 | 40 200 |
| 500 | 283 | 593 | 1120 | 2290 | 3430 | 6610 | 10 500 | 18 600 | 38 000 |
| 550 | 269 | 563 | 1060 | 2180 | 3260 | 6280 | 10 000 | 17 700 | 36 100 |
| 600 | 257 | 537 | 1010 | 2080 | 3110 | 5990 | 9550 | 16 900 | 34 400 |
| 650 | 246 | 514 | 969 | 1990 | 2980 | 5740 | 9150 | 16 200 | 33 000 |
| 700 | 236 | 494 | 931 | 1910 | 2860 | 5510 | 8790 | 15 500 | 31 700 |
| 750 | 228 | 476 | 897 | 1840 | 2760 | 5310 | 8470 | 15 000 | 30 500 |
| 800 | 220 | 460 | 866 | 1780 | 2660 | 5130 | 8180 | 14 500 | 29 500 |
| 850 | 213 | 445 | 838 | 1720 | 2580 | 4960 | 7910 | 14 000 | 28 500 |
| 900 | 206 | 431 | 812 | 1670 | 2500 | 4810 | 7670 | 13 600 | 27 700 |
| 950 | 200 | 419 | 789 | 1620 | 2430 | 4670 | 7450 | 13 200 | 26 900 |
| 1000 | 195 | 407 | 767 | 1580 | 2360 | 4550 | 7240 | 12 800 | 26 100 |
| 1100 | 185 | 387 | 729 | 1500 | 2240 | 4320 | 6890 | 12 200 | 24 800 |
| 1200 | 177 | 369 | 695 | 1430 | 2140 | 4120 | 6570 | 11 600 | 23 700 |
| 1300 | 169 | 353 | 666 | 1370 | 2050 | 3940 | 6290 | 11 100 | 22 700 |
| 1400 | 162 | 340 | 640 | 1310 | 1970 | 3790 | 6040 | 10 700 | 21 800 |
| 1500 | 156 | 327 | 616 | 1270 | 1900 | 3650 | 5820 | 10 300 | 21 000 |
| 1600 | 151 | 316 | 595 | 1220 | 1830 | 3530 | 5620 | 10 000 | 20 300 |
| 1700 | 146 | 306 | 576 | 1180 | 1770 | 3410 | 5440 | 9610 | 19 600 |
| 1800 | 142 | 296 | 558 | 1150 | 1720 | 3310 | 5270 | 9320 | 19 000 |
| 1900 | 138 | 288 | 542 | 1110 | 1670 | 3210 | 5120 | 9050 | 18 400 |
| 2000 | 134 | 280 | 527 | 1080 | 1620 | 3120 | 4980 | 8800 | 18 000 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa

* Table entries are rounded to 3 significant digits.

**TABLE 1216.2(6)**
**SCHEDULE 40 METALLIC PIPE [NFPA 54-12: TABLE 6.2(g)]***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | GAS: | NATURAL | | |
| | | | | | | INLET PRESSURE: | 5.0 psi | | |
| | | | | | | PRESSURE DROP: | 3.5 psi | | |
| | | | | | | SPECIFIC GRAVITY: | 0.60 | | |
| | PIPE SIZE (inch) | | | | | | | | |
| NOMINAL: | ½ | ¾ | 1 | 1¼ | 1½ | 2 | 2½ | 3 | 4 |
| ACTUAL ID: | 0.622 | 0.824 | 1.049 | 1.380 | 1.610 | 2.067 | 2.469 | 3.068 | 4.026 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | |
| 10 | 3190 | 6430 | 11 800 | 24 200 | 36 200 | 69 700 | 111 000 | 196 000 | 401 000 |
| 20 | 2250 | 4550 | 8320 | 17 100 | 25 600 | 49 300 | 78 600 | 139 000 | 283 000 |
| 30 | 1840 | 3720 | 6790 | 14 000 | 20 900 | 40 300 | 64 200 | 113 000 | 231 000 |
| 40 | 1590 | 3220 | 5880 | 12 100 | 18 100 | 34 900 | 55 600 | 98 200 | 200 000 |
| 50 | 1430 | 2880 | 5260 | 10 800 | 16 200 | 31 200 | 49 700 | 87 900 | 179 000 |
| 60 | 1300 | 2630 | 4800 | 9860 | 14 800 | 28 500 | 45 400 | 80 200 | 164 000 |
| 70 | 1200 | 2430 | 4450 | 9130 | 13 700 | 26 400 | 42 000 | 74 300 | 151 000 |
| 80 | 1150 | 2330 | 4260 | 8540 | 12 800 | 24 700 | 39 300 | 69 500 | 142 000 |
| 90 | 1060 | 2150 | 3920 | 8050 | 12 100 | 23 200 | 37 000 | 65 500 | 134 000 |
| 100 | 979 | 1980 | 3620 | 7430 | 11 100 | 21 400 | 34 200 | 60 400 | 123 000 |
| 125 | 876 | 1770 | 3240 | 6640 | 9950 | 19 200 | 30 600 | 54 000 | 110 000 |
| 150 | 786 | 1590 | 2910 | 5960 | 8940 | 17 200 | 27 400 | 48 500 | 98 900 |
| 175 | 728 | 1470 | 2690 | 5520 | 8270 | 15 900 | 25 400 | 44 900 | 91 600 |
| 200 | 673 | 1360 | 2490 | 5100 | 7650 | 14 700 | 23 500 | 41 500 | 84 700 |
| 250 | 558 | 1170 | 2200 | 4510 | 6760 | 13 000 | 20 800 | 36 700 | 74 900 |
| 300 | 506 | 1060 | 1990 | 4090 | 6130 | 11 800 | 18 800 | 33 300 | 67 800 |
| 350 | 465 | 973 | 1830 | 3760 | 5640 | 10 900 | 17 300 | 30 600 | 62 400 |
| 400 | 433 | 905 | 1710 | 3500 | 5250 | 10 100 | 16 100 | 28 500 | 58 100 |
| 450 | 406 | 849 | 1600 | 3290 | 4920 | 9480 | 15 100 | 26 700 | 54 500 |
| 500 | 384 | 802 | 1510 | 3100 | 4650 | 8950 | 14 300 | 25 200 | 51 500 |
| 550 | 364 | 762 | 1440 | 2950 | 4420 | 8500 | 13 600 | 24 000 | 48 900 |
| 600 | 348 | 727 | 1370 | 2810 | 4210 | 8110 | 12 900 | 22 900 | 46 600 |
| 650 | 333 | 696 | 1310 | 2690 | 4030 | 7770 | 12 400 | 21 900 | 44 600 |
| 700 | 320 | 669 | 1260 | 2590 | 3880 | 7460 | 11 900 | 21 000 | 42 900 |
| 750 | 308 | 644 | 1210 | 2490 | 3730 | 7190 | 11 500 | 20 300 | 41 300 |
| 800 | 298 | 622 | 1170 | 2410 | 3610 | 6940 | 11 100 | 19 600 | 39 900 |
| 850 | 288 | 602 | 1130 | 2330 | 3490 | 6720 | 10 700 | 18 900 | 38 600 |
| 900 | 279 | 584 | 1100 | 2260 | 3380 | 6520 | 10 400 | 18 400 | 37 400 |
| 950 | 271 | 567 | 1070 | 2190 | 3290 | 6330 | 10 100 | 17 800 | 36 400 |
| 1000 | 264 | 551 | 1040 | 2130 | 3200 | 6150 | 9810 | 17 300 | 35 400 |
| 1100 | 250 | 524 | 987 | 2030 | 3030 | 5840 | 9320 | 16 500 | 33 600 |
| 1200 | 239 | 500 | 941 | 1930 | 2900 | 5580 | 8890 | 15 700 | 32 000 |
| 1300 | 229 | 478 | 901 | 1850 | 2770 | 5340 | 8510 | 15 000 | 30 700 |
| 1400 | 220 | 460 | 866 | 1780 | 2660 | 5130 | 8180 | 14 500 | 29 500 |
| 1500 | 212 | 443 | 834 | 1710 | 2570 | 4940 | 7880 | 13 900 | 28 400 |
| 1600 | 205 | 428 | 806 | 1650 | 2480 | 4770 | 7610 | 13 400 | 27 400 |
| 1700 | 198 | 414 | 780 | 1600 | 2400 | 4620 | 7360 | 13 000 | 26 500 |
| 1800 | 192 | 401 | 756 | 1550 | 2330 | 4480 | 7140 | 12 600 | 25 700 |
| 1900 | 186 | 390 | 734 | 1510 | 2260 | 4350 | 6930 | 12 300 | 25 000 |
| 2000 | 181 | 379 | 714 | 1470 | 2200 | 4230 | 6740 | 11 900 | 24 300 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa

* Table entries are rounded to 3 significant digits.

**TABLE 1216.2(7)**
**SEMI-RIGID COPPER TUBING [NFPA 54-12: TABLE 6.2(h)][1, 2]**

| | | | | | | | GAS: | NATURAL | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | INLET PRESSURE: | LESS THAN 2 psi | | |
| | | | | | | | PRESSURE DROP: | 0.3 in. w.c. | | |
| | | | | | | | SPECIFIC GRAVITY: | 0.60 | | |
| | | TUBE SIZE (inch) | | | | | | | | |
| NOMINAL: | K & L: | ¼ | ⅜ | ½ | ⅝ | ¾ | 1 | 1¼ | 1½ | 2 |
| | ACR: | ⅜ | ½ | ⅝ | ¾ | ⅞ | 1⅛ | 1⅜ | – | – |
| OUTSIDE: | | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 |
| INSIDE:[3] | | 0.305 | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.245 | 1.481 | 1.959 |
| LENGTH (feet) | | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | |
| 10 | | 20 | 42 | 85 | 148 | 210 | 448 | 806 | 1270 | 2650 |
| 20 | | 14 | 29 | 58 | 102 | 144 | 308 | 554 | 873 | 1820 |
| 30 | | 11 | 23 | 47 | 82 | 116 | 247 | 445 | 701 | 1460 |
| 40 | | 10 | 20 | 40 | 70 | 99 | 211 | 381 | 600 | 1250 |
| 50 | | NA | 17 | 35 | 62 | 88 | 187 | 337 | 532 | 1110 |
| 60 | | NA | 16 | 32 | 56 | 79 | 170 | 306 | 482 | 1000 |
| 70 | | NA | 14 | 29 | 52 | 73 | 156 | 281 | 443 | 924 |
| 80 | | NA | 13 | 27 | 48 | 68 | 145 | 262 | 413 | 859 |
| 90 | | NA | 13 | 26 | 45 | 64 | 136 | 245 | 387 | 806 |
| 100 | | NA | 12 | 24 | 43 | 60 | 129 | 232 | 366 | 761 |
| 125 | | NA | 11 | 22 | 38 | 53 | 114 | 206 | 324 | 675 |
| 150 | | NA | 10 | 20 | 34 | 48 | 103 | 186 | 294 | 612 |
| 175 | | NA | NA | 18 | 31 | 45 | 95 | 171 | 270 | 563 |
| 200 | | NA | NA | 17 | 29 | 41 | 89 | 159 | 251 | 523 |
| 250 | | NA | NA | 15 | 26 | 37 | 78 | 141 | 223 | 464 |
| 300 | | NA | NA | 13 | 23 | 33 | 71 | 128 | 202 | 420 |
| 350 | | NA | NA | 12 | 22 | 31 | 65 | 118 | 186 | 387 |
| 400 | | NA | NA | 11 | 20 | 28 | 61 | 110 | 173 | 360 |
| 450 | | NA | NA | 11 | 19 | 27 | 57 | 103 | 162 | 338 |
| 500 | | NA | NA | 10 | 18 | 25 | 54 | 97 | 153 | 319 |
| 550 | | NA | NA | NA | 17 | 24 | 51 | 92 | 145 | 303 |
| 600 | | NA | NA | NA | 16 | 23 | 49 | 88 | 139 | 289 |
| 650 | | NA | NA | NA | 15 | 22 | 47 | 84 | 133 | 277 |
| 700 | | NA | NA | NA | 15 | 21 | 45 | 81 | 128 | 266 |
| 750 | | NA | NA | NA | 14 | 20 | 43 | 78 | 123 | 256 |
| 800 | | NA | NA | NA | 14 | 20 | 42 | 75 | 119 | 247 |
| 850 | | NA | NA | NA | 13 | 19 | 40 | 73 | 115 | 239 |
| 900 | | NA | NA | NA | 13 | 18 | 39 | 71 | 111 | 232 |
| 950 | | NA | NA | NA | 13 | 18 | 38 | 69 | 108 | 225 |
| 1000 | | NA | NA | NA | 12 | 17 | 37 | 67 | 105 | 219 |
| 1100 | | NA | NA | NA | 12 | 16 | 35 | 63 | 100 | 208 |
| 1200 | | NA | NA | NA | 11 | 16 | 34 | 60 | 95 | 199 |
| 1300 | | NA | NA | NA | 11 | 15 | 32 | 58 | 91 | 190 |
| 1400 | | NA | NA | NA | 10 | 14 | 31 | 56 | 88 | 183 |
| 1500 | | NA | NA | NA | NA | 14 | 30 | 54 | 84 | 176 |
| 1600 | | NA | NA | NA | NA | 13 | 29 | 52 | 82 | 170 |
| 1700 | | NA | NA | NA | NA | 13 | 28 | 50 | 79 | 164 |
| 1800 | | NA | NA | NA | NA | 13 | 27 | 49 | 77 | 159 |
| 1900 | | NA | NA | NA | NA | 12 | 26 | 47 | 74 | 155 |
| 2000 | | NA | NA | NA | NA | 12 | 25 | 46 | 72 | 151 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

**Notes:**

[1] Table entries are rounded to 3 significant digits.

[2] NA means a flow of less than 10 $ft^3/h$ (0.283 $m^3/h$).

[3] Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

**TABLE 1216.2(8)**
**SEMI-RIGID COPPER TUBING [NFPA 54-12: TABLE 6.2(i)][1, 2]**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | GAS: | NATURAL | | |
| | | | | | | | INLET PRESSURE: | LESS THAN 2 psi | | |
| | | | | | | | PRESSURE DROP: | 0.5 in. w.c. | | |
| | | | | | | | SPECIFIC GRAVITY: | 0.60 | | |
| | | TUBE SIZE (inch) | | | | | | | | |
| NOMINAL: | K & L: | ¼ | ⅜ | ½ | ⅝ | ¾ | 1 | 1¼ | 1½ | 2 |
| | ACR: | ⅜ | ½ | ⅝ | ¾ | ⅞ | 1⅛ | 1⅜ | – | – |
| OUTSIDE: | | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 |
| INSIDE:[3] | | 0.305 | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.245 | 1.481 | 1.959 |
| LENGTH (feet) | | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | |
| 10 | | 27 | 55 | 111 | 195 | 276 | 590 | 1060 | 1680 | 3490 |
| 20 | | 18 | 38 | 77 | 134 | 190 | 406 | 730 | 1150 | 2400 |
| 30 | | 15 | 30 | 61 | 107 | 152 | 326 | 586 | 925 | 1930 |
| 40 | | 13 | 26 | 53 | 92 | 131 | 279 | 502 | 791 | 1650 |
| 50 | | 11 | 23 | 47 | 82 | 116 | 247 | 445 | 701 | 1460 |
| 60 | | 10 | 21 | 42 | 74 | 105 | 224 | 403 | 635 | 1320 |
| 70 | | NA | 19 | 39 | 68 | 96 | 206 | 371 | 585 | 1220 |
| 80 | | NA | 18 | 36 | 63 | 90 | 192 | 345 | 544 | 1130 |
| 90 | | NA | 17 | 34 | 59 | 84 | 180 | 324 | 510 | 1060 |
| 100 | | NA | 16 | 32 | 56 | 79 | 170 | 306 | 482 | 1000 |
| 125 | | NA | 14 | 28 | 50 | 70 | 151 | 271 | 427 | 890 |
| 150 | | NA | 13 | 26 | 45 | 64 | 136 | 245 | 387 | 806 |
| 175 | | NA | 12 | 24 | 41 | 59 | 125 | 226 | 356 | 742 |
| 200 | | NA | 11 | 22 | 39 | 55 | 117 | 210 | 331 | 690 |
| 250 | | NA | NA | 20 | 34 | 48 | 103 | 186 | 294 | 612 |
| 300 | | NA | NA | 18 | 31 | 44 | 94 | 169 | 266 | 554 |
| 350 | | NA | NA | 16 | 28 | 40 | 86 | 155 | 245 | 510 |
| 400 | | NA | NA | 15 | 26 | 38 | 80 | 144 | 228 | 474 |
| 450 | | NA | NA | 14 | 25 | 35 | 75 | 135 | 214 | 445 |
| 500 | | NA | NA | 13 | 23 | 33 | 71 | 128 | 202 | 420 |
| 550 | | NA | NA | 13 | 22 | 32 | 68 | 122 | 192 | 399 |
| 600 | | NA | NA | 12 | 21 | 30 | 64 | 116 | 183 | 381 |
| 650 | | NA | NA | 12 | 20 | 29 | 62 | 111 | 175 | 365 |
| 700 | | NA | NA | 11 | 20 | 28 | 59 | 107 | 168 | 350 |
| 750 | | NA | NA | 11 | 19 | 27 | 57 | 103 | 162 | 338 |
| 800 | | NA | NA | 10 | 18 | 26 | 55 | 99 | 156 | 326 |
| 850 | | NA | NA | 10 | 18 | 25 | 53 | 96 | 151 | 315 |
| 900 | | NA | NA | NA | 17 | 24 | 52 | 93 | 147 | 306 |
| 950 | | NA | NA | NA | 17 | 24 | 50 | 90 | 143 | 297 |
| 1000 | | NA | NA | NA | 16 | 23 | 49 | 88 | 139 | 289 |
| 1100 | | NA | NA | NA | 15 | 22 | 46 | 84 | 132 | 274 |
| 1200 | | NA | NA | NA | 15 | 21 | 44 | 80 | 126 | 262 |
| 1300 | | NA | NA | NA | 14 | 20 | 42 | 76 | 120 | 251 |
| 1400 | | NA | NA | NA | 13 | 19 | 41 | 73 | 116 | 241 |
| 1500 | | NA | NA | NA | 13 | 18 | 39 | 71 | 111 | 232 |
| 1600 | | NA | NA | NA | 13 | 18 | 38 | 68 | 108 | 224 |
| 1700 | | NA | NA | NA | 12 | 17 | 37 | 66 | 104 | 217 |
| 1800 | | NA | NA | NA | 12 | 17 | 36 | 64 | 101 | 210 |
| 1900 | | NA | NA | NA | 11 | 16 | 35 | 62 | 98 | 204 |
| 2000 | | NA | NA | NA | 11 | 16 | 34 | 60 | 95 | 199 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

Notes:

[1] Table entries are rounded to 3 significant digits.

[2] NA means a flow of less than 10 $ft^3/h$ (0.283 $m^3/h$).

[3] Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

**TABLE 1216.2(9)**
**SEMI-RIGID COPPER TUBING [NFPA 54-12: TABLE 6.2(j)][1, 2]**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | GAS: | NATURAL | | |
| | | | | | | | INLET PRESSURE: | LESS THAN 2 psi | | |
| | | | | | | | PRESSURE DROP: | 1.0 in. w.c. | | |
| | | | | | | | SPECIFIC GRAVITY: | 0.60 | | |
| INTENDED USE: TUBE SIZING BETWEEN HOUSE LINE REGULATOR AND THE APPLIANCE | | | | | | | | | | |
| | | TUBE SIZE (inch) | | | | | | | | |
| NOMINAL: | K & L: | ¼ | ⅜ | ½ | ⅝ | ¾ | 1 | 1¼ | 1½ | 2 |
| | ACR: | ⅜ | ½ | ⅝ | ¾ | ⅞ | 1⅛ | 1⅜ | – | – |
| OUTSIDE: | | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 |
| INSIDE:[3] | | 0.305 | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.245 | 1.481 | 1.959 |
| LENGTH (feet) | | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | |
| 10 | | 39 | 80 | 162 | 283 | 402 | 859 | 1550 | 2440 | 5080 |
| 20 | | 27 | 55 | 111 | 195 | 276 | 590 | 1060 | 1680 | 3490 |
| 30 | | 21 | 44 | 89 | 156 | 222 | 474 | 853 | 1350 | 2800 |
| 40 | | 18 | 38 | 77 | 134 | 190 | 406 | 730 | 1150 | 2400 |
| 50 | | 16 | 33 | 68 | 119 | 168 | 359 | 647 | 1020 | 2130 |
| 60 | | 15 | 30 | 61 | 107 | 152 | 326 | 586 | 925 | 1930 |
| 70 | | 13 | 28 | 57 | 99 | 140 | 300 | 539 | 851 | 1770 |
| 80 | | 13 | 26 | 53 | 92 | 131 | 279 | 502 | 791 | 1650 |
| 90 | | 12 | 24 | 49 | 86 | 122 | 262 | 471 | 742 | 1550 |
| 100 | | 11 | 23 | 47 | 82 | 116 | 247 | 445 | 701 | 1460 |
| 125 | | NA | 20 | 41 | 72 | 103 | 219 | 394 | 622 | 1290 |
| 150 | | NA | 18 | 37 | 65 | 93 | 198 | 357 | 563 | 1170 |
| 175 | | NA | 17 | 34 | 60 | 85 | 183 | 329 | 518 | 1080 |
| 200 | | NA | 16 | 32 | 56 | 79 | 170 | 306 | 482 | 1000 |
| 250 | | NA | 14 | 28 | 50 | 70 | 151 | 271 | 427 | 890 |
| 300 | | NA | 13 | 26 | 45 | 64 | 136 | 245 | 387 | 806 |
| 350 | | NA | 12 | 24 | 41 | 59 | 125 | 226 | 356 | 742 |
| 400 | | NA | 11 | 22 | 39 | 55 | 117 | 210 | 331 | 690 |
| 450 | | NA | 10 | 21 | 36 | 51 | 110 | 197 | 311 | 647 |
| 500 | | NA | NA | 20 | 34 | 48 | 103 | 186 | 294 | 612 |
| 550 | | NA | NA | 19 | 32 | 46 | 98 | 177 | 279 | 581 |
| 600 | | NA | NA | 18 | 31 | 44 | 94 | 169 | 266 | 554 |
| 650 | | NA | NA | 17 | 30 | 42 | 90 | 162 | 255 | 531 |
| 700 | | NA | NA | 16 | 28 | 40 | 86 | 155 | 245 | 510 |
| 750 | | NA | NA | 16 | 27 | 39 | 83 | 150 | 236 | 491 |
| 800 | | NA | NA | 15 | 26 | 38 | 80 | 144 | 228 | 474 |
| 850 | | NA | NA | 15 | 26 | 36 | 78 | 140 | 220 | 459 |
| 900 | | NA | NA | 14 | 25 | 35 | 75 | 135 | 214 | 445 |
| 950 | | NA | NA | 14 | 24 | 34 | 73 | 132 | 207 | 432 |
| 1000 | | NA | NA | 13 | 23 | 33 | 71 | 128 | 202 | 420 |
| 1100 | | NA | NA | 13 | 22 | 32 | 68 | 122 | 192 | 399 |
| 1200 | | NA | NA | 12 | 21 | 30 | 64 | 116 | 183 | 381 |
| 1300 | | NA | NA | 12 | 20 | 29 | 62 | 111 | 175 | 365 |
| 1400 | | NA | NA | 11 | 20 | 28 | 59 | 107 | 168 | 350 |
| 1500 | | NA | NA | 11 | 19 | 27 | 57 | 103 | 162 | 338 |
| 1600 | | NA | NA | 10 | 18 | 26 | 55 | 99 | 156 | 326 |
| 1700 | | NA | NA | 10 | 18 | 25 | 53 | 96 | 151 | 315 |
| 1800 | | NA | NA | NA | 17 | 24 | 52 | 93 | 147 | 306 |
| 1900 | | NA | NA | NA | 17 | 24 | 50 | 90 | 143 | 297 |
| 2000 | | NA | NA | NA | 16 | 23 | 49 | 88 | 139 | 289 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

**Notes:**

[1] Table entries are rounded to 3 significant digits.

[2] NA means a flow of less than 10 $ft^3/h$ (0.283 $m^3/h$).

[3] Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

**TABLE 1216.2(10)**
**SEMI-RIGID COPPER TUBING [NFPA 54-12: TABLE 6.2(k)][2]**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | GAS: | NATURAL | | |
| | | | | | | | INLET PRESSURE: | LESS THAN 2 psi | | |
| | | | | | | | PRESSURE DROP: | 17.0 in. w.c. | | |
| | | | | | | | SPECIFIC GRAVITY: | 0.60 | | |
| | | TUBE SIZE (inch) | | | | | | | | |
| NOMINAL: | K & L: | ¼ | ⅜ | ½ | ⅝ | ¾ | 1 | 1¼ | 1½ | 2 |
| | ACR: | ⅜ | ½ | ⅝ | ¾ | ⅞ | 1⅛ | 1⅜ | – | – |
| OUTSIDE: | | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 |
| INSIDE:[1] | | 0.305 | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.245 | 1.481 | 1.959 |
| LENGTH (feet) | | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | |
| 10 | | 190 | 391 | 796 | 1390 | 1970 | 4220 | 7590 | 12 000 | 24 900 |
| 20 | | 130 | 269 | 547 | 956 | 1360 | 2900 | 5220 | 8230 | 17 100 |
| 30 | | 105 | 216 | 439 | 768 | 1090 | 2330 | 4190 | 6610 | 13 800 |
| 40 | | 90 | 185 | 376 | 657 | 932 | 1990 | 3590 | 5650 | 11 800 |
| 50 | | 79 | 164 | 333 | 582 | 826 | 1770 | 3180 | 5010 | 10 400 |
| 60 | | 72 | 148 | 302 | 528 | 749 | 1600 | 2880 | 4540 | 9460 |
| 70 | | 66 | 137 | 278 | 486 | 689 | 1470 | 2650 | 4180 | 8700 |
| 80 | | 62 | 127 | 258 | 452 | 641 | 1370 | 2460 | 3890 | 8090 |
| 90 | | 58 | 119 | 243 | 424 | 601 | 1280 | 2310 | 3650 | 7590 |
| 100 | | 55 | 113 | 229 | 400 | 568 | 1210 | 2180 | 3440 | 7170 |
| 125 | | 48 | 100 | 203 | 355 | 503 | 1080 | 1940 | 3050 | 6360 |
| 150 | | 44 | 90 | 184 | 321 | 456 | 974 | 1750 | 2770 | 5760 |
| 175 | | 40 | 83 | 169 | 296 | 420 | 896 | 1610 | 2540 | 5300 |
| 200 | | 38 | 77 | 157 | 275 | 390 | 834 | 1500 | 2370 | 4930 |
| 250 | | 33 | 69 | 140 | 244 | 346 | 739 | 1330 | 2100 | 4370 |
| 300 | | 30 | 62 | 126 | 221 | 313 | 670 | 1210 | 1900 | 3960 |
| 350 | | 28 | 57 | 116 | 203 | 288 | 616 | 1110 | 1750 | 3640 |
| 400 | | 26 | 53 | 108 | 189 | 268 | 573 | 1030 | 1630 | 3390 |
| 450 | | 24 | 50 | 102 | 177 | 252 | 538 | 968 | 1530 | 3180 |
| 500 | | 23 | 47 | 96 | 168 | 238 | 508 | 914 | 1440 | 3000 |
| 550 | | 22 | 45 | 91 | 159 | 226 | 482 | 868 | 1370 | 2850 |
| 600 | | 21 | 43 | 87 | 152 | 215 | 460 | 829 | 1310 | 2720 |
| 650 | | 20 | 41 | 83 | 145 | 206 | 441 | 793 | 1250 | 2610 |
| 700 | | 19 | 39 | 80 | 140 | 198 | 423 | 762 | 1200 | 2500 |
| 750 | | 18 | 38 | 77 | 135 | 191 | 408 | 734 | 1160 | 2410 |
| 800 | | 18 | 37 | 74 | 130 | 184 | 394 | 709 | 1120 | 2330 |
| 850 | | 17 | 35 | 72 | 126 | 178 | 381 | 686 | 1080 | 2250 |
| 900 | | 17 | 34 | 70 | 122 | 173 | 370 | 665 | 1050 | 2180 |
| 950 | | 16 | 33 | 68 | 118 | 168 | 359 | 646 | 1020 | 2120 |
| 1000 | | 16 | 32 | 66 | 115 | 163 | 349 | 628 | 991 | 2060 |
| 1100 | | 15 | 31 | 63 | 109 | 155 | 332 | 597 | 941 | 1960 |
| 1200 | | 14 | 29 | 60 | 104 | 148 | 316 | 569 | 898 | 1870 |
| 1300 | | 14 | 28 | 57 | 100 | 142 | 303 | 545 | 860 | 1790 |
| 1400 | | 13 | 27 | 55 | 96 | 136 | 291 | 524 | 826 | 1720 |
| 1500 | | 13 | 26 | 53 | 93 | 131 | 280 | 505 | 796 | 1660 |
| 1600 | | 12 | 25 | 51 | 89 | 127 | 271 | 487 | 768 | 1600 |
| 1700 | | 12 | 24 | 49 | 86 | 123 | 262 | 472 | 744 | 1550 |
| 1800 | | 11 | 24 | 48 | 84 | 119 | 254 | 457 | 721 | 1500 |
| 1900 | | 11 | 23 | 47 | 81 | 115 | 247 | 444 | 700 | 1460 |
| 2000 | | 11 | 22 | 45 | 79 | 112 | 240 | 432 | 681 | 1420 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

**Notes:**

[1] Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

[2] Table entries are rounded to 3 significant digits.

**TABLE 1216.2(11)**
**SEMI-RIGID COPPER TUBING [NFPA 54-12: TABLE 6.2(I)][2]**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | GAS: | NATURAL | | |
| | | | | | | | INLET PRESSURE: | 2.0 psi | | |
| | | | | | | | PRESSURE DROP: | 1.0 psi | | |
| | | | | | | | SPECIFIC GRAVITY: | 0.60 | | |
| | | TUBE SIZE (inch) | | | | | | | | |
| NOMINAL: | K & L: | ¼ | ⅜ | ½ | ⅝ | ¾ | 1 | 1¼ | 1½ | 2 |
| | ACR: | ⅜ | ½ | ⅝ | ¾ | ⅞ | 1⅛ | 1⅜ | – | – |
| OUTSIDE: | | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 |
| INSIDE:[1] | | 0.305 | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.245 | 1.481 | 1.959 |
| LENGTH (feet) | | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | |
| 10 | | 245 | 506 | 1030 | 1800 | 2550 | 5450 | 9820 | 15 500 | 32 200 |
| 20 | | 169 | 348 | 708 | 1240 | 1760 | 3750 | 6750 | 10 600 | 22 200 |
| 30 | | 135 | 279 | 568 | 993 | 1410 | 3010 | 5420 | 8550 | 17 800 |
| 40 | | 116 | 239 | 486 | 850 | 1210 | 2580 | 4640 | 7310 | 15 200 |
| 50 | | 103 | 212 | 431 | 754 | 1070 | 2280 | 4110 | 6480 | 13 500 |
| 60 | | 93 | 192 | 391 | 683 | 969 | 2070 | 3730 | 5870 | 12 200 |
| 70 | | 86 | 177 | 359 | 628 | 891 | 1900 | 3430 | 5400 | 11 300 |
| 80 | | 80 | 164 | 334 | 584 | 829 | 1770 | 3190 | 5030 | 10 500 |
| 90 | | 75 | 154 | 314 | 548 | 778 | 1660 | 2990 | 4720 | 9820 |
| 100 | | 71 | 146 | 296 | 518 | 735 | 1570 | 2830 | 4450 | 9280 |
| 125 | | 63 | 129 | 263 | 459 | 651 | 1390 | 2500 | 3950 | 8220 |
| 150 | | 57 | 117 | 238 | 416 | 590 | 1260 | 2270 | 3580 | 7450 |
| 175 | | 52 | 108 | 219 | 383 | 543 | 1160 | 2090 | 3290 | 6850 |
| 200 | | 49 | 100 | 204 | 356 | 505 | 1080 | 1940 | 3060 | 6380 |
| 250 | | 43 | 89 | 181 | 315 | 448 | 956 | 1720 | 2710 | 5650 |
| 300 | | 39 | 80 | 164 | 286 | 406 | 866 | 1560 | 2460 | 5120 |
| 350 | | 36 | 74 | 150 | 263 | 373 | 797 | 1430 | 2260 | 4710 |
| 400 | | 33 | 69 | 140 | 245 | 347 | 741 | 1330 | 2100 | 4380 |
| 450 | | 31 | 65 | 131 | 230 | 326 | 696 | 1250 | 1970 | 4110 |
| 500 | | 30 | 61 | 124 | 217 | 308 | 657 | 1180 | 1870 | 3880 |
| 550 | | 28 | 58 | 118 | 206 | 292 | 624 | 1120 | 1770 | 3690 |
| 600 | | 27 | 55 | 112 | 196 | 279 | 595 | 1070 | 1690 | 3520 |
| 650 | | 26 | 53 | 108 | 188 | 267 | 570 | 1030 | 1620 | 3370 |
| 700 | | 25 | 51 | 103 | 181 | 256 | 548 | 986 | 1550 | 3240 |
| 750 | | 24 | 49 | 100 | 174 | 247 | 528 | 950 | 1500 | 3120 |
| 800 | | 23 | 47 | 96 | 168 | 239 | 510 | 917 | 1450 | 3010 |
| 850 | | 22 | 46 | 93 | 163 | 231 | 493 | 888 | 1400 | 2920 |
| 900 | | 22 | 44 | 90 | 158 | 224 | 478 | 861 | 1360 | 2830 |
| 950 | | 21 | 43 | 88 | 153 | 217 | 464 | 836 | 1320 | 2740 |
| 1000 | | 20 | 42 | 85 | 149 | 211 | 452 | 813 | 1280 | 2670 |
| 1100 | | 19 | 40 | 81 | 142 | 201 | 429 | 772 | 1220 | 2540 |
| 1200 | | 18 | 38 | 77 | 135 | 192 | 409 | 737 | 1160 | 2420 |
| 1300 | | 18 | 36 | 74 | 129 | 183 | 392 | 705 | 1110 | 2320 |
| 1400 | | 17 | 35 | 71 | 124 | 176 | 376 | 678 | 1070 | 2230 |
| 1500 | | 16 | 34 | 68 | 120 | 170 | 363 | 653 | 1030 | 2140 |
| 1600 | | 16 | 33 | 66 | 116 | 164 | 350 | 630 | 994 | 2070 |
| 1700 | | 15 | 31 | 64 | 112 | 159 | 339 | 610 | 962 | 2000 |
| 1800 | | 15 | 30 | 62 | 108 | 154 | 329 | 592 | 933 | 1940 |
| 1900 | | 14 | 30 | 60 | 105 | 149 | 319 | 575 | 906 | 1890 |
| 2000 | | 14 | 29 | 59 | 102 | 145 | 310 | 559 | 881 | 1830 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa

**Notes:**

[1] Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

[2] Table entries are rounded to 3 significant digits.

## TABLE 1216.2(12)
## SEMI-RIGID COPPER TUBING [NFPA 54-12: TABLE 6.2(m)][3]

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | GAS: | NATURAL | | |
| | | | | | | | INLET PRESSURE: | 2.0 psi | | |
| | | | | | | | PRESSURE DROP: | 1.5 psi | | |
| | | | | | | | SPECIFIC GRAVITY: | 0.60 | | |
| INTENDED USE: PIPE SIZING BETWEEN POINT OF DELIVERY AND THE HOUSE LINE REGULATOR. TOTAL LOAD SUPPLIED BY A SINGLE HOUSE LINE REGULATOR NOT EXCEEDING 150 CUBIC FEET PER HOUR.[2] | | | | | | | | | | |
| | | TUBE SIZE (inch) | | | | | | | | |
| NOMINAL: | K & L: | ¼ | ⅜ | ½ | ⅝ | ¾ | 1 | 1¼ | 1½ | 2 |
| | ACR: | ⅜ | ½ | ⅝ | ¾ | ⅞ | 1⅛ | 1⅜ | – | – |
| OUTSIDE: | | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 |
| INSIDE:[1] | | 0.305 | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.245 | 1.481 | 1.959 |
| LENGTH (feet) | | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | |
| 10 | | 303 | 625 | 1270 | 2220 | 3150 | 6740 | 12 100 | 19 100 | 39 800 |
| 20 | | 208 | 430 | 874 | 1530 | 2170 | 4630 | 8330 | 13 100 | 27 400 |
| 30 | | 167 | 345 | 702 | 1230 | 1740 | 3720 | 6690 | 10 600 | 22 000 |
| 40 | | 143 | 295 | 601 | 1050 | 1490 | 3180 | 5730 | 9030 | 18 800 |
| 50 | | 127 | 262 | 532 | 931 | 1320 | 2820 | 5080 | 8000 | 16 700 |
| 60 | | 115 | 237 | 482 | 843 | 1200 | 2560 | 4600 | 7250 | 15 100 |
| 70 | | 106 | 218 | 444 | 776 | 1100 | 2350 | 4230 | 6670 | 13 900 |
| 80 | | 98 | 203 | 413 | 722 | 1020 | 2190 | 3940 | 6210 | 12 900 |
| 90 | | 92 | 190 | 387 | 677 | 961 | 2050 | 3690 | 5820 | 12 100 |
| 100 | | 87 | 180 | 366 | 640 | 907 | 1940 | 3490 | 5500 | 11 500 |
| 125 | | 77 | 159 | 324 | 567 | 804 | 1720 | 3090 | 4880 | 10 200 |
| 150 | | 70 | 144 | 294 | 514 | 729 | 1560 | 2800 | 4420 | 9200 |
| 175 | | 64 | 133 | 270 | 472 | 670 | 1430 | 2580 | 4060 | 8460 |
| 200 | | 60 | 124 | 252 | 440 | 624 | 1330 | 2400 | 3780 | 7870 |
| 250 | | 53 | 110 | 223 | 390 | 553 | 1180 | 2130 | 3350 | 6980 |
| 300 | | 48 | 99 | 202 | 353 | 501 | 1070 | 1930 | 3040 | 6320 |
| 350 | | 44 | 91 | 186 | 325 | 461 | 984 | 1770 | 2790 | 5820 |
| 400 | | 41 | 85 | 173 | 302 | 429 | 916 | 1650 | 2600 | 5410 |
| 450 | | 39 | 80 | 162 | 283 | 402 | 859 | 1550 | 2440 | 5080 |
| 500 | | 36 | 75 | 153 | 268 | 380 | 811 | 1460 | 2300 | 4800 |
| 550 | | 35 | 72 | 146 | 254 | 361 | 771 | 1390 | 2190 | 4560 |
| 600 | | 33 | 68 | 139 | 243 | 344 | 735 | 1320 | 2090 | 4350 |
| 650 | | 32 | 65 | 133 | 232 | 330 | 704 | 1270 | 2000 | 4160 |
| 700 | | 30 | 63 | 128 | 223 | 317 | 676 | 1220 | 1920 | 4000 |
| 750 | | 29 | 60 | 123 | 215 | 305 | 652 | 1170 | 1850 | 3850 |
| 800 | | 28 | 58 | 119 | 208 | 295 | 629 | 1130 | 1790 | 3720 |
| 850 | | 27 | 57 | 115 | 201 | 285 | 609 | 1100 | 1730 | 3600 |
| 900 | | 27 | 55 | 111 | 195 | 276 | 590 | 1060 | 1680 | 3490 |
| 950 | | 26 | 53 | 108 | 189 | 268 | 573 | 1030 | 1630 | 3390 |
| 1000 | | 25 | 52 | 105 | 184 | 261 | 558 | 1000 | 1580 | 3300 |
| 1100 | | 24 | 49 | 100 | 175 | 248 | 530 | 954 | 1500 | 3130 |
| 1200 | | 23 | 47 | 95 | 167 | 237 | 505 | 910 | 1430 | 2990 |
| 1300 | | 22 | 45 | 91 | 160 | 227 | 484 | 871 | 1370 | 2860 |
| 1400 | | 21 | 43 | 88 | 153 | 218 | 465 | 837 | 1320 | 2750 |
| 1500 | | 20 | 42 | 85 | 148 | 210 | 448 | 806 | 1270 | 2650 |
| 1600 | | 19 | 40 | 82 | 143 | 202 | 432 | 779 | 1230 | 2560 |
| 1700 | | 19 | 39 | 79 | 138 | 196 | 419 | 753 | 1190 | 2470 |
| 1800 | | 18 | 38 | 77 | 134 | 190 | 406 | 731 | 1150 | 2400 |
| 1900 | | 18 | 37 | 74 | 130 | 184 | 394 | 709 | 1120 | 2330 |
| 2000 | | 17 | 36 | 72 | 126 | 179 | 383 | 690 | 1090 | 2270 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa

**Notes:**

1 Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

2 Where this table is used to size the tubing upstream of a line pressure regulator, the pipe or tubing downstream of the line pressure regulator shall be sized using a pressure drop no greater than 1 inch water column (0.249 kPa).

3 Table entries are rounded to 3 significant digits.

**TABLE 1216.2(13)**
**SEMI-RIGID COPPER TUBING [NFPA 54-12: TABLE 6.2(n)][2]**

| | | GAS: | NATURAL | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | INLET PRESSURE: | 5.0 psi | | | | | | |
| | | PRESSURE DROP: | 3.5 psi | | | | | | |
| | | SPECIFIC GRAVITY: | 0.60 | | | | | | |
| | | TUBE SIZE (inch) | | | | | | | |
| NOMINAL: | K & L: | ¼ | ⅜ | ½ | ⅝ | ¾ | 1 | 1¼ | 1½ | 2 |
| | ACR: | ⅜ | ½ | ⅝ | ¾ | ⅞ | 1⅛ | 1⅜ | – | – |
| OUTSIDE: | | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 |
| INSIDE:[1] | | 0.305 | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.245 | 1.481 | 1.959 |
| LENGTH (feet) | | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | |
| 10 | | 511 | 1050 | 2140 | 3750 | 5320 | 11 400 | 20 400 | 32 200 | 67 100 |
| 20 | | 351 | 724 | 1470 | 2580 | 3650 | 7800 | 14 000 | 22 200 | 46 100 |
| 30 | | 282 | 582 | 1180 | 2070 | 2930 | 6270 | 11 300 | 17 800 | 37 000 |
| 40 | | 241 | 498 | 1010 | 1770 | 2510 | 5360 | 9660 | 15 200 | 31 700 |
| 50 | | 214 | 441 | 898 | 1570 | 2230 | 4750 | 8560 | 13 500 | 28 100 |
| 60 | | 194 | 400 | 813 | 1420 | 2020 | 4310 | 7750 | 12 200 | 25 500 |
| 70 | | 178 | 368 | 748 | 1310 | 1860 | 3960 | 7130 | 11 200 | 23 400 |
| 80 | | 166 | 342 | 696 | 1220 | 1730 | 3690 | 6640 | 10 500 | 21 800 |
| 90 | | 156 | 321 | 653 | 1140 | 1620 | 3460 | 6230 | 9820 | 20 400 |
| 100 | | 147 | 303 | 617 | 1080 | 1530 | 3270 | 5880 | 9270 | 19 300 |
| 125 | | 130 | 269 | 547 | 955 | 1360 | 2900 | 5210 | 8220 | 17 100 |
| 150 | | 118 | 243 | 495 | 866 | 1230 | 2620 | 4720 | 7450 | 15 500 |
| 175 | | 109 | 224 | 456 | 796 | 1130 | 2410 | 4350 | 6850 | 14 300 |
| 200 | | 101 | 208 | 424 | 741 | 1050 | 2250 | 4040 | 6370 | 13 300 |
| 250 | | 90 | 185 | 376 | 657 | 932 | 1990 | 3580 | 5650 | 11 800 |
| 300 | | 81 | 167 | 340 | 595 | 844 | 1800 | 3250 | 5120 | 10 700 |
| 350 | | 75 | 154 | 313 | 547 | 777 | 1660 | 2990 | 4710 | 9810 |
| 400 | | 69 | 143 | 291 | 509 | 722 | 1540 | 2780 | 4380 | 9120 |
| 450 | | 65 | 134 | 273 | 478 | 678 | 1450 | 2610 | 4110 | 8560 |
| 500 | | 62 | 127 | 258 | 451 | 640 | 1370 | 2460 | 3880 | 8090 |
| 550 | | 58 | 121 | 245 | 429 | 608 | 1300 | 2340 | 3690 | 7680 |
| 600 | | 56 | 115 | 234 | 409 | 580 | 1240 | 2230 | 3520 | 7330 |
| 650 | | 53 | 110 | 224 | 392 | 556 | 1190 | 2140 | 3370 | 7020 |
| 700 | | 51 | 106 | 215 | 376 | 534 | 1140 | 2050 | 3240 | 6740 |
| 750 | | 49 | 102 | 207 | 362 | 514 | 1100 | 1980 | 3120 | 6490 |
| 800 | | 48 | 98 | 200 | 350 | 497 | 1060 | 1910 | 3010 | 6270 |
| 850 | | 46 | 95 | 194 | 339 | 481 | 1030 | 1850 | 2910 | 6070 |
| 900 | | 45 | 92 | 188 | 328 | 466 | 1000 | 1790 | 2820 | 5880 |
| 950 | | 43 | 90 | 182 | 319 | 452 | 967 | 1740 | 2740 | 5710 |
| 1000 | | 42 | 87 | 177 | 310 | 440 | 940 | 1690 | 2670 | 5560 |
| 1100 | | 40 | 83 | 169 | 295 | 418 | 893 | 1610 | 2530 | 5280 |
| 1200 | | 38 | 79 | 161 | 281 | 399 | 852 | 1530 | 2420 | 5040 |
| 1300 | | 37 | 76 | 154 | 269 | 382 | 816 | 1470 | 2320 | 4820 |
| 1400 | | 35 | 73 | 148 | 259 | 367 | 784 | 1410 | 2220 | 4630 |
| 1500 | | 34 | 70 | 143 | 249 | 353 | 755 | 1360 | 2140 | 4460 |
| 1600 | | 33 | 68 | 138 | 241 | 341 | 729 | 1310 | 2070 | 4310 |
| 1700 | | 32 | 65 | 133 | 233 | 330 | 705 | 1270 | 2000 | 4170 |
| 1800 | | 31 | 63 | 129 | 226 | 320 | 684 | 1230 | 1940 | 4040 |
| 1900 | | 30 | 62 | 125 | 219 | 311 | 664 | 1200 | 1890 | 3930 |
| 2000 | | 29 | 60 | 122 | 213 | 302 | 646 | 1160 | 1830 | 3820 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa

**Notes:**

[1] Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

[2] Table entries are rounded to 3 significant digits.

**TABLE 1216.2(14)**
**CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54-12: TABLE 6.2(o)][1, 2]**

| | |
|---|---|
| GAS: | NATURAL |
| INLET PRESSURE: | LESS THAN 2 psi |
| PRESSURE DROP: | 0.5 in. w.c. |
| SPECIFIC GRAVITY: | 0.60 |

| | TUBE SIZE (EHD)[3] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOW DESIGNATION: | 13 | 15 | 18 | 19 | 23 | 25 | 30 | 31 | 37 | 39 | 46 | 48 | 60 | 62 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | | | | | | |
| 5 | 46 | 63 | 115 | 134 | 225 | 270 | 471 | 546 | 895 | 1037 | 1790 | 2070 | 3660 | 4140 |
| 10 | 32 | 44 | 82 | 95 | 161 | 192 | 330 | 383 | 639 | 746 | 1260 | 1470 | 2600 | 2930 |
| 15 | 25 | 35 | 66 | 77 | 132 | 157 | 267 | 310 | 524 | 615 | 1030 | 1200 | 2140 | 2400 |
| 20 | 22 | 31 | 58 | 67 | 116 | 137 | 231 | 269 | 456 | 536 | 888 | 1050 | 1850 | 2080 |
| 25 | 19 | 27 | 52 | 60 | 104 | 122 | 206 | 240 | 409 | 482 | 793 | 936 | 1660 | 1860 |
| 30 | 18 | 25 | 47 | 55 | 96 | 112 | 188 | 218 | 374 | 442 | 723 | 856 | 1520 | 1700 |
| 40 | 15 | 21 | 41 | 47 | 83 | 97 | 162 | 188 | 325 | 386 | 625 | 742 | 1320 | 1470 |
| 50 | 13 | 19 | 37 | 42 | 75 | 87 | 144 | 168 | 292 | 347 | 559 | 665 | 1180 | 1320 |
| 60 | 12 | 17 | 34 | 38 | 68 | 80 | 131 | 153 | 267 | 318 | 509 | 608 | 1080 | 1200 |
| 70 | 11 | 16 | 31 | 36 | 63 | 74 | 121 | 141 | 248 | 295 | 471 | 563 | 1000 | 1110 |
| 80 | 10 | 15 | 29 | 33 | 60 | 69 | 113 | 132 | 232 | 277 | 440 | 527 | 940 | 1040 |
| 90 | 10 | 14 | 28 | 32 | 57 | 65 | 107 | 125 | 219 | 262 | 415 | 498 | 887 | 983 |
| 100 | 9 | 13 | 26 | 30 | 54 | 62 | 101 | 118 | 208 | 249 | 393 | 472 | 843 | 933 |
| 150 | 7 | 10 | 20 | 23 | 42 | 48 | 78 | 91 | 171 | 205 | 320 | 387 | 691 | 762 |
| 200 | 6 | 9 | 18 | 21 | 38 | 44 | 71 | 82 | 148 | 179 | 277 | 336 | 600 | 661 |
| 250 | 5 | 8 | 16 | 19 | 34 | 39 | 63 | 74 | 133 | 161 | 247 | 301 | 538 | 591 |
| 300 | 5 | 7 | 15 | 17 | 32 | 36 | 57 | 67 | 95 | 148 | 226 | 275 | 492 | 540 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

**Notes:**

1 Table entries are rounded to 3 significant digits.

2 Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing to the following equation: $L = 1.3\ n$, where $L$ is additional length (ft) of tubing and $n$ is the number of additional fittings, bends, or both.

3 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 1216.2(15)**
**CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54-12: TABLE 6.2(p)][1, 2]**

| | |
|---|---|
| GAS: | NATURAL |
| INLET PRESSURE: | LESS THAN 2 psi |
| PRESSURE DROP: | 3.0 in. w.c. |
| SPECIFIC GRAVITY: | 0.60 |

INTENDED USE: INITIAL SUPPLY PRESSURE OF 8.0 INCH WATER COLUMN OR GREATER

| | TUBE SIZE (EHD)[3] | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOW DESIGNATION: | 13 | 15 | 18 | 19 | 23 | 25 | 30 | 31 | 37 | 46 | 48 | 60 | 62 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | | | | | |
| 5 | 120 | 160 | 277 | 327 | 529 | 649 | 1180 | 1370 | 2140 | 4430 | 5010 | 8800 | 10 100 |
| 10 | 83 | 112 | 197 | 231 | 380 | 462 | 828 | 958 | 1530 | 3200 | 3560 | 6270 | 7160 |
| 15 | 67 | 90 | 161 | 189 | 313 | 379 | 673 | 778 | 1250 | 2540 | 2910 | 5140 | 5850 |
| 20 | 57 | 78 | 140 | 164 | 273 | 329 | 580 | 672 | 1090 | 2200 | 2530 | 4460 | 5070 |
| 25 | 51 | 69 | 125 | 147 | 245 | 295 | 518 | 599 | 978 | 1960 | 2270 | 4000 | 4540 |
| 30 | 46 | 63 | 115 | 134 | 225 | 270 | 471 | 546 | 895 | 1790 | 2070 | 3660 | 4140 |
| 40 | 39 | 54 | 100 | 116 | 196 | 234 | 407 | 471 | 778 | 1550 | 1800 | 3180 | 3590 |
| 50 | 35 | 48 | 89 | 104 | 176 | 210 | 363 | 421 | 698 | 1380 | 1610 | 2850 | 3210 |
| 60 | 32 | 44 | 82 | 95 | 161 | 192 | 330 | 383 | 639 | 1260 | 1470 | 2600 | 2930 |
| 70 | 29 | 41 | 76 | 88 | 150 | 178 | 306 | 355 | 593 | 1170 | 1360 | 2420 | 2720 |
| 80 | 27 | 38 | 71 | 82 | 141 | 167 | 285 | 331 | 555 | 1090 | 1280 | 2260 | 2540 |
| 90 | 26 | 36 | 67 | 77 | 133 | 157 | 268 | 311 | 524 | 1030 | 1200 | 2140 | 2400 |
| 100 | 24 | 34 | 63 | 73 | 126 | 149 | 254 | 295 | 498 | 974 | 1140 | 2030 | 2280 |
| 150 | 19 | 27 | 52 | 60 | 104 | 122 | 206 | 240 | 409 | 793 | 936 | 1660 | 1860 |
| 200 | 17 | 23 | 45 | 52 | 91 | 106 | 178 | 207 | 355 | 686 | 812 | 1440 | 1610 |
| 250 | 15 | 21 | 40 | 46 | 82 | 95 | 159 | 184 | 319 | 613 | 728 | 1290 | 1440 |
| 300 | 13 | 19 | 37 | 42 | 75 | 87 | 144 | 168 | 234 | 559 | 665 | 1180 | 1320 |

For SI units: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

**Notes:**

[1] Table entries are rounded to 3 significant digits.

[2] Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing to the following equation: $L = 1.3\ n$, where $L$ is additional length (ft) of tubing and $n$ is the number of additional fittings, bends, or both.

[3] 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 1216.2(16)
## CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54-12: TABLE 6.2(q)][1, 2]

| | |
|---|---|
| GAS: | NATURAL |
| INLET PRESSURE: | LESS THAN 2 psi |
| PRESSURE DROP: | 6.0 in. w.c. |
| SPECIFIC GRAVITY: | 0.60 |

INTENDED USE: INITIAL SUPPLY PRESSURE OF 11.0 INCH WATER COLUMN OR GREATER

| | TUBE SIZE (EHD)[3] | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOW DESIGNATION: | 13 | 15 | 18 | 19 | 23 | 25 | 30 | 31 | 37 | 46 | 48 | 60 | 62 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | | | | | |
| 5 | 173 | 229 | 389 | 461 | 737 | 911 | 1690 | 1950 | 3000 | 6280 | 7050 | 12 400 | 14 260 |
| 10 | 120 | 160 | 277 | 327 | 529 | 649 | 1180 | 1370 | 2140 | 4430 | 5010 | 8800 | 10 100 |
| 15 | 96 | 130 | 227 | 267 | 436 | 532 | 960 | 1110 | 1760 | 3610 | 4100 | 7210 | 8260 |
| 20 | 83 | 112 | 197 | 231 | 380 | 462 | 828 | 958 | 1530 | 3120 | 3560 | 6270 | 7160 |
| 25 | 74 | 99 | 176 | 207 | 342 | 414 | 739 | 855 | 1370 | 2790 | 3190 | 5620 | 6400 |
| 30 | 67 | 90 | 161 | 189 | 313 | 379 | 673 | 778 | 1250 | 2540 | 2910 | 5140 | 5850 |
| 40 | 57 | 78 | 140 | 164 | 273 | 329 | 580 | 672 | 1090 | 2200 | 2530 | 4460 | 5070 |
| 50 | 51 | 69 | 125 | 147 | 245 | 295 | 518 | 599 | 978 | 1960 | 2270 | 4000 | 4540 |
| 60 | 46 | 63 | 115 | 134 | 225 | 270 | 471 | 546 | 895 | 1790 | 2070 | 3660 | 4140 |
| 70 | 42 | 58 | 106 | 124 | 209 | 250 | 435 | 505 | 830 | 1660 | 1920 | 3390 | 3840 |
| 80 | 39 | 54 | 100 | 116 | 196 | 234 | 407 | 471 | 778 | 1550 | 1800 | 3180 | 3590 |
| 90 | 37 | 51 | 94 | 109 | 185 | 221 | 383 | 444 | 735 | 1460 | 1700 | 3000 | 3390 |
| 100 | 35 | 48 | 89 | 104 | 176 | 210 | 363 | 421 | 698 | 1380 | 1610 | 2850 | 3210 |
| 150 | 28 | 39 | 73 | 85 | 145 | 172 | 294 | 342 | 573 | 1130 | 1320 | 2340 | 2630 |
| 200 | 24 | 34 | 63 | 73 | 126 | 149 | 254 | 295 | 498 | 974 | 1140 | 2030 | 2280 |
| 250 | 21 | 30 | 57 | 66 | 114 | 134 | 226 | 263 | 447 | 870 | 1020 | 1820 | 2040 |
| 300 | 19 | 27 | 52 | 60 | 104 | 122 | 206 | 240 | 409 | 793 | 936 | 1660 | 1860 |

For SI units: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

**Notes:**

1 Table entries are rounded to 3 significant digits.

2 Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing to the following equation: $L = 1.3\,n$, where $L$ is additional length (ft) of tubing and $n$ is the number of additional fittings, bends, or both.

3 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 1216.2(17)**
**CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54-12: TABLE 6.2(r)][1, 2, 3, 4]**

| | |
|---|---|
| GAS: | NATURAL |
| INLET PRESSURE: | 2.0 psi |
| PRESSURE DROP: | 1.0 psi |
| SPECIFIC GRAVITY: | 0.60 |

| | TUBE SIZE (EHD)[5] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOW DESIGNATION: | 13 | 15 | 18 | 19 | 23 | 25 | 30 | 31 | 37 | 39 | 46 | 48 | 60 | 62 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | | | | | | |
| 10 | 270 | 353 | 587 | 700 | 1100 | 1370 | 2590 | 2990 | 4510 | 5037 | 9600 | 10 700 | 18 600 | 21 600 |
| 25 | 166 | 220 | 374 | 444 | 709 | 876 | 1620 | 1870 | 2890 | 3258 | 6040 | 6780 | 11 900 | 13 700 |
| 30 | 151 | 200 | 342 | 405 | 650 | 801 | 1480 | 1700 | 2640 | 2987 | 5510 | 6200 | 10 900 | 12 500 |
| 40 | 129 | 172 | 297 | 351 | 567 | 696 | 1270 | 1470 | 2300 | 2605 | 4760 | 5380 | 9440 | 10 900 |
| 50 | 115 | 154 | 266 | 314 | 510 | 624 | 1140 | 1310 | 2060 | 2343 | 4260 | 4820 | 8470 | 9720 |
| 75 | 93 | 124 | 218 | 257 | 420 | 512 | 922 | 1070 | 1690 | 1932 | 3470 | 3950 | 6940 | 7940 |
| 80 | 89 | 120 | 211 | 249 | 407 | 496 | 892 | 1030 | 1640 | 1874 | 3360 | 3820 | 6730 | 7690 |
| 100 | 79 | 107 | 189 | 222 | 366 | 445 | 795 | 920 | 1470 | 1685 | 3000 | 3420 | 6030 | 6880 |
| 150 | 64 | 87 | 155 | 182 | 302 | 364 | 646 | 748 | 1210 | 1389 | 2440 | 2800 | 4940 | 5620 |
| 200 | 55 | 75 | 135 | 157 | 263 | 317 | 557 | 645 | 1050 | 1212 | 2110 | 2430 | 4290 | 4870 |
| 250 | 49 | 67 | 121 | 141 | 236 | 284 | 497 | 576 | 941 | 1090 | 1890 | 2180 | 3850 | 4360 |
| 300 | 44 | 61 | 110 | 129 | 217 | 260 | 453 | 525 | 862 | 999 | 1720 | 1990 | 3520 | 3980 |
| 400 | 38 | 52 | 96 | 111 | 189 | 225 | 390 | 453 | 749 | 871 | 1490 | 1730 | 3060 | 3450 |
| 500 | 34 | 46 | 86 | 100 | 170 | 202 | 348 | 404 | 552 | 783 | 1330 | 1550 | 2740 | 3090 |

For SI units: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa

**Notes:**

[1] Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 0.75 psi (5.17 kPa), DO NOT USE THIS TABLE. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator are capable of varying with flow rate.

[2] CAUTION: Capacities shown in table are capable of exceeding maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.

[3] Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing according to the following equation: $L = 1.3\ n$, where $L$ is additional length (ft) of tubing and $n$ is the number of additional fittings, bends, or both.

[4] Table entries are rounded to 3 significant digits.

[5] 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 1216.2(18)
## CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54-12: TABLE 6.2(s)][1, 2, 3, 4]

| | |
|---|---|
| GAS: | NATURAL |
| INLET PRESSURE: | 5.0 psi |
| PRESSURE DROP: | 3.5 psi |
| SPECIFIC GRAVITY: | 0.60 |

| | TUBE SIZE (EHD)[5] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOW DESIGNATION: | 13 | 15 | 18 | 19 | 23 | 25 | 30 | 31 | 37 | 39 | 46 | 48 | 60 | 62 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | | | | | | | |
| 10 | 523 | 674 | 1080 | 1300 | 2000 | 2530 | 4920 | 5660 | 8300 | 9140 | 18 100 | 19 800 | 34 400 | 40 400 |
| 25 | 322 | 420 | 691 | 827 | 1290 | 1620 | 3080 | 3540 | 5310 | 5911 | 11 400 | 12 600 | 22 000 | 25 600 |
| 30 | 292 | 382 | 632 | 755 | 1180 | 1480 | 2800 | 3230 | 4860 | 5420 | 10 400 | 11 500 | 20 100 | 23 400 |
| 40 | 251 | 329 | 549 | 654 | 1030 | 1280 | 2420 | 2790 | 4230 | 4727 | 8970 | 10 000 | 17 400 | 20 200 |
| 50 | 223 | 293 | 492 | 586 | 926 | 1150 | 2160 | 2490 | 3790 | 4251 | 8020 | 8930 | 15 600 | 18 100 |
| 75 | 180 | 238 | 403 | 479 | 763 | 944 | 1750 | 2020 | 3110 | 3506 | 6530 | 7320 | 12 800 | 14 800 |
| 80 | 174 | 230 | 391 | 463 | 740 | 915 | 1690 | 1960 | 3020 | 3400 | 6320 | 7090 | 12 400 | 14 300 |
| 100 | 154 | 205 | 350 | 415 | 665 | 820 | 1510 | 1740 | 2710 | 3057 | 5650 | 6350 | 11 100 | 12 800 |
| 150 | 124 | 166 | 287 | 339 | 548 | 672 | 1230 | 1420 | 2220 | 2521 | 4600 | 5200 | 9130 | 10 500 |
| 200 | 107 | 143 | 249 | 294 | 478 | 584 | 1060 | 1220 | 1930 | 2199 | 3980 | 4510 | 7930 | 9090 |
| 250 | 95 | 128 | 223 | 263 | 430 | 524 | 945 | 1090 | 1730 | 1977 | 3550 | 4040 | 7110 | 8140 |
| 300 | 86 | 116 | 204 | 240 | 394 | 479 | 860 | 995 | 1590 | 1813 | 3240 | 3690 | 6500 | 7430 |
| 400 | 74 | 100 | 177 | 208 | 343 | 416 | 742 | 858 | 1380 | 1581 | 2800 | 3210 | 5650 | 6440 |
| 500 | 66 | 89 | 159 | 186 | 309 | 373 | 662 | 766 | 1040 | 1422 | 2500 | 2870 | 5060 | 5760 |

For SI units: 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa

**Notes:**

1. Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 1 psi ( 7 kPa), DO NOT USE THIS TABLE. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across regulator are capable of varying with the flow rate.
2. CAUTION: Capacities shown in table are capable of exceeding the maximum capacity of selected regulator. Consult tubing manufacturer for guidance.
3. Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing to the following equation: $L = 1.3\ n$, where $L$ is additional length (feet) of tubing and $n$ is the number of additional fittings, bends, or both.
4. Table entries are rounded to 3 significant digits.
5. 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 1216.2(19)**
**POLYETHYLENE PLASTIC PIPE [NFPA 54-12: TABLE 6.2(t)]***

| | |
|---|---|
| GAS: | NATURAL |
| INLET PRESSURE: | LESS THAN 2 psi |
| PRESSURE DROP: | 0.3 in. w.c. |
| SPECIFIC GRAVITY: | 0.60 |

| | PIPE SIZE (inch) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NOMINAL OD: | ½ | ¾ | 1 | 1 ¼ | 1 ½ | 2 | 3 | 4 |
| DESIGNATION: | SDR 9.3 | SDR 11 | SDR 11 | SDR 10 | SDR 11 | SDR 11 | SDR 11 | SDR 11 |
| ACTUAL ID: | 0.660 | 0.860 | 1.077 | 1.328 | 1.554 | 1.943 | 2.864 | 3.682 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | |
| 10 | 153 | 305 | 551 | 955 | 1440 | 2590 | 7170 | 13 900 |
| 20 | 105 | 210 | 379 | 656 | 991 | 1780 | 4920 | 9520 |
| 30 | 84 | 169 | 304 | 527 | 796 | 1430 | 3950 | 7640 |
| 40 | 72 | 144 | 260 | 451 | 681 | 1220 | 3380 | 6540 |
| 50 | 64 | 128 | 231 | 400 | 604 | 1080 | 3000 | 5800 |
| 60 | 58 | 116 | 209 | 362 | 547 | 983 | 2720 | 5250 |
| 70 | 53 | 107 | 192 | 333 | 503 | 904 | 2500 | 4830 |
| 80 | 50 | 99 | 179 | 310 | 468 | 841 | 2330 | 4500 |
| 90 | 46 | 93 | 168 | 291 | 439 | 789 | 2180 | 4220 |
| 100 | 44 | 88 | 159 | 275 | 415 | 745 | 2060 | 3990 |
| 125 | 39 | 78 | 141 | 243 | 368 | 661 | 1830 | 3530 |
| 150 | 35 | 71 | 127 | 221 | 333 | 598 | 1660 | 3200 |
| 175 | 32 | 65 | 117 | 203 | 306 | 551 | 1520 | 2940 |
| 200 | 30 | 60 | 109 | 189 | 285 | 512 | 1420 | 2740 |
| 250 | 27 | 54 | 97 | 167 | 253 | 454 | 1260 | 2430 |
| 300 | 24 | 48 | 88 | 152 | 229 | 411 | 1140 | 2200 |
| 350 | 22 | 45 | 81 | 139 | 211 | 378 | 1050 | 2020 |
| 400 | 21 | 42 | 75 | 130 | 196 | 352 | 974 | 1880 |
| 450 | 19 | 39 | 70 | 122 | 184 | 330 | 914 | 1770 |
| 500 | 18 | 37 | 66 | 115 | 174 | 312 | 863 | 1670 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

* Table entries are rounded to 3 significant digits.

**TABLE 1216.2(20)**
**POLYETHYLENE PLASTIC PIPE [NFPA 54-12: TABLE 6.2(u)]***

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | GAS: | NATURAL | | |
| | | | | | INLET PRESSURE: | LESS THAN 2 psi | | |
| | | | | | PRESSURE DROP: | 0.5 in. w.c. | | |
| | | | | | SPECIFIC GRAVITY: | 0.60 | | |
| | PIPE SIZE (inch) | | | | | | | |
| NOMINAL OD: | ½ | ¾ | 1 | 1 ¼ | 1 ½ | 2 | 3 | 4 |
| DESIGNATION: | SDR 9.3 | SDR 11 | SDR 11 | SDR 10 | SDR 11 | SDR 11 | SDR 11 | SDR 11 |
| ACTUAL ID: | 0.660 | 0.860 | 1.077 | 1.328 | 1.554 | 1.943 | 2.864 | 3.682 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | |
| 10 | 201 | 403 | 726 | 1260 | 1900 | 3410 | 9450 | 18 260 |
| 20 | 138 | 277 | 499 | 865 | 1310 | 2350 | 6490 | 12 550 |
| 30 | 111 | 222 | 401 | 695 | 1050 | 1880 | 5210 | 10 080 |
| 40 | 95 | 190 | 343 | 594 | 898 | 1610 | 4460 | 8630 |
| 50 | 84 | 169 | 304 | 527 | 796 | 1430 | 3950 | 7640 |
| 60 | 76 | 153 | 276 | 477 | 721 | 1300 | 3580 | 6930 |
| 70 | 70 | 140 | 254 | 439 | 663 | 1190 | 3300 | 6370 |
| 80 | 65 | 131 | 236 | 409 | 617 | 1110 | 3070 | 5930 |
| 90 | 61 | 123 | 221 | 383 | 579 | 1040 | 2880 | 5560 |
| 100 | 58 | 116 | 209 | 362 | 547 | 983 | 2720 | 5250 |
| 125 | 51 | 103 | 185 | 321 | 485 | 871 | 2410 | 4660 |
| 150 | 46 | 93 | 168 | 291 | 439 | 789 | 2180 | 4220 |
| 175 | 43 | 86 | 154 | 268 | 404 | 726 | 2010 | 3880 |
| 200 | 40 | 80 | 144 | 249 | 376 | 675 | 1870 | 3610 |
| 250 | 35 | 71 | 127 | 221 | 333 | 598 | 1660 | 3200 |
| 300 | 32 | 64 | 115 | 200 | 302 | 542 | 1500 | 2900 |
| 350 | 29 | 59 | 106 | 184 | 278 | 499 | 1380 | 2670 |
| 400 | 27 | 55 | 99 | 171 | 258 | 464 | 1280 | 2480 |
| 450 | 26 | 51 | 93 | 160 | 242 | 435 | 1200 | 2330 |
| 500 | 24 | 48 | 88 | 152 | 229 | 411 | 1140 | 2200 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

* Table entries are rounded to 3 significant digits.

**TABLE 1216.2(21)**
**POLYETHYLENE PLASTIC PIPE [NFPA 54-12: TABLE 6.2(v)]***

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | GAS: | NATURAL | | |
| | | | | | INLET PRESSURE: | 2.0 psi | | |
| | | | | | PRESSURE DROP: | 1.0 psi | | |
| | | | | | SPECIFIC GRAVITY: | 0.60 | | |
| | PIPE SIZE (inch) | | | | | | | |
| NOMINAL OD: | ½ | ¾ | 1 | 1 ¼ | 1 ½ | 2 | 3 | 4 |
| DESIGNATION: | SDR 9.3 | SDR 11 | SDR 11 | SDR 10 | SDR 11 | SDR 11 | SDR 11 | SDR 11 |
| ACTUAL ID: | 0.660 | 0.860 | 1.077 | 1.328 | 1.554 | 1.943 | 2.864 | 3.682 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR | | | | | | | |
| 10 | 1860 | 3720 | 6710 | 11 600 | 17 600 | 31 600 | 87 300 | 169 000 |
| 20 | 1280 | 2560 | 4610 | 7990 | 12 100 | 21 700 | 60 000 | 116 000 |
| 30 | 1030 | 2050 | 3710 | 6420 | 9690 | 17 400 | 48 200 | 93 200 |
| 40 | 878 | 1760 | 3170 | 5490 | 8300 | 14 900 | 41 200 | 79 700 |
| 50 | 778 | 1560 | 2810 | 4870 | 7350 | 13 200 | 36 600 | 70 700 |
| 60 | 705 | 1410 | 2550 | 4410 | 6660 | 12 000 | 33 100 | 64 000 |
| 70 | 649 | 1300 | 2340 | 4060 | 6130 | 11 000 | 30 500 | 58 900 |
| 80 | 603 | 1210 | 2180 | 3780 | 5700 | 10 200 | 28 300 | 54 800 |
| 90 | 566 | 1130 | 2050 | 3540 | 5350 | 9610 | 26 600 | 51 400 |
| 100 | 535 | 1070 | 1930 | 3350 | 5050 | 9080 | 25 100 | 48 600 |
| 125 | 474 | 949 | 1710 | 2970 | 4480 | 8050 | 22 300 | 43 000 |
| 150 | 429 | 860 | 1550 | 2690 | 4060 | 7290 | 20 200 | 39 000 |
| 175 | 395 | 791 | 1430 | 2470 | 3730 | 6710 | 18 600 | 35 900 |
| 200 | 368 | 736 | 1330 | 2300 | 3470 | 6240 | 17 300 | 33 400 |
| 250 | 326 | 652 | 1180 | 2040 | 3080 | 5530 | 15 300 | 29 600 |
| 300 | 295 | 591 | 1070 | 1850 | 2790 | 5010 | 13 900 | 26 800 |
| 350 | 272 | 544 | 981 | 1700 | 2570 | 4610 | 12 800 | 24 700 |
| 400 | 253 | 506 | 913 | 1580 | 2390 | 4290 | 11 900 | 22 900 |
| 450 | 237 | 475 | 856 | 1480 | 2240 | 4020 | 11 100 | 21 500 |
| 500 | 224 | 448 | 809 | 1400 | 2120 | 3800 | 10 500 | 20 300 |
| 550 | 213 | 426 | 768 | 1330 | 2010 | 3610 | 9990 | 19 300 |
| 600 | 203 | 406 | 733 | 1270 | 1920 | 3440 | 9530 | 18 400 |
| 650 | 194 | 389 | 702 | 1220 | 1840 | 3300 | 9130 | 17 600 |
| 700 | 187 | 374 | 674 | 1170 | 1760 | 3170 | 8770 | 16 900 |
| 750 | 180 | 360 | 649 | 1130 | 1700 | 3050 | 8450 | 16 300 |
| 800 | 174 | 348 | 627 | 1090 | 1640 | 2950 | 8160 | 15 800 |
| 850 | 168 | 336 | 607 | 1050 | 1590 | 2850 | 7890 | 15 300 |
| 900 | 163 | 326 | 588 | 1020 | 1540 | 2770 | 7650 | 14 800 |
| 950 | 158 | 317 | 572 | 990 | 1500 | 2690 | 7430 | 14 400 |
| 1000 | 154 | 308 | 556 | 963 | 1450 | 2610 | 7230 | 14 000 |
| 1100 | 146 | 293 | 528 | 915 | 1380 | 2480 | 6870 | 13 300 |
| 1200 | 139 | 279 | 504 | 873 | 1320 | 2370 | 6550 | 12 700 |
| 1300 | 134 | 267 | 482 | 836 | 1260 | 2270 | 6270 | 12 100 |
| 1400 | 128 | 257 | 463 | 803 | 1210 | 2180 | 6030 | 11 600 |
| 1500 | 124 | 247 | 446 | 773 | 1170 | 2100 | 5810 | 11 200 |
| 1600 | 119 | 239 | 431 | 747 | 1130 | 2030 | 5610 | 10 800 |
| 1700 | 115 | 231 | 417 | 723 | 1090 | 1960 | 5430 | 10 500 |
| 1800 | 112 | 224 | 404 | 701 | 1060 | 1900 | 5260 | 10 200 |
| 1900 | 109 | 218 | 393 | 680 | 1030 | 1850 | 5110 | 9900 |
| 2000 | 106 | 212 | 382 | 662 | 1000 | 1800 | 4970 | 9600 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283 $m^3/h$, 1 pound-force per square inch = 6.8947 kPa

* Table entries are rounded to 3 significant digits.

**TABLE 1216.2(22)**
**POLYETHYLENE PLASTIC TUBING [NFPA 54-12: TABLE 6.2(w)][2, 3]**

| | GAS: | NATURAL |
|---|---|---|
| | INLET PRESSURE: | LESS THAN 2.0 psi |
| | PRESSURE DROP: | 0.3 in. w.c. |
| | SPECIFIC GRAVITY: | 0.60 |
| | PLASTIC TUBING SIZE (CTS)[1] (inch) | |
| NOMINAL OD: | ½ | 1 |
| DESIGNATION: | SDR 7 | SDR 11 |
| ACTUAL ID: | 0.445 | 0.927 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR | |
| 10 | 54 | 372 |
| 20 | 37 | 256 |
| 30 | 30 | 205 |
| 40 | 26 | 176 |
| 50 | 23 | 156 |
| 60 | 21 | 141 |
| 70 | 19 | 130 |
| 80 | 18 | 121 |
| 90 | 17 | 113 |
| 100 | 16 | 107 |
| 125 | 14 | 95 |
| 150 | 13 | 86 |
| 175 | 12 | 79 |
| 200 | 11 | 74 |
| 225 | 10 | 69 |
| 250 | NA | 65 |
| 275 | NA | 62 |
| 300 | NA | 59 |
| 350 | NA | 54 |
| 400 | NA | 51 |
| 450 | NA | 47 |
| 500 | NA | 45 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283m$^3$/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

**Notes:**

1 CTS = Copper tube size.

2 Table entries are rounded to 3 significant digits.

3 NA means a flow of less than 10 ft$^3$/h (0.283 m$^3$/h).

**TABLE 1216.2(23)**
**POLYETHYLENE PLASTIC TUBING [NFPA 54-12: TABLE 6.2(x)][2, 3]**

| | GAS: | NATURAL |
|---|---|---|
| | INLET PRESSURE: | LESS THAN 2.0 psi |
| | PRESSURE DROP: | 0.5 in. w.c. |
| | SPECIFIC GRAVITY: | 0.60 |
| | PLASTIC TUBING SIZE (CTS)[1] (inch) | |
| NOMINAL OD: | ½ | 1 |
| DESIGNATION: | SDR 7 | SDR 11 |
| ACTUAL ID: | 0.445 | 0.927 |
| LENGTH (feet) | CAPACITY IN CUBIC FEET OF GAS PER HOUR | |
| 10 | 72 | 490 |
| 20 | 49 | 337 |
| 30 | 39 | 271 |
| 40 | 34 | 232 |
| 50 | 30 | 205 |
| 60 | 27 | 186 |
| 70 | 25 | 171 |
| 80 | 23 | 159 |
| 90 | 22 | 149 |
| 100 | 21 | 141 |
| 125 | 18 | 125 |
| 150 | 17 | 113 |
| 175 | 15 | 104 |
| 200 | 14 | 97 |
| 225 | 13 | 91 |
| 250 | 12 | 86 |
| 275 | 11 | 82 |
| 300 | 11 | 78 |
| 350 | 10 | 72 |
| 400 | NA | 67 |
| 450 | NA | 63 |
| 500 | NA | 59 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 cubic foot per hour = 0.0283m$^3$/h, 1 pound-force per square inch = 6.8947 kPa, 1 inch water column = 0.249 kPa

**Notes:**

1 CTS = Copper tube size.

2 Table entries are rounded to 3 significant digits.

3 NA means a flow of less than 10 ft$^3$/h (0.283 m$^3$/h).

**TABLE 1216.2(24)**
**SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.3(a)]***

| | |
|---|---|
| GAS: | UNDILUTED PROPANE |
| INLET PRESSURE: | 10.0 psi |
| PRESSURE DROP: | 1.0 psi |
| SPECIFIC GRAVITY: | 1.50 |

INTENDED USE: PIPE SIZING BETWEEN FIRST STAGE (HIGH PRESSURE) REGULATOR AND SECOND STAGE (LOW PRESSURE) REGULATOR

| | PIPE SIZE (inch) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| NOMINAL INSIDE: | ½ | ¾ | 1 | 1¼ | 1½ | 2 | 2½ | 3 | 4 |
| ACTUAL: | 0.622 | 0.824 | 1.049 | 1.380 | 1.610 | 2.067 | 2.469 | 3.068 | 4.026 |
| LENGTH (feet) | CAPACITY IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| 10 | 3320 | 6950 | 13 100 | 26 900 | 40 300 | 77 600 | 124 000 | 219 000 | 446 000 |
| 20 | 2280 | 4780 | 9000 | 18 500 | 27 700 | 53 300 | 85 000 | 150 000 | 306 000 |
| 30 | 1830 | 3840 | 7220 | 14 800 | 22 200 | 42 800 | 68 200 | 121 000 | 246 000 |
| 40 | 1570 | 3280 | 6180 | 12 700 | 19 000 | 36 600 | 58 400 | 103 000 | 211 000 |
| 50 | 1390 | 2910 | 5480 | 11 300 | 16 900 | 32 500 | 51 700 | 91 500 | 187 000 |
| 60 | 1260 | 2640 | 4970 | 10 200 | 15 300 | 29 400 | 46 900 | 82 900 | 169 000 |
| 70 | 1160 | 2430 | 4570 | 9380 | 14 100 | 27 100 | 43 100 | 76 300 | 156 000 |
| 80 | 1080 | 2260 | 4250 | 8730 | 13 100 | 25 200 | 40 100 | 70 900 | 145 000 |
| 90 | 1010 | 2120 | 3990 | 8190 | 12 300 | 23 600 | 37 700 | 66 600 | 136 000 |
| 100 | 956 | 2000 | 3770 | 7730 | 11 600 | 22 300 | 35 600 | 62 900 | 128 000 |
| 125 | 848 | 1770 | 3340 | 6850 | 10 300 | 19 800 | 31 500 | 55 700 | 114 000 |
| 150 | 768 | 1610 | 3020 | 6210 | 9300 | 17 900 | 28 600 | 50 500 | 103 000 |
| 175 | 706 | 1480 | 2780 | 5710 | 8560 | 16 500 | 26 300 | 46 500 | 94 700 |
| 200 | 657 | 1370 | 2590 | 5320 | 7960 | 15 300 | 24 400 | 43 200 | 88 100 |
| 250 | 582 | 1220 | 2290 | 4710 | 7060 | 13 600 | 21 700 | 38 300 | 78 100 |
| 300 | 528 | 1100 | 2080 | 4270 | 6400 | 12 300 | 19 600 | 34 700 | 70 800 |
| 350 | 486 | 1020 | 1910 | 3930 | 5880 | 11 300 | 18 100 | 31 900 | 65 100 |
| 400 | 452 | 945 | 1780 | 3650 | 5470 | 10 500 | 16 800 | 29 700 | 60 600 |
| 450 | 424 | 886 | 1670 | 3430 | 5140 | 9890 | 15 800 | 27 900 | 56 800 |
| 500 | 400 | 837 | 1580 | 3240 | 4850 | 9340 | 14 900 | 26 300 | 53 700 |
| 550 | 380 | 795 | 1500 | 3070 | 4610 | 8870 | 14 100 | 25 000 | 51 000 |
| 600 | 363 | 759 | 1430 | 2930 | 4400 | 8460 | 13 500 | 23 900 | 48 600 |
| 650 | 347 | 726 | 1370 | 2810 | 4210 | 8110 | 12 900 | 22 800 | 46 600 |
| 700 | 334 | 698 | 1310 | 2700 | 4040 | 7790 | 12 400 | 21 900 | 44 800 |
| 750 | 321 | 672 | 1270 | 2600 | 3900 | 7500 | 12 000 | 21 100 | 43 100 |
| 800 | 310 | 649 | 1220 | 2510 | 3760 | 7240 | 11 500 | 20 400 | 41 600 |
| 850 | 300 | 628 | 1180 | 2430 | 3640 | 7010 | 11 200 | 19 800 | 40 300 |
| 900 | 291 | 609 | 1150 | 2360 | 3530 | 6800 | 10 800 | 19 200 | 39 100 |
| 950 | 283 | 592 | 1110 | 2290 | 3430 | 6600 | 10 500 | 18 600 | 37 900 |
| 1000 | 275 | 575 | 1080 | 2230 | 3330 | 6420 | 10 200 | 18 100 | 36 900 |
| 1100 | 261 | 546 | 1030 | 2110 | 3170 | 6100 | 9720 | 17 200 | 35 000 |
| 1200 | 249 | 521 | 982 | 2020 | 3020 | 5820 | 9270 | 16 400 | 33 400 |
| 1300 | 239 | 499 | 940 | 1930 | 2890 | 5570 | 8880 | 15 700 | 32 000 |
| 1400 | 229 | 480 | 903 | 1850 | 2780 | 5350 | 8530 | 15 100 | 30 800 |
| 1500 | 221 | 462 | 870 | 1790 | 2680 | 5160 | 8220 | 14 500 | 29 600 |
| 1600 | 213 | 446 | 840 | 1730 | 2590 | 4980 | 7940 | 14 000 | 28 600 |
| 1700 | 206 | 432 | 813 | 1670 | 2500 | 4820 | 7680 | 13 600 | 27 700 |
| 1800 | 200 | 419 | 789 | 1620 | 2430 | 4670 | 7450 | 13 200 | 26 900 |
| 1900 | 194 | 407 | 766 | 1570 | 2360 | 4540 | 7230 | 12 800 | 26 100 |
| 2000 | 189 | 395 | 745 | 1530 | 2290 | 4410 | 7030 | 12 400 | 25 400 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa

* Table entries are rounded to 3 significant digits.

**TABLE 1216.2(25)**
**SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.3(b)]***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | GAS: | UNDILUTED PROPANE | | |
| | | | | | | INLET PRESSURE: | 10.0 psi | | |
| | | | | | | PRESSURE DROP: | 3.0 psi | | |
| | | | | | | SPECIFIC GRAVITY: | 1.50 | | |
| INTENDED USE: PIPE SIZING BETWEEN FIRST STAGE (HIGH PRESSURE) REGULATOR AND SECOND STAGE (LOW PRESSURE) REGULATOR | | | | | | | | | |
| | PIPE SIZE (inch) | | | | | | | | |
| NOMINAL INSIDE: | ½ | ¾ | 1 | 1¼ | 1½ | 2 | 2½ | 3 | 4 |
| ACTUAL: | 0.622 | 0.824 | 1.049 | 1.380 | 1.610 | 2.067 | 2.469 | 3.068 | 4.026 |
| LENGTH (feet) | CAPACITY IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| 10 | 5890 | 12 300 | 23 200 | 47 600 | 71 300 | 137 000 | 219 000 | 387 000 | 789 000 |
| 20 | 4050 | 8460 | 15 900 | 32 700 | 49 000 | 94 400 | 150 000 | 266 000 | 543 000 |
| 30 | 3250 | 6790 | 12 800 | 26 300 | 39 400 | 75 800 | 121 000 | 214 000 | 436 000 |
| 40 | 2780 | 5810 | 11 000 | 22 500 | 33 700 | 64 900 | 103 000 | 183 000 | 373 000 |
| 50 | 2460 | 5150 | 9710 | 19 900 | 29 900 | 57 500 | 91 600 | 162 000 | 330 000 |
| 60 | 2230 | 4670 | 8790 | 18 100 | 27 100 | 52 100 | 83 000 | 147 000 | 299 000 |
| 70 | 2050 | 4300 | 8090 | 16 600 | 24 900 | 47 900 | 76 400 | 135 000 | 275 000 |
| 80 | 1910 | 4000 | 7530 | 15 500 | 23 200 | 44 600 | 71 100 | 126 000 | 256 000 |
| 90 | 1790 | 3750 | 7060 | 14 500 | 21 700 | 41 800 | 66 700 | 118 000 | 240 000 |
| 100 | 1690 | 3540 | 6670 | 13 700 | 20 500 | 39 500 | 63 000 | 111 000 | 227 000 |
| 125 | 1500 | 3140 | 5910 | 12 100 | 18 200 | 35 000 | 55 800 | 98 700 | 201 000 |
| 150 | 1360 | 2840 | 5360 | 11 000 | 16 500 | 31 700 | 50 600 | 89 400 | 182 000 |
| 175 | 1250 | 2620 | 4930 | 10 100 | 15 200 | 29 200 | 46 500 | 82 300 | 167 800 |
| 200 | 1160 | 2430 | 4580 | 9410 | 14 100 | 27 200 | 43 300 | 76 500 | 156 100 |
| 250 | 1030 | 2160 | 4060 | 8340 | 12 500 | 24 100 | 38 400 | 67 800 | 138 400 |
| 300 | 935 | 1950 | 3680 | 7560 | 11 300 | 21 800 | 34 800 | 61 500 | 125 400 |
| 350 | 860 | 1800 | 3390 | 6950 | 10 400 | 20 100 | 32 000 | 56 500 | 115 300 |
| 400 | 800 | 1670 | 3150 | 6470 | 9690 | 18 700 | 29 800 | 52 600 | 107 300 |
| 450 | 751 | 1570 | 2960 | 6070 | 9090 | 17 500 | 27 900 | 49 400 | 100 700 |
| 500 | 709 | 1480 | 2790 | 5730 | 8590 | 16 500 | 26 400 | 46 600 | 95 100 |
| 550 | 673 | 1410 | 2650 | 5450 | 8160 | 15 700 | 25 000 | 44 300 | 90 300 |
| 600 | 642 | 1340 | 2530 | 5200 | 7780 | 15 000 | 23 900 | 42 200 | 86 200 |
| 650 | 615 | 1290 | 2420 | 4980 | 7450 | 14 400 | 22 900 | 40 500 | 82 500 |
| 700 | 591 | 1240 | 2330 | 4780 | 7160 | 13 800 | 22 000 | 38 900 | 79 300 |
| 750 | 569 | 1190 | 2240 | 4600 | 6900 | 13 300 | 21 200 | 37 400 | 76 400 |
| 800 | 550 | 1150 | 2170 | 4450 | 6660 | 12 800 | 20 500 | 36 200 | 73 700 |
| 850 | 532 | 1110 | 2100 | 4300 | 6450 | 12 400 | 19 800 | 35 000 | 71 400 |
| 900 | 516 | 1080 | 2030 | 4170 | 6250 | 12 000 | 19 200 | 33 900 | 69 200 |
| 950 | 501 | 1050 | 1970 | 4050 | 6070 | 11 700 | 18 600 | 32 900 | 67 200 |
| 1000 | 487 | 1020 | 1920 | 3940 | 5900 | 11 400 | 18 100 | 32 000 | 65 400 |
| 1100 | 463 | 968 | 1820 | 3740 | 5610 | 10 800 | 17 200 | 30 400 | 62 100 |
| 1200 | 442 | 923 | 1740 | 3570 | 5350 | 10 300 | 16 400 | 29 000 | 59 200 |
| 1300 | 423 | 884 | 1670 | 3420 | 5120 | 9870 | 15 700 | 27 800 | 56 700 |
| 1400 | 406 | 849 | 1600 | 3280 | 4920 | 9480 | 15 100 | 26 700 | 54 500 |
| 1500 | 391 | 818 | 1540 | 3160 | 4740 | 9130 | 14 600 | 25 700 | 52 500 |
| 1600 | 378 | 790 | 1490 | 3060 | 4580 | 8820 | 14 100 | 24 800 | 50 700 |
| 1700 | 366 | 765 | 1440 | 2960 | 4430 | 8530 | 13 600 | 24 000 | 49 000 |
| 1800 | 355 | 741 | 1400 | 2870 | 4300 | 8270 | 13 200 | 23 300 | 47 600 |
| 1900 | 344 | 720 | 1360 | 2780 | 4170 | 8040 | 12 800 | 22 600 | 46 200 |
| 2000 | 335 | 700 | 1320 | 2710 | 4060 | 7820 | 12 500 | 22 000 | 44 900 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa

* Table entries are rounded to 3 significant digits.

**TABLE 1216.2(26)**
**SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.3(c)]***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | GAS: | UNDILUTED PROPANE | | |
| | | | | | | INLET PRESSURE: | 2.0 psi | | |
| | | | | | | PRESSURE DROP: | 1.0 psi | | |
| | | | | | | SPECIFIC GRAVITY: | 1.50 | | |
| INTENDED USE: PIPE SIZING BETWEEN 2 PSI SERVICE AND LINE PRESSURE REGULATOR | | | | | | | | | |
| | PIPE SIZE (inch) | | | | | | | | |
| NOMINAL: | ½ | ¾ | 1 | 1¼ | 1½ | 2 | 2½ | 3 | 4 |
| ACTUAL ID: | 0.622 | 0.824 | 1.049 | 1.380 | 1.610 | 2.067 | 2.469 | 3.068 | 4.026 |
| LENGTH (feet) | CAPACITY IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| 10 | 2680 | 5590 | 10 500 | 21 600 | 32 400 | 62 400 | 99 500 | 176 000 | 359 000 |
| 20 | 1840 | 3850 | 7240 | 14 900 | 22 300 | 42 900 | 68 400 | 121 000 | 247 000 |
| 30 | 1480 | 3090 | 5820 | 11 900 | 17 900 | 34 500 | 54 900 | 97 100 | 198 000 |
| 40 | 1260 | 2640 | 4980 | 10 200 | 15 300 | 29 500 | 47 000 | 83 100 | 170 000 |
| 50 | 1120 | 2340 | 4410 | 9060 | 13 600 | 26 100 | 41 700 | 73 700 | 150 000 |
| 60 | 1010 | 2120 | 4000 | 8210 | 12 300 | 23 700 | 37 700 | 66 700 | 136 000 |
| 70 | 934 | 1950 | 3680 | 7550 | 11 300 | 21 800 | 34 700 | 61 400 | 125 000 |
| 80 | 869 | 1820 | 3420 | 7020 | 10 500 | 20 300 | 32 300 | 57 100 | 116 000 |
| 90 | 815 | 1700 | 3210 | 6590 | 9880 | 19 000 | 30 300 | 53 600 | 109 000 |
| 100 | 770 | 1610 | 3030 | 6230 | 9330 | 18 000 | 28 600 | 50 600 | 103 000 |
| 125 | 682 | 1430 | 2690 | 5520 | 8270 | 15 900 | 25 400 | 44 900 | 91 500 |
| 150 | 618 | 1290 | 2440 | 5000 | 7490 | 14 400 | 23 000 | 40 700 | 82 900 |
| 175 | 569 | 1190 | 2240 | 4600 | 6890 | 13 300 | 21 200 | 37 400 | 76 300 |
| 200 | 529 | 1110 | 2080 | 4280 | 6410 | 12 300 | 19 700 | 34 800 | 71 000 |
| 250 | 469 | 981 | 1850 | 3790 | 5680 | 10 900 | 17 400 | 30 800 | 62 900 |
| 300 | 425 | 889 | 1670 | 3440 | 5150 | 9920 | 15 800 | 27 900 | 57 000 |
| 350 | 391 | 817 | 1540 | 3160 | 4740 | 9120 | 14 500 | 25 700 | 52 400 |
| 400 | 364 | 760 | 1430 | 2940 | 4410 | 8490 | 13 500 | 23 900 | 48 800 |
| 450 | 341 | 714 | 1340 | 2760 | 4130 | 7960 | 12 700 | 22 400 | 45 800 |
| 500 | 322 | 674 | 1270 | 2610 | 3910 | 7520 | 12 000 | 21 200 | 43 200 |
| 550 | 306 | 640 | 1210 | 2480 | 3710 | 7140 | 11 400 | 20 100 | 41 100 |
| 600 | 292 | 611 | 1150 | 2360 | 3540 | 6820 | 10 900 | 19 200 | 39 200 |
| 650 | 280 | 585 | 1100 | 2260 | 3390 | 6530 | 10 400 | 18 400 | 37 500 |
| 700 | 269 | 562 | 1060 | 2170 | 3260 | 6270 | 9990 | 17 700 | 36 000 |
| 750 | 259 | 541 | 1020 | 2090 | 3140 | 6040 | 9630 | 17 000 | 34 700 |
| 800 | 250 | 523 | 985 | 2020 | 3030 | 5830 | 9300 | 16 400 | 33 500 |
| 850 | 242 | 506 | 953 | 1960 | 2930 | 5640 | 9000 | 15 900 | 32 400 |
| 900 | 235 | 490 | 924 | 1900 | 2840 | 5470 | 8720 | 15 400 | 31 500 |
| 950 | 228 | 476 | 897 | 1840 | 2760 | 5310 | 8470 | 15 000 | 30 500 |
| 1000 | 222 | 463 | 873 | 1790 | 2680 | 5170 | 8240 | 14 600 | 29 700 |
| 1100 | 210 | 440 | 829 | 1700 | 2550 | 4910 | 7830 | 13 800 | 28 200 |
| 1200 | 201 | 420 | 791 | 1620 | 2430 | 4680 | 7470 | 13 200 | 26 900 |
| 1300 | 192 | 402 | 757 | 1550 | 2330 | 4490 | 7150 | 12 600 | 25 800 |
| 1400 | 185 | 386 | 727 | 1490 | 2240 | 4310 | 6870 | 12 100 | 24 800 |
| 1500 | 178 | 372 | 701 | 1440 | 2160 | 4150 | 6620 | 11 700 | 23 900 |
| 1600 | 172 | 359 | 677 | 1390 | 2080 | 4010 | 6390 | 11 300 | 23 000 |
| 1700 | 166 | 348 | 655 | 1340 | 2010 | 3880 | 6180 | 10 900 | 22 300 |
| 1800 | 161 | 337 | 635 | 1300 | 1950 | 3760 | 6000 | 10 600 | 21 600 |
| 1900 | 157 | 327 | 617 | 1270 | 1900 | 3650 | 5820 | 10 300 | 21 000 |
| 2000 | 152 | 318 | 600 | 1230 | 1840 | 3550 | 5660 | 10 000 | 20 400 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa

* Table entries are rounded to 3 significant digits.

**TABLE 1216.2(27)**
**SCHEDULE 40 METALLIC PIPE [NFPA 54: TABLE 6.3(d)]***

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | GAS: | UNDILUTED PROPANE | | |
| | | | | | | INLET PRESSURE: | 11.0 in. w.c. | | |
| | | | | | | PRESSURE DROP: | 0.5 in. w.c. | | |
| | | | | | | SPECIFIC GRAVITY: | 1.50 | | |
| INTENDED USE: PIPE SIZING BETWEEN SINGLE OR SECOND STAGE (LOW PRESSURE) REGULATOR AND APPLIANCE | | | | | | | | | |
| | PIPE SIZE (inch) | | | | | | | | |
| NOMINAL INSIDE: | ½ | ¾ | 1 | 1¼ | 1½ | 2 | 2½ | 3 | 4 |
| ACTUAL ID: | 0.622 | 0.824 | 1.049 | 1.380 | 1.610 | 2.067 | 2.469 | 3.068 | 4.026 |
| LENGTH (feet) | CAPACITY IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| 10 | 291 | 608 | 1150 | 2350 | 3520 | 6790 | 10 800 | 19 100 | 39 000 |
| 20 | 200 | 418 | 787 | 1620 | 2420 | 4660 | 7430 | 13 100 | 26 800 |
| 30 | 160 | 336 | 632 | 1300 | 1940 | 3750 | 5970 | 10 600 | 21 500 |
| 40 | 137 | 287 | 541 | 1110 | 1660 | 3210 | 5110 | 9030 | 18 400 |
| 50 | 122 | 255 | 480 | 985 | 1480 | 2840 | 4530 | 8000 | 16 300 |
| 60 | 110 | 231 | 434 | 892 | 1340 | 2570 | 4100 | 7250 | 14 800 |
| 80 | 101 | 212 | 400 | 821 | 1230 | 2370 | 3770 | 6670 | 13 600 |
| 100 | 94 | 197 | 372 | 763 | 1140 | 2200 | 3510 | 6210 | 12 700 |
| 125 | 89 | 185 | 349 | 716 | 1070 | 2070 | 3290 | 5820 | 11 900 |
| 150 | 84 | 175 | 330 | 677 | 1010 | 1950 | 3110 | 5500 | 11 200 |
| 175 | 74 | 155 | 292 | 600 | 899 | 1730 | 2760 | 4880 | 9950 |
| 200 | 67 | 140 | 265 | 543 | 814 | 1570 | 2500 | 4420 | 9010 |
| 250 | 62 | 129 | 243 | 500 | 749 | 1440 | 2300 | 4060 | 8290 |
| 300 | 58 | 120 | 227 | 465 | 697 | 1340 | 2140 | 3780 | 7710 |
| 350 | 51 | 107 | 201 | 412 | 618 | 1190 | 1900 | 3350 | 6840 |
| 400 | 46 | 97 | 182 | 373 | 560 | 1080 | 1720 | 3040 | 6190 |
| 450 | 42 | 89 | 167 | 344 | 515 | 991 | 1580 | 2790 | 5700 |
| 500 | 40 | 83 | 156 | 320 | 479 | 922 | 1470 | 2600 | 5300 |
| 550 | 37 | 78 | 146 | 300 | 449 | 865 | 1380 | 2440 | 4970 |
| 600 | 35 | 73 | 138 | 283 | 424 | 817 | 1300 | 2300 | 4700 |
| 650 | 33 | 70 | 131 | 269 | 403 | 776 | 1240 | 2190 | 4460 |
| 700 | 32 | 66 | 125 | 257 | 385 | 741 | 1180 | 2090 | 4260 |
| 750 | 30 | 64 | 120 | 246 | 368 | 709 | 1130 | 2000 | 4080 |
| 800 | 29 | 61 | 115 | 236 | 354 | 681 | 1090 | 1920 | 3920 |
| 850 | 28 | 59 | 111 | 227 | 341 | 656 | 1050 | 1850 | 3770 |
| 900 | 27 | 57 | 107 | 220 | 329 | 634 | 1010 | 1790 | 3640 |
| 950 | 26 | 55 | 104 | 213 | 319 | 613 | 978 | 1730 | 3530 |
| 1000 | 25 | 53 | 100 | 206 | 309 | 595 | 948 | 1680 | 3420 |
| 1100 | 25 | 52 | 97 | 200 | 300 | 578 | 921 | 1630 | 3320 |
| 1200 | 24 | 50 | 95 | 195 | 292 | 562 | 895 | 1580 | 3230 |
| 1300 | 23 | 48 | 90 | 185 | 277 | 534 | 850 | 1500 | 3070 |
| 1400 | 22 | 46 | 86 | 176 | 264 | 509 | 811 | 1430 | 2930 |
| 1500 | 21 | 44 | 82 | 169 | 253 | 487 | 777 | 1370 | 2800 |
| 1600 | 20 | 42 | 79 | 162 | 243 | 468 | 746 | 1320 | 2690 |
| 1700 | 19 | 40 | 76 | 156 | 234 | 451 | 719 | 1270 | 2590 |
| 1800 | 19 | 39 | 74 | 151 | 226 | 436 | 694 | 1230 | 2500 |
| 1900 | 18 | 38 | 71 | 146 | 219 | 422 | 672 | 1190 | 2420 |
| 2000 | 18 | 37 | 69 | 142 | 212 | 409 | 652 | 1150 | 2350 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 inch water column = 0.249 kPa

* Table entries are rounded to 3 significant digits.

**TABLE 1216.2(28)**
**SEMI-RIGID COPPER TUBING [NFPA 54: TABLE 6.3(e)][2]**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | GAS: | UNDILUTED PROPANE | | |
| | | | | | | | INLET PRESSURE: | 10.0 psi | | |
| | | | | | | | PRESSURE DROP: | 1.0 psi | | |
| | | | | | | | SPECIFIC GRAVITY: | 1.50 | | |
| INTENDED USE: TUBE SIZING BETWEEN FIRST STAGE (HIGH PRESSURE) REGULATOR AND SECOND STAGE (LOW PRESSURE) REGULATOR | | | | | | | | | | |
| | | TUBE SIZE (inch) | | | | | | | | |
| NOMINAL: | K & L: | ¼ | ⅜ | ½ | ⅝ | ¾ | 1 | 1¼ | 1½ | 2 |
| | ACR: | ⅜ | ½ | ⅝ | ¾ | ⅞ | 1⅛ | 1⅜ | – | – |
| OUTSIDE: | | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 |
| INSIDE:[1] | | 0.305 | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.245 | 1.481 | 1.959 |
| LENGTH (feet) | | CAPACITY IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| 10 | | 513 | 1060 | 2150 | 3760 | 5330 | 11 400 | 20 500 | 32 300 | 67 400 |
| 20 | | 352 | 727 | 1480 | 2580 | 3670 | 7830 | 14 100 | 22 200 | 46 300 |
| 30 | | 283 | 584 | 1190 | 2080 | 2940 | 6290 | 11 300 | 17 900 | 37 200 |
| 40 | | 242 | 500 | 1020 | 1780 | 2520 | 5380 | 9690 | 15 300 | 31 800 |
| 50 | | 215 | 443 | 901 | 1570 | 2230 | 4770 | 8590 | 13 500 | 28 200 |
| 60 | | 194 | 401 | 816 | 1430 | 2020 | 4320 | 7780 | 12 300 | 25 600 |
| 70 | | 179 | 369 | 751 | 1310 | 1860 | 3980 | 7160 | 11 300 | 23 500 |
| 80 | | 166 | 343 | 699 | 1220 | 1730 | 3700 | 6660 | 10 500 | 21 900 |
| 90 | | 156 | 322 | 655 | 1150 | 1630 | 3470 | 6250 | 9850 | 20 500 |
| 100 | | 147 | 304 | 619 | 1080 | 1540 | 3280 | 5900 | 9310 | 19 400 |
| 125 | | 131 | 270 | 549 | 959 | 1360 | 2910 | 5230 | 8250 | 17 200 |
| 150 | | 118 | 244 | 497 | 869 | 1230 | 2630 | 4740 | 7470 | 15 600 |
| 175 | | 109 | 225 | 457 | 799 | 1130 | 2420 | 4360 | 6880 | 14 300 |
| 200 | | 101 | 209 | 426 | 744 | 1060 | 2250 | 4060 | 6400 | 13 300 |
| 250 | | 90 | 185 | 377 | 659 | 935 | 2000 | 3600 | 5670 | 11 800 |
| 300 | | 81 | 168 | 342 | 597 | 847 | 1810 | 3260 | 5140 | 10 700 |
| 350 | | 75 | 155 | 314 | 549 | 779 | 1660 | 3000 | 4730 | 9840 |
| 400 | | 70 | 144 | 292 | 511 | 725 | 1550 | 2790 | 4400 | 9160 |
| 450 | | 65 | 135 | 274 | 480 | 680 | 1450 | 2620 | 4130 | 8590 |
| 500 | | 62 | 127 | 259 | 453 | 643 | 1370 | 2470 | 3900 | 8120 |
| 550 | | 59 | 121 | 246 | 430 | 610 | 1300 | 2350 | 3700 | 7710 |
| 600 | | 56 | 115 | 235 | 410 | 582 | 1240 | 2240 | 3530 | 7350 |
| 650 | | 54 | 111 | 225 | 393 | 558 | 1190 | 2140 | 3380 | 7040 |
| 700 | | 51 | 106 | 216 | 378 | 536 | 1140 | 2060 | 3250 | 6770 |
| 750 | | 50 | 102 | 208 | 364 | 516 | 1100 | 1980 | 3130 | 6520 |
| 800 | | 48 | 99 | 201 | 351 | 498 | 1060 | 1920 | 3020 | 6290 |
| 850 | | 46 | 96 | 195 | 340 | 482 | 1030 | 1850 | 2920 | 6090 |
| 900 | | 45 | 93 | 189 | 330 | 468 | 1000 | 1800 | 2840 | 5910 |
| 950 | | 44 | 90 | 183 | 320 | 454 | 970 | 1750 | 2750 | 5730 |
| 1000 | | 42 | 88 | 178 | 311 | 442 | 944 | 1700 | 2680 | 5580 |
| 1100 | | 40 | 83 | 169 | 296 | 420 | 896 | 1610 | 2540 | 5300 |
| 1200 | | 38 | 79 | 161 | 282 | 400 | 855 | 1540 | 2430 | 5050 |
| 1300 | | 37 | 76 | 155 | 270 | 383 | 819 | 1470 | 2320 | 4840 |
| 1400 | | 35 | 73 | 148 | 260 | 368 | 787 | 1420 | 2230 | 4650 |
| 1500 | | 34 | 70 | 143 | 250 | 355 | 758 | 1360 | 2150 | 4480 |
| 1600 | | 33 | 68 | 138 | 241 | 343 | 732 | 1320 | 2080 | 4330 |
| 1700 | | 32 | 66 | 134 | 234 | 331 | 708 | 1270 | 2010 | 4190 |
| 1800 | | 31 | 64 | 130 | 227 | 321 | 687 | 1240 | 1950 | 4060 |
| 1900 | | 30 | 62 | 126 | 220 | 312 | 667 | 1200 | 1890 | 3940 |
| 2000 | | 29 | 60 | 122 | 214 | 304 | 648 | 1170 | 1840 | 3830 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa

**Notes:**

[1] Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

[2] Table entries are rounded to 3 significant digits.

## TABLE 1216.2(29)
## SEMI-RIGID COPPER TUBING [NFPA 54: TABLE 6.3(f)][2, 3]

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | GAS: | UNDILUTED PROPANE | | |
| | | | | | | | INLET PRESSURE: | 11.0 in. w.c. | | |
| | | | | | | | PRESSURE DROP: | 0.5 in. w.c. | | |
| | | | | | | | SPECIFIC GRAVITY: | 1.50 | | |
| INTENDED USE: TUBE SIZING BETWEEN SINGLE OR SECOND STAGE (LOW PRESSURE) REGULATOR AND APPLIANCE | | | | | | | | | | |
| | | TUBE SIZE (inch) | | | | | | | | |
| NOMINAL: | K & L: | ¼ | ⅜ | ½ | ⅝ | ¾ | 1 | 1¼ | 1½ | 2 |
| | ACR: | ⅜ | ½ | ⅝ | ¾ | ⅞ | 1⅛ | 1⅜ | – | – |
| OUTSIDE: | | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 |
| INSIDE:[1] | | 0.305 | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.245 | 1.481 | 1.959 |
| LENGTH (feet) | | CAPACITY IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| 10 | | 45 | 93 | 188 | 329 | 467 | 997 | 1800 | 2830 | 5890 |
| 20 | | 31 | 64 | 129 | 226 | 321 | 685 | 1230 | 1950 | 4050 |
| 30 | | 25 | 51 | 104 | 182 | 258 | 550 | 991 | 1560 | 3250 |
| 40 | | 21 | 44 | 89 | 155 | 220 | 471 | 848 | 1340 | 2780 |
| 50 | | 19 | 39 | 79 | 138 | 195 | 417 | 752 | 1180 | 2470 |
| 60 | | 17 | 35 | 71 | 125 | 177 | 378 | 681 | 1070 | 2240 |
| 70 | | 16 | 32 | 66 | 115 | 163 | 348 | 626 | 988 | 2060 |
| 80 | | 15 | 30 | 61 | 107 | 152 | 324 | 583 | 919 | 1910 |
| 90 | | 14 | 28 | 57 | 100 | 142 | 304 | 547 | 862 | 1800 |
| 100 | | 13 | 27 | 54 | 95 | 134 | 287 | 517 | 814 | 1700 |
| 125 | | 11 | 24 | 48 | 84 | 119 | 254 | 458 | 722 | 1500 |
| 150 | | 10 | 21 | 44 | 76 | 108 | 230 | 415 | 654 | 1360 |
| 175 | | NA | 20 | 40 | 70 | 99 | 212 | 382 | 602 | 1250 |
| 200 | | NA | 18 | 37 | 65 | 92 | 197 | 355 | 560 | 1170 |
| 250 | | NA | 16 | 33 | 58 | 82 | 175 | 315 | 496 | 1030 |
| 300 | | NA | 15 | 30 | 52 | 74 | 158 | 285 | 449 | 936 |
| 350 | | NA | 14 | 28 | 48 | 68 | 146 | 262 | 414 | 861 |
| 400 | | NA | 13 | 26 | 45 | 63 | 136 | 244 | 385 | 801 |
| 450 | | NA | 12 | 24 | 42 | 60 | 127 | 229 | 361 | 752 |
| 500 | | NA | 11 | 23 | 40 | 56 | 120 | 216 | 341 | 710 |
| 550 | | NA | 11 | 22 | 38 | 53 | 114 | 205 | 324 | 674 |
| 600 | | NA | 10 | 21 | 36 | 51 | 109 | 196 | 309 | 643 |
| 650 | | NA | NA | 20 | 34 | 49 | 104 | 188 | 296 | 616 |
| 700 | | NA | NA | 19 | 33 | 47 | 100 | 180 | 284 | 592 |
| 750 | | NA | NA | 18 | 32 | 45 | 96 | 174 | 274 | 570 |
| 800 | | NA | NA | 18 | 31 | 44 | 93 | 168 | 264 | 551 |
| 850 | | NA | NA | 17 | 30 | 42 | 90 | 162 | 256 | 533 |
| 900 | | NA | NA | 17 | 29 | 41 | 87 | 157 | 248 | 517 |
| 950 | | NA | NA | 16 | 28 | 40 | 85 | 153 | 241 | 502 |
| 1000 | | NA | NA | 16 | 27 | 39 | 83 | 149 | 234 | 488 |
| 1100 | | NA | NA | 15 | 26 | 37 | 78 | 141 | 223 | 464 |
| 1200 | | NA | NA | 14 | 25 | 35 | 75 | 135 | 212 | 442 |
| 1300 | | NA | NA | 14 | 24 | 34 | 72 | 129 | 203 | 423 |
| 1400 | | NA | NA | 13 | 23 | 32 | 69 | 124 | 195 | 407 |
| 1500 | | NA | NA | 13 | 22 | 31 | 66 | 119 | 188 | 392 |
| 1600 | | NA | NA | 12 | 21 | 30 | 64 | 115 | 182 | 378 |
| 1700 | | NA | NA | 12 | 20 | 29 | 62 | 112 | 176 | 366 |
| 1800 | | NA | NA | 11 | 20 | 28 | 60 | 108 | 170 | 355 |
| 1900 | | NA | NA | 11 | 19 | 27 | 58 | 105 | 166 | 345 |
| 2000 | | NA | NA | 11 | 19 | 27 | 57 | 102 | 161 | 335 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 inch water column = 0.249 kPa

**Notes:**

[1] Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

[2] Table entries are rounded to 3 significant digits.

[3] NA means a flow of less than 10 000 Btu/h (2.93 kW).

**TABLE 1216.2(30)**
**SEMI-RIGID COPPER TUBING [NFPA 54: TABLE 6.3(g)][2]**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | GAS: | UNDILUTED PROPANE | | |
| | | | | | | | INLET PRESSURE: | 2.0 psi | | |
| | | | | | | | PRESSURE DROP: | 1.0 psi | | |
| | | | | | | | SPECIFIC GRAVITY: | 1.50 | | |
| INTENDED USE: TUBE SIZING BETWEEN 2 PSIG SERVICE AND LINE PRESSURE REGULATOR | | | | | | | | | | |
| | | TUBE SIZE (inch) | | | | | | | | |
| NOMINAL: | K & L: | ¼ | ⅜ | ½ | ⅝ | ¾ | 1 | 1¼ | 1½ | 2 |
| | ACR: | ⅜ | ½ | ⅝ | ¾ | ⅞ | 1⅛ | 1⅜ | – | – |
| OUTSIDE: | | 0.375 | 0.500 | 0.625 | 0.750 | 0.875 | 1.125 | 1.375 | 1.625 | 2.125 |
| INSIDE:[1] | | 0.305 | 0.402 | 0.527 | 0.652 | 0.745 | 0.995 | 1.245 | 1.481 | 1.959 |
| LENGTH (feet) | | CAPACITY IN THOUSANDS OF BTU PER HOUR | | | | | | | | |
| 10 | | 413 | 852 | 1730 | 3030 | 4300 | 9170 | 16 500 | 26 000 | 54 200 |
| 20 | | 284 | 585 | 1190 | 2080 | 2950 | 6310 | 11 400 | 17 900 | 37 300 |
| 30 | | 228 | 470 | 956 | 1670 | 2370 | 5060 | 9120 | 14 400 | 29 900 |
| 40 | | 195 | 402 | 818 | 1430 | 2030 | 4330 | 7800 | 12 300 | 25 600 |
| 50 | | 173 | 356 | 725 | 1270 | 1800 | 3840 | 6920 | 10 900 | 22 700 |
| 60 | | 157 | 323 | 657 | 1150 | 1630 | 3480 | 6270 | 9880 | 20 600 |
| 70 | | 144 | 297 | 605 | 1060 | 1500 | 3200 | 5760 | 9090 | 18 900 |
| 80 | | 134 | 276 | 562 | 983 | 1390 | 2980 | 5360 | 8450 | 17 600 |
| 90 | | 126 | 259 | 528 | 922 | 1310 | 2790 | 5030 | 7930 | 16 500 |
| 100 | | 119 | 245 | 498 | 871 | 1240 | 2640 | 4750 | 7490 | 15 600 |
| 125 | | 105 | 217 | 442 | 772 | 1100 | 2340 | 4210 | 6640 | 13 800 |
| 150 | | 95 | 197 | 400 | 700 | 992 | 2120 | 3820 | 6020 | 12 500 |
| 175 | | 88 | 181 | 368 | 644 | 913 | 1950 | 3510 | 5540 | 11 500 |
| 200 | | 82 | 168 | 343 | 599 | 849 | 1810 | 3270 | 5150 | 10 700 |
| 250 | | 72 | 149 | 304 | 531 | 753 | 1610 | 2900 | 4560 | 9510 |
| 300 | | 66 | 135 | 275 | 481 | 682 | 1460 | 2620 | 4140 | 8610 |
| 350 | | 60 | 124 | 253 | 442 | 628 | 1340 | 2410 | 3800 | 7920 |
| 400 | | 56 | 116 | 235 | 411 | 584 | 1250 | 2250 | 3540 | 7370 |
| 450 | | 53 | 109 | 221 | 386 | 548 | 1170 | 2110 | 3320 | 6920 |
| 500 | | 50 | 103 | 209 | 365 | 517 | 1110 | 1990 | 3140 | 6530 |
| 550 | | 47 | 97 | 198 | 346 | 491 | 1050 | 1890 | 2980 | 6210 |
| 600 | | 45 | 93 | 189 | 330 | 469 | 1000 | 1800 | 2840 | 5920 |
| 650 | | 43 | 89 | 181 | 316 | 449 | 959 | 1730 | 2720 | 5670 |
| 700 | | 41 | 86 | 174 | 304 | 431 | 921 | 1660 | 2620 | 5450 |
| 750 | | 40 | 82 | 168 | 293 | 415 | 888 | 1600 | 2520 | 5250 |
| 800 | | 39 | 80 | 162 | 283 | 401 | 857 | 1540 | 2430 | 5070 |
| 850 | | 37 | 77 | 157 | 274 | 388 | 829 | 1490 | 2350 | 4900 |
| 900 | | 36 | 75 | 152 | 265 | 376 | 804 | 1450 | 2280 | 4750 |
| 950 | | 35 | 72 | 147 | 258 | 366 | 781 | 1410 | 2220 | 4620 |
| 1000 | | 34 | 71 | 143 | 251 | 356 | 760 | 1370 | 2160 | 4490 |
| 1100 | | 32 | 67 | 136 | 238 | 338 | 721 | 1300 | 2050 | 4270 |
| 1200 | | 31 | 64 | 130 | 227 | 322 | 688 | 1240 | 1950 | 4070 |
| 1300 | | 30 | 61 | 124 | 217 | 309 | 659 | 1190 | 1870 | 3900 |
| 1400 | | 28 | 59 | 120 | 209 | 296 | 633 | 1140 | 1800 | 3740 |
| 1500 | | 27 | 57 | 115 | 201 | 286 | 610 | 1100 | 1730 | 3610 |
| 1600 | | 26 | 55 | 111 | 194 | 276 | 589 | 1060 | 1670 | 3480 |
| 1700 | | 26 | 53 | 108 | 188 | 267 | 570 | 1030 | 1620 | 3370 |
| 1800 | | 25 | 51 | 104 | 182 | 259 | 553 | 1000 | 1570 | 3270 |
| 1900 | | 24 | 50 | 101 | 177 | 251 | 537 | 966 | 1520 | 3170 |
| 2000 | | 23 | 48 | 99 | 172 | 244 | 522 | 940 | 1480 | 3090 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa

**Notes:**

[1] Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

[2] Table entries are rounded to 3 significant digits.

**TABLE 1216.2(31)**
**CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54: TABLE 6.3(h)][1, 2]**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | GAS: | UNDILUTED PROPANE | | | | |
| | | | | | | | | | INLET PRESSURE: | 11.0 in. w.c. | | | | |
| | | | | | | | | | PRESSURE DROP: | 0.5 in. w.c. | | | | |
| | | | | | | | | | SPECIFIC GRAVITY: | 1.50 | | | | |
| INTENDED USE: CSST SIZING BETWEEN SINGLE OR SECOND STAGE (LOW PRESSURE) REGULATOR AND APPLIANCE SHUTOFF VALVE | | | | | | | | | | | | | | |
| | TUBE SIZE (EHD)[3] | | | | | | | | | | | | | |
| FLOW DESIGNATION: | 13 | 15 | 18 | 19 | 23 | 25 | 30 | 31 | 37 | 39 | 46 | 48 | 60 | 62 |
| LENGTH (feet) | CAPACITY IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | | | |
| 5 | 72 | 99 | 181 | 211 | 355 | 426 | 744 | 863 | 1420 | 1638 | 2830 | 3270 | 5780 | 6550 |
| 10 | 50 | 69 | 129 | 150 | 254 | 303 | 521 | 605 | 971 | 1179 | 1990 | 2320 | 4110 | 4640 |
| 15 | 39 | 55 | 104 | 121 | 208 | 248 | 422 | 490 | 775 | 972 | 1620 | 1900 | 3370 | 3790 |
| 20 | 34 | 49 | 91 | 106 | 183 | 216 | 365 | 425 | 661 | 847 | 1400 | 1650 | 2930 | 3290 |
| 25 | 30 | 42 | 82 | 94 | 164 | 192 | 325 | 379 | 583 | 762 | 1250 | 1480 | 2630 | 2940 |
| 30 | 28 | 39 | 74 | 87 | 151 | 177 | 297 | 344 | 528 | 698 | 1140 | 1350 | 2400 | 2680 |
| 40 | 23 | 33 | 64 | 74 | 131 | 153 | 256 | 297 | 449 | 610 | 988 | 1170 | 2090 | 2330 |
| 50 | 20 | 30 | 58 | 66 | 118 | 137 | 227 | 265 | 397 | 548 | 884 | 1050 | 1870 | 2080 |
| 60 | 19 | 26 | 53 | 60 | 107 | 126 | 207 | 241 | 359 | 502 | 805 | 961 | 1710 | 1900 |
| 70 | 17 | 25 | 49 | 57 | 99 | 117 | 191 | 222 | 330 | 466 | 745 | 890 | 1590 | 1760 |
| 80 | 15 | 23 | 45 | 52 | 94 | 109 | 178 | 208 | 307 | 438 | 696 | 833 | 1490 | 1650 |
| 90 | 15 | 22 | 44 | 50 | 90 | 102 | 169 | 197 | 286 | 414 | 656 | 787 | 1400 | 1550 |
| 100 | 14 | 20 | 41 | 47 | 85 | 98 | 159 | 186 | 270 | 393 | 621 | 746 | 1330 | 1480 |
| 150 | 11 | 15 | 31 | 36 | 66 | 75 | 123 | 143 | 217 | 324 | 506 | 611 | 1090 | 1210 |
| 200 | 9 | 14 | 28 | 33 | 60 | 69 | 112 | 129 | 183 | 283 | 438 | 531 | 948 | 1050 |
| 250 | 8 | 12 | 25 | 30 | 53 | 61 | 99 | 117 | 163 | 254 | 390 | 476 | 850 | 934 |
| 300 | 8 | 11 | 23 | 26 | 50 | 57 | 90 | 107 | 147 | 234 | 357 | 434 | 777 | 854 |

For SI units: 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 inch water column = 0.249 kPa

**Notes:**

[1] Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing to the following equation: $L = 1.3\ n$, where $L$ is additional length (ft) of tubing and $n$ is the number of additional fittings, bends, or both.

[2] Table entries are rounded to 3 significant digits.

[3] 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 1216.2(32)**
**CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54: TABLE 6.3(i)][1, 2, 3, 4]**

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | GAS: | UNDILUTED PROPANE | | | | |
| | | | | | | | | | INLET PRESSURE: | 2.0 psi | | | | |
| | | | | | | | | | PRESSURE DROP: | 1.0 psi | | | | |
| | | | | | | | | | SPECIFIC GRAVITY: | 1.50 | | | | |
| INTENDED USE: CSST SIZING BETWEEN 2 PSI SERVICE AND LINE PRESSURE REGULATOR | | | | | | | | | | | | | | |
| | TUBE SIZE (EHD)[5] | | | | | | | | | | | | | |
| FLOW DESIGNATION: | 13 | 15 | 18 | 19 | 23 | 25 | 30 | 31 | 37 | 39 | 46 | 48 | 60 | 62 |
| LENGTH (feet) | CAPACITY IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | | | |
| 10 | 426 | 558 | 927 | 1110 | 1740 | 2170 | 4100 | 4720 | 7130 | 7958 | 15 200 | 16 800 | 29 400 | 34 200 |
| 25 | 262 | 347 | 591 | 701 | 1120 | 1380 | 2560 | 2950 | 4560 | 5147 | 9550 | 10 700 | 18 800 | 21 700 |
| 30 | 238 | 316 | 540 | 640 | 1030 | 1270 | 2330 | 2690 | 4180 | 4719 | 8710 | 9790 | 17 200 | 19 800 |
| 40 | 203 | 271 | 469 | 554 | 896 | 1100 | 2010 | 2320 | 3630 | 4116 | 7530 | 8500 | 14 900 | 17 200 |
| 50 | 181 | 243 | 420 | 496 | 806 | 986 | 1790 | 2070 | 3260 | 3702 | 6730 | 7610 | 13 400 | 15 400 |
| 75 | 147 | 196 | 344 | 406 | 663 | 809 | 1460 | 1690 | 2680 | 3053 | 5480 | 6230 | 11 000 | 12 600 |
| 80 | 140 | 189 | 333 | 393 | 643 | 768 | 1410 | 1630 | 2590 | 2961 | 5300 | 6040 | 10 600 | 12 200 |
| 100 | 124 | 169 | 298 | 350 | 578 | 703 | 1260 | 1450 | 2330 | 2662 | 4740 | 5410 | 9530 | 10 900 |
| 150 | 101 | 137 | 245 | 287 | 477 | 575 | 1020 | 1180 | 1910 | 2195 | 3860 | 4430 | 7810 | 8890 |
| 200 | 86 | 118 | 213 | 248 | 415 | 501 | 880 | 1020 | 1660 | 1915 | 3340 | 3840 | 6780 | 7710 |
| 250 | 77 | 105 | 191 | 222 | 373 | 448 | 785 | 910 | 1490 | 1722 | 2980 | 3440 | 6080 | 6900 |
| 300 | 69 | 96 | 173 | 203 | 343 | 411 | 716 | 829 | 1360 | 1578 | 2720 | 3150 | 5560 | 6300 |
| 400 | 60 | 82 | 151 | 175 | 298 | 355 | 616 | 716 | 1160 | 1376 | 2350 | 2730 | 4830 | 5460 |
| 500 | 53 | 72 | 135 | 158 | 268 | 319 | 550 | 638 | 1030 | 1237 | 2100 | 2450 | 4330 | 4880 |

For SI units: 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa

**Notes:**

1 Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 0.5 psi (3.4 kPa) [based on 13 inch water column (3.2 kPa) outlet pressure], DO NOT USE THIS TABLE. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator are capable of varying with flow rate.

2 CAUTION: Capacities shown in table are capable of exceeding the maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.

3 Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing to the following equation: $L = 1.3\,n$, where $L$ is additional length (ft) of tubing and $n$ is the number of additional fittings, bends, or both.

4 Table entries are rounded to 3 significant digits.

5 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 1216.2(33)**
**CORRUGATED STAINLESS STEEL TUBING (CSST) [NFPA 54: TABLE 6.3(j)][1, 2, 3, 4]**

| | |
|---|---|
| GAS: | UNDILUTED PROPANE |
| INLET PRESSURE: | 5.0 psi |
| PRESSURE DROP: | 3.5 psi |
| SPECIFIC GRAVITY: | 1.50 |

| | TUBE SIZE (EHD)[5] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLOW DESIGNATION: | 13 | 15 | 18 | 19 | 23 | 25 | 30 | 31 | 37 | 39 | 46 | 48 | 60 | 62 |
| LENGTH (feet) | CAPACITY IN THOUSANDS OF BTU PER HOUR | | | | | | | | | | | | | |
| 10 | 826 | 1070 | 1710 | 2060 | 3150 | 4000 | 7830 | 8950 | 13 100 | 14 441 | 28 600 | 31 200 | 54 400 | 63 800 |
| 25 | 509 | 664 | 1090 | 1310 | 2040 | 2550 | 4860 | 5600 | 8400 | 9339 | 18 000 | 19 900 | 34 700 | 40 400 |
| 30 | 461 | 603 | 999 | 1190 | 1870 | 2340 | 4430 | 5100 | 7680 | 8564 | 16 400 | 18 200 | 31 700 | 36 900 |
| 40 | 396 | 520 | 867 | 1030 | 1630 | 2030 | 3820 | 4400 | 6680 | 7469 | 14 200 | 15 800 | 27 600 | 32 000 |
| 50 | 352 | 463 | 777 | 926 | 1460 | 1820 | 3410 | 3930 | 5990 | 6717 | 12 700 | 14 100 | 24 700 | 28 600 |
| 75 | 284 | 376 | 637 | 757 | 1210 | 1490 | 2770 | 3190 | 4920 | 5539 | 10 300 | 11 600 | 20 300 | 23 400 |
| 80 | 275 | 363 | 618 | 731 | 1170 | 1450 | 2680 | 3090 | 4770 | 5372 | 9990 | 11 200 | 19 600 | 22 700 |
| 100 | 243 | 324 | 553 | 656 | 1050 | 1300 | 2390 | 2760 | 4280 | 4830 | 8930 | 10 000 | 17 600 | 20 300 |
| 150 | 196 | 262 | 453 | 535 | 866 | 1060 | 1940 | 2240 | 3510 | 3983 | 7270 | 8210 | 14 400 | 16 600 |
| 200 | 169 | 226 | 393 | 464 | 755 | 923 | 1680 | 1930 | 3050 | 3474 | 6290 | 7130 | 12 500 | 14 400 |
| 250 | 150 | 202 | 352 | 415 | 679 | 828 | 1490 | 1730 | 2740 | 3124 | 5620 | 6390 | 11 200 | 12 900 |
| 300 | 136 | 183 | 322 | 379 | 622 | 757 | 1360 | 1570 | 2510 | 2865 | 5120 | 5840 | 10 300 | 11 700 |
| 400 | 117 | 158 | 279 | 328 | 542 | 657 | 1170 | 1360 | 2180 | 2498 | 4430 | 5070 | 8920 | 10 200 |
| 500 | 104 | 140 | 251 | 294 | 488 | 589 | 1050 | 1210 | 1950 | 2247 | 3960 | 4540 | 8000 | 9110 |

For SI units: 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa

**Notes:**

1 Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 0.5 psi (3.4 kPa) [based on 13 inch water column (3.2 kPa) outlet pressure], DO NOT USE THIS TABLE. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator are capable of varying with flow rate.

2 CAUTION: Capacities shown in table are capable of exceeding the maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.

3 Table includes losses for four 90 degree (1.57 rad) bends and two end fittings. Tubing runs with larger numbers of bends, fittings, or both shall be increased by an equivalent length of tubing to the following equation: $L = 1.3\ n$, where $L$ is additional length (ft) of tubing and $n$ is the number of additional fittings, bends, or both.

4 Table entries are rounded to 3 significant digits.

5 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 1216.2(34)
POLYETHYLENE PLASTIC PIPE [NFPA 54-12: TABLE 6.3(k)]*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | GAS: | UNDILUTED PROPANE | | |
| | | | | | INLET PRESSURE: | 11.0 in. w.c. | | |
| | | | | | PRESSURE DROP: | 0.5 in. w.c. | | |
| | | | | | SPECIFIC GRAVITY: | 1.50 | | |
| INTENDED USE: PE SIZING BETWEEN INTEGRAL SECOND-STAGE REGULATOR AT TANK OR SECOND-STAGE (LOW PRESSURE) REGULATOR AND BUILDING | | | | | | | | |
| | PIPE SIZE (inch) | | | | | | | |
| NOMINAL OD: | ½ | ¾ | 1 | 1¼ | 1½ | 2 | 3 | 4 |
| DESIGNATION: | SDR 9.3 | SDR 11 | SDR 11 | SDR 10 | SDR 11 | SDR 11 | SDR 11 | SDR 11 |
| ACTUAL ID: | 0.660 | 0.860 | 1.077 | 1.328 | 1.554 | 1.943 | 2.864 | 3.682 |
| LENGTH (feet) | CAPACITY IN THOUSANDS OF BTU PER HOUR | | | | | | | |
| 10 | 340 | 680 | 1230 | 2130 | 3210 | 5770 | 16 000 | 30 900 |
| 20 | 233 | 468 | 844 | 1460 | 2210 | 3970 | 11 000 | 21 200 |
| 30 | 187 | 375 | 677 | 1170 | 1770 | 3180 | 8810 | 17 000 |
| 40 | 160 | 321 | 580 | 1000 | 1520 | 2730 | 7540 | 14 600 |
| 50 | 142 | 285 | 514 | 890 | 1340 | 2420 | 6680 | 12 900 |
| 60 | 129 | 258 | 466 | 807 | 1220 | 2190 | 6050 | 11 700 |
| 70 | 119 | 237 | 428 | 742 | 1120 | 2010 | 5570 | 10 800 |
| 80 | 110 | 221 | 398 | 690 | 1040 | 1870 | 5180 | 10 000 |
| 90 | 103 | 207 | 374 | 648 | 978 | 1760 | 4860 | 9400 |
| 100 | 98 | 196 | 353 | 612 | 924 | 1660 | 4590 | 8900 |
| 125 | 87 | 173 | 313 | 542 | 819 | 1470 | 4070 | 7900 |
| 150 | 78 | 157 | 284 | 491 | 742 | 1330 | 3690 | 7130 |
| 175 | 72 | 145 | 261 | 452 | 683 | 1230 | 3390 | 6560 |
| 200 | 67 | 135 | 243 | 420 | 635 | 1140 | 3160 | 6100 |
| 250 | 60 | 119 | 215 | 373 | 563 | 1010 | 2800 | 5410 |
| 300 | 54 | 108 | 195 | 338 | 510 | 916 | 2530 | 4900 |
| 350 | 50 | 99 | 179 | 311 | 469 | 843 | 2330 | 4510 |
| 400 | 46 | 92 | 167 | 289 | 436 | 784 | 2170 | 4190 |
| 450 | 43 | 87 | 157 | 271 | 409 | 736 | 2040 | 3930 |
| 500 | 41 | 82 | 148 | 256 | 387 | 695 | 1920 | 3720 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 inch water column = 0.249 kPa

* Table entries are rounded to 3 significant digits.

TABLE 1216.2(35)
POLYETHYLENE PLASTIC PIPE [NFPA 54-12: TABLE 6.3(I)]*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | GAS: | UNDILUTED PROPANE | | |
| | | | | | INLET PRESSURE: | 2.0 psi | | |
| | | | | | PRESSURE DROP: | 1.0 psi | | |
| | | | | | SPECIFIC GRAVITY: | 1.50 | | |
| INTENDED USE: PE PIPE SIZING BETWEEN 2 PSI SERVICE REGULATOR AND LINE PRESSURE REGULATOR | | | | | | | | |
| | PIPE SIZE (inch) | | | | | | | |
| NOMINAL OD: | ½ | ¾ | 1 | 1¼ | 1½ | 2 | 3 | 4 |
| DESIGNATION: | SDR 9.3 | SDR 11 | SDR 11 | SDR 10 | SDR 11 | SDR 11 | SDR 11 | SDR 11 |
| ACTUAL ID: | 0.660 | 0.860 | 1.077 | 1.328 | 1.554 | 1.943 | 2.864 | 3.682 |
| LENGTH (feet) | CAPACITY IN THOUSANDS OF BTU PER HOUR | | | | | | | |
| 10 | 3130 | 6260 | 11 300 | 19 600 | 29 500 | 53 100 | 147 000 | 284 000 |
| 20 | 2150 | 4300 | 7760 | 13 400 | 20 300 | 36 500 | 101 000 | 195 000 |
| 30 | 1730 | 3450 | 6230 | 10 800 | 16 300 | 29 300 | 81 100 | 157 000 |
| 40 | 1480 | 2960 | 5330 | 9240 | 14 000 | 25 100 | 69 400 | 134 100 |
| 50 | 1310 | 2620 | 4730 | 8190 | 12 400 | 22 200 | 61 500 | 119 000 |
| 60 | 1190 | 2370 | 4280 | 7420 | 11 200 | 20 100 | 55 700 | 108 000 |
| 70 | 1090 | 2180 | 3940 | 6830 | 10 300 | 18 500 | 51 300 | 99 100 |
| 80 | 1010 | 2030 | 3670 | 6350 | 9590 | 17 200 | 47 700 | 92 200 |
| 90 | 952 | 1910 | 3440 | 5960 | 9000 | 16 200 | 44 700 | 86 500 |
| 100 | 899 | 1800 | 3250 | 5630 | 8500 | 15 300 | 42 300 | 81 700 |
| 125 | 797 | 1600 | 2880 | 4990 | 7530 | 13 500 | 37 500 | 72 400 |
| 150 | 722 | 1450 | 2610 | 4520 | 6830 | 12 300 | 33 900 | 65 600 |
| 175 | 664 | 1330 | 2400 | 4160 | 6280 | 11 300 | 31 200 | 60 300 |
| 200 | 618 | 1240 | 2230 | 3870 | 5840 | 10 500 | 29 000 | 56 100 |
| 250 | 548 | 1100 | 1980 | 3430 | 5180 | 9300 | 25 700 | 49 800 |
| 300 | 496 | 994 | 1790 | 3110 | 4690 | 8430 | 23 300 | 45 100 |
| 350 | 457 | 914 | 1650 | 2860 | 4320 | 7760 | 21 500 | 41 500 |
| 400 | 425 | 851 | 1530 | 2660 | 4020 | 7220 | 12 000 | 38 600 |
| 450 | 399 | 798 | 1440 | 2500 | 3770 | 6770 | 18 700 | 36 200 |
| 500 | 377 | 754 | 1360 | 2360 | 3560 | 6390 | 17 700 | 34 200 |
| 550 | 358 | 716 | 1290 | 2240 | 3380 | 6070 | 16 800 | 32 500 |
| 600 | 341 | 683 | 1230 | 2140 | 3220 | 5790 | 16 000 | 31 000 |
| 650 | 327 | 654 | 1180 | 2040 | 3090 | 5550 | 15 400 | 29 700 |
| 700 | 314 | 628 | 1130 | 1960 | 2970 | 5330 | 14 700 | 28 500 |
| 750 | 302 | 605 | 1090 | 1890 | 2860 | 5140 | 14 200 | 27 500 |
| 800 | 292 | 585 | 1050 | 1830 | 2760 | 4960 | 13 700 | 26 500 |
| 850 | 283 | 566 | 1020 | 1770 | 2670 | 4800 | 13 300 | 25 700 |
| 900 | 274 | 549 | 990 | 1710 | 2590 | 4650 | 12 900 | 24 900 |
| 950 | 266 | 533 | 961 | 1670 | 2520 | 4520 | 12 500 | 24 200 |
| 1000 | 259 | 518 | 935 | 1620 | 2450 | 4400 | 12 200 | 23 500 |
| 1100 | 246 | 492 | 888 | 1540 | 2320 | 4170 | 11 500 | 22 300 |
| 1200 | 234 | 470 | 847 | 1470 | 2220 | 3980 | 11 000 | 21 300 |
| 1300 | 225 | 450 | 811 | 1410 | 2120 | 3810 | 10 600 | 20 400 |
| 1400 | 216 | 432 | 779 | 1350 | 2040 | 3660 | 10 100 | 19 600 |
| 1500 | 208 | 416 | 751 | 1300 | 1960 | 3530 | 9760 | 18 900 |
| 1600 | 201 | 402 | 725 | 1260 | 1900 | 3410 | 9430 | 18 200 |
| 1700 | 194 | 389 | 702 | 1220 | 1840 | 3300 | 9130 | 17 600 |
| 1800 | 188 | 377 | 680 | 1180 | 1780 | 3200 | 8850 | 17 100 |
| 1900 | 183 | 366 | 661 | 1140 | 1730 | 3110 | 8590 | 16 600 |
| 2000 | 178 | 356 | 643 | 1110 | 1680 | 3020 | 8360 | 16 200 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 pound-force per square inch = 6.8947 kPa

* Table entries are rounded to 3 significant digits.

TABLE 1216.2(36)
POLYETHYLENE PLASTIC TUBING [NFPA 54-12: TABLE 6.3(m)][2]

| | | |
|---|---|---|
| | GAS: | UNDILUTED PROPANE |
| | INLET PRESSURE: | 11.0 in. w.c. |
| | PRESSURE DROP: | 0.5 in. w.c. |
| | SPECIFIC GRAVITY: | 1.50 |
| INTENDED USE: PE TUBE SIZING BETWEEN INTEGRAL SECOND-STAGE REGULATOR AT TANK OR SECOND-STAGE (LOW PRESSURE) REGULATOR AND BUILDING | | |
| | PLASTIC TUBING SIZE (CTS)[1] (inch) | |
| NOMINAL OD: | ½ | 1 |
| DESIGNATION: | SDR 7 | SDR 11 |
| ACTUAL ID: | 0.445 | 0.927 |
| LENGTH (feet) | CAPACITY IN THOUSANDS OF BTU PER HOUR | |
| 10 | 121 | 828 |
| 20 | 83 | 569 |
| 30 | 67 | 457 |
| 40 | 57 | 391 |
| 50 | 51 | 347 |
| 60 | 46 | 314 |
| 70 | 42 | 289 |
| 80 | 39 | 269 |
| 90 | 37 | 252 |
| 100 | 35 | 238 |
| 125 | 31 | 211 |
| 150 | 28 | 191 |
| 175 | 26 | 176 |
| 200 | 24 | 164 |
| 225 | 22 | 154 |
| 250 | 21 | 145 |
| 275 | 20 | 138 |
| 300 | 19 | 132 |
| 350 | 18 | 121 |
| 400 | 16 | 113 |
| 450 | 15 | 106 |
| 500 | 15 | 100 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW, 1 inch water column = 0.249 kPa

**Notes:**

[1] CTS = Copper tube size.

[2] Table entries are rounded to 3 significant digits.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 13 - HEALTH CARE FACILITIES AND MEDICAL GAS AND VACUUM SYSTEMS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | X | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | X | X | X | X | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| 1301.2 | | | | | | | | | X | X | X | X | | | | | | | |

# CHAPTER 13

## HEALTH CARE FACILITIES AND MEDICAL GAS AND VACUUM SYSTEMS

### Part I – Special Requirements for Health Care Facilities.

**1301.0 Application.**

**1301.1 Where Required.** Construction and equipment requirements shall be applied to new construction and new equipment, except as modified in individual chapters. The altered, renovated, or modernized portion of an existing system or individual component shall be required to meet the installation and equipment requirements stated in this code. Where the alteration, renovation, or modernization adversely impacts existing performance requirements of a system or component, additional upgrading shall be required. [NFPA 99:1.3.2 – 1.3.2.2]

**1301.2 Health Care Facilities.** This chapter applies to the special fixtures and systems in health care facilities and to the special plumbing requirements for such facilities. Other plumbing in such facilities shall comply with other applicable sections of this code. ***[OSHPD 1, 2, 3 & 4]*** *Medical gas systems for health care facilities that are regulated by OSHPD (hospitals, skilled nursing facilities, and intermediate care facilities, licensed clinics, and correctional treatment centers) shall be in accordance with NFPA 99-2005, Standard for Health Care Facilities. See California Building Code Table 1224.2 for location and number of station outlets for oxygen, vacuum, and medical air.*

**1301.3 Breathing Air Replenishment (BAR) System.** This chapter shall not apply to breathing air replenishment (BAR) systems.

**1302.0 Medical Gas and Vacuum Piping Systems – Installation Requirements.**

**1302.1 General.** The installation of medical gas and vacuum piping systems shall be in accordance with the requirements of this chapter, the appropriate standards, or both adopted by the Authority Having Jurisdiction. For additional standards, see Table 1401.1.

**1302.2 Manufacturer's Instructions.** The installation of individual components shall be in accordance with the manufacturer's installation instructions. Such instructions shall include directions and information deemed by the manufacturer to be adequate for attaining proper operation, testing, and maintenance of the medical gas and vacuum systems. Copies of the manufacturer's instructions shall be left with the system owner. [NFPA 99:5.1.10.10.9.1 – 5.1.10.10.9.3]

**1302.3 Installation.** The installation of medical gas and vacuum systems shall be made by qualified, competent technicians who are experienced in making such installations. Installers of medical gas and vacuum systems shall meet the requirements of ASSE 6010. [NFPA 99:5.1.10.10.11.1 – 5.1.10.10.11.2]

**1302.4 Brazing.** Brazing shall be performed by individuals who are qualified under the provisions of Section 1310.6. [NFPA 99:5.1.10.10.11.3]

**1302.5 Documentation.** Prior to installation work, the installer of medical gas and vacuum piping shall provide and maintain documentation on the job site for the qualification of brazing procedures and individual brazers that are required under Section 1310.6. [NFPA 99:5.1.10.10.11.4]

**1303.0 Protrusions from Walls.**

**1303.1 Drinking Fountain Control Valves.** Drinking fountain control valves shall be flush-mounted or fully recessed where installed in corridors or other areas where patients are transported on a gurney, bed, or wheelchair.

**1303.2 Exposed Piping.** Piping exposed in corridors and other areas where subject to physical damage from the movement of carts, stretchers, portable equipment, or vehicles shall be protected. [NFPA 99:5.1.10.10.2.1]

**1304.0 Psychiatric Patient Rooms.**

**1304.1 General.** Piping and drain traps in psychiatric patient rooms shall be concealed. Fixtures and fittings shall be resistant to vandalism.

**1305.0 Locations for Ice Storage.**

**1305.1 General.** Ice makers or ice storage containers shall be located in nursing stations or similarly supervised areas to minimize potential contamination.

**1306.0 Sterilizers.**

**1306.1 General.** The requirements of this section apply to sterilizers and bedpan steamers. Such equipment shall be installed in accordance with this code and the manufacturer's installation instructions.

**1306.2 Indirect Waste Connections.** Waste drainage from sterilizers and bedpan steamers shall be connected to the sanitary drainage system through an air gap in accordance with this chapter and Chapter 8. The size of indirect waste piping shall be not less than the size of the drain connection on the fixture. Each such indirect waste pipe shall not exceed 15 feet (4572 mm) in length and shall be separately piped to a receptor. Such receptors shall be located in the same room as the equipment served. Except for bedpan steamers, such indirect waste pipes shall not require traps. A trap having a seal of not less than 3 inches (76 mm) shall be provided in the indirect waste pipe for a bedpan steamer.

**1307.0 Vapor Vents and Stacks for Sterilizers.**

**1307.1 General.** Where a sterilizer has provision for a vapor vent and such a vent is required by the manufacturer,

the vent shall be extended to the outdoors above the roof. Sterilizer vapor vents shall be installed in accordance with the manufacturer's installation instructions and shall not be connected to a drainage system vent.

**1308.0 Aspirators.**

**1308.1 General.** Provisions for aspirators or other water-supplied suction devices shall be installed with the specific approval of the Authority Having Jurisdiction. Where aspirators are used for removing body fluids, they shall include a collection container to collect liquids and solid particles. Aspirators shall indirectly discharge to the sanitary drainage system through an air gap in accordance with Chapter 8. The potable water supply to an aspirator shall be protected by a vacuum breaker or equivalent backflow protection device in accordance with Section 603.0. (See Section 603.5.9)

## Part II – Medical Gas and Vacuum Systems.

**1309.0 Application.**

**1309.1 General.** The provisions herein shall apply to the installation, testing, and verification of medical gas and vacuum piping in hospitals, clinics, and other health care facilities.

**1309.2 Purpose.** The purpose of this chapter is to provide requirements for the installation, testing, and verification of medical gas and medical vacuum systems, from the central supply system to the station outlets or inlets.

**1309.3 Terms.** Where the terms "medical gas" or "vacuum" occur, the provisions shall apply to piped systems for oxygen, nitrous oxide, medical air, carbon dioxide, helium, medical–surgical vacuum, waste anesthetic gas disposal, and mixtures thereof. Where the name of a specific gas or vacuum service occurs, the provision shall apply to that gas. [NFPA 99:5.1.1.2]

**1309.4 Portable Compressed Gas Systems.** This chapter does not apply to portable compressed gas systems.

**1309.5 Where Not Applicable.** This chapter does not apply to:

(1) Cylinder and container management, storage, and reserve requirements
(2) Gas central supply and bulk supply systems, except as addressed in this chapter
(3) Electrical connections and requirements
(4) Motor requirements and controls
(5) Systems having nonstandard operating pressures, except as addressed in this chapter
(6) Waste anesthetic gas disposal (WAGD) systems
(7) Surface-mounted medical gas rail systems

**1309.6 Requirements.** The requirements of this chapter shall not be interpreted to conflict with the requirements of NFPA 99. For requirements of portions of medical gas and medical vacuum systems not addressed in this chapter or medical gas and medical vacuum systems beyond the scope of this chapter refer to NFPA 99.

**1309.7 Existing Systems.** An existing system that is not in strict compliance with the provisions of this code shall be permitted to be continued in use as long as the Authority Having Jurisdiction has determined that such use does not constitute a distinct hazard to life. [NFPA 99:5.1.1.4]

**1310.0 General Requirements.**

**1310.1 Oxygen Compatibility.** Tubes, valves, fittings, station outlets, and other piping components in medical gas systems shall have been cleaned for oxygen service by the manufacturer prior to installation in accordance with CGA G-4.1 except that fittings shall be permitted to be cleaned by a supplier or agency other than the manufacturer. [NFPA 99:5.1.10.1.1]

**1310.1.1 Components.** Components include but are not limited to containers, valves, valve seats, lubricants, fittings, gaskets, and interconnecting equipment including hose. Easily ignitable materials shall be avoided.

Compatibility involves both combustibility and ease of ignition. Materials that burn in air will burn violently in pure oxygen at normal pressure and explosively in pressurized oxygen. Also, many materials that do not burn in air will do so in pure oxygen, particularly under pressure. Metals for containers and piping have to be carefully selected, depending on service conditions. The various steels are acceptable for many applications, but some service conditions are capable of calling for other materials (usually copper or its alloys) because of their greater resistance to ignition and lower rate of combustion. Similarly, materials that are capable of being ignited in air have lower ignition energies in oxygen. Many such materials are capable of being ignited by friction at a valve seat, stem packing or by adiabatic compression produced where oxygen at high pressure is rapidly introduced into a system initially at low pressure.

**1310.1.2 Materials.** Materials used in central supply systems shall meet the following requirement. [NFPA 99:5.1.3.4.4]

In those portions of systems intended to handle oxygen or nitrous oxide at gauge pressures of less than 300 pounds-force per square inches (psi) (2068 kPa), material construction shall be compatible with oxygen under the temperatures and pressures to which the components are capable of being exposed in the containment and use of oxygen, nitrous oxide, mixtures of these gases, or mixtures containing more than 23.5 percent oxygen. [NFPA 99:5.1.3.4.4(2)]

**1310.2 Certification.** Certification of medical gas and medical vacuum systems shall comply with the requirements of Section 1327.0 of this code, the Authority Having Jurisdiction, and NFPA 99.

**1310.3 Documentation.** Prior to installation work, the installer of medical gas and vacuum piping shall provide

and maintain documentation on the job site for the qualification of brazing procedures and individual brazers that are required under Section 1310.6. [NFPA 99:5.1.10.10.11.4]

**1310.3.1 Delivery.** Each length of tube shall be delivered plugged or capped by the manufacturer and kept sealed until prepared for installation. Fittings, valves, and other components shall be delivered sealed, labeled, and kept sealed until prepared for installation. [NFPA 99:5.1.10.1.2, 5.1.10.1.3]

**1310.4 Supply Source.** Medical gas and medical vacuum systems shall be supplied from a source consisting of not less than two units – primary and secondary, e.g., a manifold consisting of two cylinder banks with not less than two cylinders in each bank; not less than two air compressors; or not less than two vacuum pumps. However, two supply pipelines are not required.

**1310.5 Health Care Organization Personnel.** Health care organization personnel shall be permitted to install piping systems where the requirements of this chapter are met during installation. [NFPA 99:5.1.10.10.11.5]

**1310.6 Brazing Procedures.** Brazing procedures and brazer performance for the installation of medical gas and vacuum piping shall be qualified in accordance with either Section IX of the ASME Boiler and Pressure Vessel Code or AWS B2.2, both as modified below. [NFPA 99:5.1.10.10.12.1]

**1310.6.1 Examination.** Brazers shall be qualified by visual examination of the test coupon followed by sectioning. [NFPA 99:5.1.10.10.12.2]

**1310.6.2 Brazing Procedure Specification (BPS).** The brazing procedure specification (BPS) shall address cleaning, joint clearance, overlap, internal purge gas flow rate, and filler metal. [NFPA 99:5.1.10.10.12.3]

**1310.6.3 Documentation.** The brazing procedure specification and the record of brazer performance qualification shall document filler metal used, cleaning, joint clearance, overlap, internal purge gas, and flow rate during brazing of coupon, and the absence of internal oxidation in the completed coupon. [NFPA 99:5.1.10.10.12.4]

**1310.6.4 Procedures.** Brazing procedures qualified by a technically competent group or agency shall be permitted under the following conditions:

(1) The brazing procedure specification and the procedure qualification record meets the requirements of this code.

(2) The employer obtains a copy of both the brazing procedure specification and the supporting qualification records from the group or agency and signs and dates these records, thereby accepting responsibility for the qualifications that were performed by the group or agency.

(3) The employer qualifies not less than one brazer following each brazing procedure specification used. [NFPA 99:5.1.10.10.12.5]

**1310.6.5 Conditions of Acceptance.** An employer shall be permitted to accept brazer qualification records of a previous employer under the following conditions:

(1) The brazer has been qualified following the same or an equivalent procedure that the new employer uses.

(2) The new employer obtains a copy of the record of brazer performance qualification tests from the previous employer and signs and dates these records, thereby accepting responsibility for the qualifications performed by the previous employer. [NFPA 99:5.1.10.10.12.6]

**1310.6.6 Qualifications.** Performance qualifications of brazers shall remain in effect indefinitely unless the brazer does not braze with the qualified procedure for a period exceeding 6 months, or there is a specific reason to question the ability of the brazer. [NFPA 99:5.1.10.10.12.7]

**1311.0 Plan Review.**

**1311.1 Plans and Specifications.** Before a medical gas or medical vacuum system is installed or altered in a hospital, medical facility, or clinic, duplicate plans and specifications shall be filed with the Authority Having Jurisdiction. Approval of the plans shall be obtained prior to issuance of a permit by the Authority Having Jurisdiction.

**1311.2 Requirements.** Plans and specifications shall show the following, in detail:

(1) Plot plan of the site, drawn to scale, indicating the location of existing or new cylinder storage areas, property lines, driveways, and existing or proposed buildings.

(2) Piping layout of the proposed piping system or alteration, including alarms, valves, origin of gases, and user outlets/inlets. The demand and loading of a piping, existing or future, shall also be indicated.

(3) Complete specification of materials.

**1311.3 Extent of Work.** Plans and specifications submitted to the Authority Having Jurisdiction shall clearly indicate the nature and extent of the work proposed and shall show in detail that such work will conform to the provisions of this code.

**1311.4 Record.** A record of as-built plans and valve identification records shall remain on the site.

**1312.0 System Performance.**

**1312.1 Required Operating Pressures.** Medical gas and medical vacuum systems shall be capable of delivering service in the pressure ranges listed in Table 1312.1.

**1312.2 Minimum Flow Rates.** Medical gas and medical vacuum systems shall be capable of supplying the flow rates listed in Table 1312.2.

**1312.3 Minimum Station Outlets/Inlets.** Station outlets and inlets for medical gas and medical vacuum systems shall be provided as listed in Table 1312.3.

**TABLE 1312.1**
**STANDARD DESIGNATION COLORS AND OPERATING PRESSURES FOR GAS AND VACUUM SYSTEMS**
**[NFPA 99: TABLE 5.1.11]**

| GAS SERVICE | ABBREVIATED NAME | COLORS (BACKGROUND/TEXT) | STANDARD GAUGE PRESSURE |
|---|---|---|---|
| Medical air | Med Air | Yellow/black | 50–55 psi |
| Carbon dioxide | $CO_2$ | Gray/black or gray/white | 50–55 psi |
| Helium | He | Brown/white | 50–55 psi |
| Nitrogen | $N_2$ | Black/white | 160–185 psi |
| Nitrous oxide | $N_2O$ | Blue/white | 50–55 psi |
| Oxygen | $O_2$ | Green/white or white/green | 50–55 psi |
| Oxygen/carbon dioxide mixture | $O_2/CO_2$ *n*% (*n* is % of $CO_2$) | Green/white | 50–55 psi |
| Medical–surgical vacuum | Med Vac | White/black | 15 inch to 30 inch HgV |
| Waste anesthetic gas disposal | WAGD | Violet/white | Varies with system type |
| Other mixtures | Gas A%/ Gas B% | Colors as above major gas for background/minor gas for text | None |
| Nonmedical air (Level 3 gas-powered device) | — | Yellow-and-white diagonal stripe/black | None |
| Nonmedical and Level 3 vacuum | — | White-and-black diagonal stripe/black boxed | None |
| Laboratory air | — | Yellow-and-white checker-board/black | None |
| Laboratory vacuum | — | White-and-black checkerboard/black boxed | None |
| Instrument air | — | Red/white | 160–185 psi |

For SI units: 1 inch = 25.4 mm, 1 pound-force per square inch = 6.8947 kPa

**TABLE 1312.2**
**MINIMUM FLOW RATES (cubic feet per minute)**

| MEDICAL SYSTEM | FLOW RATE |
|---|---|
| Oxygen | .71 CFM per outlet[1] |
| Nitrous Oxide | .71 CFM per outlet[1] |
| Medical Compressed Air | .71 CFM per outlet[1] |
| Nitrogen | 15 CFM free air per outlet |
| Vacuum | 1 SCFM per inlet[2] |
| Carbon Dioxide | .71 CFM per outlet[1] |
| Helium | .71 CFM per outlet |

For SI units: 1 cubic foot per minute (CFM) = 0.47 L/s

**Notes:**

[1] A room designed for a permanently located respiratory ventilator or anesthesia machine shall have an outlet capable of a flow rate of 6.36 CFM (3.0 L/s) at the station outlet.

[2] For testing and certification purposes, individual station inlets shall be capable of a flow rate of 3 SCFM, while maintaining a system pressure of not less than 12 inches of mercury (41 kPa) at the nearest adjacent vacuum inlet.

## 1313.0 Required Pipe Sizing.

**1313.1 Maximum Demand.** Where the maximum demand for each medical gas or vacuum system and the maximum length of piping between the source equipment and the most distant station outlet/inlet do not exceed the values in Table 1313.2, the size of pipe of each section of the system shall be determined using Table 1313.1 and Table 1313.2. The size for systems beyond the range of Table 1313.2 shall be determined by using the methods in accordance with Section 1313.3 of this chapter.

**1313.2 Sizing Procedures.** To determine the size of each section of pipe in a system within the range of Table 1313.2, proceed as follows:

(1) Measure the length of the pipe from the source equipment location to the most remote station inlet/outlet on the system.

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**TABLE 1312.3**
**MINIMUM OUTLETS/INLETS PER STATION**

| LOCATION | OXYGEN | MEDICAL VACUUM | MEDICAL AIR | NITROUS OXIDE | NITROGEN | HELIUM | CARBON DIOXIDE |
|---|---|---|---|---|---|---|---|
| Patient rooms for medical/surgical, obstetrics, and pediatrics | 1/bed | 1/bed | 1/bed | — | — | — | — |
| Examination/treatment for nursing units | 1/bed | 1/bed | — | — | — | — | — |
| Intensive care (all) | 3/bed | 3/bed | 2/bed | — | — | — | — |
| Nursery[1] | 2/bed | 2/bed | 1/bed | — | — | — | — |
| General operating rooms | 2/room | 3/room[4] | 2/room | 1/room | 1/room | — | — |
| Cystoscopic and invasive special procedures | 2/room | 3/room[4] | 2/room | — | — | — | — |
| Recovery delivery and labor/delivery/recovery rooms[2] | 2/bed<br>2/room | 2/bed<br>3/room[4] | 1/bed<br>1/room | — | — | — | — |
| Labor rooms | 1/bed | 1/bed | 1/bed | — | — | — | — |
| First aid and emergency treatment[3] | 1/bed | 1/bed[4] | 1/bed | — | — | — | — |
| Autopsy | — | 1/station | 1/station | — | — | — | — |
| Anesthesia workroom | 1/station | — | 1/station | — | — | — | — |

**Notes:**
[1] Includes pediatric nursery.
[2] Includes obstetric recovery.
[3] Emergency trauma rooms used for surgical procedures shall be classified as general operating rooms.
[4] Vacuum inlets required are in addition to inlets used as part of a scavenging system for removal of anesthetizing gases.

(2) In Table 1313.2, select the column showing that distance, or the next longer distance where the table does not give the exact length.

(3) Starting at the most remote outlet/inlet, find in the vertical column just selected the medical gas or vacuum demand for that inlet/outlet. Where the exact figure of demand is not shown, choose the next larger figure below in the column.

(4) Opposite this demand figure, in the first column at the left in Table 1313.2, will be found the correct size of pipe.

(5) Using this same vertical column, proceed in a similar manner for each section of pipe serving this inlet/outlet. For each section of pipe, determine the total gas or vacuum demand supplied by the section, using Table 1313.1.

(6) Size each section of branch piping not previously sized by measuring the distance from the source equipment location to the most remote inlet/outlet in that branch, and follow the procedures of Section 1313.2(2) through Section 1313.2(5). Size branch piping in the order of the distance from the source location, beginning with the most distant outlet not previously sized.

**1313.3 Engineering Methods.** For conditions other than those covered by Section 1313.1 of this section, such as longer runs of greater gas or vacuum demands, the size of each gas or vacuum piping system shall be determined by standard engineering methods acceptable to the Authority Having Jurisdiction, and each system shall be so designed that the total pressure drop or gain between the source equipment and an inlet/outlet shall not exceed the allowable pressures shown in Table 1312.1.

**1314.0 Workmanship.**

**1314.1 Accepted Engineering Practices.** Design, construction, and workmanship shall be in conformity with accepted engineering practices and shall meet the requirements of this code.

**1314.2 Imperfections.** Cracks, holes, or other imperfections in materials shall not be concealed by welding, brazing, or soldering, or by using paint, wax, tar, other leak-sealing or repair agents.

**1314.3 Burred Ends.** Burred ends of tubing shall be deburred using a deburring tool to the full bore of the tube, and chips shall be removed.

**1315.0 Materials.**

**1315.1 General.** The provisions of this section shall apply to the field-installed piping for the distribution of medical piped gases.

**1315.2 Cleaning.** Tubes, valves, fittings, station outlets, and other piping components in medical gas systems shall have been cleaned for oxygen service by the manufacturer prior to installation in accordance with CGA G-4.1 except that fittings shall be permitted to be cleaned by a supplier or agency other than the manufacturer. [NFPA 99:5.1.10.1.1]

**1315.3 Delivery.** Each length of tube shall be delivered plugged or capped by the manufacturer and kept sealed until prepared for installation. Fittings, valves, and other components shall be delivered sealed, labeled, and kept sealed until prepared for installation. [NFPA 99:5.1.10.1.2, 5.1.10.1.3]

**TABLE 1313.1**
**SYSTEM SIZING – FLOW REQUIREMENTS FOR STATION INLET/OUTLET[1]**

| NUMBER OF INLET/OUTLET TERMINAL UNITS PER FACILITY | DIVERSITY PERCENTAGE OF AVERAGE FLOW PER INLET/OUTLET TERMINAL UNITS | MINIMUM PERMISSIBLE SYSTEM FLOW OF ALL PRESSURIZED MEDICAL GAS SYSTEMS[2] (standard cubic feet per minute) |
|---|---|---|
| 1–10 | 100% | Actual Demand |
| 11–25 | 75% | 7.0 |
| 26–50 | 50% | 13.1 |
| 51–100 | 50% | 17.5 |

**Notes:**
[1] Flow rates of station inlets/outlets in accordance with Table 1312.2.
[2] The minimum system flow is the average inlet/outlet flow times the number of station inlets/outlets times the diversity percentage.

**TABLE 1313.2**
**SIZE OF GAS/VACUUM PIPING**

| MAXIMUM DELIVERY CAPACITY[3] (standard cubic feet per minute) | | | | | | |
|---|---|---|---|---|---|---|
| | | LENGTH OF PIPING (feet)[1] | | | | |
| MEDICAL SYSTEM | GAS PIPE SIZE (inches)[2] | 100 | 250 | 500 | 750 | 1000 |
| Oxygen | ½ | 15.0 | 10.6 | 7.4 | 5.9 | 5.1 |
| | ¾ | 40.0 | 28.3 | 19.6 | 15.7 | 13.3 |
| | 1 | 50.0 | 50.0 | 40.2 | 32.2 | 27.7 |
| Nitrous Oxide | ½ | 15.0 | 9.5 | 6.5 | 5.3 | 4.5 |
| | ¾ | 30.0 | 24.7 | 17.1 | 13.7 | 11.7 |
| | 1 | 40.0 | 40.0 | 34.7 | 28.2 | 24.3 |
| Medical Air | ½ | 18.1 | 11.1 | 7.8 | 6.3 | 5.3 |
| | ¾ | 40.0 | 29.9 | 21.0 | 16.5 | 14.1 |
| | 1 | 50.0 | 50.0 | 42.1 | 35.8 | 29.2 |
| Vacuum | 1 | 22.8 | 13.7 | 9.5 | 7.6 | 6.5 |
| | 1¼ | 40.1 | 24.5 | 16.7 | 13.3 | 11.2 |
| | 1½ | 63.7 | 38.9 | 26.8 | 21.1 | 17.9 |
| | 2 | 132.7 | 81.4 | 56.0 | 45.0 | 38.3 |
| Nitrogen | ½ | 25.0 | 25.0 | 25.0 | 23.8 | 20.6 |
| | ¾ | 60.0 | 60.0 | 60.0 | 60.0 | 54.2 |
| | 1 | 110.0 | 110.0 | 110.0 | 110.0 | 110.0 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm
**Notes:**
[1] Length of piping includes a 30 percent allowance for fittings.
[2] One-half inch (15 mm) diameter pipe is the minimum size allowed in medical gas systems.
[3] Based on the following maximum pressure drops:
(a) Oxygen, nitrous oxide, and medical air – 5 psig (34 kPa)
(b) Vacuum – 1.96 psig (13.5 kPa)
(c) Nitrogen – 20 psig (138 kPa)

**1315.4 Tubes.** Tubes shall be hard-drawn seamless copper ASTM B 819 medical gas tube, Type L, except that where operating pressures are exceeding a gauge pressure of 185 psi (1276 kPa), Type K shall be used for sizes exceeding DN80 (NPS 3) (80 mm) (3⅛ inches O.D.).

ASTM B 819 medical gas tube shall be identified by the manufacturer's markings "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue (Type L) or green (Type K). [NFPA 99:5.1.10.1.4, 5.1.10.1.5]

Piping for vacuum systems shall be constructed of one of the following:

(1) Hard-drawn seamless copper tube in accordance with one of the following:
   (a) ASTM B 88 (Types K, L, M)
   (b) ASTM B 280 (copper ACR tube)
   (c) ASTM B 819 copper medical gas tubing (Types K or L)

(2) Stainless steel tube [NFPA 99:5.1.10.2.1]:

(a) Piping systems shall be designed and sized to deliver the required flow rates at the utilization pressures.

(b) Mains and branches in medical gas piping systems shall be not less than DN15 (NPS ½) (15 mm) (⅝ of an inch O.D.) size.

(c) Mains and branches in medical-surgical vacuum systems shall be not less than DN20 (NPS ¾) (20 mm) (⅞ of an inch O.D.) size.

(d) Drops to individual station outlets and inlets shall be not less than DN15 (NPS ½) (15 mm) (⅝ of an inch O.D.) size.

(e) Runouts to alarm panels and connecting tubing for gauges and alarm devices shall be permitted to be DN8 (NPS ¼) (8 mm) (⅜ of an inch O.D.) size. [NFPA 99:5.1.10.10.1.1 – 5.1.10.10.1.5]

**1315.5 Changes in Direction.** Turns, offsets, and other changes in direction in welded or brazed medical gas and vacuum piping shall be made with wrought-copper capillary fittings in accordance with ASME B16.22 or brazed fittings in accordance with ASME B16.50. [NFPA 99:5.1.10.3.1]

**1315.5.1 Cast-Copper Alloy Fittings.** Cast-copper alloy fittings shall not be permitted. [NFPA 99:5.1.10.3.2]

**1315.5.2 Branch Connections.** Branch connections in vacuum piping systems shall be permitted to be made using mechanically formed, drilled, and extruded tee-branch connections that are formed in accordance with the tool manufacturer's instructions and brazed. [NFPA 99:5.1.10.3.3]

**1315.6 Special Fittings.** The following special fittings shall be permitted to be used in lieu of brazed joints:

(1) Memory-metal couplings having temperature and pressure ratings joints not less than that of a brazed joint.

(2) Listed or approved metallic gas tube fittings that, where made up, provide a permanent joint having the mechanical, thermal, and sealing integrity of a brazed joint.

(3) Dielectric fittings where required by the manufacturer of special medical equipment to electrically isolate the equipment from the piping distribution system.

(4) Axially swaged, elastic strain preload fittings providing metal to metal seal having pressure and temperature ratings not less than that of a brazed joint and, where complete, are permanent and nonseparable. [NFPA 99:5.1.10.7]

**1315.7 Prohibited Joints.** The following joints shall be prohibited throughout medical gas and vacuum distribution pipeline systems:

(1) Flared and compression-type connections, including connections to station outlets and inlets, alarm devices, and other components.

(2) Other straight-threaded connections, including unions.

(3) The use of pipe-crimping tools to permanently stop the flow. [NFPA 99:5.1.10.8]

**1315.7.1 Threaded Joints.** Threaded joints in medical gas and vacuum distribution piping shall meet the following requirements:

(1) Be limited to connections to pressure/vacuum indicators, alarm devices, and source equipment.

(2) Be tapered pipe threads in accordance with ASME B1.20.1.

(3) Be made up with polytetrafluoroethylene (such as Teflon™) tape or other thread sealant recommended for oxygen service, with the sealant applied to the male threads only. [NFPA 99:5.1.10.4]

**1315.8 Shutoff Valves.** New or replacement shutoff valves shall be as follows:

(1) Quarter turn, full ported ball type.

(2) Brass or bronze construction.

(3) Have extensions for brazing.

(4) Have a handle indicating open or closed.

(5) Consist of three pieces permitting in-line serviceability. [NFPA 99:5.1.4.3]

**1315.9 Soldered Joints.** Soldered joints in copper Level 3 vacuum and Level 3 gas-powered systems piping shall be made in accordance with ASTM B 828 using a lead-free solder filler metal containing not more than 0.2 percent lead by volume. [NFPA 99:5.3.10.5]

**1316.0 Cleaning for Medical Gas Piping Systems.**

**1316.1 Cleaning.** The interior surfaces of tube ends, fittings, and other components that were cleaned for oxygen service by the manufacturer, but become contaminated prior to being installed, shall be permitted to be recleaned on-site by the installer by thoroughly scrubbing the interior surfaces with a clean, hot water–alkaline solution, such as sodium carbonate or trisodium phosphate, 1 pound to 3 gallons (0.5 kg to 11 L) of potable water and thoroughly rinsing them with clean, hot potable water. Other aqueous cleaning solutions shall be permitted to be used for on-site recleaning permitted above, provided that they are as recommended in CGA G-4.1. [NFPA 99:5.1.10.5.3.10, 5.1.10.5.3.11]

**1316.2 Contaminated Materials.** Material that has become contaminated internally and is not clean for oxygen service shall not be installed. [NFPA 99:5.1.10.5.3.12]

**1317.0 Installation of Piping.**

**1317.1 Pipe Protection.** Piping shall be protected against freezing, corrosion, and physical damage. [NFPA 99:5.1.10.10.2]

Piping underground within buildings or embedded in concrete floors or walls shall be installed in a continuous conduit. [NFPA 99:5.1.10.10.2.2]

**1317.2 Location.** Piping risers shall be permitted to be installed in pipe shafts where protected from physical damage, effects of excessive heat, corrosion, or contact with oil. [NFPA 99:5.1.10.10.3.1]

Piping shall not be installed in kitchens, elevator shafts, elevator machine rooms, areas with open flames, electrical service equipment exceeding 600 volts, and areas prohibited under *California Electrical Code*, except for the following locations:

(1) Room locations for medical air compressor supply systems and medical-surgical vacuum pump supply systems.

(2) Room locations for secondary distribution circuit panels and breakers having a maximum voltage rating of 600 volts.

Medical gas piping shall be permitted to be installed in the same service trench or tunnel with fuel gas lines, fuel oil lines, electrical lines, steam lines, and similar utilities provided that the space is ventilated (naturally or mechanically) and the ambient temperature around the medical gas piping shall not exceed 130°F (54°C). [NFPA 99:5.1.10.10.3.3]

Medical gas piping shall not be located where subject to contact with oil, including a possible flooding area in the case of a major oil leak. [NFPA 99:5.1.10.10.3.4]

**1317.3 Frost Protection.** Buried piping outside of buildings shall be installed below the local level of frost penetration. [NFPA 99:5.1.10.10.5.1]

**1317.4 Underground Piping.** The installation procedure for underground piping shall protect the piping from physical damage while being backfilled. [NFPA 99:5.1.10.10.5.2]

Where underground piping is protected by a conduit, cover, or other enclosure, the following requirements shall be met:

(1) Access shall be provided at the joints for visual inspection and leak testing.

(2) The conduit, cover, or enclosure shall be self-draining and not retain groundwater in prolonged contact with the pipe. [NFPA 99:5.1.10.10.5.3]

Buried piping that will be subject to surface loads shall be buried at a depth that will protect the piping or its enclosure from excessive stresses. [NFPA 99:5.1.10.10.5.4]

The minimum backfilled cover above the top of the pipe or its enclosure for buried piping outside of buildings shall be 36 inches (914 mm), except that the minimum cover shall be permitted to be reduced to 18 inches (457 mm) where physical damage is otherwise prevented. [NFPA 99:5.1.10.10.5.5]

Trenches shall be excavated so that the pipe enclosure has firm, substantially continuous bearing on the bottom of the trench. [NFPA 99:5.1.10.10.5.6]

Backfill shall be clean and compacted so as to protect and uniformly support the pipe enclosure. [NFPA 99:5.1.10.10.5.7]

A continuous tape or marker placed immediately above the enclosure shall clearly identify the pipeline by specific name. [NFPA 99:5.1.10.10.5.8]

A continuous warning means shall also be provided above the pipeline at approximately one-half the depth of bury. [NFPA 99:5.1.10.10.5.9]

Where underground piping is installed through a wall sleeve, the ends of the sleeve shall be sealed to prevent the entrance of groundwater into the building. [NFPA 99:5.1.10.10.5.10]

**1317.5 Connectors.** Hose and flexible connectors, both metallic and nonmetallic, shall not be longer than necessary and shall not penetrate or be concealed in walls, floors, ceilings, or partitions. Flexible connectors, metallic or nonmetallic, shall have a minimum burst pressure, with a gauge pressure of 1000 psi (6895 kPa). [NFPA 99:5.1.10.10.7]

**1317.6 Positive-Pressure Medical Gas Piping Distribution Systems.** Where a positive-pressure medical gas piping distribution system, originally used or constructed for the use at one pressure and for one gas, is converted for operation at another pressure or for another gas, the provisions of Section 1315.0 shall apply as if the system were new. [NFPA 99:5.1.10.10.10.1]

A vacuum system shall not be permitted to be converted for use as a gas system. [NFPA 99:5.1.10.10.10.2]

**1317.7 Support.** Piping shall be supported from the building structure in accordance with MSS SP-69. [NFPA 99:5.1.10.10.4.1]

Hangers and supports shall comply with MSS SP-58. [NFPA 99:5.1.10.10.4.2]

Hangers for copper tube shall have a copper finish and be sized for copper tube. [NFPA 99:5.1.10.10.4.3]

In damp locations, copper tube hangers or supports that are in contact with the tube shall be plastic-coated or otherwise be insulated from the tube. [NFPA 99:5.1.10.10.4.4]

Maximum support spacing shall be in accordance with Table 1317.7. [NFPA 99:5.1.10.10.4.5]

**1317.8 Seismic Provisions.** Where required, medical gas and vacuum piping shall be seismically restrained against earthquakes in accordance with the applicable building code. [NFPA 99:5.1.10.10.4.6]

Seismic considerations shall comply with the requirements of this code and the Authority Having Jurisdiction.

**1317.9 Testing.** Two or more medical gas piping systems shall not be interconnected for testing or other reason. Leak testing shall be accomplished by separately charging and testing the individual piping system. [NFPA 99:5.1.10.10.8]

**1317.10 Labeled.** Piping shall be labeled by stenciling or adhesive markers that identify the patient medical gas, the support gas, or vacuum system, and include:

(1) The name of the gas/vacuum system or the chemical symbol in accordance with Table 1312.1.

(2) The gas or vacuum system color code in accordance with Table 1312.1.

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(3) Where positive-pressure gas piping systems operate at pressures other than the standard gauge pressure in Table 1312.1, the pipe labeling shall include the operating pressure in addition to the name of the gas. [NFPA 99:5.1.11.1.1]

**1318.0 Joints.**

**1318.1 General.** This section sets forth the requirements for pipe joint installation for positive-pressure medical gas systems.

**1318.2 Brazed Joints.** Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 1000°F (538°C) to retain the integrity of the piping system in the event of fire exposure. [NFPA 99:5.1.10.5.1.1]

Brazed tube joints shall be the socket type. [NFPA 99:5.1.10.5.1.2]

Filler metals shall bond with and be metallurgically compatible with the base metals being joined. [NFPA 99:5.1.10.5.1.3]

Filler metals shall comply with AWS A5.8. [NFPA 99:5.1.10.5.1.4]

Copper-to-copper joints shall be brazed using a copper–phosphorus or copper-phosphorus-silver brazing filler metal (BCuP series) without flux. [NFPA 99:5.1.10.5.1.5]

Flux shall only be used where brazing dissimilar metals, such as copper and bronze or brass, using a silver (BAg series) brazing filler material. [NFPA 99:5.1.10.5.4.1]

Joints to be brazed in place shall be accessible for necessary preparation, assembly, heating, filler application, cooling, cleaning, and inspection. [NFPA 99:5.1.10.5.1.7]

**1318.3 Tube Ends.** Tube ends shall be cut square using a sharp tubing cutter to avoid deforming the tube. [NFPA 99:5.1.10.5.2.1]

The cutting wheels on tubing cutters shall be free from grease, oil, or other lubricant not suitable for oxygen service. [NFPA 99:5.1.10.5.2.2]

The cut ends of the tube shall be deburred with a sharp, clean deburring tool, taking care to prevent chips from entering the tube. [NFPA 99:5.1.10.5.2.3]

**1318.4 Cleaning Procedures.** The interior surfaces of tubes, fittings, and other components that are cleaned for oxygen service shall be stored and handled to avoid contamination prior to assembly and brazing. [NFPA 99:5.1.10.5.3.1]

The exterior surfaces of tube ends shall be cleaned prior to brazing to remove surface oxides. [NFPA 99:5.1.10.5.3.2]

Where cleaning the exterior surfaces of tube ends, no matter shall be permitted to enter the tube. [NFPA 99:5.1.10.5.3.3]

Where the interior surfaces of fitting sockets become contaminated prior to brazing, they shall be recleaned for oxygen in accordance with Section 1316.1 and shall be cleaned for brazing with a clean, oil-free wire brush. [NFPA 99:5.1.10.5.3.4]

Clean, nonshedding, abrasive pads shall be used to clean the exterior surfaces of tube ends. [NFPA 99:5.1.10.5.3.5]

The use of steel wool or sand cloth shall be prohibited. [NFPA 99:5.1.10.5.3.6]

The cleaning process shall not result in grooving of the surfaces to be joined. [NFPA 99:5.1.10.5.3.7]

After being abraded, the surfaces shall be wiped using a clean, lint-free white cloth. [NFPA 99:5.1.10.5.3.8]

Tubes, fittings, valves, and other components shall be visually examined internally before being joined to verify that they have not become contaminated for oxygen service and that they are free of obstructions or debris. [NFPA 99:5.1.10.5.3.9]

The interior surfaces of tube ends, fittings, and other components that were cleaned for oxygen service by the manufacturer, but become contaminated prior to being installed, shall be permitted to be recleaned on-site by the installer by thoroughly scrubbing the interior surfaces with a clean, hot water–alkaline solution, such as sodium carbonate or trisodium phosphate 1 pound to 3 gallons (0.5

**TABLE 1317.7**
**MAXIMUM PIPE SUPPORT SPACING**
**[NFPA 99:5.1.10.10.4.5]**

| PIPE SIZE | | | HANGER SPACING (feet) |
|---|---|---|---|
| DN8 | (NPS ¼) | (⅜ of an inch O.D.) | 5 |
| DN10 | (NPS ⅜) | (½ of an inch O.D.) | 6 |
| DN15 | (NPS ½) | (⅝ of an inch O.D.) | 6 |
| DN20 | (NPS ¾) | (⅞ of an inch O.D.) | 7 |
| DN25 | (NPS 1) | (1⅛ of an inch O.D.) | 8 |
| DN32 | (NPS 1¼) | (1⅜ of an inch O.D.) | 9 |
| DN40 and larger | (NPS 1½) | (1⅝ of an inch O.D.) | 10 |
| Vertical risers, all sizes, every floor but not to exceed: | | | 15 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm

kg to 11 L) of potable water and thoroughly rinsing them with clean, hot potable water. [NFPA 99:5.1.10.5.3.10]

Material that has become contaminated internally and is not clean for oxygen service shall not be installed. [NFPA 99:5.1.10.5.3.12]

Joints shall be brazed within 8 hours after the surfaces are cleaned for brazing. [NFPA 99:5.1.10.5.3.13]

**1318.5 Flux.** Flux shall only be used where brazing dissimilar metals such as copper and bronze or brass, using a silver (BAg series) brazing filler metal. [NFPA 99:5.1.10.5.4.1]

Surfaces shall be cleaned for brazing in accordance with Section 1318.4. [NFPA 99:5.1.10.5.4.2]

Flux shall be applied sparingly to minimize contamination of the inside of the tube with flux. [NFPA 99:5.1.10.5.4.3]

The flux shall be applied and worked over the cleaned surfaces to be brazed using a stiff bristle brush to ensure complete coverage and wetting of the surfaces with flux. [NFPA 99:5.1.10.5.4.4]

Short sections of copper tube shall be brazed onto the noncopper component and the interior of the subassembly shall be cleaned of flux prior to installation in the piping system. [NFPA 99:5.1.10.5.4.5]

On joints DN20 (NPS ¾) (20 mm) (⅞ of an inch O.D.) size and smaller, flux-coated brazing rods shall be permitted to be used in lieu of applying flux to the surfaces being joined. [NFPA 99:5.1.10.5.4.6]

**1318.6 Heat and Brazing.** Tube ends shall be inserted fully into the socket of the fitting. [NFPA 99:5.1.10.5.6.1]

Where flux is permitted, the joint shall be heated slowly until the flux has liquefied. [NFPA 99:5.1.10.5.6.2]

After flux is liquefied, or where flux is not permitted to be used, the joint shall be heated quickly to the brazing temperature, taking care not to overheat the joint. [NFPA 99:5.1.10.5.6.3]

**1318.7 Purge Gas.** Where being brazed, joints shall be continuously purged with oil-free, dry nitrogen NF to prevent the formation of copper oxide on the inside surfaces of the joint. [NFPA 99:5.1.10.5.5.1]

The source of the purge gas shall be monitored, and the installer shall be audibly alerted where the source content is low. [NFPA 99:5.1.10.5.5.2]

The purge gas flow rate shall be controlled by the use of a pressure regulator and flow meter or combination thereof. [NFPA 99:5.1.10.5.5.3]

Pressure regulators alone shall not be used to control purge gas flow rates. [NFPA 99:5.1.10.5.5.4]

In order to assure that ambient air has been removed from the pipeline prior to brazing, an oxygen analyzer shall be used to verify the effectiveness of the purge. The oxygen analyzer shall read below 1 percent oxygen concentration before brazing is to begin. [NFPA 99:5.1.10.5.5.5]

During and after installation, openings in the piping system shall be kept sealed to maintain a nitrogen atmosphere within the piping to prevent debris or other contaminants from entering the system. [NFPA 99:5.1.10.5.5.6]

While a joint is being brazed, a discharge opening shall be provided on the opposite side of the joint from where the purge gas is being introduced. [NFPA 99:5.1.10.5.5.7]

The flow of purge gas shall be maintained until the joint is cool to the touch. [NFPA 99:5.1.10.5.5.8]

After the joint has cooled, the purge discharge opening shall be sealed to prevent contamination of the inside of the tube and maintain the nitrogen atmosphere within the piping system. [NFPA 99:5.1.10.5.5.9]

The final connection of new piping to an existing, in-use pipeline shall be permitted to be made without the use of a nitrogen purge. [NFPA 99:5.1.10.5.5.10]

After a final connection in a positive-pressure medical gas pipeline is made without a nitrogen purge, an outlet in the immediate downstream zone of the affected portions of both the new and existing in-use piping shall be tested in accordance with the following: [NFPA 99:5.1.10.5.5.11]

(1) Each joint in the final connection between the new work and the existing system shall be leak-tested with the gas of system designation at the normal operating pressure by means of soapy water or other means safe for use with oxygen. [NFPA 99:5.1.12.3.9.2]

(2) For pressure gases, immediately after the final connection is made and leak-tested, the specific altered zone and components in the immediate zone or area that is downstream from the point or area of intrusion shall be purged. [NFPA 99:5.1.12.3.9.3]

(3) Before the new work is used for patient care, positive-pressure gases shall be tested for operational pressure, and gas concentration in accordance with NFPA 99. [NFPA 99:5.1.12.3.9.4]

(4) Permanent records of these tests shall be maintained. [NFPA 99:5.1.12.3.9.5]

Where using the autogenous orbital welding process, joints shall be continuously purged inside and outside with inert gas(es) in accordance with the qualified welding procedure. [NFPA 99:5.1.10.5.5.12]

**1318.8 Prohibited Joints.** After brazing, the outside of all joints shall be cleaned by washing with water and a wire brush to remove residue and permit clear visual inspection of the joint. [NFPA 99:5.1.10.5.7.1]

Where flux has been used, the wash water shall be hot. [NFPA 99:5.1.10.5.7.2]

Each brazed joint shall be visually inspected after cleaning the outside surfaces. [NFPA 99:5.1.10.5.7.3]

Joints exhibiting the following conditions shall not be permitted:

(1) Flux or flux residue (where flux or flux-coated BAg series rods are used with dissimilar metals).

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(2) Base metal melting or erosion.

(3) Unmelted filler metal.

(4) Failure of the filler metal to be clearly visible around the joint at the interface between the socket and the tube.

(5) Cracks in the tube or component.

(6) Cracks in the brazed filler metal.

(7) Failure of the joint to hold the test pressure under the installer-performed initial pressure test (Section 1326.10) and standing pressure test (Section 1326.11). [NFPA 99:5.1.10.5.7.4 ]

Brazed joints that are identified as defective under conditions of Section 1318.8(2) or Section 1318.8(5) shall be replaced. [NFPA 99:5.1.10.5.7.5]

Brazed joints that are identified as defective under Section 1318.8(1), Section 1318.8(3), Section 1318.8(4), Section 1318.8(6), or Section 1318.8(7) shall be permitted to be repaired, except that no joint shall be reheated more than once before being replaced. [NFPA 99:5.1.10.5.7.6]

**1319.0 Valves – Requirements, Locations, and Labeling.**

**1319.1 General Requirements.** Shutoff valves accessible to other than authorized personnel shall be installed in valve boxes with frangible or removable windows large enough to permit manual operation of valves. [NFPA 99:5.1.4.2.1]

Shutoff valves for use in certain areas, such as psychiatric or pediatric, shall be permitted to be secured with the approval of the Authority Having Jurisdiction to prevent inappropriate access. [NFPA 99:5.1.4.2.2]

**1319.1.1 Enclosures.** Where valves are concealed in an enclosure, the door or entry to the enclosure shall be identified and color coded with the type of gas service installed, as described in Section 1322.0. Enclosures shall be of sufficient size to permit valve operation. Valve handles in the off position shall prevent closure of the access panel or door.

**1319.2 In-Line Shutoff Valves.** In-line shutoff valves intended for use to isolate piping for maintenance or modification shall meet the following requirements:

(1) Be located in a restricted area.

(2) Be locked or latched open.

(3) Be identified in accordance with Section 1322.3. [NFPA 99:5.1.4.9.1]

**1319.3 Future Piping.** Shutoff valves provided for the connection of future piping shall meet the following requirements:

(1) Be located in a restricted area.

(2) Be locked or latched closed.

(3) Be identified in accordance with Section 1322.3. [NFPA 99:5.1.4.10]

**1319.3.1 Labeled.** Future connection valves shall be labeled as to gas content. [NFPA 99:5.1.4.10.1]

**1319.3.2 Downstream Piping.** Downstream piping shall be closed with a brazed cap with tubing allowance for cutting and rebrazing. [NFPA 99:5.1.4.10.2]

**1319.3.3 Zone Valve.** A zone valve shall be located immediately outside each vital life-support, critical care, and anesthetizing location in each medical gas, vacuum line, or both and located so as to be readily accessible in an emergency. [NFPA 99:5.1.4.8.7]

**1319.3.4 Special Installations.** Gas-delivery columns, hose reels, ceiling tracks, control panels, pendants, booms, or other special installations shall be located downstream of the zone valve. [NFPA 99:5.1.4.8.7.1]

**1319.3.5 Arrangement.** Zone valves shall be so arranged that shutting off the supply of gas to one operating room or anesthetizing location will not affect the others. [NFPA 99:5.1.4.8.7.2]

**1319.4 Source Valves.** A shutoff valve shall be placed at the immediate connection of each source system to the distribution piping to permit the entire source, including accessory devices (e.g., air dryers, final line regulators, etc.), to be isolated from the facility. [NFPA 99:5.1.4.4]

**1319.4.1 Location.** The source valve shall be located in the immediate vicinity of the source equipment. [NFPA 99:5.1.4.4.1]

**1319.4.2 Labeled.** The source valve shall be labeled in accordance with Section 1322.3, Source Valve for the (Source Name). [NFPA 99:5.1.4.4.2]

**1319.5 Main Valves.** A shutoff valve shall be provided in the main supply line inside of the building, except where one or more of the following conditions exist:

(1) The source and source valve are located inside the building served.

(2) The source system is physically mounted to the wall of the building served and the pipeline enters the building in the immediate vicinity of the source valve. [NFPA 99:5.1.4.5]

**1319.5.1 Access.** The main line valve shall be located to permit access by authorized personnel (e.g., by locating above a ceiling or behind a locked access door). [NFPA 99:5.1.4.5.1]

**1319.5.2 Location.** The main line valve shall be located on the facility side of the source valve and outside of the source room, enclosure, or where the main line first enters the building. [NFPA 99:5.1.4.5.2]

**1319.5.3 Labeled.** The main line shall be labeled in accordance with Section 1322.3. [NFPA 99:5.1.4.5.3]

**1319.6 Riser Valves.** Each riser supplied from the main line shall be provided with a shutoff valve adjacent to the riser connection. Riser valves shall be permitted to be located above ceilings, but shall remain accessible and not be obstructed. [NFPA 99:5.1.4.6, 5.1.4.6.1]

**1319.7 Zone Valves.** Station outlets/inlets shall be supplied through a zone valve as follows:

(1) The zone valve shall be placed such that a wall intervenes between the valve and outlets/inlets that it controls.

(2) The zone valve shall serve outlets/inlets located on that same story. [NFPA 99:5.1.4.8]

**1319.7.1 Readily Operable.** Zone valves shall be readily operable from a standing position in the corridor on the same floor they serve. [NFPA 99:5.1.4.8.1]

**1319.7.2 Arrangement.** Zone valves shall be so arranged that shutting off the supply of medical gas or vacuum to one zone will not affect the supply of medical gas or vacuum to another zone or the rest of the system. [NFPA 99:5.1.4.8.2]

**1319.8 Service Valves.** Service valves shall be placed in the branch piping prior to a zone valve box assembly on that branch. [NFPA 99:5.1.4.7.2]

**1319.8.1 Branch Piping.** Only one service valve shall be required for each branch off of a riser regardless of how many zone valve boxes are installed on that lateral. [NFPA 99:5.1.4.7.1]

**1319.8.2 Servicing.** Service valves shall be installed to allow servicing or modification of lateral branch piping from a main or riser without shutting down the entire main, riser, or facility. [NFPA 99:5.1.4.7]

**1320.0 Pressure-Regulating Equipment.**

**1320.1 Where Required.** Pressure-regulating equipment shall be installed in the supply main upstream of the final line-pressure valve. Where multiple piping systems for the same gas at different operating pressures are required, separate pressure-regulating equipment, relief valves, and source shutoff valves shall be provided for each pressure.

**1320.2 Pressure-Relief Valves.** Each central supply system shall have a pressure-relief valve set at 50 percent above normal line pressure, installed downstream of the pressure regulator and upstream of the shutoff valve. This pressure-relief valve shall be permitted to be set at a higher pressure, provided another pressure-relief valve set at 50 percent above normal line pressure is installed in the main supply line.

**1320.2.1 Excess Pressure.** Pressure-relief valves shall close automatically where excess pressure has been released.

**1320.2.2 Venting.** Pressure-relief valves set at 50 percent shall be vented to the outside from gas systems, except medical air, or where the total capacity of the supply system is in excess of 3000 cubic feet (84.95 $m^3$) of gas.

**1320.2.3 Design.** Pressure-relief valves shall be of brass or bronze and specially designed for the gas service involved.

**1320.2.4 Isolation.** A pressure-relief valve shall not be isolated from its intended use by a valve.

**1320.3 Pressure Gauges.** Pressure and vacuum indicators shall be readable from a standing position. Pressure/vacuum indicators shall be provided at the following locations, as a minimum:

(1) Adjacent to the alarm-initiating device for source main-line pressure and vacuum alarms in the master alarm system.

(2) At or in area alarm panels to indicate the pressure/vacuum at the alarm activating device for each system that is monitored by the panel.

(3) On the station outlet/inlet side of zone valves. [NFPA 99:5.1.8.2.1, 5.1.8.2.2]

**1321.0 Station Outlets/Inlets.**

**1321.1 General.** Station outlets and inlets shall be installed in strict accordance with the manufacturer's installation instructions.

**1321.2 Post Installation.** After installation of the piping, but before installation of the station outlets/inlets and other medical gas and medical gas system components (e.g., pressure-actuating switches for alarms, manifolds, pressure gauges, or pressure relief valves), the line shall be blown clear by means of oil-free, dry nitrogen.

**1322.0 Labeling and Identification.**

**1322.1 General.** The gas content of medical gas piping systems shall be readily identifiable by labeling with the name and pressure contained. Such labeling shall be by means of metal tags, stenciling, stamping, or adhesive markers, in a manner that is not readily removable. Where supplementary color identification of piping is used, it shall be in accordance with the gases and colors indicated in CGA C-9, see Table 1312.1.

**1322.2 Pipe Labeling.** Piping shall be labeled by stenciling or adhesive markers that identify the medical gas, support gas, or vacuum system and include:

(1) The name of the gas/vacuum system or the chemical symbol shall comply with Table 1312.1.

(2) The gas or vacuum system color code shall comply with Table 1312.1.

(3) Where positive-pressure gas piping systems operate at pressures other than the standard gauge in Table 1312.1, the pipe labeling shall include the operating pressure in addition to the name of the gas. [NFPA 99:5.1.11.1.1]

Pipe labels shall be located as follows:

(a) At intervals of not more than 20 feet (6096 mm).

(b) Not less than once in or above every room.

(c) On both sides of walls or partitions penetrated by the piping.

(d) Not less than once in every story height traversed by risers. [NFPA 99:5.1.11.1.2]

**1322.3 Shutoff Valve Identification.** Shutoff valves shall be identified as follows:

(1) The name or chemical symbol for the specific medical gas or vacuum system.

(2) The room or areas served.

(3) A caution to not close or open valve except in emergency. [NFPA 99:5.1.11.2.1]

**1322.4 Station Outlet/Inlet Identification.** Station outlets and inlets shall be identified as to the name or chemical symbol for the specific medical gas or vacuum provided. [NFPA 99:5.1.11.3.1]

**1322.5 Shutoff Valve Labeling.** The shutoff valves described in Section 1319.0 shall be labeled to reflect the rooms that are controlled by such valves. Labeling shall be kept current from initial construction through acceptance. Valves shall be labeled in substance as follows:

In-line shutoff valves shall be labeled in substance as follows:

**CAUTION**
**(NAME OF MEDICAL GAS) VALVE**
**DO NOT CLOSE EXCEPT IN EMERGENCY**
**THIS VALVE CONTROLS SUPPLY TO...**

Source valves shall be labeled in substance as follows:

**SOURCE VALVE**
**FOR THE (SOURCE NAME)**

Main line valves shall be labeled in substance as follows:

**MAIN LINE VALVE FOR THE**
**(GAS/VACUUM NAME) SERVING THE**
**(NAME OF BUILDING)**

Riser valve(s) shall be labeled in substance as follows:

**RISER FOR THE (GAS/VACUUM NAME)**
**SERVING (NAME OF THE AREA/BUILDING**
**SERVED BY THE PARTICULAR RISER)**

Service valve(s) shall be labeled in substance as follows:

**SERVICE VALVE FOR THE**
**(GAS/VACUUM NAME) SERVING**
**(NAME OF THE AREA/BUILDING**
**SERVED BY THE PARTICULAR VALVE)**

[NFPA 99:5.1.11.2.3 - 5.1.11.2.6]

**1323.0 Alarms.**

**1323.1 General.** Master, area, and local alarm systems used for medical gas and vacuum systems shall include the following:

(1) Separate visual indicators for each condition monitored, except as permitted for local alarms that are displayed on master alarm panels.

(2) Visual indicators that remain in alarm until the situation that has caused the alarm is resolved.

(3) A cancelable audible indication of each alarm condition that produces a sound with a minimum level of not less than 80 decibels at 3 feet (914 mm).

(4) A means to visually identify a lamp or LED failure.

(5) Visual and audible indication that the wiring to an alarm initiating device is disconnected.

(6) Labeling of each indicator, indicating the condition monitored.

(7) Labeling of each alarm panel for its area of surveillance.

(8) Reinitiation of the audible signal if another alarm condition occurs while the audible alarm is silenced.

(9) Power for master and area alarms from the life safety branch of the emergency electrical system as described in NFPA 99 Chapter 4, Electrical Systems.

(10) Power for local alarms, dew point sensors, and carbon monoxide sensors permitted to be from the same essential electrical branch as is used to power the air compressor system.

(11) Wiring from switches or sensors that is supervised or protected as required by Section 517.30(C)(3) of *California Electrical Code*, for emergency system circuits.

(12) Assurance by the responsible authority of the facility that the labeling of alarms, where room numbers or designations are used, is accurate and up-to-date.

(13) Provisions for automatic restart after a power loss of 10 seconds (e.g., during generator startup) without giving false signals or requiring manual reset.

**1323.2 Components.** Functioning of alarm components shall be verified in accordance with testing and monitoring requirements of the manufacturer and the Authority Having Jurisdiction.

**1324.0 Medical Air System.**

**1324.1 General.** Medical air compressors shall be installed in a well-lit, ventilated, and clean location and shall be accessible. The location shall be provided with drainage facilities. The medical air compressor area shall be located separately from medical gas cylinder system sources, and shall be readily accessible for maintenance.

**1324.2 Medical Air Compressors.** Medical air compressors shall be sufficient to serve the peak calculated demand with the largest single compressor out of service. In no case shall there be less than two compressors. [NFPA 99:5.1.3.5.11.2]

Medical air compressor systems shall consist of the following:

(1) Components:
   (a) Compressors for medical air
   (b) Aftercoolers
   (c) Medical air receivers
   (d) Medical air dryers
   (e) Medical air filters
   (f) Medical air regulators
   (g) Medical air local alarms

   Components shall be arranged to permit service and a continuous supply of medical air in the event of a single fault failure. Component arrangement shall be permitted to vary in accordance with the technology(ies) employed, provided an equal level of operating redundancy and medical air quality is maintained. [NFPA 99:5.1.3.5.11.1]

(2) An automatic means to prevent backflow from on-cycle compressors through off-cycle compressors. [NFPA 99:5.1.3.5.3.2(2)]

(3) A manual shutoff valve to isolate each compressor from the centrally piped system and from other compressors for maintenance or repair without loss of pressure in the system. [NFPA 99:5.1.3.5.3.2(3)]

(4) Intake filter-mufflers of the dry type. [NFPA 99:5.1.3.5.3.2(4)]

(5) Pressure-relief valves set at 50 percent above line pressure. [NFPA 99:5.1.3.5.3.2(5)]

(6) Piping between the compressor and the source shutoff valve compatible with oxygen that does not contribute to contaminant levels. [NFPA 99:5.1.3.5.3.2(6)]

(7) Materials and devices used between the medical air intake and the medical air source valve shall be permitted to be of a design or construction appropriate for the service, as determined by the manufacturer as long as such materials and devices do not contribute to contaminant levels. [NFPA 99:5.1.3.5.3.2(7)]

**1324.3 Air Source.** The medical air compressors shall draw their air from a source of clean air located where no contamination is anticipated from engine exhausts, fuel storage vents, medical-surgical vacuum system discharges, particulate matter, or odor. [NFPA 99:5.1.3.5.13.1]

**1324.4 Air Intakes.** Compressor intake piping shall be hard-drawn seamless copper, and one of the following:

(1) ASTM B 88 (Types K or L)

(2) ASTM B 280 (copper ACR tube)

(3) ASTM B 819 (Types K or L) [NFPA 99:5.1.3.5.13.4]

The compressor air intake shall be located outdoors above roof level, at a distance not less than 10 feet (3048 mm) from a door, window, exhaust, other intake, or opening in the building and a distance of not less than 20 feet (6096 mm) aboveground. [NFPA 99:5.1.3.5.13.2]

Where an air source equal to or better than outside air (e.g., air already filtered for use in operating room ventilating systems) is available, it shall be permitted to be used for the medical air compressors with the following provisions:

(1) This alternate source of supply air shall be available on a continuous 24 hours-per-day, 7 days-per-week basis.

(2) Ventilating systems having fans with motors or drive belts located in the air stream shall not be used as a source of medical air intake. [NFPA 99:5.1.3.5.13.3]

Air intakes for separate compressors shall be permitted to be joined together to one common intake where the following conditions are met:

(1) The common intake is sized to minimize backpressure in accordance with the manufacturer's recommendations.

(2) Each compressor can be isolated by manual or check valve, blind flange, or tube cap to prevent open inlet piping where compressors are removed for service and consequent backflow of room air into the other compressor(s). [NFPA 99:5.1.3.5.13.5]

**1324.4.1 Isolation Valve.** Each medical air compressor shall have an isolation valve installed so that shutting off or failure of the largest unit will not affect the operation of the other unit(s).

**1324.5 Drains.** Drains shall be installed on dryers, aftercoolers, separators, and receivers.

**1324.6 Medical Air Receivers.** Medical air receivers shall be provided with proper valves to allow the flow of compressed air to enter and exit out of separate receiver ports during normal operation and allow the receiver to be bypassed during service without shutting down the medical air system. [NFPA 99:5.1.3.5.11.4]

**1324.7 Requirements for Medical Air Receivers.** Receivers for medical air shall meet the following requirements:

(1) Be made of corrosion-resistant materials or otherwise be made corrosion resistant.

(2) Comply with Section VIII of the ASME Boiler and Pressure Vessel Code.

(3) Be equipped with a pressure-relief valve, automatic drain, manual drain, sight glass, and pressure indicator.

(4) Be of a capacity sufficient to prevent the compressor from short cycling. [NFPA 99:5.1.3.5.6]

Piping within compressor systems upstream of the source shutoff valve shall comply with Section 1315.0 and Section 1318.0, except that stainless steel shall be permitted to be used as a piping material.

**1325.0 Medical Vacuum Pump System.**

**1325.1 General.** The vacuum plant shall be installed in a well-lit, ventilated, and clean location with accessibility. The location shall be provided with drainage facilities. The vacuum plant, where installed as a source, shall be located separately from other medical vacuum system sources, and shall be readily accessible for maintenance.

**1325.2 Medical-Surgical Vacuum Sources.** Medical-surgical vacuum sources shall consist of the following:

(1) Two or more vacuum pumps sufficient to serve the peak calculated demand with the largest single vacuum pump out of service.

(2) An automatic means to prevent backflow from on-cycle vacuum pumps through off-cycle vacuum pumps.

(3) A shutoff valve or other isolation means to isolate each vacuum pump from the centrally piped system and other vacuum pumps for maintenance or repair without loss of vacuum in the system.

(4) A vacuum receiver.

(5) Piping between the vacuum pump(s), discharge(s), receiver(s), and the vacuum source shutoff valve shall be in accordance with Section 1315.4, except that stainless, galvanized, or black steel pipe shall be permitted to be used.

(6) Materials and devices used between the medical vacuum exhaust and the medical vacuum source shall be permitted to be of a design or construction appropriate for the service, as determined by the manufacturer. [NFPA 99:5.1.3.6.1.2]

**1325.2.1 Pumps.** Additional pumps shall automatically activate where the pumps in operation are incapable of maintaining the required vacuum.

Automatic or manual alternation of pumps shall allow division of operating time. Where automatic alternation of pumps is not provided, the facility staff shall arrange a schedule for manual alternation. [NFPA 99:5.1.3.6.6.1, 5.1.3.6.6.2]

**1325.3 Exhausts.** The medical-surgical vacuum pumps shall exhaust in a manner and location that will minimize the hazards of noise and contamination to the facility and its environment.

The exhaust shall be located as follows:

(1) Outdoors.

(2) Not less than 10 feet (3048 mm) from a door, window, air intake, or other openings in buildings.

(3) At a level different from air intakes.

(4) Where prevailing winds, adjacent buildings, topography, or other influences that would not divert the exhaust into occupied areas or prevent dispersion of the exhaust.

The end of the exhaust shall be turned down and screened or otherwise be protected against the entry of vermin, debris, or precipitation by screening fabricated or composed of a non-corroding material.

The exhaust shall be piped of materials approved for medical–surgical vacuum piping under Section 1315.4.

The exhaust shall be free of dips and loops that might trap condensate or oil. Where such low points are unavoidable, a drip leg and valved drain shall be installed. [NFPA 99:5.1.3.6.7.1 - 5.1.3.6.7.5]

**1325.3.1 Multiple Pumps.** Vacuum exhausts from multiple pumps shall be permitted to be joined together to one common exhaust where the following conditions are met:

(1) The common exhaust is sized to minimize backpressure in accordance with the pump manufacturer's recommendations.

(2) Each pump shall be isolated by manual or check valve, blind flange, or tube cap to prevent open exhaust piping where pumps are removed for service and consequent flow of exhaust air into the room. [NFPA 99:5.1.3.6.7.6]

**1325.4 Receivers.** Receivers for vacuum shall meet the following requirements:

(1) Be made of ferrous, nonferrous, or both materials.

(2) Comply with Section VIII of the ASME Boiler and Pressure Vessel Code.

(3) Withstand a gauge pressure of 60 psi (414 kPa) and 29.9 inch (759 mm) gauge HgV.

(4) Be equipped with a manual drain.

(5) Be of a capacity based on the technology of the pumps. [NFPA 99:5.1.3.6.3]

**1325.5 Piping.** Piping between vacuum pumps, discharges, receivers, and the vacuum main line valve shall be in accordance with Section 1315.4, except that stainless, galvanized, or black steel pipe shall be permitted to be used. [NFPA 99:5.1.3.6.1.2(5)]

**1325.6 Drains.** Drains shall be installed and terminate in an approved location.

**1326.0 Testing and Inspection.**

**1326.1 Where Required.** Inspection and testing shall be performed on new piped gas systems, additions, renovations, temporary installations, or repaired systems, to assure the facility, by a documented procedure, that the applicable provisions of this document have been adhered to and system integrity has been achieved or maintained. [NFPA 99:5.1.12.1.1]

**1326.1.1 Requirements.** Tests and inspections required by this section shall not be interpreted to conflict with the requirements of NFPA 99. Final certification or verification shall require the completion of the following tests and inspections:

(1) Testing for hospital grade receptacles required at patient bed locations and in anesthetizing locations shall be performed after initial installation, replacement, or servicing of the device.

(2) Additional testing of receptacles in patient care areas shall be performed at intervals defined by documented performance data.

(3) Receptacles at patient bed locations and in anesthetizing locations not listed as hospital-grade shall be tested at intervals not exceeding 12 months. [NFPA 99:4.3.4.1.1 - 4.3.4.1.3]

For requirements of the portions of medical gas and medical vacuum systems testing and inspection not addressed in this chapter or medical gas and medical vacuum systems testing and inspection beyond the scope of this chapter, refer to NFPA 99.

**1326.2 Systems.** Systems that are breached and components that are subject to additions, renovations, or replacement (e.g., new gas sources: bulk, manifolds, compressors, dryers, alarms) shall be inspected and appropriately tested. [NFPA 99:5.1.12.1.3]

**1326.2.1 Breached.** Systems shall be deemed breached at the point of pipeline intrusion by physical separation or by system component removal, replacement, or addition.

Breached portions of the systems subject to inspection and testing shall be confined to the specific altered zone and components in the immediate zone or area that is located upstream for vacuum systems and downstream for pressure gases at the point or area of intrusion. [NFPA 99:5.1.12.1.4, 5.1.12.1.5]

**1326.3 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 24 hours before the work is to be inspected.

**1326.4 Responsibility.** The equipment, material, and labor necessary for inspection and testing shall be furnished by the permit holder or by the person who is requiring the inspection.

**1326.5 Testing.** The test shall be conducted in the presence of the Authority Having Jurisdiction or a duly appointed representative.

**1326.6 Retesting.** Where the Authority Having Jurisdiction finds that the work does not pass tests, necessary corrections shall be made and the work shall then be resubmitted for test or inspection.

**1326.7 Initial Pressure Test – Piped Gas Systems.** Before attachment of system components (e.g., pressure-actuating switches for alarms, manifolds, pressure gauges, or pressure-relief valves), but after installation of the station outlets and inlets, with test caps in place, each section of the piping system shall be subjected to a test pressure of one and one-half times the working pressure [150 psig (1034 kPa gauge)] with oil-free dry nitrogen. This test pressure shall be maintained until each joint has been examined for leakage by means of soapy water or other equally effective means of leak detection safe for use with oxygen. The source shutoff valve shall be closed. Leaks shall be located, repaired, and retested in accordance with this section.

**1326.8 Cross-Connection Test – Piped Gas Systems.** It shall be determined that no cross-connections exist between medical gas and vacuum piping systems.

Piping systems shall be reduced to atmospheric pressure.

Sources of test gas shall be disconnected from piping systems except for the one system being tested.

The system under test shall be charged with oil-free, dry nitrogen NF to a gauge pressure of 50 psi (345 kPa).

After the installation of the individual faceplates with approved adapters matching outlet/inlet labels, each individual outlet/inlet (in each installed medical gas and vacuum piping system) shall be checked to determine that the test gas is being dispensed from the piping system being tested. [NFPA 99:5.1.12.2.4 - 5.1.12.2.4.4]

**1326.8.1 Source of Test Gas.** The source of test gas shall be disconnected, and the system tested shall be reduced to atmospheric pressure. [NFPA 99:5.1.12.3.3.1(E)]

It shall be determined that no cross-connections exist between the various medical gas and vacuum piping systems. [NFPA 99:5.1.12.2.4]

The cross-connection test shall be repeated for each installed medical gas and vacuum piping system. [NFPA 99:5.1.12.2.4.5]

**1326.8.2 Cross-Connection Testing.** Where a medical vacuum system is installed, the cross-connection testing shall include that piped vacuum system with medical gas piping systems.

**1326.8.3 Medical-Surgical Vacuum Systems.** Medical-surgical vacuum systems shall be in operation so that these vacuum systems are tested at the same time the medical gas systems are tested. [NFPA 99:5.1.12.3.3.2(D)]

The proper labeling and identification of system outlets/inlets shall be confirmed during these tests. [NFPA 99:5.1.12.2.4.6]

**1326.9 Standing Pressure Test – Piped Gas Systems.** After successful completion of the initial pressure tests under Section 1326.7, medical gas distribution piping shall be subject to a standing pressure test.

Tests shall be conducted after the final installation of station outlet valve bodies, face plates, and other distribution system components (e.g., pressure alarm devices, pressure indicators, line pressure-relief valves, manufactured assemblies, hose, etc.).

The source valve shall be closed during this test.

The piping systems shall be subjected to a 24 hour standing pressure test using oil-free, dry nitrogen NF.

Test pressures shall be 20 percent above the normal system operating line pressure. [NFPA 99:5.1.12.2.6 - 5.1.12.2.6.4]

**1326.9.1 Requirements.** After the piping system is filled with test gas, the supply valve and outlets shall be closed and the source of test gas disconnected.

Tests shall be conducted after the final installation of station outlet valve bodies, face plates, and other distribution system components (e.g., pressure alarm devices, pressure indicators, line pressure-relief valves, manufactured assemblies, hose, etc.). [NFPA 99:5.1.12.2.6.1]

The source valve shall be closed during this test. [NFPA 99:5.1.12.2.6.2]

The piping systems shall be subjected to a 24 hour standing pressure test using oil-free, dry nitrogen NF. [NFPA 99:5.1.12.2.6.3]

Test pressures shall be 20 percent above the normal system operating line pressure. [NFPA 99:5.1.12.2.6.4]

Leaks shall be located, repaired (where permitted), or replaced (where required), and retested. [NFPA 99:5.1.12.2.6.6]

At the conclusion of the tests, there shall be no change in the test pressure other than that attributed to changes of ambient temperature. [NFPA 99:5.1.12.2.6.5]

**1326.10 Initial Pressure Test – Piped Vacuum Systems.** Each section of the piping in medical gas and vacuum systems shall be pressure tested. Initial pressure tests shall be conducted as follows:

(1) After installation of station outlets/inlets rough-in assemblies. Test caps shall be permitted to be used.

(2) Prior to the installation of components of the distribution piping system that would be damaged by the test pressure (e.g., pressure/vacuum alarm devices, pressure/vacuum indicators, line pressure-relief valves, manufactured assemblies with flexible hose, etc.).

The source shutoff valve shall remain closed during these tests.

The test pressure for pressure gases shall be one and one-half times the system working pressure, and not less than a gauge pressure of 150 psi (1034 kPa).

The test pressure for vacuum shall be not less than a gauge pressure of 60 psi (414 kPa).

The test pressure shall be maintained until each joint has been examined for leakage by means of soapy water or other equally effective means of leak detection that is safe for use with oxygen.

Leaks shall be located, repaired (where permitted), replaced (where required), and retested. [NFPA 99:5.1.12.2.3.1 - 5.1.12.2.3.7]

**1326.11 Standing Pressure Test – Piped Vacuum Systems.** After successful completion of the initial pressure tests under Section 1326.10, vacuum distribution piping shall be subjected to a standing vacuum test.

Tests shall be conducted after installation of all components of the vacuum system.

The piping systems shall be subjected to a 24 hour standing vacuum test.

Test pressure shall be between 12 inch (305 mm) gauge HgV and full vacuum.

During the test, the source of test vacuum shall be disconnected from the piping system.

At the conclusion of the test, there shall be no change in the vacuum other than that attributed to changes of ambient temperature, as permitted in this section.

Test vacuum changes due to expansion or contraction shall be permitted to be determined by means of the following pressure temperature relationship:

(1) The calculated final absolute pressure equals the initial absolute pressure times the final absolute temperature, divided by the initial absolute temperature.

(2) Absolute pressure is the gauge pressure reading plus 14.7 psi (101 kPa).

(3) Absolute temperature is the temperature reading plus 460°F (238°C).

(4) The final allowable gauge pressure reading equals the final allowable absolute pressure minus a gauge pressure of 14.7 psi (101 kPa).

Leaks shall be located, repaired (where permitted), or replaced (where required), and retested. [NFPA 99:5.1.12.2.7 - 5.1.12.2.7.7]

**1326.12 Corrections.** Notices of correction or violation shall be written by the Authority Having Jurisdiction and posted at the site of the work, mailed or delivered to the permittee or an authorized representative. Refusal or failure to comply with such notice or order within 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.

**1326.13 Approval.** Upon satisfactory completion of tests and certification of the medical gas and medical vacuum systems, a certificate of approval shall be issued by the Authority Having Jurisdiction to the permittee.

**1326.14 Covering or Use.** No medical gas or medical vacuum system or part thereof shall be covered, concealed, or put into use until it has been tested, inspected, and accepted as required in this code.

**1326.15 Uncovering.** A medical gas and vacuum system or part thereof that is covered or concealed before testing and inspected as required in this code shall be uncovered for inspection, after notice to uncover the work has been issued to the permittee or his authorized representative by the Authority Having Jurisdiction.

**1327.0 System Certification.**

**1327.1 Certification.** Prior to a medical gas system being placed in service, such system shall be certified in accordance with Section 1327.2.

**1327.1.1 Verification Tests.** Verification tests shall be performed after tests in accordance with Section 1326.0 have been completed. [NFPA 99:5.1.12.3.1.1]

Testing shall be conducted by a party technically competent and experienced in the field of medical gas and vacuum pipeline testing and meeting the requirements of ASSE 6030. [NFPA 99:5.1.12.3.1.3]

Testing shall be performed by a party other than the installing contractor. [NFPA 99:5.1.12.3.1.4]

Where systems have not been installed by in-house personnel, testing shall be permitted by personnel of that organization who meet the requirements of this section. [NFPA 99:5.1.12.3.1.5]

**1327.2 Certification Tests.** Certification tests, verified and attested to by the certification agency, shall include the following:

(1) Verifying in accordance with the installation requirements.

(2) Testing and checking for leakage, correct zoning, and identification of control valves.

(3) Checking for identification and labeling of pipelines, station outlets, and control valves.

(4) Testing for cross-connection, flow rate, system pressure drop, and system performance.

(5) Functional testing of pressure relief valves and safety valves.

(6) Functional testing of sources of supply.

(7) Functional testing of alarm systems, including accuracy of system components.

(8) Purge flushing of system and filling with specific source gases.

(9) Testing for purity and cleanliness of source gases.

(10) Testing for specific gas identity at each station outlet.

**1327.3 Reports.** The inspection and testing reports shall be submitted directly to the party that contracted for the testing, who shall submit the report through channels to the responsible facility authority and others that are required.

Reports shall contain detailed listings of findings and results. [NFPA 99:5.1.12.1.6, 5.1.12.1.7]

**1327.4 Report Items.** A report that includes the specific items mentioned in Section 1327.2 and other information required by this chapter shall be delivered to the Authority Having Jurisdiction prior to acceptance of the system.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 14 - REFERENCED STANDARDS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | X | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | X | | X | X | | | X | X | X | X | X | X | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| Table 1401.1 | X | | X | X | | | X | X | X | X | X | X | | | | | | | |
| ASME A112.20.2-2004 | | † | | | | | | | | | | | | | | | | | |
| ASTM E 119-2007a | | † | | | | | | | | | | | | | | | | | |
| ASTM E 814-2006 | | † | | | | | | | | | | | | | | | | | |
| NSF 350-2011 | | † | | | | | | | | | | | | | | | | | |
| UL 263-2003 | | † | | | | | | | | | | | | | | | | | |
| UL 1479-2003 | | † | | | | | | | | | | | | | | | | | |

The state agency does not adopt sections identified by the following symbol: †

# CHAPTER 14
## REFERENCED STANDARDS

**1401.0 General.**

**1401.1 Standards.** The standards listed in Table 1401.1 are intended for use in the design, testing, and installation of materials, devices, appliances, and equipment regulated by this code.

**TABLE 1401.1**
**REFERENCED STANDARDS**

| STANDARD NUMBER | STANDARD TITLE | APPLICATION | REFERENCED SECTIONS |
|---|---|---|---|
| AHAM DW-1-2010* | Household Electric Dishwashers | Appliances | 301.1.2, 301.2 |
| AHAM FWD-1-2009* | Food Waste Disposers | Appliances | 301.1.2, 301.2 |
| APSP 1-2003* | Public Swimming Pools | Swimming Pools, Spas, and Hot Tubs | USPSHTC |
| ASCE 25-2006* | Earthquake-Actuated Automatic Gas Shutoff Devices | Fuel Gas | 301.1.2, 301.2 |
| ***ASHRAE 90.1-2010**** | Energy Standard for Buildings Except Low-Rise Residential Buildings | Miscellaneous | L 603.3.1, Table L 603.4.2 |
| ASHRAE 90.2-2007* | Energy-Efficient Design of Low-Rise Residential Buildings | Miscellaneous | 301.1.2, 301.2 |
| ASME A13.1-2007* | Scheme for the Identification of Piping Systems | Piping | 301.1.2, 301.2 |
| ***ASME A112.1.2-2004**** | Air Gaps in Plumbing Systems (For Plumbing Fixtures and Water-Connected Receptors) | Fittings | Table 603.2 |
| ***ASME A112.1.3-2000 (R2010)**** | Air Gap Fittings for Use with Plumbing Fixtures, Appliances, and Appurtenances | Fittings | Table 603.2 |
| ***ASME A112.3.1-2007**** | Stainless Steel Drainage Systems for Sanitary DWV, Storm, and Vacuum Applications, Above- and Below Ground (Notes 1 and 7) | Piping, Ferrous | 705.8.2, Table 701.1 |
| ASME A112.3.4-2000 (R2004)* | Macerating Toilet Systems and Related Components | Fixtures | 301.1.2, 301.2 |
| ASME A112.4.1-2009* | Water Heater Relief Valve Drain Tubes | Appliances | 301.1.2, 301.2 |
| ASME A112.4.2-2009* | Water Closet Personal Hygiene Devices | Fixtures | 301.1.2, 301.2 |
| ASME A112.4.3-1999 (R2010)* | Plastic Fittings for Connecting Water Closets to the Sanitary Drainage System | Fittings | 301.1.2, 301.2 |
| ASME A112.4.14-2004 (R2010) | Manually Operated, Quarter-Turn Shutoff Valves for Use in Plumbing Systems | Valves | 301.1.2, 301.2 |
| ASME A112.6.1M-1997 (R2008) | Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use | Fixtures | 301.1.2, 301.2 |
| ASME A112.6.2-2000 (R2010)* | Framing-Affixed Supports for Off-the-Floor Water Closets with Concealed Tanks | Fixtures | 301.1.2, 301.2 |
| ASME A112.6.3-2001 (R2007)* | Floor and Trench Drains | DWV Components | 301.1.2, 301.2 |
| ASME A112.6.4-2003 (R2008)* | Roof, Deck, and Balcony Drains | DWV Components | 301.1.2, 301.2 |
| ASME A112.6.7-2010* | Sanitary Floor Sinks | Fixtures | 301.1.2, 301.2 |
| ASME A112.6.9-2005 (R2010)* | Siphonic Roof Drains | DWV Components | 301.1.2, 301.2 |

| STANDARD NUMBER | STANDARD TITLE | APPLICATION | REFERENCED SECTIONS |
|---|---|---|---|
| ASME A112.14.1-2003 (R2008)* | Backwater Valves | Valves | 301.1.2, 301.2 |
| ASME A112.14.3-2000 (R2004)* | Grease Interceptors | Fixtures | 301.1.2, 301.2 |
| ASME A112.14.4-2001 (R2007)* | Grease Removal Devices | Fixtures | 301.1.2, 301.2 |
| ***ASME A112.14.6-2010**** | FOG (Fats, Oils, and Greases) Disposal Systems | Fixtures | 1015.4 |
| ***ASME A112.18.1-2005/CSA B125.1-2005*** | Plumbing Supply Fittings | Fittings | 402.10, 403.5, 408.2, 408.3, 417.1, 417.3, 417.4, 420.2, 603.5.20, L 402.4.1, L 402.4.2.1, L 402.5.1 |
| ASME A112.18.2-2005/CSA B125.2-2005 | Plumbing Waste Fittings | Fittings | 301.1.2, 301.2 |
| ***ASME A112.18.3-2002 (R2008)**** | Performance Requirements for Backflow Protection Devices and Systems in Plumbing Fixture Fittings | Backflow Protection | 417.3, 417.4 |
| ASME A112.18.6-2009/CSA B125.6-2009* | Flexible Water Connectors | Piping | 301.1.2, 301.2 |
| ***ASME A112.18.7-1999 (R2004)**** | Deck Mounted Bath/Shower Transfer Valves with Integral Backflow Protection | Valves | 417.2 |
| ASME A112.18.9-2011* | Protectors/Insulators for Exposed Waste and Supplies on Accessible Fixtures | Miscellaneous | 301.1.2, 301.2 |
| ASME A112.19.1-2008/CSA B45.2-2008* | Enamelled Cast Iron and Enamelled Steel Plumbing Fixtures | Fixtures | 301.1.2, 301.2 |
| ***ASME A112.19.2-2008/CSA B45.1-2008**** | Ceramic Plumbing Fixtures | Fixtures | L 402.2, L 402.3 |
| ***ASME A112.19.3-2008/CSA B45.4-2008**** | Stainless Steel Plumbing Fixtures | Fixtures | L 402.3.1 |
| ASME A112.19.5-2005* | Trim for Water-Closet Bowls, Tanks, and Urinals | Fixtures | 301.1.2, 301.2 |
| ***ASME A112.19.7-2006**** | Hydromassage Bathtub Appliances | Fixtures | 409.6 |
| ASME A112.19.10-2003 (R2008)* | Dual Flush Devices for Water Closets | Fixtures | 301.1.2, 301.2 |
| ASME A112.19.12-2006 (R2011)* | Wall Mounted, Pedestal Mounted, Adjustable, Elevating, Tilting, and Pivoting Lavatory, Sink, and Shampoo Bowl Carrier Systems and Drainage Waste Systems | Fixtures | 301.1.2, 301.2 |
| ***ASME A112.19.14-2006 (R2011)**** | Six-Liter Water Closets Equipped with a Dual Flushing Device | Fixtures | L 402.2.1 |
| ASME A112.19.15-2005 (R2010)* | Bathtubs/Whirlpool Bathtubs with Pressure Sealed Doors | Fixtures | 301.1.2, 301.2 |
| ***ASME A112.19.19-2006 (R2011)**** | Vitreous China Nonwater Urinals | Fixtures | L 402.3.1 |
| ASME A112.21.3M-1985 (R2007)* | Hydrants for Utility and Maintenance Use (Note 1) | Valves | 301.1.2, 301.2 |
| ASME A112.36.2M-1991 (R2008)* | Cleanouts (Note 1) | DWV Components | 301.1.2, 301.2 |
| ***ASME B1.20.1-1983 (R2006)**** | Pipe Threads, General Purpose, Inch | Joints | 605.2.3, 605.3.5, 605.4.3, 605.6.2, 605.13.3, 705.1.3, 705.3.3, 705.5.4, 705.6.2, 705.7.3, 1208.5.7, 1315.7.1(2) |

| STANDARD NUMBER | STANDARD TITLE | APPLICATION | REFERENCED SECTIONS |
|---|---|---|---|
| ASME B1.20.3-1976 (R2008)* | Dryseal Pipe Threads, Inch | Joints | 301.1.2, 301.2 |
| ***ASME B16.1-2010**** | Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 | Fittings | 1208.5.10 |
| ***ASME B16.3-2006**** | Malleable Iron Threaded Fittings: Classes 150 and 300 | Fittings | Table 604.1, Table 701.1 |
| ***ASME B16.4-2006**** | Gray Iron Threaded Fittings (Classes 125 and 250) | Fittings | Table 604.1 |
| ASME B16.5-2009* | Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch | Fittings | 301.1.2, 301.2 |
| ***ASME B16.12-2009**** | Cast Iron Threaded Drainage Fittings (Note 1) | Fittings | Table 701.1 |
| ***ASME B16.15-2006**** | Cast Copper Alloy Threaded Fittings: Classes 125 and 250 | Fittings | Table 604.1 |
| ***ASME B16.18-2001 (R2005)**** | Cast Copper Alloy Solder Joint Pressure Fittings (Note 1) | Fittings | Table 604.1 |
| ***ASME B16.20-2007**** | Metallic Gaskets For Pipe Flanges: Ring-Joint, Spiral-Wound, and Jacketed | Joints | 1208.5.10 |
| ASME B16.21-2005* | Nonmetallic Flat Gaskets for Pipe Flanges | Joints | 301.1.2, 301.2 |
| ***ASME B16.22-2001 (R2010)**** | Wrought Copper and Copper Alloy Solder Joint Pressure Fittings | Fittings | 1315.5, Table 604.1 |
| ***ASME B16.23-2002 (R2006)**** | Cast Copper Alloy Solder Joint Drainage Fittings: DWV | Fittings | Table 701.1 |
| ASME B16.24-2006* | Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500 and 2500 | Fittings | 301.1.2, 301.2 |
| ***ASME B16.26-2006**** | Cast Copper Alloy Fittings for Flared Copper Tubes | Fittings | Table 604.1 |
| ***ASME B16.29-2007**** | Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings–DWV (Note 1) | Fittings | Table 701.1 |
| ASME B16.33-2002 (R2007)* | Manually Operated Metallic Gas Valves for use in Gas Piping Systems up to 125 psi (Sizes NPS 1/2 - NPS 2) | Valves | 301.1.2, 301.2 |
| ASME B16.34-2009* | Valves-Flanged, Threaded, and Welding End | Valves | 301.1.2, 301.2 |
| ASME B16.39-2009* | Malleable Iron Threaded Pipe Unions: Classes 150, 250 and 300 (Includes Revision Services) | Fittings | 301.1.2, 301.2 |
| ASME B16.40-2008* | Manually Operated Thermoplastic Gas Shutoffs and Valves in Gas Distribution Systems | Valves | 301.1.2, 301.2 |
| ASME B16.47-2006* | Large Diameter Steel Flanges: NPS 26 through NPS 60 Metric/Inch | Fittings | 301.1.2, 301.2 |
| ***ASME B16.50-2001 (R2008)**** | Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings | Fittings | 1315.5 |
| ASME B31.1-2010* | Power Piping | Piping | 301.1.2, 301.2 |
| ***ASME B31.3-2010**** | Process Piping | Piping | F 12.1 |
| ***ASME B36.10M-2004 (R2010)**** | Welded and Seamless Wrought Steel Pipe | Piping, Ferrous | 1208.5.2.2(1) |
| ASME B36.19-2004 (R2010)* | Stainless Steel Pipe | Piping, Ferrous | 301.1.2, 301.2 |
| ASME BPVC Section IV-2010* | Rules for Construction of Heating Boilers | Miscellaneous | 301.1.2, 301.2 |

| STANDARD NUMBER | STANDARD TITLE | APPLICATION | REFERENCED SECTIONS |
|---|---|---|---|
| ***ASME BPVC Section VIII-2010**** | Rules for Construction of Pressure Vessels Division 1 | Miscellaneous | 1324.7(2), 1325.4(2), E 36.6.2 |
| ***ASME BPVC Section IX-2010**** | Welding and Brazing Qualifications | Certification | 225.0, 1310.6 |
| ***ASSE 1001-2008**** | Atmospheric Type Vacuum Breakers | Backflow Protection | Table 603.2 |
| ***ASSE 1002-2008**** | Anti-Siphon Fill Valves for Water Closet Tanks | Backflow Protection | Table 603.2 |
| ASSE 1003-2009* | Water Pressure Reducing Valves for Domestic Water Distribution Systems | Valves | 301.1.2, 301.2 |
| ASSE 1004-2008* | Backflow Prevention Requirements for Commercial Dishwashing Machines | Backflow Protection | 301.1.2, 301.2 |
| ASSE 1007-1986* | Home Laundry Equipment | Appliances | 301.1.2, 301.2 |
| ASSE 1008-2006* | Plumbing Aspects of Residential Food Waste Disposer Units | Appliances | 301.1.2, 301.2 |
| ASSE 1010-2004* | Water Hammer Arresters | Water Supply Component | 301.1.2, 301.2 |
| ASSE 1011-2004* | Hose Connection Vacuum Breakers | Backflow Protection | 301.1.2, 301.2 |
| ASSE 1012-2009* | Backflow Preventers with an Intermediate Atmospheric Vent | Backflow Protection | 301.1.2, 301.2 |
| ***ASSE 1013-2009**** | Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers | Backflow Protection | Table 603.2 |
| ASSE 1014-2005* | Backflow Prevention Devices for Hand-Held Shower | Backflow Protection | 301.1.2, 301.2 |
| ***ASSE 1015-2009**** | Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies | Backflow Protection | Table 603.2 |
| ***ASSE 1016-2005**** | Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations | Valves | 408.3 |
| ASSE 1017-2009* | Temperature Actuated Mixing Valves for Hot Water Distribution Systems | Valves | 301.1.2, 301.2 |
| ASSE 1018-2001* | Trap Seal Primer Valves-Potable Water Supplied | Valves | 301.1.2, 301.2 |
| ***ASSE 1019-2004**** | Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type | Backflow Protection | Table 603.2 |
| ***ASSE 1020-2004**** | Pressure Vacuum Breaker Assembly | Backflow Protection | Table 603.2 |
| ASSE 1021-2001 | Drains Air Gaps for Domestic Dishwasher Applications | Backflow Protection | 301.1.2, 301.2 |
| ***ASSE 1022-2003**** | Backflow Preventer for Beverage Dispensing Equipment | Backflow Protection | 603.5.12, Table 603.2 |
| ASSE 1023-1979 | Hot Water Dispensers Household Storage Type-Electrical | Appliances | 301.1.2, 301.2 |
| ASSE 1024-2004* | Dual Check Backflow Preventers | Backflow Protection | 301.1.2, 301.2 |
| ASSE 1032-2004* | Dual Check Valve Type Backflow Preventers for Carbonated Beverage Dispensers, Post Mix Type | Backflow Protection | 301.1.2, 301.2 |
| ASSE 1035-2008* | Laboratory Faucet Backflow Preventers | Backflow Protection | 301.1.2, 301.2 |
| ASSE 1037-1990 | Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures | Backflow Protection | 301.1.2, 301.2 |
| ASSE 1044-2001* | Trap Seal Primer Devices-Drainage Types and Electronic Design Types | DWV Components | 301.1.2, 301.2 |

| STANDARD NUMBER | STANDARD TITLE | APPLICATION | REFERENCED SECTIONS |
|---|---|---|---|
| ***ASSE 1047-2009**** | Reduced Pressure Detector Fire Protection Backflow Prevention Assemblies | Backflow Protection | Table 603.2 |
| ***ASSE 1048-2009**** | Double Check Detector Fire Protection Backflow Prevention Assemblies | Backflow Protection | Table 603.2 |
| ASSE 1052-2004* | Hose Connection Backflow Preventers | Backflow Protection | 301.1.2, 301.2 |
| ASSE 1053-2004 | Dual Check Backflow Preventer Wall Hydrants – Freeze Resistant Type | Backflow Protection | 301.1.2, 301.2 |
| ASSE 1055-2009* | Chemical Dispensing Systems | Backflow Protection | 301.1.2, 301.2 |
| ***ASSE 1056-2001**** | Spill Resistant Vacuum Breakers | Backflow Protection | Table 603.2 |
| ASSE 1057-2001 | Freeze Resistant Sanitary Yard Hydrant with Backflow Protection | Backflow Protection | 301.1.2, 301.2 |
| ASSE 1060-2006* | Outdoor Enclosures for Fluid Conveying Components | Miscellaneous | 301.1.2, 301.2 |
| ***ASSE 1061-2006**** | Push-Fit Fittings | Fittings | 605.3.3.3, 605.4.1, Table 604.1 |
| ASSE 1062-2006* | Temperature Actuated Flow Reduction (TAFR) Valves for Individual Fixture Fittings | Valves | 301.1.2, 301.2 |
| ASSE 1066-1997 | Individual Pressure Balancing In-Line Valves for Individual Fixture Fittings (Note 6) | Valves | 301.1.2, 301.2 |
| ***ASSE 1069-2005**** | Automatic Temperature Control Mixing Valves | Valves | 408.3 |
| ***ASSE 1070-2004**** | Water Temperature Limiting Devices | Valves | 409.4, 410.3, 421.2 |
| ASSE 1071-2008 | Temperature Actuated Mixing Valves for Plumbed Emergency Equipment | Valves | 301.1.2, 301.2 |
| ***ASSE 1079-2005*** | Dielectric Pipe Unions | Joints | 605.16, 605.17.1, 605.17.3 |
| ***ASSE Series 5000-2009**** | Cross-Connection Control Professional Qualifications | Certification | 603.2 |
| ***ASSE Series 6000-2006**** | Professional Qualifications Standard for Medical Gas Systems Personnel | Certification | 1302.3, 1327.1.1 |
| ASTM A 47-1999 (R2009) | Ferritic Malleable Iron Castings | Piping, Ferrous | 301.1.2, 301.2 |
| ASTM A 48-2003 (R2008) | Gray Iron Castings | Piping, Ferrous | 301.1.2, 301.2 |
| ***ASTM A 53/A 53M-2010*** | Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless | Piping, Ferrous | 1208.5.2.2(2), Table 604.1, Table 701.1 |
| ***ASTM A 74-2009*** | Cast Iron Soil Pipe and Fittings (Notes 1 and 7) | Piping, Ferrous | Table 701.1 |
| ***ASTM A 106/A 106M-2010*** | Seamless Carbon Steel Pipe for High-Temperature Service | Piping, Ferrous | 1208.5.2.2(3) |
| ASTM A 126-2004 (R2009) | Gray Iron Castings for Valves, Flanges, and Pipe Fittings | Piping, Ferrous | 301.1.2, 301.2 |
| ASTM A 197-2000 (R2006) | Cupola Malleable Iron | Piping, Ferrous | 301.1.2, 301.2 |
| ***ASTM A 254-1997 (R2007)*** | Copper-Brazed Steel Tubing | Piping, Ferrous | 1208.5.3.1, E 32.1 |
| ***ASTM A 269-2010*** | Seamless and Welded Austenitic Stainless Steel Tubing for General Service | Piping, Ferrous | F 8.2, Table 604.1 |
| ***ASTM A 312-2009*** | Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes | Piping, Ferrous | Table 604.1 |

| STANDARD NUMBER | STANDARD TITLE | APPLICATION | REFERENCED SECTIONS |
|---|---|---|---|
| ASTM A 377-2003 (R2008)[e1] | Ductile-Iron Pressure Pipe | Piping, Ferrous | 301.1.2, 301.2 |
| ***ASTM A 479/A 479M-2010a*** | Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels | Piping, Ferrous | F 8.3 |
| ASTM A 518-1999 (R2008) | Corrosion-Resistant High-Silicon Iron Castings | Piping, Ferrous | 301.1.2, 301.2 |
| ASTM A 536-1984 (R2009) | Ductile Iron Castings | Piping, Ferrous | 301.1.2, 301.2 |
| ASTM A 653/A 653M-2010 | Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process | Piping, Ferrous | 301.1.2, 301.2 |
| ASTM A 733-2003 (R2009)[e1] | Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples | Piping, Ferrous | 301.1.2, 301.2 |
| ASTM A 861-2004 (R2008) | High-Silicon Iron Pipe and Fittings (Note 1) | Piping, Ferrous | 301.1.2, 301.2 |
| ***ASTM A 888-2009*** | Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications (Note 7) | Piping, Ferrous | Table 701.1 |
| ASTM A 1045-2008 | Flexible Poly (Vinyl Chloride) (PVC) Gaskets used in Connection of Water Closets to Sanitary Drainage | Piping, Plastic | 301.1.2, 301.2 |
| ***ASTM A 1056-2008*** | Cast Iron Couplings used for Joining Hubless Cast Iron Soil Pipe and Fittings | Piping, Ferrous | 705.4.2 |
| ASTM B 29-2003 (R2009) | Refined Lead | Joints | 301.1.2, 301.2 |
| ***ASTM B 32-2008*** | Solder Metal (Note 2) | Joints | 605.3.4, 705.5.3 |
| ***ASTM B 42-2010*** | Seamless Copper Pipe, Standard Sizes | Piping, Copper Alloy | Table 604.1 |
| ***ASTM B 43-2009*** | Seamless Red Brass Pipe, Standard Sizes | Piping, Copper Alloy | Table 604.1, Table 701.1 |
| ***ASTM B 75-2002 (R2010)*** | Seamless Copper Tube (Note 7) | Piping, Copper Alloy | Table 604.1, Table 701.1 |
| ***ASTM B 88-2009*** | Seamless Copper Water Tube | Piping, Copper Alloy | 604.3, 903.2.4, 1208.5.3.2, 1315.4(1), 1324.4(1), E 32.1, Table 604.1 |
| ***ASTM B 135-2010*** | Seamless Brass Tube | Piping, Copper Alloy | Table 604.1 |
| ASTM B 152-2009 | Copper Sheet, Strip, Plate, and Rolled Bar | Miscellaneous | 301.1.2, 301.2 |
| ASTM B 187-2006 | Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes | Miscellaneous | 301.1.2, 301.2 |
| ***ASTM B 210-2004*** | Aluminum and Aluminum-Alloy Drawn Seamless Tubes | Piping, Ferrous | 1208.5.3.3 |
| ***ASTM B 241/B 241M-2010*** | Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube | Piping, Ferrous | 1208.5.2.4, 1208.5.3.3 |
| ***ASTM B 251-2010*** | General Requirements for Wrought Seamless Copper and Copper-Alloy Tube (Note 7) | Piping, Copper Alloy | Table 604.1, Table 701.1 |
| ***ASTM B 280-2008*** | Seamless Copper Tube for Air Conditioning and Refrigeration Field Service | Piping, Copper Alloy | 1208.5.3.2, 1315.4(1), 1324.4(2), E 32.1 |
| ***ASTM B 302-2007*** | Threadless Copper Pipe, Standard Sizes (Note 7) | Piping, Copper Alloy | Table 604.1, Table 701.1 |
| ***ASTM B 306-2009*** | Copper Drainage Tube (DWV) (Note 7) | Piping, Copper Alloy | 903.2.4, Table 701.1 |
| ASTM B 370-2009 | Copper Sheet and Strip for Building Construction | Miscellaneous | 301.1.2, 301.2 |

| STANDARD NUMBER | STANDARD TITLE | APPLICATION | REFERENCED SECTIONS |
|---|---|---|---|
| ***ASTM B 447-2007*** | Welded Copper Tube | Piping, Copper Alloy | Table 604.1 |
| ASTM B 584-2009a | Copper Alloy Sand Castings for General Applications (Note 3) | Piping, Copper Alloy | 301.1.2, 301.2 |
| ASTM B 587-2008 | Welded Brass Tube | Piping, Copper Alloy | 301.1.2, 301.2 |
| ASTM B 687-1999 (R2005)[e1] | Brass, Copper, and Chromium-Plated Pipe Nipples | Piping, Copper Alloy | 301.1.2, 301.2 |
| ***ASTM B 813-2010*** | Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube | Joints | 605.3.4, 705.5.3 |
| ***ASTM B 819-2000 (R2006)*** | Seamless Copper Tube for Medical Gas Systems | Piping, Copper Alloy | 1315.4(1), 1324.4(3) |
| ***ASTM B 828-2002 (R2010)*** | Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings | Joints | 605.3.4, 705.5.3, 1315.9 |
| ***ASTM C 4-2004 (R2009)*** | Clay Drain Tile and Perforated Clay Drain Tile | Piping, Non-Metallic | Table 1102.5 |
| ***ASTM C 14-2007*** | Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Note 7) | Piping, Non-Metallic | Table 701.1 |
| ***ASTM C 296-2000 (R2009)[e1]*** | Asbestos-Cement Pressure Pipe | Piping, Non-Metallic | Table 604.1 |
| ASTM C 412-2005a | Concrete Drain Tile | Piping, Non-Metallic | 301.1.2, 301.2 |
| ***ASTM C 425-2004 (R2009)*** | Compression Joints for Vitrified Clay Pipe and Fittings | Joints | 705.9.1 |
| ***ASTM C 428-2005 (R2006)*** | Asbestos-Cement Nonpressure Sewer Pipe (Notes 4, 5 and 7) | Piping, Non-Metallic | Table 701.1 |
| ASTM C 443-2010 | Joints for Concrete Pipe and Manholes, Using Rubber Gaskets | Joints | 301.1.2, 301.2 |
| ***ASTM C 444-2003 (R2009)*** | Perforated Concrete Pipe | Piping, Non-Metallic | Table 1102.5 |
| ASTM C 478-2009 | Precast Reinforced Concrete Manhole Sections | Miscellaneous | 301.1.2, 301.2 |
| ***ASTM C 508-2000 (R2009)[e1]*** | Asbestos-Cement Underdrain Pipe | Piping, Non-Metallic | Table 1102.5 |
| ***ASTM C 564-2009a*** | Rubber Gaskets for Cast Iron Soil Pipe and Fittings | Joints | 705.4.2 |
| ***ASTM C 700-2011*** | Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated (Note 7) | Piping, Non-Metallic | Table 701.1, Table 1102.5 |
| ***ASTM C 966-1998 (R2008)*** | Installing Asbestos-Cement Nonpressure Pipe | Piping, Non-Metallic | Table 1102.5 |
| ASTM C 1053-2000 (R2010) | Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications (Note 1) | Piping, Non-Metallic | 301.1.2, 301.2 |
| ASTM C 1173-2010 | Flexible Transition Couplings for Underground Piping Systems | Joints | 301.1.2, 301.2 |
| ASTM C 1227-2009 | Precast Concrete Septic Tanks | DWV Components | 301.1.2, 301.2 |
| ***ASTM C 1277-2009a*** | Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings | Joints | 705.4.2 |
| ASTM C 1440-2008 | Thermoplastic Elastomeric (TPE) Gasket Materials for Drain, Waste, and Vent (DWV), Sewer, Sanitary and Storm Plumbing Systems | Joints | 301.1.2, 301.2 |
| ASTM C 1460-2008 | Shielded Transition Couplings for Use With Dissimilar DWV Pipe and Fittings Above Ground | Joints | 301.1.2, 301.2 |

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|---|---|---|---|
| ASTM C 1461-2008 | 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 Use | Joints | 301.1.2, 301.2 |
| *ASTM C 1540-2009a* | Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings | Joints | 705.4.2 |
| *ASTM D 1527-1999 (R2005)** | Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80 (Note 7) | Piping, Plastic | Table 701.1 |
| ASTM D 1784-2008 | Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds | Piping, Plastic | 301.1.2, 301.2 |
| *ASTM D 1785-2006** | Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120 (Note 7) | Piping, Plastic | Table 604.1, Table 701.1 |
| *ASTM D 1869-1995 (R2010)* | Rubber Rings for Asbestos-Cement Pipe | Joints | 605.1.1, 705.2.1 |
| *ASTM D 2235-2004 (R2011)** | Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings | Joints | 705.1.2 |
| *ASTM D 2239-2003** | Polyethylene (PE) Plastic Pipe, (SDR-PR) Based on Controlled Inside Diameter | Piping, Plastic | Table 604.1 |
| *ASTM D 2241-2009** | Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series) | Piping, Plastic | Table 604.1 |
| ASTM D 2321-2011* | Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications (Note 7) | Piping, Plastic | 301.1.2, 301.2 |
| *ASTM D 2464-2006** | Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 (Note 1) | Fittings | Table 604.1 |
| *ASTM D 2466-2006** | Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 (Note 1) | Fittings | Table 604.1 |
| *ASTM D 2467-2006** | Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80 (Note 1) | Fittings | Table 604.1 |
| *ASTM D 2513-2011** | Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings (Note 1) | Piping, Plastic | 1208.5.4, 1208.5.4.2(B), 1208.5.9.2, 1210.1.7.1(1), E 32.3 |
| *ASTM D 2517-2006** | Reinforced Epoxy Resin Gas Pressure Pipe and Fittings | Piping, Plastic | E 32.3 |
| *ASTM D 2564-2004 (R2009)** | Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems | Joints | 605.13.2, 705.7.2 |
| *ASTM D 2609-2002 (R2008)** | Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe (Note 1) | Fittings | Table 604.1 |
| *ASTM D 2657-2007** | Heat Fusion Joining of Polyolefin Pipe and Fittings (Note 1) | Joints | 605.7.1 |
| *ASTM D 2661-2008** | Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings (Notes 1 and 7) | Piping, Plastic | Table 701.1 |
| *ASTM D 2665-2010** | Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings (Note 7) | Piping, Plastic | Table 701.1 |
| ASTM D 2672-1996a (R2009)* | Joints for IPS PVC Pipe Using Solvent Cement | Joints | 301.1.2, 301.2 |
| *ASTM D 2680-2001 (R2009)** | Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping (Note 7) | Piping, Plastic | Table 701.1 |
| *ASTM D 2683-2010** | Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing | Fittings | Table 604.1, Table 701.1 |
| *ASTM D 2729-2011** | Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings (Notes 1 and 7) | Piping, Plastic | Table 1102.5 |
| *ASTM D 2737-2003** | Polyethylene (PE) Plastic Tubing | Piping, Plastic | Table 604.1 |

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|---|---|---|---|
| ASTM D 2751-2005* | Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings (Notes 1 and 7) | Piping, Plastic | 301.1.2, 301.2 |
| ASTM D 2774-2010* | Underground Installation of Thermoplastic Pressure Piping | Piping, Plastic | 301.1.2, 301.2 |
| ***ASTM D 2846-2009b**** | Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems | Piping, Plastic | 605.4.2, Table 604.1 |
| ASTM D 2855-1996 (R2010)* | Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings | Joints | 301.1.2, 301.2 |
| ASTM D 2996-2001 (R2007)e1* | Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe | Piping, Plastic | 301.1.2, 301.2 |
| ASTM D 3034-2008* | Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings (Note 7) | Piping, Plastic | 301.1.2, 301.2 |
| ***ASTM D 3035-2010**** | Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter | Piping, Plastic | Table 604.1 |
| ASTM D 3122-1995 (R2009)* | Solvent Cements for Styrene-Rubber (SR) Plastic Pipe and Fittings | Joints | 301.1.2, 301.2 |
| ASTM D 3138-2004 (R2011)* | Solvent Cements for Transition Joints Between Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Non-Pressure Piping Components | Joints | 301.1.2, 301.2 |
| ***ASTM D 3139-1998 (R2011)**** | Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals | Joints | 605.13.1 |
| ***ASTM D 3212-2007**** | Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals | Joints | 705.1.1, 705.7.1 |
| ***ASTM D 3261-2010a**** | Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing | Fittings | Table 604.1, Table 701.1 |
| ASTM D 3311-2009a* | Drain, Waste, and Vent (DWV) Plastic Fittings Patterns (Note 1) | Fittings | 301.1.2, 301.2 |
| ASTM D 3965-2005* | Rigid Acrylonitrile-Butadiene-Styrene (ABS) Materials for Pipe and Fittings | Piping, Plastic | 301.1.2, 301.2 |
| ASTM D 4068-2009* | Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane | Miscellaneous | 301.1.2, 301.2 |
| ASTM D 4101-2010a | Polypropylene Injection and Extrusion Materials | Miscellaneous | 301.1.2, 301.2 |
| ASTM D 4551-1996 (R2008)e1* | Poly (Vinyl Chloride) (PVC) Plastic Flexible Concealed Water-Containment Membrane | Miscellaneous | 301.1.2, 301.2 |
| ASTM D 6104-1997 (R2003) | Determining the Performance of Oil/Water Separators Subjected to Surface Run-Off | Miscellaneous | 301.1.2, 301.2 |
| ***ASTM E 84-2010b**** | Surface Burning Characteristics of Building Materials | Miscellaneous | 701.1(2), 903.1(2), 1101.3 |
| ***ASTM E 119-2010b**** | Fire Tests of Building Construction and Materials | Miscellaneous | 1504.3, 1505.3 |
| ***ASTM E 814-2011**** | Fire Tests of Penetration Firestop Systems | Miscellaneous | 208.0, 222.0, 1504.3, 1505.3 |
| ASTM F 402-2005* | Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings | Joints | 301.1.2, 301.2 |
| ***ASTM F 405-2005**** | Corrugated Polyethylene (PE) Pipe and Fittings | Piping, Plastic | Table 1102.5 |
| ASTM F 409-2002 (R2008)* | Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings (Note 1) | Piping, Plastic | 301.1.2, 301.2 |
| ***ASTM F 437-2009**** | Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80 | Fittings | Table 604.1 |
| ***ASTM F 438-2009**** | Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40 | Fittings | Table 604.1 |
| ***ASTM F 439-2009**** | Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80 | Fittings | Table 604.1 |

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|---|---|---|---|
| ***ASTM F 441-2009**** | Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80 | Piping, Plastic | Table 604.1 |
| ***ASTM F 442-2009**** | Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR) | Piping, Plastic | Table 604.1 |
| ASTM F 446-1985 (R2009) | Grab Bars and Accessories Installed in the Bathing Area | Miscellaneous | 301.1.2, 301.2 |
| ASTM F 480-2006b[e1]* | Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR), Schedule 40 and Schedule 80 | Piping, Plastic | 301.1.2, 301.2 |
| ***ASTM F 493-2010**** | Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings | Joints | 605.4.2 |
| ***ASTM F 628-2008**** | Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core (Notes 1 and 7) | Piping, Plastic | Table 701.1 |
| ***ASTM F 656-2010**** | Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings | Joints | 605.4.2, 605.13.2, 705.7.2 |
| ASTM F 667-2006* | Large Diameter Corrugated Polyethylene Pipe and Fittings | Piping, Plastic | 301.1.2, 301.2 |
| ***ASTM F 714-2010**** | Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter | Piping, Plastic | Table 701.1 |
| ***ASTM F 794-2003 (R2009)**** | Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter (Note 7) | Piping, Plastic | Table 701.1 |
| ASTM F 810-2007* | Smoothwall Polyethylene (PE) Pipe for Use in Drainage and Waste Disposal Absorption Fields | Piping, Plastic | 301.1.2, 301.2 |
| ***ASTM F 876-2010**** | Crosslinked Polyethylene (PEX) Tubing | Piping, Plastic | 605.10.1, Table 604.1 |
| ***ASTM F 877-2007**** | Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems | Piping, Plastic | Table 604.1 |
| ***ASTM F 891-2010**** | Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core (Note 7) | Piping, Plastic | Table 701.1 |
| ASTM F 894-2007* | Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe (Note 7) | Piping, Plastic | 301.1.2, 301.2 |
| ASTM F 949-2010* | Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings (Note 7) | Piping, Plastic | 301.1.2, 301.2 |
| ***ASTM F 1055-1998 (R2006)**** | Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing | Fittings | Table 604.1, Table 701.1 |
| ***ASTM F 1216-2009**** | Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube | Piping, Plastic | 715.3 |
| ***ASTM F 1281-2007**** | Crosslinked Polyethylene/Aluminum/ Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe | Piping, Plastic | Table 604.1 |
| ***ASTM F 1282-2010**** | Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe | Piping, Plastic | Table 604.1 |
| ASTM F 1335-2004* | Pressure-Rated Composite Pipe and Fittings for Elevated Temperature Service | Piping, Plastic | 301.1.2, 301.2 |
| ASTM F 1336-2007* | Poly (Vinyl Chloride) (PVC) Gasketed Sewer Fittings | Fittings | 301.1.2, 301.2 |
| ASTM F 1412-2009* | Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems | Piping, Plastic | 301.1.2, 301.2 |
| ASTM F 1476-2007* | Performance of Gasketed Mechanical Couplings for Use in Piping Applications | Joints | 301.1.2, 301.2 |
| ***ASTM F 1488-2009[e1]**** | Coextruded Composite Pipe (Note 7) | Piping, Plastic | Table 701.1 |
| ASTM F 1499-2001 (R2008)* | Coextruded Composite Drain, Waste, and Vent Pipe (DWV) | Piping, Plastic | 301.1.2, 301.2 |

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|---|---|---|---|
| ASTM F 1673-2010* | Polyvinylidene Fluoride (PVDF) Corrosive Waste Drainage Systems | Piping, Plastic | 301.1.2, 301.2 |
| ASTM F 1743-2008* | Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP) | Piping, Plastic | 301.1.2, 301.2 |
| ***ASTM F 1807-2010$^{e1}$**** | Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing | Fittings | Table 604.1 |
| ***ASTM F 1866-2007**** | Poly (Vinyl Chloride) (PVC) Plastic Schedule 40 Drainage and DWV Fabricated Fittings | Fittings | Table 701.1 |
| ASTM F 1924-2005 (R2011)* | Plastic Mechanical Fittings for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing | Fittings | 301.1.2, 301.2 |
| ASTM F 1948-2005 (R2011)* | Metallic Mechanical Fittings for Use on Outside Diameter Controlled Thermoplastic Gas Distribution Pipe and Tubing | Fittings | 301.1.2, 301.2 |
| ***ASTM F 1960-2010**** | Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-linked Polyethylene (PEX) Tubing | Fittings | Table 604.1 |
| ***ASTM F 1961-2009**** | Metal Mechanical Cold Flare Compression Fittings with Disc Spring for Crosslinked Polyethylene (PEX) Tubing | Fittings | Table 604.1 |
| ***ASTM F 1970-2005**** | Special Engineered Fittings, Appurtenances or Valves for Use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems | Piping, Plastic | Table 604.1 |
| ***ASTM F 1973-2008**** | Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide 11 (PA11) and Polyamide 12 (PA12) Fuel Gas Distribution Systems | Fuel Gas | 1210.1.7.1(2) |
| ***ASTM F 1974-2009**** | Metal Insert Fittings for Polyethylene/ Aluminum/Polyethylene and Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene Composite Pressure Pipe | Fittings | 605.8.1, 605.11.1, Table 604.1 |
| ASTM F 1986-2001 (R2006)* | Multilayer Pipe Type 2, Compression Fittings, and Compression Joints for Hot and Cold Drinking-Water Systems | Fittings | 301.1.2, 301.2 |
| ***ASTM F 2080-2009**** | Cold-Expansion Fittings with Metal Compression-Sleeves for Crosslinked Polyethylene (PEX) Pipe | Fittings | Table 604.1 |
| ***ASTM F 2098-2008**** | Stainless Steel Clamps for Securing SDR9 Cross-linked Polyethylene (PEX) Tubing to Metal Insert and Plastic Insert Fittings | Joints | Table 604.1 |
| ***ASTM F 2159-2010**** | Plastic Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing | Joints | Table 604.1 |
| ASTM F 2165-2002 (R2008)* | Flexible Pre-Insulated Piping | Piping, Plastic | 301.1.2, 301.2 |
| ***ASTM F 2206-2002**** | Fabricated Fittings of Butt-Fused Polyethylene (PE) Plastic Pipe, Fittings, Sheet Stock, Plate Stock, or Block Stock | DWV Components | Table 701.1 |
| ***ASTM F 2262-2009**** | Crosslinked Polyethylene/Aluminum/ Crosslinked Polyethylene Tubing OD Controlled SDR9 | Piping, Plastic | Table 604.1 |
| ASTM F 2306-2008 | Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications | Piping, Plastic | 301.1.2, 301.2 |
| ***ASTM F 2389-2010*** | Pressure-Rated Polypropylene (PP) Piping Systems | Piping, Plastic | 605.12.1, Table 604.1 |
| ***ASTM F 2434-2009**** | Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing and SDR9 Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene (PEX-AL-PEX) Tubing | Fittings | 605.11.1, Table 604.1 |

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|---|---|---|---|
| *ASTM F 2509-2006** | Field-Assembled Anodeless Riser Kits for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing | Fuel Gas | 1210.1.7.1(3) |
| *ASTM F 2735-2009* | Plastic Insert Fittings for SDR9 Cross-linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing | Fittings | Table 604.1 |
| *ASTM F 2769-2009* | Polyethylene of Raised Temperature (PE-RT) Plastic Hot and Cold-Water Tubing and Distribution Systems | Piping and Fittings, Plastic | Table 604.1 |
| ASTM F 2831-2011* | Standard Practice for Internal Non Structural Epoxy Barrier Coating Material Used in Rehabilitation of Metallic Pressurized Piping Systems | Miscellaneous | 301.1.2, 301.2 |
| *AWS A5.8-2004** | Filler Metals for Brazing and Braze Welding | Joints | 605.2.1, 605.3.1, 705.3.1, 705.5.1, 1318.2 |
| *AWS A5.9-2006** | Bare Stainless Steel Welding Electrodes and Rods | Joints | 605.14.2 |
| *AWS B2.2-2010** | Brazing Procedure and Performance Qualification | Certification | 1310.6 |
| *AWS B2.4-2006** | Welding Procedure and Performance Qualification for Thermoplastics | Joints, Certification | 1208.5.9.2 |
| *AWWA C110-2008** | Ductile-Iron and Gray-Iron Fittings | Fittings | Table 604.1 |
| *AWWA C111-2007** | Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings | Joints | 605.5.1, 605.5.2 |
| *AWWA C151-2009** | Ductile-Iron Pipe, Centrifugally Cast | Piping, Ferrous | Table 604.1 |
| *AWWA C153-2006** | Ductile-Iron Compact Fittings for Water Service | Fittings | Table 604.1 |
| AWWA C203-2008* | Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape – Hot Applied | Miscellaneous | 301.1.2, 301.2 |
| *AWWA C210-2007** | Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines | Miscellaneous | 604.8 |
| AWWA C213-2007* | Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines | Miscellaneous | 301.1.2, 301.2 |
| AWWA C215-2010* | Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines | Miscellaneous | 301.1.2, 301.2 |
| AWWA C500-2009* | Metal-Seated Gate Valves for Water Supply Service | Valves | 301.1.2, 301.2 |
| AWWA C504-2010* | Rubber Seated Butterfly Valves, 3 in. (75 mm) through 72 in. (1800 mm) | Valves | 301.1.2, 301.2 |
| AWWA C507-2005* | Ball Valves, 6 in. through 48 in. (150 mm through 1200 mm) | Valves | 301.1.2, 301.2 |
| *AWWA C510-2007** | Double Check Valve Backflow Prevention Assembly | Backflow Protection | Table 603.2 |
| *AWWA C511-2007** | Reduced-Pressure Principle Backflow Prevention Assembly | Backflow Protection | Table 603.2 |
| AWWA C606-2006* | Grooved and Shouldered Joints | Joints | 301.1.2, 301.2 |
| *AWWA C900-2007** | Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 12 in. (100 mm through 300 mm), for Water Transmission and Distribution | Piping, Plastic | Table 604.1 |
| *AWWA C901-2008** | Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. (13 mm) through 3 in. (76 mm), for Water Service | Piping, Plastic | Table 604.1 |
| *AWWA C904-2006** | Cross-Linked Polyethylene (PEX) Pressure Pipe, 1/2 in. (12 mm) through 3 in. (76 mm), for Water Service | Piping, Plastic | Table 604.1 |

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|---|---|---|---|
| AWWA C907-2004* | Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 in. through 12 in. (100 mm through 300 mm), for Water Distribution | Fittings | 301.1.2, 301.2 |
| ***CGA C-9-2004 (R2008)*** | Standard Color Marking of Compressed Gas Containers for Medical Use | Miscellaneous | 1322.1 |
| ***CGA G-4.1-2009*** | Cleaning Equipment for Oxygen Service | Miscellaneous | 1310.1, 1315.2, 1316.1 |
| ***CGA S-1.3-2008*** | Pressure Relief Device Standards-Part 3-Stationary Storage Containers for Compressed Gases | Fuel Gas | F 5.8 |
| ***CGA V-1-2005*** | Compressed Gas Cylinder Valve Outlet and Inlet Connections | Valves | F 6.6, F 7.4 |
| ***CISPI 301-2009*** | Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications (Notes 1 and 7) | Piping, Ferrous | Table 701.1 |
| ***CISPI 310-2009*** | Couplings for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications | Joints | 705.4.2 |
| CSA No. 3-1992 | U.S. Requirements for Excess Flow Valves | Fuel Gas | 301.1.2, 301.2 |
| CSA A257-2009 | Concrete Pipe and Manhole Sections | Piping | 301.1.2, 301.2 |
| CSA B45.0-2002 (R2008) | General Requirements for Plumbing Fixtures | Fixtures | 301.1.2, 301.2 |
| CSA B45.5-2002 (R2008) | Plastic Plumbing Fixtures | Fixtures | 301.1.2, 301.2 |
| CSA B45.9-2002 (R2008) | Macerating Systems and Related Components | DWV Components | 301.1.2, 301.2 |
| CSA B45.10-2001 (R2006) | Hydromassage Bathtubs | Fixtures | 301.1.2, 301.2 |
| CSA B45.11-2004 | Glass Lavatories | Fixtures | 301.1.2, 301.2 |
| CSA B64-2007 | Backflow Preventers and Vacuum Breakers | Backflow Protection | 301.1.2, 301.2 |
| ***CSA B64.1.1-2007*** | Atmospheric Vacuum Breakers (AVB) | Backflow Protection | Table 603.2 |
| ***CSA B64.1.2-2007*** | Pressure Vacuum Breakers (PVB) | Backflow Protection | Table 603.2 |
| CSA B64.2-2007 | Hose Connection Vacuum Breakers (HCVB) | Backflow Protection | 301.1.2, 301.2 |
| ***CSA B64.2.1.1-2007*** | Hose Connection Dual Check Vacuum Breakers (HCDVB) | Backflow Protection | Table 603.2 |
| ***CSA B64.4-2007*** | Reduced Pressure Principle (RP) Backflow Preventers | Backflow Protection | Table 603.2 |
| ***CSA B64.4.1-2007*** | Reduced Pressure Principle Backflow Preventers for Fire Protection Systems (RPF) | Backflow Protection | Table 603.2 |
| ***CSA B64.5-2007*** | Double Check Valve (DVCA) Backflow Preventers | Backflow Protection | Table 603.2 |
| ***CSA B64.5.1-2007*** | Double Check Valve Backflow Preventers for Fire Protection Systems (DVCAF) | Backflow Protection | Table 603.2 |
| CSA B64.7-2007 | Laboratory Faucet Vacuum Breakers (LFVB) | Backflow Protection | 301.1.2, 301.2 |
| CSA B66-2005 | Design, Material, and Manufacturing Requirements for Prefabricated Septic Tanks and Sewage Holding Tanks | DWV Components | 301.1.2, 301.2 |

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|---|---|---|---|
| CSA B79-2008 | Commercial and Residential Drains and Cleanouts | DWV Components | 301.1.2, 301.2 |
| ***CSA B125.3-2005*** | Plumbing Fittings | Fittings | 409.4, 410.3, 421.2, Table 603.2 |
| CSA B128.1-2006/B128.2-2006 | Design and Installation of Non-Potable Water Systems/Maintenance and Field Testing of Non-Potable Water Systems (Note 1) | Miscellaneous | 301.1.2, 301.2 |
| ***CSA B137.1-2009*** | Polyethylene (PE) Pipe, Tubing, and Fittings for Cold-Water Pressure Services | Piping, Plastic | Table 604.1 |
| ***CSA B137.5-2009*** | Crosslinked Polyethylene (PEX) Tubing Systems for Pressure Applications | Piping, Plastic | Table 604.1 |
| ***CSA B137.9-2009*** | Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure-Pipe Systems | Piping, Plastic | Table 604.1 |
| ***CSA B137.10-2009*** | Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Composite Pressure-Pipe Systems | Piping, Plastic | Table 604.1 |
| ***CSA B137.11-2009*** | Polypropylene (PP-R) Pipe and Fittings for Pressure Applications | Piping, Plastic | 605.12.1, Table 604.1 |
| CSA B181.3-2006 | Polyolefin and Polyvinylidene Fluoride (PVDF) Laboratory Drainage Systems | Piping, Plastic | 301.1.2, 301.2 |
| CSA B242-2005 | Groove- and Shoulder-Type Mechanical Pipe Couplings | Fittings | 301.1.2, 301.2 |
| CSA B356-2010 | Water Pressure Reducing Valves for Domestic Water Supply Systems | Valves | 301.1.2, 301.2 |
| CSA B481-2007 | Grease Interceptors | DWV Components | 301.1.2, 301.2 |
| CSA G401-2007 | Corrugated Steel Pipe Products | Piping, Ferrous | 301.1.2, 301.2 |
| ***CSA LC-1a-2009**** | Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST) (same as CSA 6.26a) | Fuel Gas | 1208.5.3.4 |
| CSA LC-3-2000 (R2005)* | Appliance Stands and Drain Pans | Miscellaneous | 301.1.2, 301.2 |
| ***CSA LC-4-2007**** | Press-Connect Copper and Copper Alloy Fittings for Use in Fuel Gas Distribution Systems (same as CSA 6.32) | Fuel Gas | 1208.5.8.2 |
| CSA Z21.10.1a-2009* | Gas Water Heaters – Volume I, Storage Water Heaters with Input Ratings of 75 000 Btu Per Hour or Less (same as CSA 4.1a) | Fuel Gas, Appliances | 301.1.2, 301.2 |
| ***CSA Z21.10.3b-2008 (R2010)**** | Gas Water Heaters – Volume III, Storage Water Heaters with Input Ratings Above 75 000 Btu Per Hour, Circulating and Instantaneous (same as CSA 4.3b) | Fuel Gas, Appliances | Table L 603.4.2 |
| CSA Z21.12b-1994 (R2010)* | Draft Hoods | Fuel Gas, Appliances | 301.1.2, 301.2 |
| CSA Z21.13a-2010* | Gas-Fired Low Pressure Steam and Hot Water Boilers (same as CSA 4.9a) | Fuel Gas, Appliances | 301.1.2, 301.2 |
| CSA Z21.15-2009* | Manually Operated Gas Valves for Appliances, Appliance Connector Valves, and Hose End Valves (same as CSA 9.1) | Fuel Gas | 301.1.2, 301.2 |
| CSA Z21.22b-2001 (R2008)* | Relief Valves for Hot Water Supply Systems (same as CSA 4.4b) | Valves | 301.1.2, 301.2 |
| ***CSA Z21.24a-2009**** | Connectors for Gas Appliances (same as CSA 6.10a) | Fuel Gas | 1211.1(3), 1211.2 |
| CSA Z21.40.1a-1997 (R2007)* | Gas-Fired, Heat Activated Air Conditioning and Heat Pump Appliances (same as CSA 2.91a) | Fuel Gas, Appliances | UMC |
| CSA Z21.41b-2010* | Quick-Disconnect Devices for Use with Gas Fuel Appliances (same as CSA 6.9b) | Fuel Gas | 301.1.2, 301.2 |
| CSA Z21.47b-2008* | Gas-Fired Central Furnaces (same as CSA 2.3b) | Fuel Gas, Appliances | UMC |

| STANDARD NUMBER | STANDARD TITLE | APPLICATION | REFERENCED SECTIONS |
|---|---|---|---|
| ***CSA Z21.54b-2009**** | Gas Hose Connectors for Portable Outdoor Gas-Fired Appliances (same as CSA 8.4b) | Fuel Gas | 1211.3.2 |
| CSA Z21.56a-2008* | Gas-Fired Pool Heaters (same as CSA 4.7a) | Fuel Gas, Swimming Pools, Spas, and Hot Tubs | USPSHTC |
| ***CSA Z21.69-2009**** | Connectors for Movable Gas Appliances (same as CSA 6.16) | Fuel Gas | 1211.1(6) |
| ***CSA Z21.80b-2010**** | Line Pressure Regulators (same as CSA 6.22b) | Fuel Gas | 1208.7.2, 1208.7.5.1(1) |
| CSA Z21.81a-2007 (R2010)* | Cylinder Connection Devices (same as CSA 6.25a) | Fuel Gas | 301.1.2, 301.2 |
| CSA Z21.86-2008* | Vented Gas-Fired Space Heating Appliances (same as CSA 2.32) | Fuel Gas, Appliances | UMC |
| ***CSA Z21.90b-2006**** | Gas Convenience Outlets and Optional Enclosures (same as CSA 6.24b) | Fuel Gas | 1211.7 |
| CSA Z83.11b-2009* | Gas Food Service Equipment (same as CSA 1.8b) | Fuel Gas, Appliances | UMC |
| CSA Z317.1-2009* | Special Requirements for Plumbing Installations in Health Care Facilities | Miscellaneous | 301.1.2, 301.2 |
| IAPMO IGC 154-2009 | Tub/Shower Enclosures and Shower Panel Assemblies | Fixtures | 301.1.2, 301.2 |
| IAPMO IGC 157-2010 | Ball Valves | Valves | 301.1.2, 301.2 |
| IAPMO IGC 172-2010 | Glass Lavatories, Sinks and Counter Tops | Fixtures | 301.1.2, 301.2 |
| IAPMO IGC 193-2010 | Safety Plates, Plate Straps, Notched Plates and Safety Collars | Miscellaneous | 301.1.2, 301.2 |
| IAPMO IGC 194-2004a | Copper Alloy or Aluminum Alloy Sinks and Lavatories | Fixtures | 301.1.2, 301.2 |
| IAPMO IGC 217-2007 | Metallic Bathtubs, Shower Pans and Whirlpool Bathtubs | Fixtures | 301.1.2, 301.2 |
| IAPMO IGC 226-2006a | Drinking Water Fountains With or Without Chiller or Heater | Fixtures | 301.1.2, 301.2 |
| IAPMO PS 23-2006a | Dishwasher Drain Airgaps | Backflow Protection | 301.1.2, 301.2 |
| IAPMO PS 25-2002 | Metallic Fittings for Joining Polyethylene Pipe for Water Service and Yard Piping | Joints | 301.1.2, 301.2 |
| IAPMO PS 33-2010c | Flexible PVC Hose for Pools, Hot Tubs, Spas and Jetted Bathtub | Fixtures, Swimming Pools, Spas, and Hot Tubs | 301.1.2, 301.2, USPSHTC |
| IAPMO PS 34-2003 | Polyethylene Encasement Sleeve for Potable Water Pipe and Tubing | Piping | 301.1.2, 301.2 |
| IAPMO PS 36-1990 | Lead Free Sealing Compounds for Threaded Joints | Joints | 301.1.2, 301.2 |
| IAPMO PS 37-1990 | Black Plastic PVC or PE Pressure-Sensitive Corrosion Preventive Tape | Miscellaneous | 301.1.2, 301.2 |
| IAPMO PS 42-1996 | Pipe Alignment & Secondary Support Systems | Miscellaneous | 301.1.2, 301.2 |
| IAPMO PS 43-2007 | Cushioned Bathtubs and Whirlpool Bathtub Appliances | Fixtures | 301.1.2, 301.2 |
| IAPMO PS 46-2010c | Field-Fabricated Tiling Kits | Miscellaneous | 301.1.2, 301.2 |
| IAPMO PS 50-2010 | Flush Valves with Dual Flush Device For Water Closets or Water Closet Tank with an Integral Flush Valves with a Dual Flush Device | Fixtures | 301.1.2, 301.2 |

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|---|---|---|---|
| IAPMO PS 51-1998 | Plastic and Metallic Expansion Joints | Joints | 301.1.2, 301.2 |
| IAPMO PS 52-2009 | Pump/Dose, Sumps and Sewage Ejector Tanks with or without a Pump | DWV Components | 301.1.2, 301.2 |
| IAPMO PS 53-2008 | Grooved Mechanical Pipe Couplings and Grooved End Fittings | Joints | 301.1.2, 301.2 |
| IAPMO PS 54-2010 | Metallic and Plastic Utility Boxes | Miscellaneous | 301.1.2, 301.2 |
| IAPMO PS 55-1992 | Bathwaste Strainer Drains | Fixtures | 301.1.2, 301.2 |
| IAPMO PS 57-2002 | PVC Hydraulically Actuated Diaphragm Type Water Control Valves | Valves | 301.1.2, 301.2 |
| IAPMO PS 59-2010 | Septic Effluent and Waste Water Diverter Valves or Diversion System | DWV Components | 301.1.2, 301.2 |
| IAPMO PS 60-1996 | Sewage Holding Tank Containing Sewage Ejector Pump for Direct Mounted Water Closet | DWV Components | 301.1.2, 301.2 |
| IAPMO PS 63-2005 | Plastic Leaching Chambers | DWV Components | 301.1.2, 301.2 |
| IAPMO PS 64-2007a | Pipe Flashings | Miscellaneous | 301.1.2, 301.2 |
| ***IAPMO PS 65-2002*** | Airgap Units for Water Conditioning Equipment Installation | Backflow Protection | 611.2 |
| IAPMO PS 66-2000 | Dielectric Waterway Fittings | Fittings | 301.1.2, 301.2 |
| IAPMO PS 67-2010 | Early-Closure Replacement Flappers or Early-Closure Replacement Flapper with Mechanical Assemblies | Fixtures | 301.1.2, 301.2 |
| IAPMO PS 69-2006 | Bathwaste and Overflow Assemblies with Tub Filler Spout | DWV Components | 301.1.2, 301.2 |
| IAPMO PS 72-2007 | Valves with Atmospheric Vacuum Breakers | Valves | 301.1.2, 301.2 |
| IAPMO PS 73-1993 | Dental Vacuum Pumps | Miscellaneous | 301.1.2, 301.2 |
| IAPMO PS 76-1995 | Ballcock or Flushometer Valve Tailpiece Trap Primers and Trap Primer Receptors/Adapters | DWV Components | 301.1.2, 301.2 |
| IAPMO PS 79-2005 | Multiport Electronic Trap Primer | DWV Components | 301.1.2, 301.2 |
| IAPMO PS 80-2008 | Clarifiers | DWV Components | 301.1.2, 301.2 |
| IAPMO PS 81-2006 | Precast Concrete Seepage Pit Liners and Covers | DWV Components | 301.1.2, 301.2 |
| IAPMO PS 82-1995 | Fiberglass (Glass Fiber Reinforced Thermosetting Resin) Fittings | Fittings | 301.1.2, 301.2 |
| IAPMO PS 85-1995 | Tools for Mechanically Formed Tee Connections in Copper Tubing | Miscellaneous | 301.1.2, 301.2 |
| IAPMO PS 86-1995 | Rainwater Diverter Valve for Non-Roofed Area Slabs | DWV Components | 301.1.2, 301.2 |
| IAPMO PS 87-1995 | Diverter and Shutoff Valves for Pool/Spas | Swimming Pools, Spas, and Hot Tubs | USPSHTC |
| IAPMO PS 88-2010 | Pre-Pressurized Potable Water or Expansion Tanks | Miscellaneous | 301.1.2, 301.2 |
| IAPMO PS 89-1995 | Soaking and Hydrotherapy (Whirlpool) Bathtubs with Hydraulic Seatlift | Fixtures | 301.1.2, 301.2 |
| IAPMO PS 90-2006 | Elastomeric Test Caps/Cleanout Caps | DWV Components | 301.1.2, 301.2 |

| STANDARD NUMBER | STANDARD TITLE | APPLICATION | REFERENCED SECTIONS |
|---|---|---|---|
| IAPMO PS 91-2005a | Plastic Stabilizers for Use with Plastic Closet Bends | DWV Components | 301.1.2, 301.2 |
| IAPMO PS 92-2010 | Heat Exchangers and Indirect Water Heaters | Miscellaneous | 301.1.2, 301.2 |
| IAPMO PS 94-2008 | P-Trap, Supply Stop and Riser Insulated Protector | Miscellaneous | 301.1.2, 301.2 |
| IAPMO PS 95-2001 | Drain, Waste, and Vent Hangers and Plastic Pipe Support Hooks | DWV Components | 301.1.2, 301.2 |
| IAPMO PS 96-2002 | Passive Direct Solar Water Heaters | Appliances | USEC |
| IAPMO PS 98-1996 | Prefabricated Fiberglass Church Baptisteries | Fixtures | 301.1.2, 301.2 |
| IAPMO PS 99-2007 | Terrazzo, Marble, Concrete, Granite, and Slate Plumbing Fixtures | Fixtures | 301.1.2, 301.2 |
| IAPMO PS 100-1996 | Porous Filter Protector for Sub-Drain Weep Holes | DWV Components | 301.1.2, 301.2 |
| IAPMO PS 101-1997 | Suction Relief Valves | Valves | 301.1.2, 301.2 |
| IAPMO PS 104-1997 | Pressure Relief Connection for Dispensing Equipment | Valves | 301.1.2, 301.2 |
| IAPMO PS 105-1997 | Polyethylene Distribution Boxes | DWV Components | 301.1.2, 301.2 |
| IAPMO PS 106-2010 | Pre-Fabricated, Tileable Shower Receptors | Fixtures | 301.1.2, 301.2 |
| IAPMO PS 107-1998 | Aramid Reinforced Rubber Hose for Use in Non-Potable Water Radiant Heating and Snowmelting | Miscellaneous | 301.1.2, 301.2 |
| IAPMO PS 108-1998 | Restaurant Fire Suppression Systems | Miscellaneous | 301.1.2, 301.2 |
| IAPMO PS 110-2006a | PVC Cold Water Compression Fittings | Fittings | 301.1.2, 301.2 |
| IAPMO PS 111-1999 | PVC Cold Water Gripper Fittings | Fittings | 301.1.2, 301.2 |
| IAPMO PS 112-1999 | PVC Plastic Valves for Cold Water Distribution Systems Outside a Building and CPVC Plastic Valves for Hot and Cold Water Distribution Systems | Valves | 301.1.2, 301.2 |
| IAPMO PS 113-2010 | Hydraulically Powered Household Food Waste Disposers | Appliances | 301.1.2, 301.2 |
| IAPMO PS 114-1999[e1] | Remote Floor Box Industrial Water Supply, Air Supply, Drainage | Miscellaneous | 301.1.2, 301.2 |
| IAPMO PS 115-2007 | Hot Water On-Demand or Automatic Activated Hot Water Pumping Systems | Miscellaneous | 301.1.2, 301.2 |
| IAPMO PS 116-1999 | Hot Water Circulating Devices Which Do Not Use a Pump | Miscellaneous | 301.1.2, 301.2 |
| IAPMO PS 117-2008 | Copper and Copper Alloy Tubing System Incorporating Press-Type or Nail-Type Connections | Fittings | 301.1.2, 301.2 |
| IAPMO PS 119-2006 | Water Energized Sump Pump | Miscellaneous | 301.1.2, 301.2 |
| IAPMO Z124.1.2-2005* | Plastic Bathtub and Shower Units | Fixtures | 301.1.2, 301.2 |
| IAPMO Z124.3-2005* | Plastic Lavatories | Fixtures | 301.1.2, 301.2 |
| IAPMO Z124.4-2006* | Plastic Water Closet Bowls and Tanks | Fixtures | 301.1.2, 301.2 |
| IAPMO Z124.5-2006* | Plastic Toilet (Water Closet) Seats | Fixtures | 301.1.2, 301.2 |

| STANDARD NUMBER | STANDARD TITLE | APPLICATION | REFERENCED SECTIONS |
|---|---|---|---|
| IAPMO Z124.6-2007 | Plastic Sinks | Fixtures | 301.1.2, 301.2 |
| IAPMO Z124.7-1997* | Prefabricated Plastic Spa Shells | Fixtures, Swimming Pools, Spas, and Hot Tubs | 301.1.2, 301.2, USPSHTC |
| IAPMO Z124.8-1990* | Plastic Bathtub Liners | Fixtures | 301.1.2, 301.2 |
| ***IAPMO Z124.9-2004**** | Plastic Urinal Fixtures (Note 1) | Fixtures | L 402.3 |
| IAPMO Z1000-2007* | Prefabricated Septic Tanks | DWV Components | 301.1.2, 301.2 |
| ***IAPMO Z1001-2007**** | Prefabricated Gravity Grease Interceptors | DWV Components | 1014.3.4 |
| ***ICC A117.1-2009**** | Accessible and Usable Buildings and Facilities | Miscellaneous | 408.6 |
| ***ISEA Z358.1-2009**** | Emergency Eyewash and Shower Equipment | Miscellaneous | 416.1, 416.2 |
| ISO/IEC Guide 65-1996 | General Requirements for Bodies Operating Product Certification Systems | Certification | 301.1.2, 301.2 |
| ***MSS SP-6-2007*** | Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings | Fuel Gas | 1208.5.10 |
| MSS SP-25-2008* | Marking Systems for Valves, Fittings, Flanges, and Unions | Miscellaneous | 301.1.2, 301.2 |
| MSS SP-42-2009* | Corrosion Resistant Gate, Globe, Angle and Check Valves with Flanged and Butt Weld Ends (Classes 150, 300 & 600) | Piping, Ferrous | 301.1.2, 301.2 |
| MSS SP-44-2010* | Steel Pipeline Flanges | Fittings | 301.1.2, 301.2 |
| ***MSS SP-58-2009*** | Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation | Fuel Gas | 1210.2.4, 1317.7 |
| MSS SP-67-2002a* | Butterfly Valves | Valves | 301.1.2, 301.2 |
| ***MSS SP-69-2003**** | Pipe Hangers and Supports -Selection and Application | Miscellaneous | 1317.7 |
| MSS SP-70-2006* | Gray Iron Gate Valves Flanged and Threaded Ends | Valves | 301.1.2, 301.2 |
| MSS SP-71-2010* | Gray Iron Swing Check Valves, Flanged and Threaded Ends | Valves | 301.1.2, 301.2 |
| MSS SP-72-2010* | Ball Valves with Flanged or Butt-Welding Ends for General Service | Valves | 301.1.2, 301.2 |
| MSS SP-78-2005a* | Gray Iron Plug Valves Flanged and Threaded Ends | Valves | 301.1.2, 301.2 |
| MSS SP-80-2008* | Bronze Gate, Globe, Angle, and Check Valves | Valves | 301.1.2, 301.2 |
| MSS SP-83-2006* | Class 3000 Steel Pipe Unions Socket Welding and Threaded | Joints | 301.1.2, 301.2 |
| MSS SP-89-2003* | Pipe Hangers and Supports-Fabrication and Installation Practices | Miscellaneous | 301.1.2, 301.2 |
| MSS SP-104-2003* | Wrought Copper Solder Joint Pressure Fittings | Fittings | 301.1.2, 301.2 |
| MSS SP-106-2003* | Cast Copper Alloy Flanges and Flanged Fittings: Class 125, 150 and 300 | Fittings | 301.1.2, 301.2 |
| MSS SP-109-1997 (R2006)* | Welded Fabricated Copper Solder Joint Pressure Fittings | Fittings | 301.1.2, 301.2 |
| MSS SP-123-1998 (R2006)* | Non-Ferrous Threaded and Solder Joint Unions for Use with Copper Water Tube | Joints | 301.1.2, 301.2 |

| STANDARD NUMBER | STANDARD TITLE | APPLICATION | REFERENCED SECTIONS |
|---|---|---|---|
| NFPA 13D-2010* | Installation of Sprinkler Systems in One- and Two Family Dwellings and Manufactured Homes | Miscellaneous | 301.1.2, 301.2 |
| NFPA 13R-2010* | Installation of Sprinkler Systems in Residential Occupancies Up to and Including Four Stories in Height | Miscellaneous | 301.1.2, 301.2 |
| *NFPA 30A-2008** | Motor Fuel Dispensing Facilities and Repair Garages | Miscellaneous | 507.14.2 |
| *NFPA 31-2011** | Installation of Oil-Burning Equipment | Fuel Gas, Appliances | 505.3, 1202.1, E 23.1, E 35.1(2), E 36.6, E 36.6.1, E 37.1, E 38.2, E 38.3 |
| *NFPA 51-2007** | Design and Installation of Oxygen-Fuel Gas Systems for Welding, Cutting, and Allied Processes | Fuel Gas | 507.9 |
| *NFPA 54/Z223.1-2009** | National Fuel Gas Code | Fuel Gas | 1210.14, E 23.1, E 31.1, E 37.1, E 38.1 |
| *NFPA 58-2011** | Liquefied Petroleum Gas Code | Fuel Gas | 1208.5.4.2(C), 1208.5.9.4, 1210.5(6), 1210.5.1(2), 1212.1, E 23.1, E 23.2, E 24.1, E 29.1, E 34.1, E 37.1, E 38.1 |
| *NFPA 70-2011** | National Electrical Code | Miscellaneous | 1210.17, 1317.2, 1323.1(11), F 7.1 |
| NFPA 80-2010* | Fire Doors and Other Opening Protectives | Miscellaneous | 301.1.2, 301.2 |
| NFPA 85-2011* | Boiler and Combustion Systems Hazards Code | Appliances | 301.1.2, 301.2 |
| *NFPA 88A-2011** | Parking Structures | Miscellaneous | 507.14.1 |
| *NFPA 99-2005** | Health Care Facilities | Piping | 1309.6, 1310.2, 1318.7(3), 1323.1(9), 1326.1.1 |
| NFPA 99C-2005* | Gas and Vacuum Systems | Piping | 301.1.2, 301.2 |
| NFPA 130-2010* | Fixed Guideway Transit and Passenger Rail Systems | Miscellaneous | 301.1.2, 301.2 |
| *NFPA 211-2010** | Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances | Fuel Gas, Appliances | 509.5.2, 509.5.3, 509.5.6.1, 509.5.6.3 |
| NFPA 220-2009* | Types of Building Construction | Miscellaneous | 301.1.2, 301.2 |
| *NFPA 409-2011** | Aircraft Hangars | Miscellaneous | 507.15 |
| NFPA 501A-2009* | Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities | Miscellaneous | 301.1.2, 301.2 |
| NFPA 502-2011* | Road Tunnels, Bridges, and Other Limited Access Highways | Miscellaneous | 301.1.2, 301.2 |
| *NFPA 780-2011** | Installation of Lightning Protection Systems | Fuel Gas | 1210.15.4 |
| NFPA 1981-2007* | Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services | Miscellaneous | 301.1.2, 301.2 |
| *NFPA 1989-2008** | Breathing Air Quality for Emergency Services Respiratory Protection | Miscellaneous | F 12.7 |
| NFPA 5000-2009* | Building Construction and Safety Code | Miscellaneous | 301.1.2, 301.2 |
| NSF 2-2010* | Food Equipment | Appliances | 301.1.2, 301.2 |
| NSF 3-2009* | Commercial Warewashing Equipment | Appliances | 301.1.2, 301.2 |

| STANDARD NUMBER | STANDARD TITLE | APPLICATION | REFERENCED SECTIONS |
|---|---|---|---|
| NSF 4-2009* | Commercial Cooking, Rethermalization, and Powered Hot Food Holding and Transport Equipment | Appliances | 301.1.2, 301.2 |
| NSF 5-2009* | Water Heaters, Hot Water Supply Boilers, and Heat Recovery Equipment | Appliances | 301.1.2, 301.2 |
| NSF 12-2009* | Automatic Ice Making Equipment | Appliances | 301.1.2, 301.2 |
| ***NSF 14-2010**** | Plastics Piping System Components and Related Materials | Piping, Plastic | 301.1, 611.3 |
| NSF 18-2009* | Manual Food and Beverage Dispensing Equipment | Appliances | 301.1.2, 301.2 |
| NSF 29-2009* | Detergent and Chemical Feeders for Commercial Spray-Type Dishwashing Machines | Appliances | 301.1.2, 301.2 |
| NSF 40-2009* | Residential Wastewater Treatment Systems | DWV Components | 301.1.2, 301.2 |
| NSF 41-2005* | Non-Liquid Saturated Treatment Systems | DWV Components | 301.1.2, 301.2 |
| ***NSF 42-2009**** | Drinking Water Treatment Units–Aesthetic Effects | Appliances | 611.1, 611.3 |
| ***NSF 44-2009**** | Residential Cation Exchange Water Softeners | Appliances | 611.1, 611.3 |
| NSF 46-2010* | Evaluation of Components and Devices Used in Wastewater Treatment Systems | DWV Components | 301.1.2, 301.2 |
| ***NSF 53-2009e**** | Drinking Water Treatment Units–Health Effects | Appliances | 611.1, 611.3, K 104.2.1, L 504.2.1 |
| ***NSF 55-2009**** | Ultraviolet Microbiological Water Treatment Systems | Appliances | 611.1, 611.3 |
| ***NSF 58-2009**** | Reverse Osmosis Drinking Water Treatment Systems | Appliances | 611.1, 611.2, 611.3 |
| ***NSF 61-2010a**** | Drinking Water System Components– Health Effects | Water Supply Components | 415.1, 417.1, 604.1, 604.8, 606.1, 607.2, 608.2 |
| ***NSF 62-2009**** | Drinking Water Distillation Systems | Appliances | 611.1, 611.3 |
| NSF 169-2009* | Special Purpose Food Equipment and Devices | Appliances | 301.1.2, 301.2 |
| *NSF 350-2011* | *Onsite Residential and Commercial Water Reuse Treatment Systems*<br>***Note:** NSF/ANSI 350, amended sections follow:*<br>***5.6 Electrical Components.** Electrical components...The California Electrical Code shall be followed for all electrical components, system installation, and system operation.* | *Miscellaneous* | *1601.7, 1604.10.2* |
| PDI G-101-2010 | Testing and Rating Procedure for Hydro Mechanical Grease Interceptors with Appendix of Installation and Maintenance | DWV Components | 301.1.2, 301.2 |
| PDI G-102-2010 | Testing and Certification for Grease Interceptors with FOG Sensing and Alarm Devices | Certification | 301.1.2, 301.2 |
| PDI-WH 201-2010 | Water Hammer Arresters | Water Supply Components | 301.1.2, 301.2 |
| PSAI Z4.1-2005* | For Sanitation - In Places of Employment -Minimum Requirements | Miscellaneous | 301.1.2, 301.2 |
| SAE J512-1997 | Automotive Tube Fittings | Fittings | 301.1.2, 301.2 |
| SAE J1670-2008 | Type "F" Clamps for Plumbing Applications | Joints | 301.1.2, 301.2 |
| TCNA A118.10-2011* | Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation | Miscellaneous | 301.1.2, 301.2 |
| TCNA A137.1-2008* | Specifications for Ceramic Tile | Miscellaneous | 301.1.2, 301.2 |
| UL 70-2001 | Septic Tanks, Bituminous Coated Metal | DWV Components | 301.1.2, 301.2 |

| STANDARD NUMBER | STANDARD TITLE | APPLICATION | REFERENCED SECTIONS |
|---|---|---|---|
| ***UL 80-2007**** | Steel Tanks for Oil-Burner Fuels and Other Combustible Liquids (with revisions through August 26, 2009) | Fuel Gas | E 36.6.2 |
| UL 103-2010* | Factory-Built Chimneys for Residential Type and Building Heating Appliances | Fuel Gas, Appliances | 301.1.2, 301.2 |
| UL 125-2009* | Flow Control Valves for Anhydrous Ammonia and LP-Gas (with revisions through February 26, 2010 ) | Fuel Gas | 301.1.2, 301.2 |
| UL 132-2007* | Safety Relief Valves for Anhydrous Ammonia and LP-Gas (with revisions through July 23, 2010) | Fuel Gas | 301.1.2, 301.2 |
| UL 144-1999* | LP-Gas Regulators (with revisions through August 27, 2010) | Fuel Gas | 301.1.2, 301.2 |
| UL 174-2004* | Household Electric Storage Tank Water Heaters (with revisions through April 22, 2009) | Appliances | 301.1.2, 301.2 |
| UL 252-2010* | Compressed Gas Regulators | Fuel Gas | 301.1.2, 301.2 |
| ***UL 263-2003**** | Fire Tests of Building Construction and Materials (with revisions through October 24, 2007) | Miscellaneous | 1504.3, 1505.3 |
| UL 296-2003* | Oil Burners (with revisions through March 5, 2010) | Fuel Gas, Appliances | 301.1.2, 301.2 |
| UL 343-2008 | Pumps for Oil-Burning Appliances | Fuel Gas, Appliances | 301.1.2, 301.2 |
| UL 352-2006 | Constant-Level Oil Valves (with revisions through March 16, 2010) | Fuel Gas | 301.1.2, 301.2 |
| UL 378-2006 | Draft Equipment (with revisions through January 27, 2010) | Fuel Gas, Appliances | 301.1.2, 301.2 |
| UL 399-2008* | Drinking Water Coolers (with revisions through December 15, 2009) | Appliances | 301.1.2, 301.2 |
| UL 404-2010* | Gauges, Indicating Pressure, for Compressed Gas Service | Fuel Gas | 301.1.2, 301.2 |
| UL 429-2009 | Electrically Operated Valves (with revisions through January 6, 2010) | Valves | 301.1.2, 301.2 |
| UL 430-2009* | Waste Disposers | Appliances | 301.1.2, 301.2 |
| UL 441-2010* | Gas Vents (with revisions through May 18, 2010) | Fuel Gas | 301.1.2, 301.2 |
| UL 443-2006* | Steel Auxiliary Tanks for Oil-Burner Fuel (with revisions through March 25, 2008) | Fuel Gas | 301.1.2, 301.2 |
| UL 499-2005* | Electric Heating Appliances (with revisions through November 30, 2010) | Appliances | 301.1.2, 301.2 |
| UL 536-1997* | Flexible Metallic Hose (with revisions through June 9, 2003) | Fuel Gas | 301.1.2, 301.2 |
| UL 563-2009* | Ice Makers (with revisions through November 19, 2009) | Appliances | 301.1.2, 301.2 |
| UL 565-1998 | Liquid-Level Gauges and Indicators for Anhydrous Ammonia and LP-Gas (with revisions through June 1, 2001) | Fuel Gas | 301.1.2, 301.2 |
| UL 569-1995* | Pigtails and Flexible Hose Connectors for LP-Gas (with revisions through November 3, 2009) | Fuel Gas | 301.1.2, 301.2 |
| ***UL 651-2005**** | Schedule 40 and 80 Rigid PVC Conduit and Fittings (with revisions through March 11, 2010) | Piping, Plastic | 1208.5.4.1 |
| ***UL 723-2008**** | Test for Surface Burning Characteristics of Building Materials (with revisions through September 13, 2010) | Miscellaneous | 701.1(2), 903.1(2), 1101.3 |
| UL 726-1995 | Oil-Fired Boiler Assemblies (with revisions through April 22, 2010) | Fuel Gas, Appliances | 301.1.2, 301.2 |
| UL 732-1995* | Oil-Fired Storage Tank Water Heaters (with revisions through April 22, 2010) | Fuel Gas, Appliances | 301.1.2, 301.2 |

| STANDARD NUMBER | STANDARD TITLE | APPLICATION | REFERENCED SECTIONS |
|---|---|---|---|
| UL 749-2008 | Household Dishwashers | Appliances | 301.1.2, 301.2 |
| UL 778-2010* | Motor-Operated Water Pumps (with revisions through August 25, 2011) | Appliances | 301.1.2, 301.2 |
| UL 834-2004* | Heating, Water Supply, and Power Boilers–Electric (with revisions through December 4, 2009) | Appliances | 301.1.2, 301.2 |
| UL 921-2006* | Commercial Dishwashers (with revisions through June 23, 2010) | Appliances | 301.1.2, 301.2 |
| UL 959-2010* | Medium Heat Appliance Factory-Built Chimneys | Fuel Gas, Appliances | 301.1.2, 301.2 |
| UL 1081-2008* | Swimming Pool Pumps, Filters, and Chlorinators (with revisions through May 31, 2010) | Swimming Pools, Spas, and Hot Tubs | USPSHTC |
| UL 1206-2003* | Electric Commercial Clothes-Washing Equipment (with revisions through June 16, 2010) | Appliances | 301.1.2, 301.2 |
| UL 1261-2001* | Electric Water Heaters for Pools and Tubs (with revisions through June 16, 2010) | Appliances, Swimming Pools, Spas, and Hot Tubs | 301.1.2, 301.2, USPSHTC |
| UL 1331-2005 | Station Inlets and Outlets (with revisions through August 18, 2010) | Medical Gas | 301.1.2, 301.2 |
| UL 1453-2004* | Electric Booster and Commercial Storage Tank Water Heaters (with revisions through December 4, 2009) | Appliances | 301.1.2, 301.2 |
| UL 1469-2006 | Strength of Body and Hydraulic Pressure Loss Testing of Backflow Special Check Valves (with revisions through March 19, 2010) | Backflow Protection | 301.1.2, 301.2 |
| ***UL 1479-2003**** | Fire Tests of Through-Penetration Firestops (with revisions through March 1, 2010) | Miscellaneous | 208.0, 222.0, 1504.3, 1505.3 |
| UL 1795-2009 | Hydromassage Bathtubs (with revisions through March 23, 2010) | Fixtures | 301.1.2, 301.2 |
| UL 1951-1994* | Electric Plumbing Accessories (with revisions through June 25, 2010) | Miscellaneous | 301.1.2, 301.2 |
| UL 2157-1997* | Electrical Clothes Washing Machines and Extractors (with revisions through February 16, 2010) | Appliances | 301.1.2, 301.2 |
| WQA S-300-2000 | Point-of-Use Low Pressure Reverse Osmosis Drinking Water Systems | Appliances | 301.1.2, 301.2 |

*ANSI designated as an American National Standard.

***Italic/Bold referenced standards indicate where such standards are located in the narrative of the code.***

**Notes:**

[1] Although this standard is referenced in Table 1401.1, 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 605.3.4 and Section 705.5.3 for restrictions.

[3] Alloy C85200 for cleanout plugs.

[4] Limited to domestic sewage.

[5] Type II only.

[6] ASSE 1066 is not intended to limit the maximum outlet temperature at point of use.

[7] See Section 314.0 for trenching, excavation, and backfilling requirements where installing building drains and sewers. Engineers shall be permitted to consult ASTM D 2321, for thermoplastic pipe, where preparing plans and specifications for sewer mains or specific projects.

## ABBREVIATIONS IN TABLE 1401.1

| | |
|---|---|
| AHAM | Association of Home Appliance Manufacturers, 1111 19th Street, N.W., Suite 402, Washington DC 20036. |
| ANSI | American National Standards Institute, Inc., 25 W. 43rd Street, 4th Floor, New York, NY 10036. |
| APSP | Association of Pool and Spa Professionals, 2111 Eisenhower Avenue, Suite 500, Alexandria, VA 22314-4695. |
| ASCE | American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191-4400. |
| ASHRAE | American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. |
| ASME | American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990. |
| ASPE | American Society of Plumbing Engineers, 2980 S. River Road, Des Plaines, IL 60018. |
| ASSE | American Society of Sanitary Engineering, 901 Canterbury, Suite A, Westlake, Ohio 44145. |
| ASTM | American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. |
| AWS | American Welding Society, 550 NW LeJeune Road, Miami, FL 33126. |
| AWWA | American Water Works Association, 6666 W. Quincy Avenue, Denver, CO 80235. |
| CGA | Compressed Gas Association, 14501 George Carter Way, Suite 103, Chantilly, VA 20151. |
| CISPI | Cast-Iron Soil Pipe Institute, 5959 Shallowford Road, Suite 419, Chattanooga, TN 37421. |
| CSA | Canadian Standards Association, 5060 Spectrum Way, Suite 100, Mississauga, Ontario, Canada, L4W 5N6. |
| (D) or [D] | Discontinued. |
| e1 | An editorial change since the last revision or reapproval. |
| IAPMO | International Association of Plumbing and Mechanical Officials, 5001 E. Philadelphia Street, Ontario, CA 91761. |
| ICC | International Code Council, 500 New Jersey Ave, NW, 6th Floor, Washington DC 20001. |
| ISEA | International Safety Equipment Association, 1901 N. Moore Street, Arlington, VA 22209-1762. |
| ISO | International Organization for Standardization, 1 ch. de la Voie-Creuse, Casa Postale 56, CH-1211 Geneva 20, Switzerland. |
| MSS | Manufacturers Standardization Society of the Valve and Fittings Industry, 127 Park Street, N.E., Vienna, VA 22180. |
| NFPA | National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02169-7471. |
| NSF | NSF International, 789 Dixboro Road, Ann Arbor, MI 48113-0140. |
| PDI | Plumbing and Drainage Institute, 800 Turnpike Street, Suite 300, North Andover, MA 01845. |
| PSAI | Portable Sanitation Association International, 7800 Metro Parkway, Suite 104, Bloomington, MN 55425. |
| SAE | Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096. |
| TCNA | Tile Council of North America, Inc. 100 Clemson Research Blvd., Anderson, SC 29625. |
| UMC | Uniform Mechanical Code (published by IAPMO). |
| USEC | Uniform Solar Energy Code (published by IAPMO). |
| USPSHTC | Uniform Swimming Pool, Spa & Hot Tub Code (published by IAPMO). |
| UL | Underwriters Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062. |
| WQA | Water Quality Association, 4151 Naperville Road, Lisle, IL 60532-3696. |

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 15 - FIRESTOP PROTECTION

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |

# CHAPTER 15
## FIRESTOP PROTECTION

**1501.0 General.**

**1501.1 Applicability.** Piping penetrations of required 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, and this chapter.

**1502.0 Plans and Specifications.**

**1502.1 Penetrations.** Plans and specifications shall indicate with sufficient detail how penetrations of fire-resistance-rated assemblies shall be firestopped prior to obtaining design approval.

**1503.0 Installation.**

**1503.1 Materials.** Firestop systems shall be installed in accordance with this chapter, the building code, and the manufacturer's installation instructions.

**1504.0 Combustible Piping Installations.**

**1504.1 General Requirements.** Combustible piping installations shall be protected in accordance with the appropriate fire resistance rating requirements in the building code that list the acceptable area, height, and type of construction for use in specific occupancies to assure compliance and integrity of the fire resistance rating prescribed.

**1504.2 Fire-Resistance Rating.** Where penetrating a fire-resistance-rated wall, partition, floor, floor-ceiling assembly, roof-ceiling assembly, or shaft enclosure, the fire resistance rating of the assembly shall be restored to its original rating.

**1504.3 Firestop Systems.** Penetrations shall be protected by an approved penetration firestop system installed as tested in accordance with ASTM E 119, ASTM E 814, UL 263, or UL 1479 with a positive pressure differential of not less than 0.01 of an inch of water (0.002 kPa). Systems shall have an F rating of not less than 1 hour but not less than the required fire resistance rating of the assembly being penetrated. Systems protecting floor penetrations shall have a T rating of not less than 1 hour but not less than the required fire resistance rating of the floor being penetrated. Floor penetrations contained within the cavity of a wall at the location of the floor penetration do not require a T rating. No T rating shall be required for floor penetrations by piping that is not in direct contact with combustible material.

**1504.4 Connections.** Where piping penetrates a rated assembly, combustible piping shall not connect to noncombustible piping unless it is capable of being demonstrated that the transition is in accordance with of Section 1504.3.

**1504.5 Insulation and Coverings.** Insulation and coverings on or in the penetrating item shall not be permitted unless the specific insulating or covering material has been tested as part of the penetrating firestop system.

**1504.6 Sleeves.** Where sleeves are used, the sleeves shall be securely fastened to the fire-resistance-rated assembly. The (inside) annular space between the sleeve and the penetrating item and the (outside) annular space between the sleeve and the fire-resistance-rated assembly shall be firestopped in accordance with this chapter.

**1505.0 Noncombustible Piping Installations.**

**1505.1 General Requirements.** Noncombustible piping installations shall be protected in accordance with the appropriate fire resistance rating requirements in the building code that list the acceptable area, height, and type of construction for use in specific occupancies to ensure compliance and integrity of the fire-resistance rating prescribed.

**1505.2 Fire-Resistance Rating.** Where penetrating a fire-resistance-rated wall, partition, floor, floor-ceiling assembly, roof-ceiling assembly, or shaft enclosure, the fire-resistance rating of the assembly shall be restored to its original rating.

**Exceptions:**

(1) Concrete, mortar, or grout shall be permitted to be used to fill the annular spaces around cast-iron, copper, or steel piping that penetrates concrete or masonry fire-resistant-rated assemblies. The nominal diameter of the penetrating item shall not exceed 6 inches (150 mm), and the opening size shall not exceed 144 square inches (0.093 $m^2$).

The thickness of concrete, mortar, or grout shall be the full thickness of the assembly or the thickness necessary to provide a fire-resistance rating not less than the required fire-resistance rating of the assembly penetrated.

(2) The material used to fill the annular space shall prevent the passage of flame and hot gases capable of igniting cotton waste for the time period equivalent to the fire-resistance rating of the assembly, where tested to standard(s) referenced in Section 1505.3.

**1505.3 Firestop Systems.** Penetrations shall be protected by an approved penetration firestop system installed as tested in accordance with ASTM E 119, ASTM E 814, UL 263, or UL 1479 with a positive pressure differential of not less than 0.01 of an inch of water (0.002 kPa). Systems shall have an F rating of not less than 1 hour but not less than the required fire-resistance rating of the assembly being penetrated. Systems protecting floor penetrations shall have a T rating of not less than 1 hour but not less

than the required fire-resistance rating of the floor being penetrated. Floor penetrations contained within the cavity of a wall at the location of the floor penetration do not require a T rating. No T rating shall be required for floor penetrations by piping that is not in direct contact with combustible material.

**1505.4 Connections.** Where piping penetrates a rated assembly, combustible piping shall not connect to noncombustible piping unless it is capable of being demonstrated that the transition is in accordance with the requirements of Section 1505.3.

**1505.5 Unshielded Couplings.** Unshielded couplings shall not be used to connect noncombustible piping unless it is capable of being demonstrated that the fire-resistive integrity of the penetration is maintained.

**1505.6 Sleeves.** Where sleeves are used, the sleeves shall be securely fastened to the fire-resistance-rated assembly. The (inside) annular space between the sleeve and the penetrating item and the (outside) annular space between the sleeve and the fire-resistance-rated assembly shall be firestopped in accordance with this chapter.

**1505.7 Insulation and Coverings.** Insulation and coverings on or in the penetrating item shall not be permitted unless the specific insulating or covering material has been tested as part of the penetrating firestop system.

**1506.0 Required Inspection.**

**1506.1 General.** Prior to being concealed, piping penetrations shall be inspected by the Authority Having Jurisdiction to verify compliance with the fire-resistance rating prescribed in the building code.

**1506.2 Examination.** The Authority Having Jurisdiction shall conduct a thorough examination of sufficient representative installations, including destructive inspection, to provide verification of satisfactory compliance with this chapter, the appropriate manufacturer's installation instructions applied by the installer, construction documents, specifications, and applicable manufacturer's product information.

**1506.3 Penetrations.** The Authority Having Jurisdiction shall determine the type, size, and quantity of penetrations to be inspected.

**1506.4 Field Installations.** The Authority Having Jurisdiction shall compare the field installations with the documentation supplied by the installer to determine the following:

(1) The required F ratings (1 hour, 2 hour, 3 hour, or 4 hour) and T ratings (0 hour, 1 hour, 2 hour, 3 hour, or 4 hour) of the penetration firestop systems are at least the same as the hourly rating of the assembly being penetrated.

(2) The penetrating firestop system includes the penetrating item as documented through testing of the systems conducted by an independent testing agency.

(3) The penetrating firestop system is installed as tested.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 16 - ALTERNATE WATER SOURCES FOR NONPOTABLE APPLICATIONS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | X | | X | X | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| Intent | X | | X | X | | | | | | | | | | | | | | | |
| 1601.1 | X | | X | X | | | | | | | | | | | | | | | |
| 1601.2 | X | | X | X | | | | | | | | | | | | | | | |
| 1601.3 & Exception | X | | X | X | | | | | | | | | | | | | | | |
| 1601.5 | X | | X | X | | | | | | | | | | | | | | | |
| 1601.5.1 | X | | X | X | | | | | | | | | | | | | | | |
| 1601.6 | X | | X | X | | | | | | | | | | | | | | | |
| 1601.7.1 | X | | | | | | | | | | | | | | | | | | |
| 1601.7.2 | | | X | | | | | | | | | | | | | | | | |
| Table 1601.5 | X | | | | | | | | | | | | | | | | | | |
| 1602.1 - 1602.1.3 | X | | X | | | | | | | | | | | | | | | | |
| 1602.2 - 1602.2.4 | X | | X | | | | | | | | | | | | | | | | |
| 1602.3 | X | | X | | | | | | | | | | | | | | | | |
| 1602.4 Exception | X | | X | | | | | | | | | | | | | | | | |
| Table 1602.4 | X | | X | | | | | | | | | | | | | | | | |
| 1602.5 Exception | X | | X | | | | | | | | | | | | | | | | |
| 1602.6 | X | | X | | | | | | | | | | | | | | | | |
| 1602.7 Exceptions 2, 3 | X | | X | | | | | | | | | | | | | | | | |
| 1602.8 - 1602.8.3 | X | | X | | | | | | | | | | | | | | | | |
| 1602.9 - 1602.9.4 | X | | X | | | | | | | | | | | | | | | | |
| 1602.10 - 1602.10.3 | X | | X | | | | | | | | | | | | | | | | |
| Table 1602.10 | X | | X | | | | | | | | | | | | | | | | |
| 1602.11 - 1602.11.3 | X | | X | | | | | | | | | | | | | | | | |
| Table 1602.11 | X | | X | | | | | | | | | | | | | | | | |
| Table 1602.11.3 | X | | X | | | | | | | | | | | | | | | | |
| 1602.12 | X | | X | | | | | | | | | | | | | | | | |
| 1602.13 - 1602.13.2 | X | | X | | | | | | | | | | | | | | | | |
| 1602.15 | X | | X | | | | | | | | | | | | | | | | |
| 1604.0 | X | | X | | | | | | | | | | | | | | | | |
| 1604.1 | X | | X | | | | | | | | | | | | | | | | |
| 1604.2 | X | | X | | | | | | | | | | | | | | | | |
| 1604.3 | X | | X | | | | | | | | | | | | | | | | |
| 1604.4 | X | | X | | | | | | | | | | | | | | | | |
| 1604.5 | X | | | | | | | | | | | | | | | | | | |

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 16 - ALTERNATE WATER SOURCES FOR NONPOTABLE APPLICATIONS (continued)

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| 1604.6 | X | | X | | | | | | | | | | | | | | | | |
| 1604.7 | X | | X | | | | | | | | | | | | | | | | |
| 1604.8 | X | | X | | | | | | | | | | | | | | | | |
| 1604.10 - 1604.10.6 | X | | X | | | | | | | | | | | | | | | | |
| 1604.11 - 1604.11.2 | X | | X | X | X | | | | | | | | | | | | | | |
| 1604.12 - 1604.12.2.3 | X | | X | | | | | | | | | | | | | | | | |
| 1604.13 | X | | X | | | | | | | | | | | | | | | | |

# CHAPTER 16

## ALTERNATE WATER SOURCES FOR NONPOTABLE APPLICATIONS

*Intent*

*The provisions of this chapter are intended to:*

1. *Conserve water by facilitating greater reuse of laundry, shower, lavatory and similar sources of discharge for irrigation and/or indoor use.*
2. *Reduce the number of non-compliant gray water systems by making legal compliance easily achievable.*
3. *Provide guidance for avoiding potentially unhealthful conditions.*
4. *Provide an alternative way to relieve stress on a private sewage disposal system by diverting the graywater.*

### 1601.0 General.

**1601.1 Applicability.** *[HCD 1] Except as otherwise provided for in this chapter, the provisions of this code shall be applicable to alternate water source system installation.* ***[BSC & HCD 1]*** The provisions of this chapter shall apply to the construction, alteration, *discharge, use* and repair of alternate water source systems for nonpotable applications.

**1601.1.1 Allowable Use of Alternate Water.** Where approved or required by the Authority Having Jurisdiction, alternate water sources [reclaimed (recycled) water, rainwater, gray water and on-site treated nonpotable *gray* water] shall be permitted to be used in lieu of potable water for the applications identified in this chapter.

***1601.2 System Design.*** *Alternate water source systems complying with this chapter shall be designed by a person who demonstrates competency to design the alternate water source system as required by the Enforcing Agency. The Enforcing Agency may also require plans and specifications to be prepared by a licensed design professional for Complex Systems. Components, piping, and fittings used in any alternate water source system shall be listed.*

**1601.3 Permit.** It shall be unlawful for a person to construct, install, alter, or cause to be constructed, installed, or altered an alternate water source system in a building or on a premise without first obtaining a permit to do such work. *Prior to commencing the issuance of permits for indoor gray water systems pursuant to state requirements relating to gray water, a city, county, city and county or other local agency shall seek consultation with the local public health department to ensure that local public health concerns are addressed in local standards or ordinances, or in issuing permits. See California Water Code Section 14877.3.*

***Exception: [HCD 1]*** *A construction permit shall not be required for a clothes washer system meeting the requirements of Section 1602.1.1.*

**1601.4 Component Identification.** System components shall be properly identified as to the manufacturer.

**1601.5 Maintenance and Inspection.** Alternate water source systems and components shall be inspected and maintained in accordance with *the manufacturer's recommendations and/or as required by the Enforcing Agency.* ***[BSC]*** *Where no manufacturers recommendations exist, additional recommendations are listed in Table 1601.5.*

***1601.5.1*** **Maintenance Responsibility.** The required maintenance and inspection of alternate water source systems shall be the responsibility of the property owner, unless otherwise required by the Authority Having Jurisdiction.

**1601.6 Operation and Maintenance Manual.** An operation and maintenance manual for gray water, rainwater, and on-site treated water systems required to have a permit in accordance with Section 1601.3 shall be supplied to the building owner by the system designer *or installer*. The operating and maintenance manual shall include the following:

(1) *Diagram(s)* of the entire system and the location of system components.

(2) Instructions on operating and maintaining the system.

(3) *Instructions* on maintaining the required water quality *for on-site treated nonpotable water systems.*

(4) Details on *startup, shutdown, and* deactivating the system for maintenance, repair, or other purposes.

(5) Applicable testing, inspection, and maintenance frequencies in accordance with *Section* 1601.5.

(6) A method of contacting the *installer and/or* manufacturer(s).

*(7) Directions to the owner or occupant that the manual shall remain with the building throughout the life cycle of the structure.*

**1601.7 Minimum Water Quality Requirements.**

**1601.7.1** ***[BSC]*** The minimum water quality for alternate water source systems shall meet the applicable water quality requirements for the intended application as determined by the Authority Having Jurisdiction. In the absence of water quality requirements *for on-site nonpotable treated gray water systems, the requirements of NSF 350 shall apply.*

**Exception:** Water treatment is not required for gray water used for subsurface/*subsoil* irrigation *or a disposal field.*

***1601.7.2*** **[*HCD 1*]** The minimum water quality for alternate water source systems shall meet the applicable water quality requirements for the intended application as determined by the public health Authority Having Jurisdiction. In the absence of water quality requirements *for on-site treated nonpotable gray water systems, the following water quality requirements shall apply:*

**TABLE 1601.5 *[BSC]***
***RECOMMENDED* MINIMUM ALTERNATE WATER SOURCE TESTING, INSPECTION, AND MAINTENANCE FREQUENCY**

| DESCRIPTION | MINIMUM FREQUENCY |
|---|---|
| Inspect and clean filters and screens, and replace (where necessary). | *In accordance with manufacturer's instructions, and/or the Authority Having Jurisdiction, or every 3 months.* |
| Inspect and verify that disinfection, filters and water quality treatment devices and systems are operational and maintaining minimum water quality requirements as determined by the Authority Having Jurisdiction. | In accordance with manufacturer's instructions, and the Authority Having Jurisdiction. |
| Inspect pumps and verify operation. | *In accordance with manufacturer's instructions, and/or the Authority Having Jurisdiction, or after installation and every 12 months thereafter.* |
| Inspect valves and verify operation. | *In accordance with manufacturer's instructions, and/or Authority Having Jurisdiction, or after installation and every 12 months thereafter.* |
| Inspect pressure tanks and verify operation. | *In accordance with manufacturer's instructions, and/or the Authority Having Jurisdiction, or after installation and every 12 months thereafter.* |
| Clear debris from and inspect storage tanks, locking devices, and verify operation. | *In accordance with manufacturer's instructions, and/or the Authority Having Jurisdiction, or after installation and every 12 months thereafter.* |
| Inspect caution labels and marking. | *In accordance with manufacturer's instructions, and/or the Authority Having Jurisdiction, or after installation and every 12 months thereafter.* |
| Inspect and maintain mulch basins for gray water irrigation systems. | As needed to maintain mulch depth and prevent ponding and runoff. |
| Cross-connection inspection and test* | *In accordance with this chapter, and/or the Authority Having Jurisdiction, or after installation and every 12 months thereafter.* |

* The cross-connection test shall be performed in the presence of the Authority Having Jurisdiction in accordance with the requirements of this chapter, *unless site conditions do not require it. Alternate testing requirements shall be permitted by the Authority Having Jurisdiction.*

*1) For owner occupied single family dwellings NSF/ANSI 350.*

*2) For R-1 and R-2 occupancies, the California Department of Public Health statewide uniform criteria for disinfected tertiary recycled water as provided in California Code of Regulations, Title 22, Section 60301.230.*

**Exception:** Water treatment is not required for gray water used *in a disposal field or* for subsurface *or subsoil* irrigation.

**1601.8 Material Compatibility.** Alternate water source systems shall be constructed of materials that are compatible with the type of pipe and fitting materials, water treatment, and water conditions in the system.

**1601.9 System Controls.** Controls for pumps, valves, and other devices that contain mercury that come in contact with alternate water source water supply shall not be permitted.

## 1602.0 Gray Water Systems.

**1602.1 General.** The provisions of this section shall apply to the construction, alteration, and repair of gray water systems. *A city, county, or city and county or other local government may adopt, after a public hearing and enactment of an ordinance or resolution, building standards that are more restrictive than the gray water building standards adopted in this code. For additional information, see Health and Safety Code Section 18941.7.*

*(A) All gray water systems shall be designed with a diverter valve to allow the user to direct the flow to the building sewer and either the irrigation field or disposal field, whichever is used. The means of changing the direction flow of the gray water shall be clearly labeled and readily accessible to the user.*

*(B) Water used to wash diapers or similarly soiled or infectious garments or other prohibited contents shall be diverted by the user to the building sewer.*

*(C) Gray water shall not be used in spray irrigation, allowed to pond or runoff and shall not be discharged directly into or reach any storm sewer system or any surface body of water.*

*(D) Human contact with gray water or the soil irrigated by gray water shall be minimized and avoided, except as required to maintain the gray water system. The discharge point of any gray water subsoil irrigation or subsurface irrigation field shall be covered by at least (2) inches (51 mm) of mulch, rock, or soil, or a solid shield to minimize the possibility of human contact.*

*(E) Gray water may be released above the ground surface provided at least two (2) inches (51 mm) of mulch, rock, or soil, or a solid shield covers the release point. Other methods which provide equivalent separation are also acceptable.*

*(F) Gray water shall not contain hazardous chemicals derived from activities such as cleaning car parts, washing greasy or oily rags, or disposing of waste solutions.*

*(1) **[HCD 1]** The prohibition in Subsection (F) includes, but is not limited to, home photo labs or other similar hobbyist or home occupational activities.*

*(2) **[BSC]** photo labs or similar activities.*

*(G) Exemption from construction permit requirements of this code shall not be deemed to grant authorization for any gray water system to be installed in a manner that violates other provisions of this code or any other laws or ordinances of the Enforcing Agency.*

*(H) An operation and maintenance manual shall be provided to the owner. Directions shall indicate that the manual is to remain with the building throughout the life of the system and upon change of ownership or occupancy.*

*(I) A gray water system shall not be connected to any potable water system without an air gap, reduced-pressure principle backflow preventer, or other physical device which prevents backflow and shall not cause ponding or runoff of gray water.*

***1602.1.1 [HCD 1] Clothes Washer System.** A clothes washer system in compliance with all of the following is exempt from the construction permit specified in Section 1.8.4.1 and may be installed or altered without a construction permit:*

*(1) If required, notification has been provided to the enforcing agency regarding the proposed location and installation of a gray water irrigation or disposal system.*

*(2) The design shall allow the user to direct the flow to the irrigation or disposal field or the building sewer. The direction control of the gray water shall be clearly labeled and readily accessible to the user.*

*(3) The installation, change, alteration, or repair of the system does not include a potable water connection or a pump and does not affect other building, plumbing, electrical, or mechanical components including structural features, egress, fire-life safety, sanitation, potable water supply piping, or accessibility.*

***Note:** The pump in a clothes washer shall not be considered part of the gray water system.*

*(4) The gray water shall be contained on the site where it is generated.*

*(5) Gray water shall be directed to and contained within an irrigation or disposal field.*

*(6) Ponding or runoff is prohibited and shall be considered a nuisance.*

*(7) Gray water may be released above the ground surface provided at least two (2) inches (51 mm) of mulch, rock, or soil, or a solid shield covers the release point. Other methods which provide equivalent separation are also acceptable.*

*(8) Gray water systems shall be designed to minimize contact with humans and domestic pets.*

*(9) Water used to wash diapers or similarly soiled or infectious garments shall not be used and shall be diverted to the building sewer.*

*(10) Gray water shall not contain hazardous chemicals derived from activities such as cleaning car parts, washing greasy or oily rags, or disposing of waste solutions from home photo labs or similar hobbyist or home occupational activities.*

*(11) Exemption from construction permit requirements of this code shall not be deemed to grant authorization for any gray water system to be installed in a manner that violates other provisions of this code or any other laws or ordinances of the enforcing agency.*

*(12) An operation and maintenance manual shall be provided to the owner. Directions shall indicate that the manual is to remain with the building throughout the life of the system and upon change of ownership or occupancy.*

***1602.1.2 Simple System.** Simple systems exceed a clothes washer system and shall comply with the following:*

*(1) The discharge capacity of a gray water system shall be determined by Section 1602.8. Simple systems have a discharge capacity of 250 gallons (947 L) per day or less.*

*(2) Simple systems shall require a construction permit, unless exempted from a construction permit by the Enforcing Agency. The Enforcing Agency shall consult with the water purveyor for any public water system (as defined in Health and Safety Code Section 116275) providing drinking water to the dwelling or non-residential structure before allowing an exemption from a construction permit.*

*(3) The design of simple systems shall meet generally accepted gray water system design criteria.*

***1602.1.3 Complex System.** Any gray water system that is not a clothes washer system or simple system shall comply with the following:*

*(1) The discharge capacity of a gray water system shall be determined by Section 1602.8. Complex systems have a discharge capacity over 250 gallons (947 L) per day.*

*(2) Complex systems shall require a construction permit, unless exempted from a construction permit by the Enforcing Agency. The Enforcing Agency shall consult with the water purveyor for any public water system (as defined in Health and Safety Code, Section 116275) providing drinking water to the dwelling or non-residential structure before allowing an exemption from a construction permit.*

**1602.2 System Requirements.**

**1602.2.1 Discharge.** Gray water shall be permitted to be diverted away from a sewer or private sewage disposal system, and discharge to a subsurface irrigation or subsoil irrigation system, *or disposal field.* The gray water shall be permitted to discharge to a mulch basin for *residential occupancies.* Gray water shall not be used to irrigate root crops or food crops intended for human consumption that come in contact with soil.

**1602.2.2 Surge Capacity.** Gray water systems shall be designed to have the capacity to accommodate peak

flow rates and distribute the total amount of estimated gray water on a daily basis to a subsurface irrigation field, subsoil irrigation field, *disposal field,* or mulch basin without surfacing, ponding, or runoff. A surge tank is required for systems that are unable to accommodate peak flow rates and distribute the total amount of gray water by gravity drainage. The water discharge for gray water systems shall be determined in accordance with Section 1602.8.1 or Section 1602.8.2.

***Exception:*** *It is not the intent of this section to require that all gray water must be handled by an irrigation field or disposal field. It is acceptable for excess gray water to be diverted to the building sewer through a diverter valve or overflow drain as permitted in this chapter.*

**1602.2.3 Diversion.** The point of diversion of gray water to the sanitary drainage system shall occur downstream of fixture traps and vent connections through an approved diverter valve. The diverter *valve* shall be installed in *a readily* accessible location and clearly indicate the direction of flow.

**1602.2.4 Backwater Valves.** Gray water drains subject to backflow shall be provided with a backwater valve *at the point of connection to the building sewer system,* so located as to be accessible for inspection and maintenance.

**1602.3 Connections to Potable and Reclaimed (Recycled) Water Systems.** Gray water systems shall have no *unprotected* connection to a potable water supply, on-site treated nonpotable water supply, or reclaimed (recycled) water systems. Potable, on-site treated nonpotable, reclaimed (recycled) water, *or rainwater* is permitted to be used as makeup water for a non-pressurized storage tank provided the connection is protected by an air gap, *reduced-pressure principle backflow preventer, or other physical device which prevents backflow* in accordance with this code.

**1602.4 Location.** No gray water system or part thereof shall be located on a lot other than the lot that is the site of the building or structure that discharges the gray water, nor shall a gray water system or part thereof be located at a point having less than the minimum distances indicated in Table 1602.4.

***Exception:*** *When there exists a lawfully recorded perpetual and exclusive covenant to an easement appurtenant and right-of-way between adjoining land-owners of two or more contiguous lots to discharge gray water from one lot to an adjoining lot.*

**1602.5 Plot Plan Submission.** No permit for a gray water system shall be issued until a plot plan with data satisfactory to the Authority Having Jurisdiction has been submitted and approved.

**TABLE 1602.4**
**LOCATION OF GRAY WATER SYSTEM**

| MINIMUM HORIZONTAL DISTANCE IN CLEAR REQUIRED FROM | SURGE TANK (feet) | SUBSURFACE AND SUBSOIL IRRIGATION FIELD AND MULCH *BASIN* (feet) | *DISPOSAL FIELD* |
|---|---|---|---|
| Building structures[1] | 5[2, 3, 9] | 2[3, 8] | *5* |
| Property line adjoining private property | 5 | 5[8] | *5* |
| Water supply wells[4] | 50 | 100 | *100* |
| Streams and lakes[4] | 50 | *100*[5, 10] | *100*[5] |
| Sewage pits or cesspools | 5 | 5 | *5* |
| Sewage disposal field[10] | 5 | 4[6] | *4*[6] |
| Septic tank | 0 | 5 | *5* |
| On-site domestic water service line | 5 | *0* | *0* |
| Pressurized public water main[7] | 10 | 10 | *10*[7] |

For SI units: 1 foot = 304.8 mm

**Notes:**

[1] *Building structures do not include* porches and steps, whether covered or uncovered, breezeways, roofed carports, *roofed porte cocheres,* roofed patios, carports, covered walks, covered driveways, and similar structures or appurtenances.

[2] The distance shall be permitted to be reduced to 0 feet for aboveground tanks where first approved by the Authority Having Jurisdiction.

[3] *Underground tanks shall not be located within a 45 degree angle from the bottom of the foundation, or they shall be designed to address the surcharge imposed by the structure. The distance may be reduced to six (6) inches (153 mm) for aboveground tanks when first approved by the Enforcing Agency.*

[4] Where special hazards are involved, the distance required shall be increased as directed by the Authority Having Jurisdiction.

[5] These minimum clear horizontal distances shall apply between the irrigation or disposal field and the ocean mean higher high tide line.

[6] Add 2 feet (610 mm) for each additional foot of depth in excess of 1 foot (305 mm) below the bottom of the drain line.

[7] For parallel construction or for crossings, approval by the Authority Having Jurisdiction shall be required.

[8] The distance shall be permitted to be reduced to 1½ feet (457 mm) for drip and mulch basin irrigation systems.

[9] The distance shall be permitted to be reduced to 0 feet for surge tanks of 75 gallons (284 L) or less.

[10] *The minimum horizontal distance may be reduced to 50 feet (15 240 mm) for irrigation or disposal fields utilizing gray water which has been filtered prior to entering the distribution piping.*

**Exception:** *[HCD 1] A construction permit shall not be required for a clothes washer system in compliance with Section 1602.1.1.*

**1602.6 Prohibited Location.** Where there is insufficient lot area or inappropriate soil conditions for adequate absorption, no gray water system shall be permitted.

**1602.7 Drawings and Specifications.** The Authority Having Jurisdiction *may* require the following information to be included with or in the plot plan before a permit is issued for a gray water system, or at a time during the construction thereof:

(1) Plot plan drawn to scale and completely dimensioned, showing lot lines and structures, direction and approximate slope of surface, location of present or proposed retaining walls, drainage channels, water supply lines, wells, paved areas and structures on the plot, number of bedrooms and plumbing fixtures in each structure, location of private sewage disposal system and expansion area or building sewer connecting to the public sewer, and location of the proposed gray water system.

(2) Details of construction necessary to ensure compliance with the requirements of this chapter, together with a full description of the complete installation, including installation methods, construction, and materials.

(3) Details for holding tanks shall include dimensions, structural calculations, bracings, and such other pertinent data as required.

(4) A log of soil formations and groundwater level as determined by test holes dug in proximity to proposed irrigation *and/or disposal* area, together with a statement of water absorption characteristics of the soil at the proposed site as determined by approved percolation tests.

**Exceptions:**

*(1)* The Authority Having Jurisdiction shall permit the use of Table 1602.10 in lieu of percolation tests.

*(2) The Enforcing Agency may waive the requirement for identification of groundwater level and/or soil absorption qualities based on knowledge of local conditions.*

*(3) The absence of groundwater in a test hole three (3) vertical feet (915 mm) below the deepest irrigation or disposal point shall be sufficient to satisfy this section unless seasonal high groundwater levels have been documented to rise to within this area.*

(5) Distance between the plot and surface waters such as lakes, ponds, rivers or streams, and the slope between the plot and the surface water, where in close proximity.

**1602.8 Procedure for Estimating Gray Water Discharge.** Gray water systems shall be designed to distribute the total amount of estimated gray water on a daily basis. The water discharge for gray water systems shall be determined in accordance with Section 1602.8.1 or Section 1602.8.2.

***Exception:*** *It is not the intent of this section to require that all gray water must be handled by an irrigation field or disposal field. It is acceptable for excess gray water to be diverted to the building sewer through a diverter valve or overflow drain as permitted in this chapter.*

**1602.8.1** ***Residential Occupancies.*** The gray water discharge for *residential occupancies* shall be calculated by water use records, calculations of local daily per person interior water use, or the following procedure:

(1) The number of occupants of each dwelling unit shall be calculated as follows:

| | |
|---|---|
| First Bedroom | 2 occupants |
| Each additional bedroom | 1 occupant |

(2) The estimated gray water flows of each occupant shall be calculated as follows:

| | |
|---|---|
| Showers, bathtubs, and lavatories | 25 gallons (95 L) per day/occupant |
| Laundry | 15 gallons (57 L) per day/occupant |

(3) The total number of occupants shall be multiplied by the applicable estimated gray water discharge as provided above and the type of fixtures connected to the gray water system.

**1602.8.2 Commercial, Industrial, and Institutional Occupancies.** *The Authority Having Jurisdiction may utilize the graywater discharge procedures listed below, water use records, or other documentation to estimate graywater discharge.*

***1602.8.2.1 Lavatories.*** *Daily discharge from lavatories may be determined by the following equation:*

***(Equation 16-1)***

*Occupants* X *lavatory flow rate* X *3*

*Where:*

*The number of occupants = square footage of the building divided by the occupant load factor from the California Plumbing Code Chapter 4, Table A.*

*Lavatory fixture flow rate, new construction = That from the California Green Building Standards (CALGreen) Code Table 5.303.2.3*

*Lavatory fixture flow rate, existing fixtures = Actual flow rate for existing fixtures*

*3 = Average number of uses per person per day*

***1602.8.2.2 Showers.*** *Daily gray water discharge from showers may be determined by the following equation:*

***(Equation 16-2)***

*Number of daily uses* X *shower flow rate* X *5 minutes*

***1602.8.2.3 Commercial Clothes Washers.*** *Daily gray water discharge from commercial clothes washers may be determined by the following equation:*

***(Equation 16-3)***

*Cubic feet of capacity* X *Water Factor* X *6*

*Where:*

*Water Factor = Gallons per cubic foot*

*6 = Average number of uses per day*

*Note: Cubic feet of capacity and Water Factor are contained in product specifications or are available from the washer manufacturer.*

***1602.8.3 Daily Discharge.*** *Gray water systems using tanks shall be designed to minimize the amount of time gray water is held in the tank and shall be sized to distribute the total amount of estimated gray water on a daily basis.*

***Exception:*** *Approved on-site treated nonpotable gray water systems.*

**1602.9 Gray Water System Components.** Gray water system components shall comply with Section 1602.9.1 through 1602.9.4.

*[HCD 1]* Gray water system components shall comply with *this chapter.*

**1602.9.1 Surge Tanks.** Where installed, surge tanks shall be in accordance with the following:

(1) Surge tanks shall be constructed of solid, durable materials not subject to excessive corrosion or decay and shall be watertight. *Aboveground surge tanks shall be protected from direct sunlight or shall be constructed of UV resistant materials including but not limited to heavily tinted or opaque plastic, fiberglass, lined metal, concrete and wood.* Surge tanks constructed of steel shall be approved by the Authority Having Jurisdiction, provided such tanks are in accordance with approved applicable standards.

(2) Each surge tank shall be vented in accordance with this code. The vent size shall be determined based on the total gray water fixture units as outlined in this code.

(3) Each surge tank shall have an access opening with lockable gasketed covers or approved equivalent to allow for inspection and cleaning.

(4) Each surge tank shall have its rated capacity permanently marked on the unit. In addition, a sign stating *GRAY WATER SYSTEM, CAUTION – UNSAFE WATER* shall be permanently marked on the holding tank.

(5) Each surge tank shall have an overflow drain. The overflow drains shall have permanent connections to the building drain or building sewer, upstream of septic tanks. The overflow drain shall not be equipped with a shutoff valve.

(6) The overflow drain pipes shall not be less in size than the inlet pipe. Unions or equally effective fittings shall be provided for piping connected to the surge tank.

(7) Surge tank shall be structurally designed to withstand anticipated earth or other loads. Surge tank covers shall be capable of supporting an earth load of not less than 300 pounds per square foot ($lb/ft^2$) (1465 $kg/m^2$) where the tank is designed for underground installation.

(8) Where a surge tank is installed underground, the system shall be designed so that the tank overflow will gravity drain to the existing sewer line or septic tank. The tank shall be protected against sewer line backflow by a backwater valve installed in accordance with this code.

(9) Surge tanks shall be installed on dry, level, well-compacted soil where underground or on a level 3 inch (76 mm) thick concrete slab *or other approved method* where aboveground.

(10) Surge tanks shall be anchored to prevent against overturning where installed aboveground. Underground tanks shall be ballasted, anchored, or otherwise secured, to prevent the tank from floating out of the ground where empty. The combined weight of the tank and hold down system shall meet or exceed the buoyancy forces of the tank.

*(11) [HCD 1] An overflow drain and backwater valve is not required on a clothes washer system.*

**1602.9.2 Gray Water Pipe and Fitting Materials.** Aboveground and underground building drainage and vent pipe and fittings for gray water systems shall comply with the requirements for aboveground and underground sanitary building drainage and vent pipe and fittings in this code. These materials shall extend not less than 2 feet (610 mm) outside the building.

***1602.9.3 Animals and Insects.*** *Gray water tank openings shall be protected to prevent the entrance of insects, birds, or rodents into the tank and piping systems. Screens installed on vent pipes, inlets, and overflow pipes shall have an aperture of not greater than 1/16 of an inch (1.6mm) and shall be close fitting.*

***1602.9.4 Freeze Protection.*** *Tanks and piping installed in locations subject to freezing shall be provided with an approved means of freeze protection.*

**1602.10 Subsurface Irrigation System Zones.** Irrigation or disposal fields shall be permitted to have one or more valved zones. Each zone shall be of a size to receive the gray water anticipated in that zone.

TABLE 1602.10
DESIGN OF SIX TYPICAL SOILS

| TYPE OF SOIL | MINIMUM SQUARE FEET OF IRRIGATION/*LEACHING* AREA PER 100 GALLONS OF ESTIMATED GRAY WATER DISCHARGE PER DAY | MAXIMUM ABSORPTION CAPACITY IN GALLONS PER SQUARE FOOT OF IRRIGATION/LEACHING AREA FOR A 24-HOUR PERIOD |
|---|---|---|
| Coarse sand or gravel | 20 | 5.0 |
| Fine sand | 25 | 4.0 |
| Sandy loam | 40 | 2.5 |
| Sandy clay | 60 | 1.7 |
| Clay with considerable sand or gravel | 90 | 1.1 |
| Clay with small amounts of sand or gravel | 120 | 0.8 |

For SI units: 1 square foot = 0.0929 $m^2$, 1 gallon per day = 0.000043 L/s

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**1602.10.1 Required Area of Subsurface Irrigation Fields, Subsoil Irrigation Fields and Mulch Basins.** The minimum effective irrigation area of subsurface irrigation fields, subsoil irrigation fields, and mulch basins shall be determined by Table 1602.10 for the type of soil found in the excavation, based upon a calculation of estimated gray water discharge pursuant to Section 1602.8. For a subsoil irrigation field, the area shall be equal to the aggregate length of the perforated pipe sections within the valved zone multiplied by the width of the proposed subsoil irrigation field.

**1602.10.2 Determination of Maximum Absorption Capacity.** The irrigation field and mulch basin size shall be based on the maximum absorption capacity of the soil and determined using Table 1602.10. For soils not listed in Table 1602.10, the maximum absorption capacity for the proposed site shall be determined by percolation tests or other method acceptable to the Authority Having Jurisdiction. A gray water system shall not be permitted, where the percolation test shows the absorption capacity of the soil is unable to accommodate the maximum discharge of the proposed gray water irrigation system.

***Exception:*** *The Enforcing Agency may waive the requirement for identification of groundwater level and/or soil absorption qualities based on knowledge of local conditions.*

**1602.10.3 Groundwater Level.** No excavation for an irrigation field, disposal field, or mulch basin shall extend within 3 feet (914 mm) vertical of the highest known seasonal groundwater level, nor to a depth where gray water contaminates the groundwater or surface water. The applicant shall supply evidence of groundwater depth to the satisfaction of the Authority Having Jurisdiction.

***Note:*** *The absence of groundwater in a test hole three (3) vertical feet (915 mm) below the deepest irrigation or disposal point shall be sufficient to satisfy this section unless seasonal high groundwater levels have been documented to rise to within this area.*

***1602.11 Irrigation, Disposal Field and Mulch Basin Construction.*** *Irrigation fields, disposal fields and mulch basins used in gray water systems shall comply with this section. Gray water systems may contain either an irrigation field or a disposal field or a combination of both. This section is not intended to prevent the use of other methods of gray water irrigation or disposal approved by the Enforcing Agency.*

***1602.11.1 Mulch Basin.*** *A mulch basin may be used as an irrigation or disposal field. Mulch basins shall be sized in accordance with Table 1602.10 and of sufficient depth, length and width to prevent ponding or runoff during the gray water surge of a clothes washer, bathtub or shower. Mulch must be replenished as required due to decomposition of organic matter. Mulch basins will require periodic maintenance, reshaping or removal of dirt to maintain surge capacity and to accommodate plant growth and prevent ponding or runoff.*

**TABLE 1602.11**
**SUBSURFACE IRRIGATION DESIGN CRITERIA FOR SIX TYPICAL SOILS**

| TYPE OF SOIL | MAXIMUM EMITTER DISCHARGE (gallons per day) | MINIMUM NUMBER OF EMITTERS PER GALLON OF ESTIMATED GRAY WATER DISCHARGE PER DAY* (gallons per day) |
|---|---|---|
| Sand | 1.8 | 0.6 |
| Sandy loam | 1.4 | 0.7 |
| Loam | 1.2 | 0.9 |
| Clay loam | 0.9 | 1.1 |
| Silty clay | 0.6 | 1.6 |
| Clay | 0.5 | 2.0 |

For SI units: 1 gallon per day = 0.000043 L/s

* The estimated gray water discharge per day shall be determined in accordance with Section 1602.8 of this code.

***1602.11.2 Irrigation Field.*** *The provisions of this section are not intended to prevent the use of any appropriate material, appliance, installation, device, design or method of construction. If an alternate design is not available, the following provisions may be used as guidance in the design of a gray water irrigation field:*

*(1) Filters used in gray water irrigation systems shall be as specified by the manufacturer's installation instructions for the design flow rate and intended use. The filter backwash and flush discharge shall be contained and disposed of into the building sewer system, septic tank or, with approval of the Enforcing Agency, a separate mini-leachfield sized to accept all the backwash and flush discharge water. Filter backwash water and flush water shall not be used for any purpose. Sanitary procedures shall be followed when handling filter backwash and flush discharge or gray water.*

*(2) Emitters shall be designed to resist root intrusion and shall be of a design recommended by the manufacturer for the intended gray water flow and use. For emitter ratings, refer to Irrigation Equipment Performance Report, Drip Emitters and Micro-Sprinklers, Center for Irrigation Technology, California State University, 5730 N. Chestnut Avenue, Fresno, California 93740-0018.*

*(3) Each irrigation zone shall be designed to include no less than the number of emitters specified in Table 1602.11, or through a procedure designated by the Enforcing Agency. Minimum spacing between emitters in any direction shall be sufficient to prevent surfacing or runoff.*

*(4) The system design shall provide user controls, such as valves, switches, timers and other controllers, as appropriate, to rotate the distribution of gray water between irrigation zones.*

*(5) All drip irrigation supply lines shall be polyethylene tubing or PVC Class 200 pipe or better and Schedule 40 fittings. All joints shall be pressure tested at 40 psi (276 kPa), and shown to be drip tight for five minutes, before burial. All supply*

*piping shall be covered to a minimum depth of two (2) inches (51 mm) of mulch or soil. Drip feeder lines can be poly or flexible PVC tubing and shall be covered to a minimum depth of two (2) inches (51 mm) of mulch or soil.*

*(6) Where pressure at the discharge side of the pump exceeds 20 psi (138 kPa), a pressure-reducing valve able to maintain downstream pressure no greater than the maximum operating pressure of the installed tubing, emitters, or other components shall be installed downstream from the pump and before any emission device.*

*(7) When an irrigation system utilizes a pump, and discharges water at a point higher than the pump, a backwater valve shall be installed downstream of the pump to prevent back siphonage of water and soil.*

***1602.11.3 Disposal Field.*** *The provisions of this section are not intended to prevent the use of any appropriate material, appliance, installation, device, design or method of construction. If an alternate design is not available the following provisions may be used as guidance in the design of a gray water disposal field:*

*(A) Disposal systems shall be not less than three (3) inches (80 mm) in cross sectional dimension and shall be constructed of perforated high-density polyethylene pipe, perforated ABS pipe, perforated PVC pipe, leaching chambers or other approved materials, provided that sufficient openings are available for distribution of the gray water into the trench area. Material, construction, and perforation shall be in compliance with the appropriate absorption fields drainage standards and shall be approved by the Enforcing Agency.*

*(B) Filter material, clean stone, gravel, slag, or similar filter material acceptable to the Enforcing Agency, varying in size from three-quarter (¾) inch (19.1 mm) to two and one-half (2½) inches (64 mm) shall be placed in the trench to the depth and grade required by this section. The perforated section shall be laid on the filter material in an approved manner. The perforated section shall then be covered with filter material to the minimum depth required by this section. The filter material shall then be covered with untreated building paper, straw, or similar porous material to prevent closure of voids with earth backfill. No earth backfill shall be placed over the filter material cover until after inspection and acceptance.*

***Exception:*** *Manufactured leaching chambers shall be installed in compliance with the manufacturer's installation instructions.*

*(C) Disposal fields shall be constructed in accordance with Table 1602.11.3.*

*(D) When necessary on sloping ground to prevent excessive line slopes, disposal lines shall be stepped or installed on the contour lines of the slope. The lines between each horizontal leaching section shall be made with approved water-tight joints and installed on natural or unfilled ground.*

**TABLE 1602.11.3**
**SUBSOIL IRRIGATION FIELD CONSTRUCTION**

| DESCRIPTION | MINIMUM | MAXIMUM |
|---|---|---|
| Number of drain lines per valved zone[1] | 1 | - |
| Length of each perforated line[1] | - | 100 feet |
| Bottom width of trench[1] | 12 inches | *24* inches |
| Spacing of lines, center to center[1] | 4 feet | - |
| Depth of earth cover of lines | 10 inches | - |
| Depth of filter material cover of lines | 2 inches | - |
| Depth of filter material beneath lines[1] | 3 inches | - |
| Grade of perforated lines level | level | 3 inches per 100 feet |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 inch per foot = 83.3 mm/m

[1] *Manufactured leaching chambers shall be installed in compliance with the manufacturer's installation instructions.*

**1602.12 Gray Water System Color and Marking Information.** Pressurized gray water distribution systems shall be identified as containing nonpotable water in accordance with Section 601.2 of this code. *Marking shall be at intervals not to exceed 5 feet (1524 mm). Gray water distribution piping upstream of any connection to an irrigation or disposal field or a distribution valve shall be identified with the words "CAUTION: NONPOTABLE GRAY WATER, DO NOT DRINK".*

***1602.13 Special Provisions.***

**1602.13.1 Other Collection and Distribution Systems.** Other collection and distribution systems shall be approved as allowed by Section 301.2 of this code.

***1602.13.2 Future Connections.*** *Gray water stub-out plumbing may be allowed for future connection prior to the installation of irrigation lines and landscaping. Stub-out shall be permanently marked "CAUTION: NONPOTABLE GRAY WATER, DO NOT DRINK."*

**1602.14 Testing.** Building drains and vents for gray water systems shall be tested in accordance with this code. Surge tanks shall be filled with water to the overflow line prior to and during inspection. Seams and joints shall be left exposed, and the tank shall remain watertight. A flow test shall be performed through the system to the point of gray water discharge. Lines and components shall be watertight up to the point of the irrigation perforated and drip lines.

**1602.15 Maintenance.** Gray water systems and components shall be maintained in accordance with Section 1601.5.

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*1603.0 Reserved.*

## 1604.0 On-Site Treated Nonpotable *Gray* Water Systems.

**1604.1 General.** The provisions of this section shall apply to the installation, construction, alteration, and repair of on-site treated nonpotable *gray* water systems intended to supply uses such as water closets, urinals, trap primers for floor drains and floor sinks, above and belowground irrigation, and other uses approved by the Authority Having Jurisdiction.

*Other approved nonpotable water sources including swimming pool backwash operations, air conditioner condensate, rainwater, cooling tower blow-down water, foundation drainage, steam system condensate, fluid cooler discharge water, food steamer discharge water, combination oven discharge water, industrial process water, and fire pump test water may be permitted to be collected for re-use by gray water systems, as approved for the intended application.*

**1604.2 Plumbing Plan Submission.** No permit for an on-site treated nonpotable *gray* water system shall be issued until complete plumbing plans, with data satisfactory to the Authority Having Jurisdiction, have been submitted and approved.

**1604.3 System Changes.** No changes or connections shall be made to either the on-site treated nonpotable *gray* water system or the potable water system within a site containing an on-site treated nonpotable *gray* water system without approval by the Authority Having Jurisdiction.

**1604.4 Connections to Potable or Reclaimed (Recycled) Water Systems.** On-site treated nonpotable *gray* water systems shall have no *unprotected* connection to a potable water supply or reclaimed (recycled) water source system. Potable or reclaimed (recycled) water is permitted to be used as makeup water for a non-pressurized storage tank provided the makeup water supply is protected by an air gap, *reduced-pressure principle backflow preventer or other physical device which prevents backflow* in accordance with this code.

**1604.5 Initial Cross-Connection Test.** A cross-connection test is required in accordance with Section 1604.12.2. Before the building is occupied or the system is activated, the installer shall perform the initial cross-connection test in the presence of the Authority Having Jurisdiction and other authorities having jurisdiction. The test shall be ruled successful by the Authority Having Jurisdiction before final approval is granted.

**1604.6 On-Site Treated Nonpotable *Gray* Water System Materials.** On-site treated nonpotable *gray* water supply and distribution system materials shall comply with the requirements of this code for potable water supply and distribution systems, unless otherwise provided for in this section.

**1604.7 On-Site Treated Nonpotable *Gray* Water Devices and Systems.** Devices or equipment used to treat on-site treated nonpotable *gray* water in order to maintain the minimum water quality requirements determined by the Authority Having Jurisdiction shall be listed or labeled (third-party certified) by a listing agency (accredited conformity assessment body) and approved for the intended application.

**1604.8 On-Site Treated Nonpotable *Gray* Water System Color and Marking Information.** On-site treated *nonpotable gray* water systems shall have a colored background and marking information in accordance with Section 601.2 of this code.

**1604.9 Valves.** Valves, except fixture supply control valves, shall be equipped with a locking feature.

**1604.10 Design and Installation.** The design and installation of on-site treated nonpotable *gray water* systems shall be in accordance with Section 1604.10.1 through Section *1604.10.6*.

**1604.10.1 Listing Terms and Installation Instructions.** On-site treated nonpotable *gray* water systems shall be installed in accordance with the terms of its listing and the manufacturer's installation instructions.

**1604.10.2 Minimum Water Quality.** On-site treated nonpotable *gray* water supplied to toilets or urinals or for other uses in which it is sprayed or exposed shall be disinfected. Acceptable disinfection methods shall include chlorination, ultraviolet sterilization, ozone, or other methods as approved by the Authority Having Jurisdiction. The minimum water quality for on-site treated nonpotable *gray* water systems shall meet the applicable water quality requirements for the intended applications as determined by the public health Authority Having Jurisdiction. *In the absence of local water quality requirements for on-site treated nonpotable gray water, Section 1601.7 shall apply.*

**1604.10.3 Deactivation and Drainage.** The on-site treated nonpotable *gray* water system and the potable water system within the building shall be provided with the required appurtenances (e.g., valves, air/vacuum relief valves, etc.) to allow for deactivation or drainage as required for a cross-connection test in accordance with Section 1604.12.2.

**1604.10.4 Near Underground Potable Water Pipe.** On-site treated nonpotable *gray* water pipes shall be permitted to be run or laid in the same trench as potable water pipes with a 12 inch (305 mm) minimum vertical and horizontal separation where both pipe materials are approved for use within a building. Where piping materials do not meet this requirement the minimum separation shall be increased to 60 inches (1524 mm). The potable water piping shall be installed at an elevation above the on-site treated nonpotable *gray* water piping.

**1604.10.5 Required Filters.** A filter permitting the passage of particulates no larger than 100 microns (100 µm) shall be provided for on-site treated nonpotable *gray* water supplied to water closets, urinals, trap primers, and drip irrigation system.

*1604.10.6 Disinfection. Where the intended use of on-site treated nonpotable gray water requires disinfection and/or other treatment, on-site treated nonpotable gray water shall be disinfected as needed to ensure the required water quality is obtained at the point of use. Where chlorine is used for disinfection or treatment, water shall be tested for residual chlorine in accordance with ASTM D 1253.*

**1604.11 Signs.** Signs in buildings using on-site treated nonpotable *gray* water shall comply with Section 1604.11.1, Section 1604.11.2, *and applicable requirements of the California Building Code.*

**1604.11.1 Commercial, Industrial, Institutional, and *Residential* Restroom Signs.** A sign shall be installed in restrooms in commercial, industrial, institutional occupancies, *and shall also be installed in residential common use area restrooms* using on-site treated *nonpotable gray* water for water closets, urinals, or both. Each sign shall contain the following text:

TO CONSERVE WATER, THIS BUILDING USES ON-SITE TREATED NONPOTABLE *GRAY* WATER TO FLUSH TOILETS AND URINALS.

**1604.11.2 Equipment Room Signs.** Each room containing on-site treated *gray* water equipment shall have a sign posted with the following wording in 1 inch (25.4 mm) letters:

CAUTION ON-SITE TREATED NONPOTABLE *GRAY* WATER, DO NOT DRINK. DO NOT CONNECT TO DRINKING WATER SYSTEM. NOTICE: CONTACT BUILDING MANAGEMENT BEFORE PERFORMING ANY WORK ON THIS WATER SYSTEM.

This sign shall be posted in a location that is visible to anyone working on or near on-site treated nonpotable *gray* water equipment.

**1604.12 Inspection and Testing.** On-site treated nonpotable *gray* water systems shall be inspected and tested in accordance with Section 1604.12.1, and Section 1604.12.2 *and/or as required by the Authority Having Jurisdiction.*

**1604.12.1 Supply System Inspection and Test.** On-site treated nonpotable *gray* water systems shall be inspected and tested in accordance with this code for testing of potable water piping.

**1604.12.2 Cross-Connection Inspection and Testing.** An initial inspection and test shall be performed on both the potable and on-site treated nonpotable *gray* water systems. The potable and on-site treated nonpotable *gray* water system shall be isolated from each other and independently inspected and tested to ensure there is no cross-connection in accordance with Section 1604.12.2.1 through Section 1604.12.2.3.

**1604.12.2.1 Visual System Inspection.** Prior to commencing the cross-connection testing, a dual system inspection shall be conducted by the Authority Having Jurisdiction and other Authorities Having Jurisdiction as follows:

(1) Pumps and equipment, equipment room signs, and exposed piping in equipment room shall be checked.

(2) Valves shall be checked to ensure that valve lock seals are still in place and intact. Valve control door signs shall be checked to verify that no signs have been removed.

**1604.12.2.2 Cross-Connection Test.** The procedure for determining cross-connection shall be followed by the applicant in the presence of the Authority Having Jurisdiction and other Authorities Having Jurisdiction to determine whether a cross-connection has occurred as follows:

(1) The potable water system shall be activated and pressurized. The on-site treated nonpotable *gray* water system shall be shut down and completely drained.

(2) The potable water system shall remain pressurized for a minimum period of time specified by the Authority Having Jurisdiction while the on-site treated nonpotable *gray* water system is empty. The minimum period the on-site treated nonpotable *gray* water system is to remain depressurized shall be determined on a case-by-case basis, taking into account the size and complexity of the potable and on-site treated *gray* water distribution systems, but in no case shall that period be less than 1 hour.

(3) Fixtures, potable and on-site treated, shall be tested and inspected for flow. Flow from an on-site treated *gray* water system outlet indicates a cross-connection. No flow from a potable water outlet shall indicate that it is connected to the on-site treated *gray* water system.

(4) The drain on the on-site treated nonpotable *gray* water system shall be checked for flow during the test and at the end of the test.

(5) The potable water system shall then be completely drained.

(6) The on-site treated nonpotable *gray* water system shall then be activated and pressurized.

(7) The on-site treated *gray* nonpotable water system shall remain pressurized for a minimum period of time specified by the Authority Having Jurisdiction while the potable water system is empty. The minimum period the potable water system is to remain depressurized shall be determined on a case-by-case basis, but in no case shall that period be less than 1 hour.

(8) Fixtures, potable and on-site treated nonpotable, shall be tested and inspected for flow. Flow from a potable water system outlet indicates a cross-connection. No flow from an

on-site treated *gray* water outlet will indicate that it is connected to the potable water system.

(9) The drain on the potable water system shall be checked for flow during the test and at the end of the test.

(10) Where there is no flow detected in the fixtures which would indicate a cross-connection, the potable water system shall be repressurized.

**1604.12.2.3 Discovery of Cross-Connection.** In the event that a cross-connection is discovered, the following procedure, in the presence of the Authority Having Jurisdiction, shall be activated immediately:

(1) On-site treated nonpotable *gray* water piping to the building shall be shut down at the *source* and the on-site treated *gray* water riser shall be drained.

(2) Potable water piping to the building shall be shut down at the meter.

(3) The cross-connection shall be uncovered and disconnected.

(4) The building shall be retested in accordance with procedures listed in Section 1604.12.2.1 and Section 1604.12.2.2.

(5) The potable water system shall be chlorinated with 50 ppm chlorine for 24 hours.

(6) The potable water system shall be flushed after 24 hours, and a standard bacteriological test shall be performed. Where test results are acceptable, the potable water system shall be permitted to be recharged.

**1604.13 Sizing.** On-site treated nonpotable *gray* water piping shall be sized in accordance with Section 610.0 of this code.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 16*A* - NON-POTABLE WATER REUSE SYSTEMS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | X | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| Part II | | | | | | | | | | | | | | | | X | | | |

# CHAPTER 16*A*

## NON-POTABLE WATER REUSE SYSTEMS

### Part II *[DWR]*

**1613*A*.0 *Recycled* Water Systems – General.**

**(A)** The provisions of Part II of this chapter shall apply to the installation, construction, alteration, and repair of *recycled* water systems intended to supply water closets, urinals, trap primers for floor drains, floor sinks *and other allowed uses. The recycled water system shall not have any connections to the potable water system except via an air gap approved by the Authority Having Jurisdiction or via a temporary connection to the potable system for initial testing of the recycled water system piping.*

**(B)** No permit for any *recycled* water system shall be issued until complete plumbing plans, with appropriate data satisfactory to the Authority Having Jurisdiction, have been submitted and approved. No changes or connections shall be made to either the *recycled* water system or the potable water system within any site containing a *recycled* water system without approval by the Authority Having Jurisdiction. *See Section 1620A.0 for further details.*

**(C)** Before the building is occupied, the installer shall perform *an* initial cross-connection test in the presence of the Authority Having Jurisdiction *or* other authorities having jurisdiction. The test shall be ruled successful before final approval is granted.

**(D)** A *recycled* water system shall be designed by a person registered or licensed to perform plumbing design work.

**1614*A*.0 Definitions.**

***Recycled* Water.** Non-potable water *that* meets *California Department of Public Health statewide uniform criteria for disinfected tertiary recycled water. Recycled water is also known as reclaimed water.*

**1615*A*.0 Permit.**

It shall be unlawful for any person to construct, install, alter, or cause to be constructed, installed, or altered any *recycled* water system within a building or on a premises without first obtaining a permit to do such work from the Authority Having Jurisdiction. *Section 13553 of the Water Code specifies structures where indoor use of recycled water is allowed. These structures include commercial, retail and office buildings, theaters, auditoriums, condominium projects, schools, hotels, apartments, barracks, dormitories, jails, prisons, reformatories, and other structures as determined by the State Department of Public Health.*

**1616*A*.0 Drawings and Specifications.**

*(A) Drawings and specifications for recycled water systems shall be in accordance with the requirements identified in Chapter 1, General Code Provisions, of the California Plumbing Code.*

*(B) The drawings and specifications shall provide sufficient detail to determine compliance with the requirements of this chapter and the California Plumbing Code.*

**1617*A*.0 Pipe Material/Pipe Identification.**

*Recycled* water *pipe* shall comply with Sections 1617*A*.1 and 1617A.2.

**1617*A*.1 Pipe Materials.** *Recycled* water pipe, valves and fittings shall conform to the requirements of Sections 604.0, and 606.0.

**1617*A*.2 Color and Information.** *Recycled* water systems shall have a purple background with black uppercase lettering with the words "CAUTION: *RECYCLED* WATER, DO NOT DRINK."

*All recycled water pipe shall be permanently marked to identify that it contains recycled water. This may be accomplished by labeling piping using purple-colored (Pantone color #512) adhesive Mylar PVC tape along the entire length of the pipe or using non-metallic pipe manufactured with purple integral to the material. For either material, the identification system shall be installed so the wording above is clearly visible.*

**1618*A*.0 Installation.**

*(A) The recycled water piping system shall not include any hose bibbs. Only quick couplers that differ from those used on the potable water system shall be used on the recycled water piping system.*

**(B)** The *recycled* water system and the potable water system within the building shall be provided with the required appurtenances (valves, air/vacuum relief valves, etc.) to allow for *testing* as required for cross connection test in Section 1620*A*.0.

**(C)** *Recycled* water pipes laid in the same trench or crossing building sewer or drainage piping shall be installed in compliance with Sections 609.0 and 720.0 of this code. *Recycled* water pipes shall be protected similar to potable water pipes.

**1619*A*.0 Signs.**

**(A) Commercial, Industrial and Institutional Room Entrance Signs.** All rooms in commercial, industrial, and institutional occupancies using *recycled* water for water closets and/or urinals shall be identified with signs. Each sign shall contain one-half (½) inch (12.7

mm) letters of a highly visible color on a contrasting background. The location of the sign(s) shall be such that the sign(s) shall be visible to all users. The signs shall contain the following text:

**TO CONSERVE WATER,**
**THIS BUILDING USES *RECYCLED***
**WATER TO FLUSH TOILETS AND URINALS.**

**(B) *Equipment* Room Signs.** Each room containing *recycled* water equipment shall have a sign posted with the following wording in one (1) inch (25.4 mm) letters on a purple background:

**CAUTION**
***RECYCLED* WATER,**
**DO NOT DRINK.**
**DO NOT CONNECT TO DRINKING WATER SYSTEM.**

**NOTICE**
**CONTACT BUILDING MANAGEMENT BEFORE**
**PERFORMING ANY WORK ON**
**THIS WATER SYSTEM.**

This sign shall be posted in a location that is visible to anyone working on or near *recycled* water equipment.

**(C)** Where tank-type *toilets* (water closets) are flushed with *recycled* water, *a permanent sign (such as plastic or stainless steel) shall be installed inside the tank to warn that the water within the tank is not a suitable emergency water supply. The sign shall be labeled:*

***RECYCLED* WATER – DO NOT DRINK**

**(D) Valve Access Door Signs.** Each *recycled* water valve within a wall shall have its access door into the wall equipped with a warning sign approximately six (6) inches by six (6) inches (152 mm x 152 mm) with wording in one-half (½) inch (12.7 mm) letters on a purple background. The size, shape, and format of the sign shall be substantially the same as that specified in subsection (B) above. The signs shall be attached inside the access door frame and shall hang in the center of the access door frame. This sign requirement shall be applicable to any and all access doors, hatches, etc., leading to *recycled* water piping and appurtenances.

***(E) Valve Seals.*** *The master recycled water shut-off valve and/or the recycled water meter curb cock and each valve within a wall shall be sealed after the recycled water system* has been approved and placed into operation. These seals shall be either crimped lead wire seal or plastic break away seal which, if broken after system approval, shall be deemed conclusive evidence that the *recycled* water system has been accessed. The seals shall be purple, *numbered, and contain* the words *"RECYCLED* WATER", and shall be supplied by the recycled water purveyor, or by other arrangements acceptable to the Authority Having Jurisdiction.

**1620*A*.0 Inspection and Testing.**

**(A)** *Recycled* water piping shall be inspected and tested as outlined in this code for testing of potable water piping.

**(B)** *The recycled water system shall be inspected and tested in accordance to the following: (a) an initial cross-connection test before the initial operation of the recycled water system; (b) an annual visual system inspection; (c) a cross-connection test as required pursuant to Section 60316(a), Title 22, California Code of Regulations; (d) a cross-connection test when there is material reason to believe that the potable water and/or recycled water system separation has been compromised; and (e) a cross-connection test following remediation of a discovered cross-connection. A material reason to believe that the system has been compromised may be based on, but is not limited to, evidence gathered: (a) during a visual inspection performed pursuant to Section 1620A.0, or (b) as a result of an inspection performed following complaints of water quality or flow conditions consistent with a compromised system.*

*An initial Cross-Connection test and subsequent Annual Visual System Inspection shall be performed as follows:*

**(1) *Annual* Visual System Inspection.** *A visual* system inspection shall be conducted *annually* by the Authority Having Jurisdiction *or* other authorities having jurisdiction.

(i) Meter locations of the *recycled* water and potable water lines shall be checked to verify that no modifications were made, and that no cross-connections are visible.

(ii) *All* pumps and equipment, equipment room signs, and exposed piping in the equipment room shall be checked.

(iii) *All* valves shall be checked to ensure that valve lock seals are still in place and intact. *All* valve control door signs shall be checked to verify that no signs have been removed.

*(iv) If the visual inspection indicates that the recycled water plumbing has been modified, a Cross-Connection Test is required.*

**(2) Cross-Connection Test.** The *applicant shall perform the Cross-Connection Test as required pursuant to the first paragraph in Section 1620A.0(B).*

*The test shall be conducted* in the presence of the Authority Having Jurisdiction *or* other authorities having jurisdiction to determine whether a cross-connection occurred.

*Alternate inspection and testing requirements may be allowed by the Authority Having Jurisdiction for residential, institutional or industrial buildings where shutting off the water is not practical. The recycled water purveyor or other designated appointee may substitute for the Authority Having Jurisdiction in the above mentioned inspection and tests.*

(i) The potable water system shall be activated and pressurized. The *recycled* water system shall be shut down and completely *depressurized.*

(ii) The potable water system shall remain pressurized *while the recycled water system is depressurized.* The minimum period the *recycled* water system is to remain depressurized shall be determined on a case-by-case basis, taking into account the size and complexity of the potable and *recycled* water distribution systems.

(iii) *All* fixtures, potable and *recycled*, shall be tested and inspected for flow. Flow from any *recycled* water system outlet shall indicate a cross-connection. No flow from a potable water outlet would indicate that it may be connected to the *recycled* water system.

(iv) The drain on the *recycled* water system shall be checked for flow during the test and at the end of the period.

(v) The potable water system shall then be completely *depressurized.*

(vi) The *recycled* water system shall then be activated and pressurized. *For the initial test, a temporary connection to a potable water supply will be required to test the recycled water system plumbing. At the conclusion of the test, the temporary connection to the potable water supply shall be disconnected.*

(vii) The *recycled* water system shall remain pressurized while the potable water system is *depressurized.* The minimum period the potable water system is to remain depressurized shall be determined on a case-by-case basis.

(viii) *All* fixtures, potable and *recycled*, shall be tested and inspected for flow. Flow from any potable water system outlet shall indicate a cross-connection. No flow from a *recycled* water outlet would indicate that it is connected to the potable water system.

(ix) The drain on the potable water system shall be checked for flow during the test and at the end of the period.

(x) If there is no flow detected in any of the fixtures that would have indicated a cross-connection, the potable water system shall be repressurized.

**(3) Cross-Connection Discovered.** In the event that a cross-connection is discovered, the following procedure shall be activated immediately:

(i) *Recycled* water piping to the building shall be shut down at the meter, and the *recycled* water riser shall be drained.

(ii) Potable water piping to the building shall be shut down at the meter.

(iii) The cross-connection shall be uncovered and disconnected.

(iv) The building shall be retested following procedures listed in Sections 1620*A*.0 (B)(1) and (B)(2) above.

(v) The potable water system shall be chlorinated with fifty (50) ppm chlorine for twenty-four (24) hours.

(vi) The potable water system shall be flushed after twenty-four (24) hours, and a standard bacteriological test shall be performed. If test results are acceptable, the potable water system shall be permitted to be recharged.

Alternate testing requirements shall be permitted by the Authority Having Jurisdiction.

**1621*A*.0 Sizing.**

*Recycled* water piping shall be sized as outlined in this code for sizing potable water piping.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## CHAPTER 17 - NONPOTABLE RAINWATER CATCHMENT SYSTEMS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | X | | X | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| 1701.1 | X | | X | | | | | | | | | | | | | | | | |
| 1702.1 – 1702.2.1 | X | | | | | | | | | | | | | | | | | | |
| 1702.2.1 | | | X | | | | | | | | | | | | | | | | |
| 1702.4 | X | | X | | | | | | | | | | | | | | | | |
| 1702.9.3 | X | | X | | | | | | | | | | | | | | | | |
| 1702.9.4 | X | | X | | | | | | | | | | | | | | | | |
| 1702.9.4.1 | X | | X | | | | | | | | | | | | | | | | |
| Table 1702.9.4 | X | | X | | | | | | | | | | | | | | | | |
| 1702.9.5 | X | | X | | | | | | | | | | | | | | | | |
| 1702.9.5.4 | X | | X | | | | | | | | | | | | | | | | |
| 1702.9.5.5 | X | | X | | | | | | | | | | | | | | | | |
| 1702.9.5.6(A) | X | | X | | | | | | | | | | | | | | | | |
| 1702.9.5.6(B) | X | | X | | | | | | | | | | | | | | | | |
| 1702.9.5.7 | X | | X | | | | | | | | | | | | | | | | |
| 1702.9.5.8 | X | | X | | | | | | | | | | | | | | | | |
| 1702.10 | X | | X | | | | | | | | | | | | | | | | |
| 1702.10.1 | X | | X | | | | | | | | | | | | | | | | |
| 1702.10.2 | X | | X | | | | | | | | | | | | | | | | |
| 1702.11.2 | X | | X | | | | | | | | | | | | | | | | |
| 1702.11.2.3 | X | | X | | | | | | | | | | | | | | | | |

# CHAPTER 17
## NONPOTABLE RAINWATER CATCHMENT SYSTEMS

**1701.0 General.**

**1701.1 Applicability.** The provisions of this chapter shall apply to the installation, construction, alteration, and repair of nonpotable rainwater catchment systems. *In addition, applicable provisions in Chapter 16, Sections 1601.0 through 1601.9 for "Alternate Water Sources for Nonpotable Applications" shall apply to rainwater catchment systems.*

**1702.0 Nonpotable Rainwater Catchment Systems.**

**1702.1 General.** The installation, construction, alteration, and repair of rainwater catchments systems intended to supply uses such as water closets, urinals, trap primers for floor drains and floor sinks, irrigation, industrial processes, water features, cooling tower makeup and other uses shall be approved by the Authority Having Jurisdiction.

**1702.2 Plumbing Plan Submission.** No permit for a rainwater catchment system shall be issued until complete plumbing plans, with data satisfactory to the Authority Having Jurisdiction, have been submitted and approved.

> *1702.2.1 Permit. It shall be unlawful for a person to construct, install, alter, or cause to be constructed, installed, or altered, a nonpotable rainwater catchment system in a building or on a premise without first obtaining a permit to do such work from the Authority Having Jurisdiction.*
>
> ***Exceptions:***
>
> *(1) A permit is not required for exterior rainwater catchment systems used for outdoor non-spray irrigation with a maximum storage capacity of 5000 gallons (18 927 L) where the tank is supported directly upon grade and the ratio of height to diameter or width does not exceed 2 to 1 and it does not require electrical power or a makeup water supply connection.*
>
> *(2) [HCD 1 & HCD 2] A permit is not required for exterior rainwater catchment systems used for spray irrigation with a maximum storage capacity of 360 gallons (1363 L).*

**1702.3 System Changes.** No changes or connections shall be made to either the rainwater catchment system or the potable water system within a site containing a rainwater catchment system requiring a permit without approval by the Authority Having Jurisdiction.

**1702.4 Connections to Potable or Reclaimed (Recycled) Water Systems.** Rainwater catchment systems shall have no *unprotected* connection to a potable water supply or alternate water source system. Potable or reclaimed (recycled) water is permitted to be used as makeup water for a rainwater catchment system provided the potable or reclaimed (recycled) water supply connection is protected by an air gap or reduced-pressure principle backflow preventer in accordance with this code.

**1702.5 Initial Cross-Connection Test.** Where a portion of a rainwater catchment system is installed within a building, a cross-connection test is required in accordance with Section 1702.11.2. Before the building is occupied or the system is activated, the installer shall perform the initial cross-connection test in the presence of the Authority Having Jurisdiction and other Authorities Having Jurisdiction. The test shall be ruled successful by the Authority Having Jurisdiction before final approval is granted.

**1702.6 Sizing.** Rainwater catchment system distribution piping for indoor applications shall be sized as outlined in this code for sizing potable water piping. The design and size of rainwater drains, gutters, conductors, and leaders shall comply with Chapter 11 of this code.

**1702.7 Rainwater Catchment System Materials.** Rainwater catchment system materials shall comply with Section 1702.7.1 through Section 1702.7.3.

**1702.7.1 Water Supply and Distribution Materials.** Rainwater catchment water supply and distribution materials shall comply with the requirements of this code for potable water supply and distribution systems, unless otherwise provided for in this section.

**1702.7.2 Rainwater Catchment System Drainage Materials.** Materials used in rainwater catchment drainage systems, including gutters, downspouts, conductors, and leaders shall be in accordance with the requirements of this code for storm drainage.

**1702.7.3 Storage Tanks.** Rainwater storage tanks shall comply with Section 1702.9.5.

**1702.8 Rainwater Catchment System Color and Marking Information.** Rainwater catchment systems shall have a colored background in accordance with Section 601.2. Rainwater catchment systems shall be marked, in lettering in accordance with Section 601.2, with the words: "CAUTION: NONPOTABLE RAINWATER WATER, DO NOT DRINK."

**1702.9 Design and Installation.**

**1702.9.1 Outside Hose Bibbs.** Outside hose bibbs shall be allowed on rainwater piping systems. Hose bibbs supplying rainwater shall be marked with the words: "CAUTION: NONPOTABLE WATER, DO NOT DRINK" and Figure 1702.9.



FIGURE 1702.9

**1702.9.2 Deactivation and Drainage for Cross-Connection Test.** The rainwater catchment system and the potable water system within the building shall be provided with the required appurtenances (e.g., valves, air or vacuum relief valves, etc.) to allow for deactivation or drainage as required for a cross-connection test in accordance with Section 1702.11.2.

***1702.9.3 Collection Surfaces.*** *Rainwater shall be collected from roof surfaces, or other manmade, aboveground impervious collection surfaces. Rainwater collected from surface water runoff, vehicular parking surfaces or manmade surfaces at or below grade shall comply with the water quality requirements for on-site treated nonpotable gray water in Section 1604.0.*

***Exception:*** *Collected rainwater or storm water used exclusively for subsurface landscape irrigation.*

**1702.9.3.1 Prohibited Discharges.** Overflows and bleed-off pipes from roof-mounted equipment and appliances shall not discharge onto roof surfaces that are intended to collect rainwater.

**1702.9.4 Minimum Water Quality.** The minimum water quality for harvested rainwater shall meet the applicable water quality requirements for the intended applications as determined by the Authority Having Jurisdiction. *In the absence of water quality requirements for harvested rainwater, Table 1702.9.4 shall apply.*

***Exception: [BSC]*** *No treatment is required for rainwater used for non-spray irrigation where the maximum storage volume is less than 5000 gallons (18 927 L) where the tank is supported directly upon grade and the ratio of height to diameter or width does not exceed 2 to 1.*

***1702.9.4.1 Disinfection.*** *Where the initial quality of the collected rainwater requires disinfection or other treatment or both, the collected rainwater shall be treated as necessary to ensure the required water quality is delivered at the point of use. Where chlorine is used for disinfection or treatment, water shall be tested for residual chlorine in accordance with ASTM D 1253. The levels of residual chlorine shall not exceed the levels allowed for the intended use in accordance with the requirements of the local Enforcing Agency.*

**1702.9.5 Rainwater Storage Tanks.** Rainwater storage tanks shall be constructed and installed in accordance with Section 1702.9.5.1 through Section 1702.9.5.8.

**1702.9.5.1 Construction.** Rainwater storage shall be constructed of solid, durable materials not subject to excessive corrosion or decay and shall be watertight. Storage tanks shall be approved by the Authority Having Jurisdiction, provided such tanks are in accordance with approved applicable standards.

**1702.9.5.2 Location.** Rainwater storage tanks shall be permitted to be installed above or below grade.

**1702.9.5.3 Above Grade.** Above grade storage tanks shall be of an opaque material, approved for aboveground use in direct sunlight or shall be shielded from direct sunlight. Tanks shall be installed in an accessible location to allow for inspection and cleaning. The tank shall be installed on a foundation or platform that is constructed to accommodate loads in accordance with the building code.

**1702.9.5.4 Below Grade.** Rainwater storage tanks installed below grade shall be structurally designed to withstand anticipated earth or other loads. Holding tank covers shall be capable of supporting an earth load of not less than 300 pounds per square foot ($lb/ft^2$) (1465 $kg/m^2$) where the tank is designed for underground installation. Below grade rainwater tanks installed underground shall be provided with manholes. *Below grade storage tanks, located outside of the building, shall be provided with either a manhole not less than 24 inches (610 mm) square or a manhole with an inside diameter of not less than 24 inches (610 mm). Service ports in manhole covers shall be not less than 8 inches (203 mm) in diameter.* The manhole opening shall be located not less than 4 inches (102 mm) above the surrounding grade. The surrounding grade shall be sloped away from the manhole. Underground tanks shall be ballasted, anchored, or otherwise secured, to prevent the tank from floating out of the ground where empty. The combined weight of the tank and hold down system shall meet or exceed the buoyancy force of the tank.

**1702.9.5.5 Drainage and Overflow.** Rainwater storage tanks shall be provided with a means of draining and cleaning. The overflow drain shall not be equipped with a shutoff valve. The overflow outlet shall discharge in accordance with this code for storm drainage systems. Where discharging to the storm drainage system, the overflow drain *and tank drain* shall be protected from backflow of the storm drainage system by a backwater valve or other approved method. *Backwater valves shall be installed so that access is provided to the working parts for service and repair.*

**1702.9.5.5(A) Overflow Outlet Size.** The overflow outlet shall be sized to accommodate the flow of the rainwater entering the tank and not less than the aggregate cross-sectional area of inflow pipes.

**1702.9.5.6 Opening and Access Protection.**

**1702.9.5.6(A) Animals and Insects.** Rainwater tank openings shall be protected to prevent the entrance of insects, birds, or rodents into the tank *and piping systems. Screens installed on vent pipes, inlets, and overflow pipes shall have an aperture of not greater than 1/16 of an inch (1.6 mm) and shall be close fitting.*

**1702.9.5.6(B) Human Access.** *A minimum of one access opening shall be provided to allow*

*TABLE 1702.9.4*
*MINIMUM TREATMENT AND WATER QUALITY FOR RAINWATER*

| APPLICATION | MINIMUM TREATMENT | MINIMUM WATER QUALITY |
|---|---|---|
| *Car washing* | *Debris excluder or other approved means in compliance with Section 1702.9.10* | *N/A* |
| | *100 Micron (100 μm) in compliance with Section 1702.9.11 for drip irrigation* | |
| *Surface, subsurface and drip irrigation* | *Debris excluder or other approved means in compliance with Section 1702.9.10* | *N/A* |
| | *100 Micron (100 μm) in compliance with Section 1702.9.11 for drip irrigation* | |
| *Spray irrigation where the maximum storage volume is less than 360 gallons (1363 L)* | *Debris excluder or other approved means in compliance with Section 1702.9.10* | *N/A* |
| *Spray irrigation where the maximum storage volume is equal to or greater than 360 gallons (1363 L)* | *Debris excluder or other approved means in compliance with Section 1702.9.10* | *Escherichia coli: < 100 CFU/100 ml*<br>*Turbidity: < 10 NTU* |
| *Urinal and water closet flushing, clothes washing, and trap priming* | *Debris excluder or other approved means in compliance with Section 1702.9.10* | *Escherichia coli: < 100 CFU/100 ml* |
| | *100 Micron (100 μm) in compliance with Section 1702.9.11* | *Turbidity: < 10 NTU* |
| *Ornamental fountains and other water features* | *Debris excluder or other approved means in compliance with Section 1702.9.10* | *Escherichia coli: < 100 CFU/100 ml*<br>*Turbidity: < 10 NTU* |
| *Cooling tower make up water* | *Debris excluder or other approved means in compliance with Section 1702.9.10* | *Escherichia coli: < 100 CFU/100 ml* |
| | *100 Micron (100 μm) in compliance with Section 1702.9.11* | *Turbidity: < 10 NTU* |

*inspection and cleaning.* Rainwater tank *manholes and* access openings shall be secured by either a lockable device or other approved method *to prevent unauthorized access.*

***1702.9.5.7 Venting.*** *Rainwater tanks shall be provided with a vent sized in accordance with this code, and based on the size of the tank influent pipe. Tank vent pipes shall not be connected to the sanitary drainage system vents.*

***1702.9.5.8*** **Marking.** Rainwater tanks shall be permanently marked with the capacity and the language: "NONPOTABLE RAINWATER." Where openings are provided to allow a person to enter the tank, the opening shall be marked with the following language: "DANGER-CONFINED SPACE."

**1702.9.6 Pumps.** Pumps serving rainwater catchment systems shall be listed. Pumps supplying water to water closets, urinals, and trap primers shall be capable of delivering not less than 15 pounds-force per square inch (psi) (103 kPa) residual pressure at the highest and most remote outlet served. Where the water pressure in the rainwater supply system within the building exceeds 80 psi (552 kPa), a pressure reducing valve reducing the pressure to 80 psi (552 kPa) or less to water outlets in the building shall be installed in accordance with this code.

**1702.9.7 Roof Drains.** Primary and secondary roof drains, conductors, leaders, and gutters shall be designed and installed in accordance with this code.

**1702.9.8 Water Quality Devices and Equipment.** Devices and equipment used to treat rainwater to maintain the minimum water quality requirements determined by the Authority Having Jurisdiction shall be listed or labeled (third-party certified) by a listing agency (accredited conformity assessment body) and approved for the intended application.

**1702.9.9 Freeze Protection.** Tanks and piping installed in locations subject to freezing shall be provided with an approved means of freeze protection.

**1702.9.10 Debris Removal.** The rainwater catchment conveyance system shall be equipped with a debris excluder or other approved means to prevent the accumulation of leaves, needles, other debris and sediment from entering the storage tank. Devices or methods used to remove debris or sediment shall be accessible and sized and installed in accordance with manufacturer's installation instructions.

**1702.9.11 Required Filters.** A filter permitting the passage of particulates not larger than 100 microns (100 μm) shall be provided for rainwater supplied to water closets, urinals, trap primers, and drip irrigation systems.

**1702.9.12 Roof Gutters.** Gutters shall maintain a minimum slope and be sized in accordance with Section 1106.3.

**1702.10 Signs.** Signs in buildings using rainwater water shall be in accordance with Section 1702.10.1, Section 1702.10.2, *and applicable requirements of the California Building Code.*

**1702.10.1 Commercial, Industrial, Institutional, *and Residential* Restroom Signs.** A sign shall be installed in restrooms in commercial, industrial, and institutional occupancies, *and shall also be installed in residential common use area restrooms* using nonpotable rainwater for water closets, urinals, or both. Each sign shall contain the following text:

TO CONSERVE WATER, THIS BUILDING USES RAINWATER TO FLUSH TOILETS AND URINALS.

**1702.10.2 Equipment Room Signs.** Each equipment room containing nonpotable rainwater equipment shall have a sign posted with the following wording in 1 inch (25.4 mm) letters:

CAUTION NONPOTABLE WATER, DO NOT DRINK. DO NOT CONNECT TO DRINKING WATER SYSTEM. NOTICE: CONTACT BUILDING MANAGEMENT BEFORE PERFORMING ANY WORK ON THIS WATER SYSTEM.

This sign shall be posted in a location that is visible to anyone working on or near rainwater water equipment.

**1702.11 Inspection and Testing.** Rainwater catchment systems shall be inspected and tested in accordance with Section 1702.11.1 and Section 1702.11.2.

**1702.11.1 Supply System Inspection and Test.** Rainwater catchment systems shall be inspected and tested in accordance with the applicable provisions of this code for testing of potable water and storm drainage systems.

**1702.11.2 Cross-Connection Inspection and Testing.** An initial inspection and test in accordance with Section 1702.5 shall be performed on both the potable and rainwater catchment water systems. The potable and rainwater catchment water systems shall be isolated from each other and independently inspected and tested to ensure there is no cross-connection in accordance with Section 1702.11.2.1 through Section 1702.11.2.3.

**1702.11.2.1 Visual System Inspection.** Prior to commencing the cross-connection testing, a dual system inspection shall be conducted by the Authority Having Jurisdiction and other authorities having jurisdiction as follows:

(1) Pumps, equipment, equipment room signs, and exposed piping in an equipment room shall be checked.

**1702.11.2.2 Cross-Connection Test.** The procedure for determining cross-connection shall be followed by the applicant in the presence of the Authority Having Jurisdiction and other authorities having jurisdiction to determine whether a cross-connection has occurred as follows:

(1) The potable water system shall be activated and pressurized. The rainwater catchment water system shall be shut down and completely drained.

(2) The potable water system shall remain pressurized for a minimum period of time specified by the Authority Having Jurisdiction while the rainwater catchment water system is empty. The minimum period the rainwater catchment water system is to remain depressurized shall be determined on a case-by-case basis, taking into account the size and complexity of the potable and rainwater catchment water distribution systems, but in no case shall that period be less than 1 hour.

(3) Fixtures, potable and rainwater, shall be tested and inspected for flow. Flow from a rainwater catchment water system outlet shall indicate a cross-connection. No flow from a potable water outlet shall indicate that it is connected to the rainwater water system.

(4) The drain on the rainwater catchment water system shall be checked for flow during the test and at the end of the period.

(5) The potable water system shall then be completely drained.

(6) The rainwater catchment water system shall then be activated and pressurized.

(7) The rainwater catchment water system shall remain pressurized for a minimum period of time specified by the Authority Having Jurisdiction while the potable water system is empty. The minimum period the potable water system is to remain depressurized shall be determined on a case-by-case basis, but in no case shall that period be less than 1 hour.

(8) Fixtures, potable and rainwater catchment, shall be tested and inspected for flow. Flow from a potable water system outlet shall indicate a cross-connection. No flow from a rainwater catchment water outlet shall indicate that it is connected to the potable water system.

(9) The drain on the potable water system shall be checked for flow during the test and at the end of the period.

(10) Where there is no flow detected in the fixtures which would indicate a cross-connection, the potable water system shall be repressurized.

**1702.11.2.3 Discovery of Cross-Connection.** In the event that a cross-connection is discovered, the following procedure, in the presence of the Authority Having Jurisdiction, shall be activated immediately:

(1) Rainwater catchment water piping to the building shall be shut down at the *supply source(s)*, and the rainwater water riser shall be drained.

(2) Potable water piping to the building shall be shut down at the meter.

(3) The cross-connection shall be uncovered and disconnected.

(4) The building shall be retested following procedures listed in Section 1702.11.2.1 and Section 1702.11.2.2.

(5) The potable water system shall be chlorinated with 50 ppm chlorine for 24 hours.

(6) The potable water system shall be flushed after 24 hours, and a standard bacteriological test shall be performed. Where test results are acceptable, the potable water system shall be permitted to be recharged.

# APPENDICES

The appendices are intended to supplement the provisions of the installation requirements of this code. The definitions in Chapter 2 are also applicable to the appendices.

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## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## APPENDIX A - RECOMMENDED RULES FOR SIZING THE WATER SUPPLY SYSTEM

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | X | | X | X | | | X | X | X | X | X | X | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |

# APPENDIX A

## RECOMMENDED RULES FOR SIZING THE WATER SUPPLY SYSTEM

Because of the variable conditions encountered, it is impractical to lay down definite detailed rules of procedure for determining the sizes of water supply pipes in an appendix, which shall necessarily be limited in length. For a more adequate understanding of the problems involved, refer to Water-Distributing Systems for Buildings, Report BMS 79 of the National Bureau of Standards; and Plumbing Manual, Report BMS 66, also published by the National Bureau of Standards.

The following is a suggested order of procedure for sizing the water supply system.

**A 1.0 Preliminary Information.**

**A 1.1 Daily Service Pressure.** Obtain the necessary information regarding the minimum daily service pressure in the area where the building is to be located.

**A 1.2 Water Meter.** Where the building supply is to be metered, obtain information regarding friction loss relative to the rate of flow for meters in the range of sizes likely to be used. Friction-loss data is capable of being obtained from most manufacturers of water meters. Friction losses for disk-type meters shall be permitted to be obtained from Chart A 1.2.

**A 1.3 Local Information.** Obtain available local information regarding the use of different kinds of pipe with respect both to durability and to decrease in capacity with length of service in the particular water supply.

**A 2.0 Demand Load.**

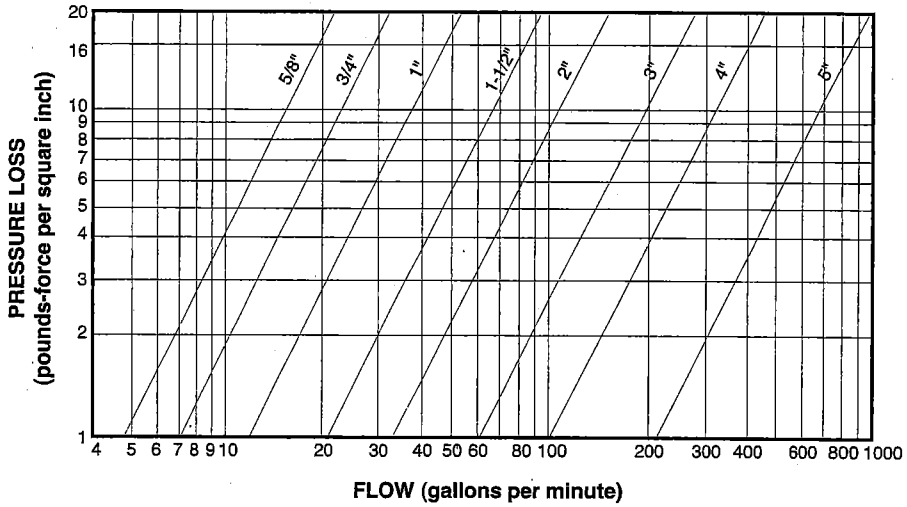
**A 2.1 Supply Demand.** Estimate the supply demand for the building main, the principal branches and risers of the system by totaling the fixture units on each, Table A 2.1, and then by reading the corresponding ordinate from Chart A 2.1 or Chart A 2.1(1), whichever is applicable.

**A 2.2 Continuous Supply Demand.** Estimate continuous supply demands in gallons per minute (gpm) (L/s) for lawn sprinklers, air conditioners, etc., and add the sum to the total demand for fixtures. The result is the estimated supply demand of the building supply.

**A 3.0 Permissible Friction Loss.**

**A 3.1 Residual Pressure.** Decide what is the desirable minimum residual pressure that shall be maintained at the highest fixture in the supply system. Where the highest group of fixtures contains flushometer valves, the residual

**CHART A 1.2**
**FRICTION LOSSES FOR DISK-TYPE WATER METERS**




For SI units: 1 inch = 25 mm, 1 pound-force per square inch = 6.8947 kPa, 1 gallon per minute = 0.06 L/s

pressure for the group shall be not less than 15 pounds-force per square inch (psi) (103 kPa). For flush tank supplies, the available residual pressure shall be not less than 8 psi (55 kPa).

**A 3.2 Elevation.** Determine the elevation of the highest fixture or group of fixtures above the water (street) main. Multiply this difference in elevation by 0.43. The result is the loss in static pressure in psi (kPa).

**A 3.3 Available Pressure.** Subtract the sum of loss in static pressure and the residual pressure to be maintained at the highest fixture from the average minimum daily service pressure. The result will be the pressure available for friction loss in the supply pipes, where no water meter is used. Where a meter is to be installed, the friction loss in the meter for the estimated maximum demand should also be subtracted from the service pressure to determine the pressure loss available for friction loss in the supply pipes.

**A 3.4 Developed Length.** Determine the developed length of pipe from the water (street) main to the highest fixture. Where close estimates are desired, compute with the aid of Table A 3.4, the equivalent length of pipe for fittings in the line from the water (street) main to the highest fixture and add the sum to the developed length. The pressure available for friction loss in psi (kPa), divided by the developed lengths of pipe from the water (street) main to the highest fixture, times 100, will be the average permissible friction loss per 100 feet (30 480 mm) length of pipe.

**A 4.0 Size of Building Supply.**

**A 4.1 Diameter.** Knowing the permissible friction loss per 100 feet (30 480 mm) of pipe and the total demand, the diameter of the building supply pipe shall be permitted to be obtained from Chart A 4.1, Chart A 4.1(1), Chart A 4.1(2), or Chart A 4.1(3), whichever is applicable. The diameter of pipe on or next above the coordinate point corresponding to the estimated total demand and the permissible friction loss will be the size needed up to the first branch from the building supply pipe.

**A 4.2 Copper and Brass Piping.** Where copper tubing or brass pipe is to be used for the supply piping and where the character of the water is such that slight changes in the hydraulic characteristics are expected, Chart A 4.1 shall be permitted to be used.

**A 4.3 Hard Water.** Chart A 4.1(1) shall be used for ferrous pipe with the most favorable water supply in regards to corrosion and caking. Where the water is hard or corrosive, Chart A 4.1(2) or Chart A 4.1(3) will be applicable. For extremely hard water, it will be advisable to make additional allowances for the reduction of capacity of hot-water lines in service.

**A 5.0 Size of Principal Branches and Risers.**

**A 5.1 Size.** The required size of branches and risers shall be permitted to be obtained in the same manner as the building supply, by obtaining the demand load on each branch or riser and using the permissible friction loss computed in Section A 3.0.

**A 5.2 Branches.** Fixture branches to the building supply, where they are sized for the same permissible friction loss per 100 feet (30 480 mm) of pipe as the branches and risers to the highest level in the building, are capable of providing inadequate water supply to the upper floor of a building. This shall be controlled by one or more of the following:

(1) Selecting the sizes of pipe for the different branches so that the total friction loss in each lower branch is approximately equal to the total loss in the riser, including both friction loss and loss in static pressure.

(2) Throttling each such branch by means of a valve until the preceding balance is obtained.

(3) Increasing the size of the building supply and risers above the minimum required to meet the maximum permissible friction loss.

**A 5.3 Water Closets.** The size of branches and mains serving flushometer tanks shall be consistent with sizing procedures for flush tank water closets.

**A 6.0 General.**

**A 6.1 Velocities.** Velocities shall not exceed 10 feet per second (ft/s) (3 m/s) or the maximum values given in the appropriate Installation Standard, except as otherwise approved by the Authority Having Jurisdiction.

**A 6.2 Pressure-Reducing Valves.** Where a pressure-reducing valve is used in the building supply, the developed length of supply piping and the permissible friction loss shall be computed from the building side of the valve.

**A 6.3 Fittings.** The allowances in Table A 3.4 for fittings are based on non-recessed threaded fittings. For recessed threaded fittings and streamlined soldered fittings, one-half of the allowances given in the table will be ample.

**TABLE A 2.1**
**WATER SUPPLY FIXTURE UNITS (WSFU) AND MINIMUM FIXTURE BRANCH PIPE SIZES[3]**

| APPLIANCES, APPURTENANCES, OR FIXTURES[2] | MINIMUM FIXTURE BRANCH PIPE SIZE[1,4] (inches) | PRIVATE | PUBLIC | ASSEMBLY[6] |
|---|---|---|---|---|
| Bathtub or Combination Bath/Shower (fill) | ½ | 4.0 | 4.0 | – |
| ¾ inch Bathtub Fill Valve | ¾ | 10.0 | 10.0 | – |
| Bidet | ½ | 1.0 | – | – |
| Clothes Washer | ½ | 4.0 | 4.0 | – |
| Dental Unit, cuspidor | ½ | – | 1.0 | – |
| Dishwasher, domestic | ½ | 1.5 | 1.5 | – |
| Drinking Fountain or Water Cooler | ½ | 0.5 | 0.5 | 0.75 |
| Hose Bibb | ½ | 2.5 | 2.5 | – |
| Hose Bibb, each additional[7] | ½ | 1.0 | 1.0 | – |
| Lavatory | ½ | 1.0 | 1.0 | 1.0 |
| Lawn Sprinkler, each head[5] | – | 1.0 | 1.0 | – |
| Mobile Home, each (minimum) | – | 12.0 | – | – |
| Sinks | – | – | – | – |
| Bar | ½ | 1.0 | 2.0 | – |
| Clinic Faucet | ½ | – | 3.0 | – |
| Clinic Flushometer Valve with or without faucet | 1 | – | 8.0 | – |
| Kitchen, domestic | ½ | 1.5 | 1.5 | – |
| Laundry | ½ | 1.5 | 1.5 | – |
| Service or Mop Basin | ½ | 1.5 | 3.0 | – |
| Washup, each set of faucets | ½ | – | 2.0 | – |
| Shower per head | ½ | 2.0 | 2.0 | – |
| Urinal, 1.0 GPF Flushometer Valve | ¾ | 3.0 | 4.0 | 5.0 |
| Urinal, greater than 1.0 GPF Flushometer Valve | ¾ | 4.0 | 5.0 | 6.0 |
| Urinal, flush tank | ½ | 2.0 | 2.0 | 3.0 |
| Wash Fountain, circular spray | ¾ | – | 4.0 | – |
| Water Closet, 1.6 GPF Gravity Tank | ½ | 2.5 | 2.5 | 3.5 |
| Water Closet, 1.6 GPF Flushometer Tank | ½ | 2.5 | 2.5 | 3.5 |
| Water Closet, 1.6 GPF Flushometer Valve | 1 | 5.0 | 5.0 | 8.0 |
| Water Closet, greater than 1.6 GPF Gravity Tank | ½ | 3.0 | 5.5 | 7.0 |
| Water Closet, greater than 1.6 GPF Flushometer Valve | 1 | 7.0 | 8.0 | 10.0 |

For SI units: 1 inch = 25 mm

**Notes:**

[1] Size of the cold branch pipe, or both the hot and cold branch pipes.

[2] Appliances, appurtenances, or fixtures not included in this table shall be permitted to be sized by reference to fixtures having a similar flow rate and frequency of use.

[3] The listed fixture unit values represent their total load on the cold water building supply. The separate cold water and hot water fixture unit value for fixtures having both cold and hot water connections shall be permitted to each be taken as three-quarters of the listed total value of the fixture.

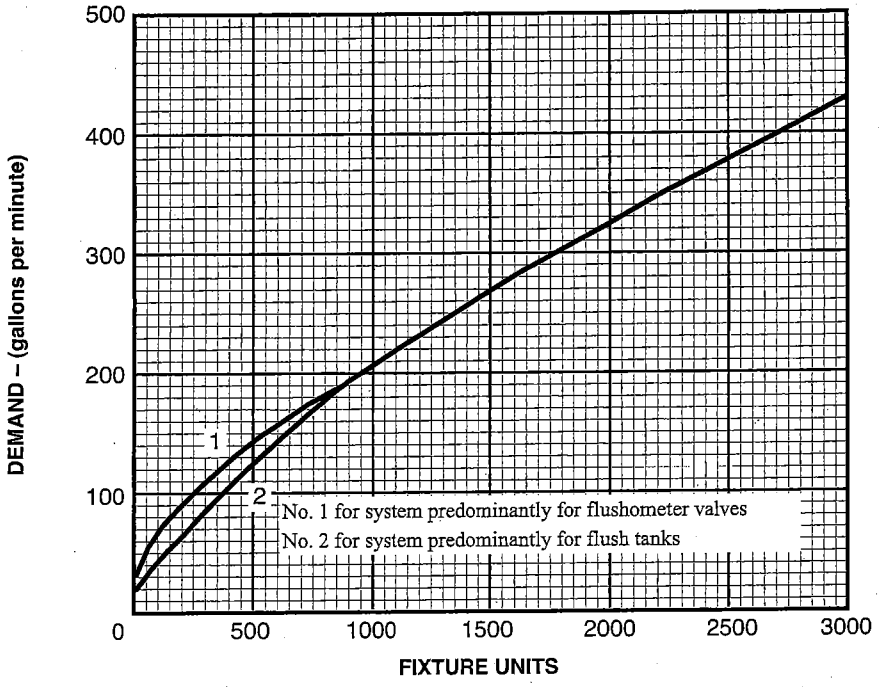
[4] The listed minimum supply branch pipe sizes for individual fixtures are the nominal (I.D.) pipe size.

[5] For fixtures or supply connections likely to impose continuous flow demands, determine the required flow in gallons per minute (gpm) (L/s) and add it separately to the demand in gpm (L/s) for the distribution system or portions thereof.

[6] Assembly [Public Use (see Table 422.1)].

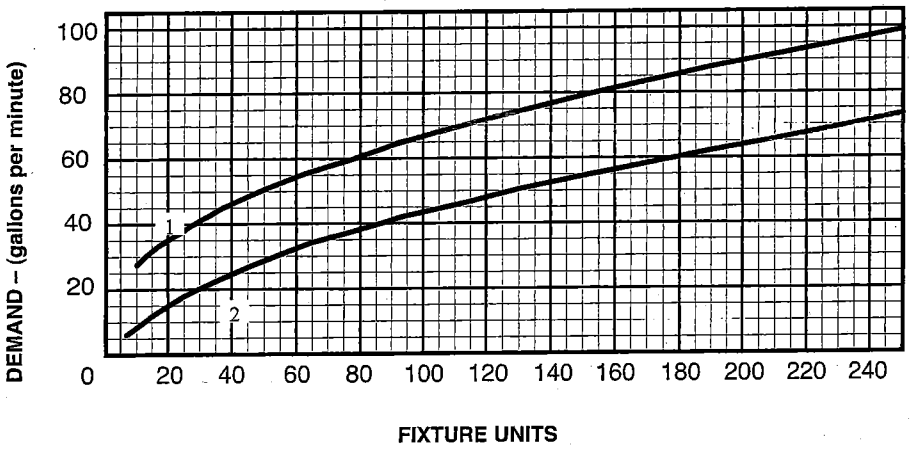
[7] Reduced fixture unit loading for additional hose bibbs is to be used where sizing total building demand and for pipe sizing where more than one hose bibb is supplied by a segment of water distribution pipe. The fixture branch to each hose bibb shall be sized on the basis of 2.5 fixture units.

CHART A 2.1
ESTIMATE CURVES FOR DEMAND LOAD




For SI units: 1 gallon per minute = 0.06 L/s

CHART A 2.1(1)
ENLARGED SCALE DEMAND LOAD




For SI units: 1 gallon per minute = 0.06 L/s

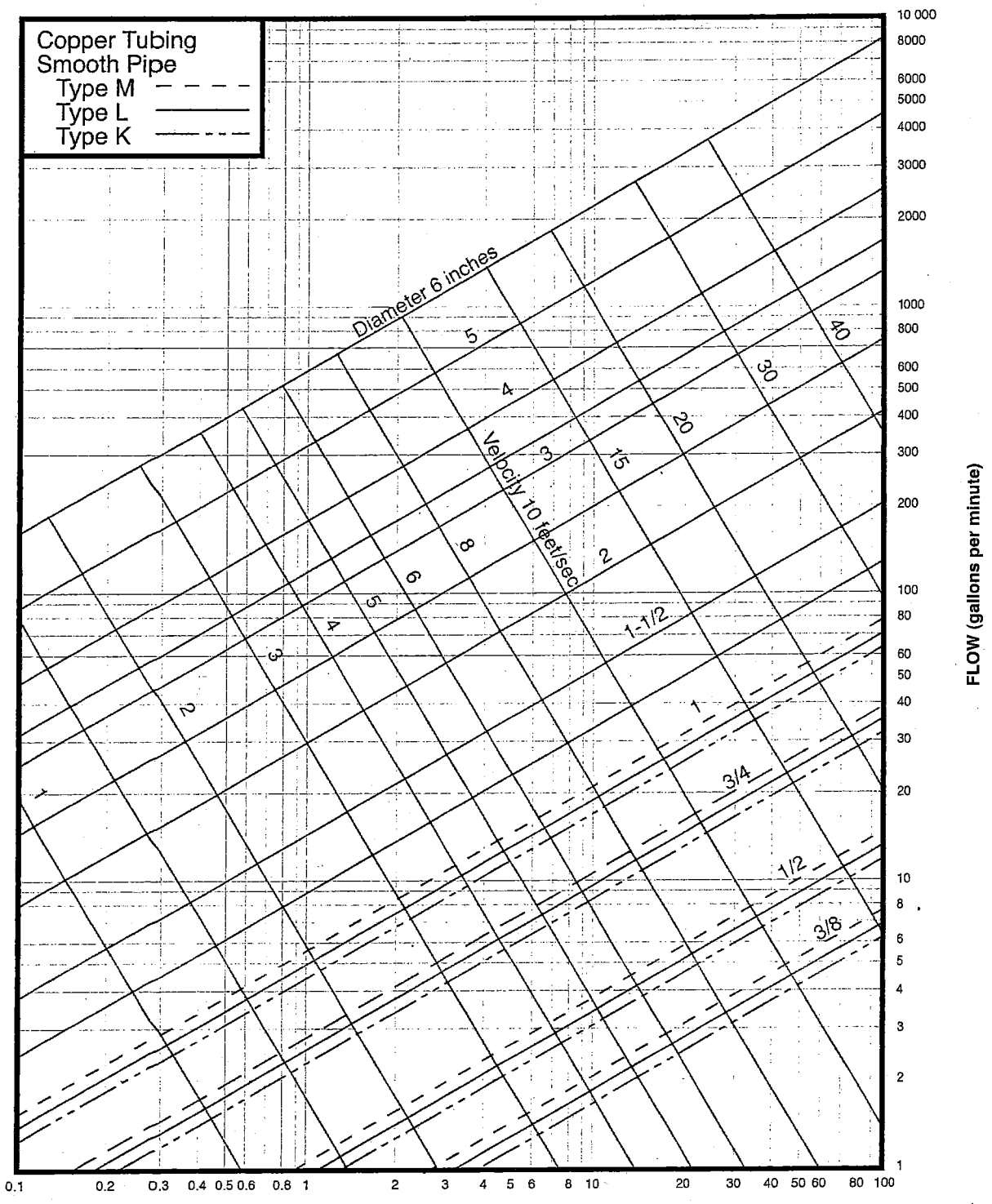
**TABLE A 3.4**
**ALLOWANCE IN EQUIVALENT LENGTH OF PIPE FOR FRICTION LOSS IN VALVES AND THREADED FITTINGS***
**EQUIVALENT LENGTH OF PIPE FOR VARIOUS FITTINGS**

| DIAMETER OF FITTING (inches) | 90° STANDARD ELBOW (feet) | 45° STANDARD ELBOW (feet) | 90° STANDARD TEE (feet) | COUPLING OR STRAIGHT RUN OF TEE (feet) | GATE VALVE (feet) | GLOBE VALVE (feet) | ANGLE VALVE (feet) |
|---|---|---|---|---|---|---|---|
| ⅜ | 1.0 | 0.6 | 1.5 | 0.3 | 0.2 | 8 | 4 |
| ½ | 2.0 | 1.2 | 3.0 | 0.6 | 0.4 | 15 | 8 |
| ¾ | 2.5 | 1.5 | 4.0 | 0.8 | 0.5 | 20 | 12 |
| 1 | 3.0 | 1.8 | 5.0 | 0.9 | 0.6 | 25 | 15 |
| 1¼ | 4.0 | 2.4 | 6.0 | 1.2 | 0.8 | 35 | 18 |
| 1½ | 5.0 | 3.0 | 7.0 | 1.5 | 1.0 | 45 | 22 |
| 2 | 7.0 | 4.0 | 10.0 | 2.0 | 1.3 | 55 | 28 |
| 2½ | 8.0 | 5.0 | 12.0 | 2.5 | 1.6 | 65 | 34 |
| 3 | 10.0 | 6.0 | 15.0 | 3.0 | 2.0 | 80 | 40 |
| 4 | 14.0 | 8.0 | 21.0 | 4.0 | 2.7 | 125 | 55 |
| 5 | 17.0 | 10.0 | 25.0 | 5.0 | 3.3 | 140 | 70 |
| 6 | 20.0 | 12.0 | 30.0 | 6.0 | 4.0 | 165 | 80 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm, 1 degree = 0.017 rad

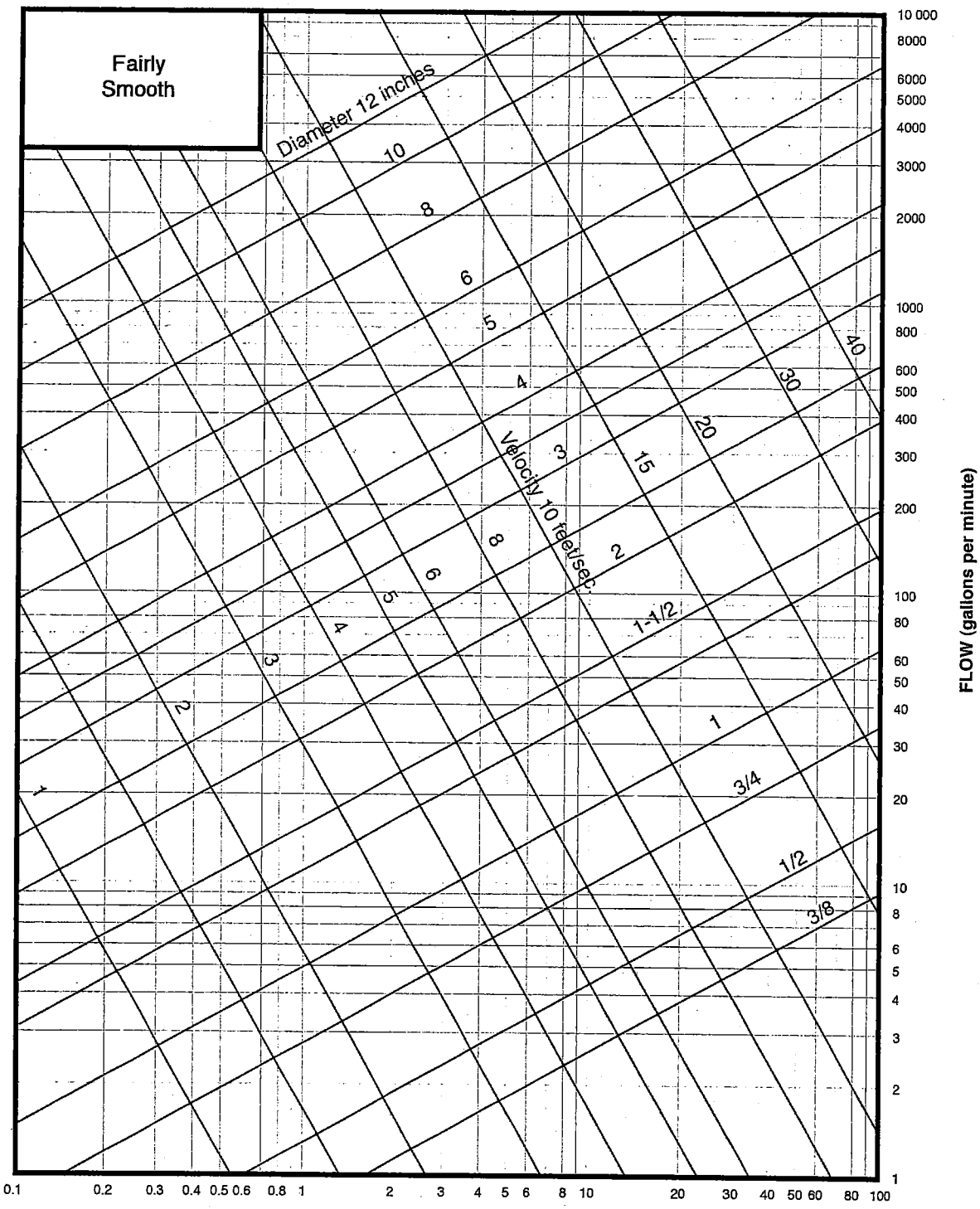
* Allowances are based on nonrecessed threaded fittings. Use one-half the allowances for recessed threaded fittings or streamlined solder fittings.

**CHART A 4.1**



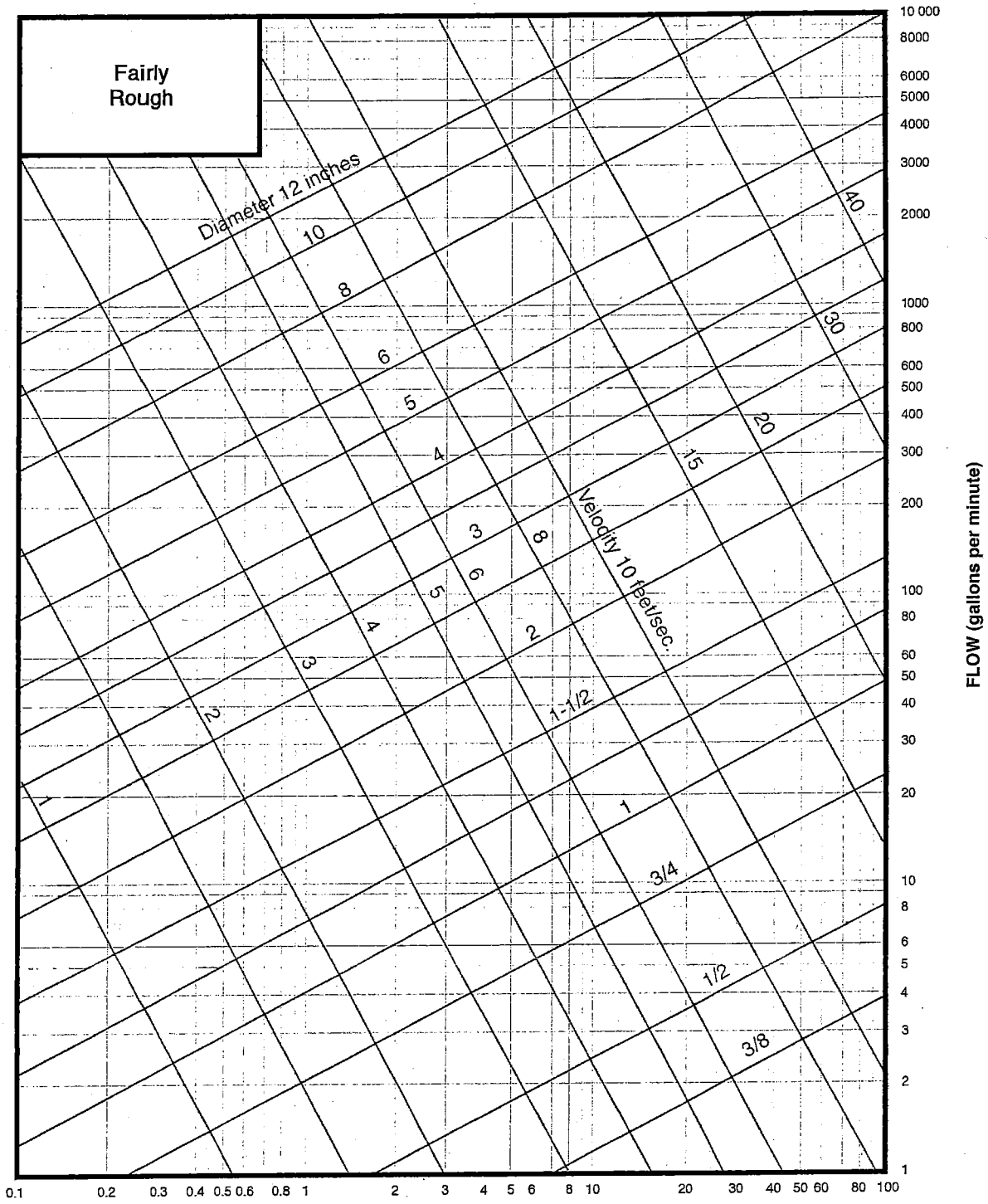

For SI units: 1 inch = 25 mm, 1 gallon per minute = 0.06 L/s, 1 pound-force per square inch = 6.8947 kPa, 1 foot = 304.8 mm, 1 foot per second = 0.3048 m/s

**CHART A 4.1(1)**



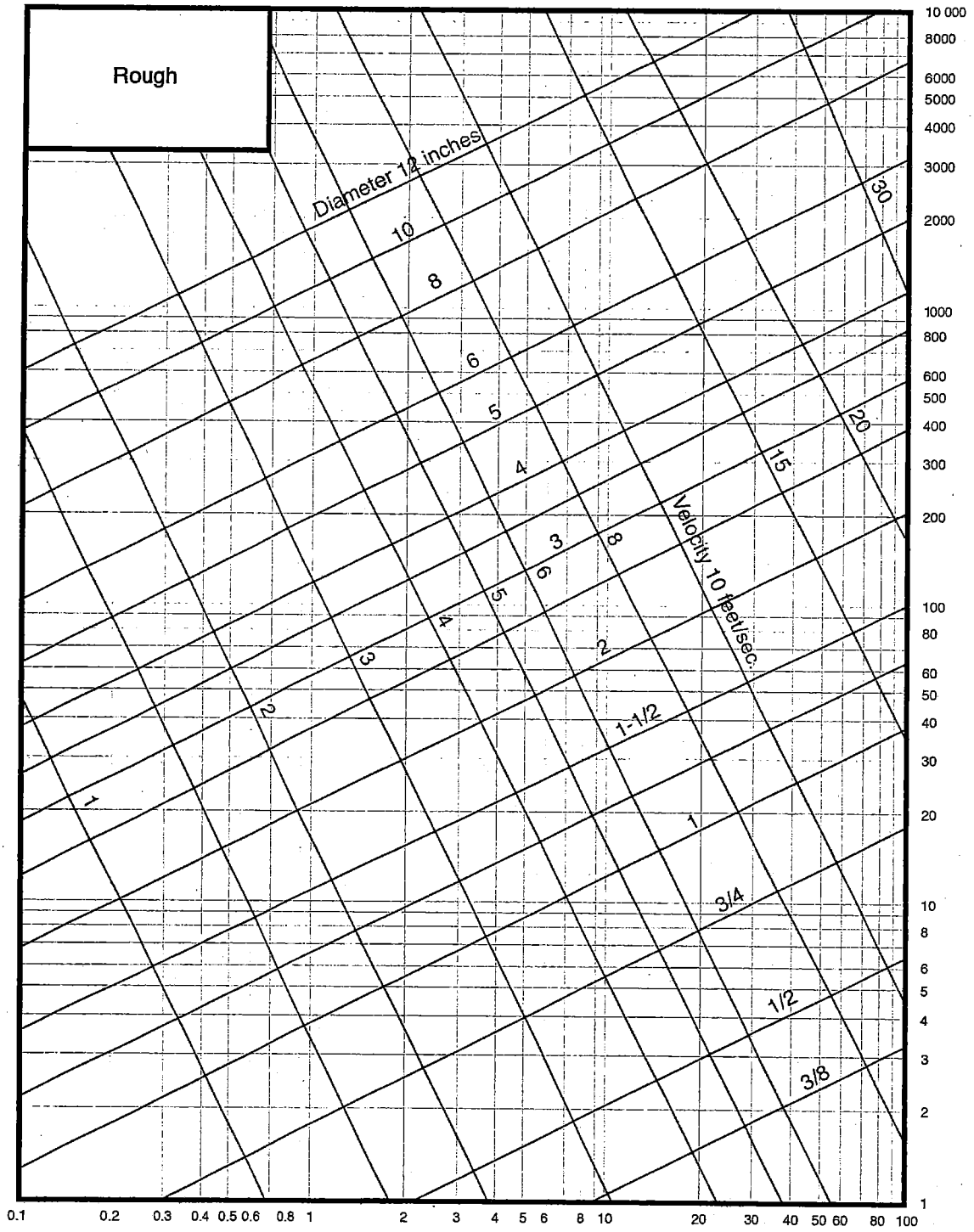

For SI units: 1 inch = 25 mm, 1 gallon per minute = 0.06 L/s, 1 pound-force per square inch = 6.8947 kPa, 1 foot = 304.8 mm, 1 foot per second = 0.3048 m/s

CHART A 4.1(2)




For SI units: 1 inch = 25 mm, 1 gallon per minute = 0.06 L/s, 1 pound-force per square inch = 6.8947 kPa, 1 foot = 304.8 mm, 1 foot per second = 0.3048 m/s

CHART A 4.1(3)




For SI units: 1 inch = 25 mm, 1 gallon per minute = 0.06 L/s, 1 pound-force per square inch = 6.8947 kPa, 1 foot = 304.8 mm, 1 foot per second = 0.3048 m/s

## A 7.0 Sizing.

**A 7.1 Example.** Assume an office building of four stories and basement; pressure on the building side of the pressure-reducing valve of 55 psi (379 kPa) (after an allowance for reduced pressure falloff at peak demand); an elevation of highest fixture above the pressure-reducing valve of 45 feet (13 716 mm); a developed length of pipe from the pressure-reducing valve to the most distant fixture of 200 feet (60 960 mm); and fixtures to be installed with flush valves for water closets and stall urinals as follows:

Where the pipe material and water supply are such that Chart A 4.1(1) applies, the required diameter of the building supply is 3½ inches (90 mm) and the required diameter of the branch to the hot-water heater is 1½ inches (40 mm).

The sizes of the various branches and risers shall be permitted to be determined in the same manner as the size of the building supply or the branch to the hot-water system, by estimating the demand for the riser or branch from Chart A 2.1 or Chart A 2.1(1) and applying the total demand estimate from the branch, riser, or section thereof to the appropriate flowchart.

**A 7.1 EXAMPLE**

| FIXTURE UNITS AND ESTIMATED DEMANDS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | BUILDING SUPPLY DEMAND | | | | BRANCH TO HOT WATER SYSTEM | | |
| KIND OF FIXTURES | NUMBER OF FIXTURES | FIXTURE UNIT DEMAND | TOTAL UNITS | BUILDING SUPPLY DEMAND (gallons per minute) | NUMBER OF FIXTURES | FIXTURE UNIT DEMAND CALCULATION | DEMAND (gallons per minute) |
| Water Closets | 130 | 8.0 | 1040 | – | – | – | – |
| Urinals | 30 | 4.0 | 120 | – | – | – | – |
| Shower heads | 12 | 2.0 | 24 | – | 12 | 12 x 2 x ¾ = 18 | – |
| Lavatories | 100 | 1.0 | 100 | – | 100 | 100 x 1 x ¾ = 75 | – |
| Service Sinks | 27 | 3.0 | 81 | – | 27 | 27 x 3 x ¾ = 61 | – |
| Total | – | – | 1365 | 252 | – | 154 | 55 |

For SI units: 1 gallon per minute = 0.06 L/s, 1 pound-force per square foot = 6.8947 kPa

Allowing for 15 psi (103 kPa) at the highest fixture under the maximum demand of 252 gallons per minute (15.88 L/s), the pressure available for friction loss is found by the following:

$$55 - [15 + (45 \times 0.43)] = 20.65 \text{ psi } (142.38 \text{ kPa})$$

The allowable friction loss per 100 feet (30 480 mm) of pipe is therefore:

$$100 \times 20.65 \div 200 = 10.32 \text{ psi } (71.15 \text{ kPa})$$

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## APPENDIX B - EXPLANATORY NOTES ON COMBINATION WASTE AND VENT SYSTEMS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | X | | | | | | X | X | X | X | X | X | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |

# APPENDIX B

## EXPLANATORY NOTES ON COMBINATION WASTE AND VENT SYSTEMS

(See Section 910.0 for specific limitations)

**B 1.0 General Requirements.** Combination waste and vent systems, as outlined in Section 910.0 of this code, cover the horizontal wet venting of a series of traps by means of a common waste and vent pipe. Pipe sizes not less than two pipe sizes larger than those required for a conventional system are designed to maintain a wetted perimeter or flow line low enough in the waste pipe to allow adequate air movement in the upper portion, thus balancing the system. Sinks, lavatories, and other fixtures that rough in above the floor, shall not be permitted on a combination waste and vent system, which, at best, is merely an expedient designed to be used in locations where it would be structurally impractical to provide venting in the conventional manner.

Combination waste and vent systems are intended primarily for extensive floor or shower drain installations where separate venting is not practical, for floor sinks in markets, demonstration or work tables in school buildings, or for similar applications where the fixtures are not adjacent to walls or partitions. Due to its oversize characteristics, such a waste system is not self-scouring and, consequently, care shall be exercised as to the type of fixtures connected thereto and to the location of cleanouts. In view of its grease-producing potential, restaurant kitchen equipment shall not be connected to a combination waste and vent system.

**B 2.0 Caution.** Caution shall be exercised to exclude appurtenances delivering large quantities or surges of water (such as pumps, sand interceptors, etc.) from combination waste and vent systems in order that adequate venting will be maintained. Small fixtures with a waste-producing potential of less than 7½ gallons per minute (gpm) (0.47 L/s) shall be permitted to be safely assigned a loading value of one unit. Long runs shall be laid at the minimum permissible slope in order to keep tailpieces as short as possible. Tailpieces shall not exceed 2 feet (610 mm) in length, which shall necessitate slopes up to 45 degrees (0.79 rad) (see definition of horizontal pipe) on some branches.

**B 3.0 Pneumatics.** It is essential that the pneumatics of such a system be properly engineered, as the air pressure within the line shall at all times balance that of outside atmosphere in order to prevent either trap seal loss or air locking between traps. Long mains shall be provided with additional relief vents located at intervals not exceeding 100 feet (30 480 mm). Each such relief vent shall equal not less than one-half of the inside cross-sectional area of the drain pipe served.

**B 4.0 Trap Sizes.** Trap sizes are required to be equivalent to the branches they serve (two pipe sizes larger than normal), and tailpieces between fixtures or floor drains and such traps shall be reduced to normal size.

**B 5.0 Layout Drawings.** Duplicate layout drawings of each such proposed piping system shall be presented to the Authority Having Jurisdiction and approval obtained before an installation is made. Complicated layouts shall be checked by qualified personnel.

**B 5.1 Example of Sizing.** A floor drain normally requires a 2 inch (50 mm) trap and waste. On a combination waste and vent system, both trap and waste shall be increased two pipe sizes (through 2½ inches and 3 inches) (65 mm and 80 mm), which would make the trap 3 inches (80 mm). Pipe sizes recognized for this purpose are 2 inches, 2½ inches, 3 inches, 3½ inches, 4 inches, 4½ inches, 5 inches, 6 inches, etc. (50 mm, 65 mm, 80 mm, 90 mm, 100 mm, 115 mm, 125 mm, 150 mm, etc.). The tailpiece between the floor drain and its trap shall be 2 inches (50 mm) (or normal size) to ensure that the amount of wastewater entering the trap partially fills the waste branch. A 3 inch (80 mm) floor drain would thus require a 4 inch (100 mm) trap, and a 4 inch (100 mm) floor drain would require a 5 inch (125 mm) trap for the reasons previously stated.

WHERE IN DOUBT, CHECK WITH YOUR LOCAL Authority Having Jurisdiction.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## APPENDIX C - ALTERNATE PLUMBING SYSTEMS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |

# APPENDIX C
## ALTERNATE PLUMBING SYSTEMS

**C 1.0 General.**

**C 1.1 Applicability.** The intent of this appendix is to provide clarification of procedures for the design and approval of engineered plumbing systems, alternate materials, and equipment not specifically covered in other parts of the code.

**C 1.2 Provisions.** The provisions of this appendix apply to the design, installation, and inspection of an engineered plumbing system, alternate material, and equipment.

**C 1.3 Authority Having Jurisdiction.** The Authority Having Jurisdiction has the right to require descriptive details of an engineered plumbing system, alternate material, or equipment including pertinent technical data to be filed.

**C 1.4 Standards and Specifications.** Components, materials, and equipment shall comply with standards and specifications listed in Table 1401.1 of this code and other national consensus standards applicable to plumbing systems and materials.

**C 1.5 Alternate Materials and Equipment.** Where such standards and specifications are not available, alternate materials and equipment shall be approved in accordance with the provisions of Section 301.2 of this code.

**C 2.0 Engineered Plumbing Systems.**

**C 2.1 Definition.** For the purposes of this code, this definition shall apply to this appendix:

**Engineered Plumbing System.** A system designed for a specific building project with drawings and specifications indicating plumbing materials to be installed, all as prepared by a person registered or licensed to perform plumbing design work.

**C 2.2 Inspection and Installation.** In other than one- and two-family dwellings, the designer of the system is to provide periodic inspection of the installation on a schedule approved by the Authority Having Jurisdiction. Prior to the final approval, the designer shall verify to the Authority Having Jurisdiction that the installation is in accordance with the approved plans, specifications, and data and such amendments thereto. The designer shall certify to the Authority Having Jurisdiction that the installation is in accordance with the applicable engineered design criteria.

**C 2.3 Owner Information.** The designer of the system shall provide the building owner with information concerning the system, considerations applicable for subsequent modifications to the system, and maintenance requirements as applicable.

**C 3.0 Water Heat Exchangers.**

**C 3.1 Protection from Contamination.** Heat exchangers used for heat transfer, heat recovery, or solar heating shall protect the potable water system from being contaminated by the heat-transfer medium.

**C 3.2 Single-Wall Heat Exchangers.** Single-wall heat exchangers shall comply with the following requirements:

(1) The heat-transfer medium is either potable water or contains essentially nontoxic transfer fluids having a toxicity rating or class of 1 (see Section 207.0).

(2) The pressure of the heat-transfer medium is maintained at less than the normal minimum operating pressure of the potable water system.

**Exception:** Steam in accordance with Section C 3.2(1) above.

(3) The equipment is permanently labeled to indicate that only additives recognized as safe by the FDA shall be used in the heat-transfer medium.

**C 3.3 Alternate Designs.** Other heat exchanger designs shall be permitted where approved by the Authority Having Jurisdiction.

**C 4.0 Fixture Unit Values for Private or Private Use Bathroom Groups.**

**C 4.1 Fixtures.** Table C 4.1 and Table C 4.1(1) reflect the fixture unit loads for the fixtures in bathrooms as groups, rather than as individual fixtures. Such fixtures include water closets, lavatories, and bathtubs or showers. The tables reflect diversity in the use of fixtures within a bathroom and between multiple bathrooms.

**C 4.2 Water Supply Fixture Unit Values.** The listed water supply fixture unit values in Table C 4.1 reflect the load of entire bathroom groups on the cold water building supply. Individual hot and cold water branch piping to the fixtures shall be permitted to be sized in accordance with Chapter 6 and Appendix A.

**C 4.3 Drainage Fixture Unit Values.** The listed drainage fixture unit values in Table C 4.1(1) reflect the load of entire bathroom groups on the sanitary drainage system. Where fixtures within bathrooms connect to different branches of the drainage system, the fixture unit values for the individual fixtures shall be used, as listed in Table 702.1 of this code.

**C 5.0 Drainage System Sizing.**

**C 5.1 Definition.** For the purposes of this code, this definition shall apply to this appendix:

**Branch Interval.** A length of soil or waste stack corresponding in general to a story height, but in no case less than 8 feet (2438 mm), within which the horizontal branches from one floor or story of the building are connected to the stack.

TABLE C 4.1
WATER SUPPLY FIXTURE UNITS (WSFU) FOR BATHROOM GROUPS[1, 2]

| | PRIVATE USE BATHROOM GROUP | | SERVING 3 OR MORE PRIVATE USE BATHROOM GROUPS | |
|---|---|---|---|---|
| | COLD | HOT[3] | COLD | HOT |
| Bathroom Groups Having up to 1.6 GPF Gravity-Tank Water Closets | | | | |
| Half-Bath or Powder Room | 3.5 | 0.8 | 2.5 | 0.5 |
| 1 Bathroom Group | 5.0 | 2.5 | 3.5 | 1.8 |
| 1½ Bathrooms | 6.0 | 2.5 | – | – |
| 2 Bathrooms | 7.0 | 3.5 | – | – |
| 2½ Bathrooms | 8.0 | 3.6 | – | – |
| 3 Bathrooms | 9.0 | 4.5 | – | – |
| Each Additional ½ Bath | 0.5 | 0.1 | – | – |
| Each Additional Bathroom Group | 1.0 | 0.5 | – | – |
| Bathroom Groups Having up to 1.6 GPF Pressure-Tank Water Closets | | | | |
| Half-Bath or Powder Room | 3.5 | 0.8 | 2.5 | 0.5 |
| 1 Bathroom Group | 5.0 | 2.5 | 3.5 | 1.8 |
| 1½ Bathrooms | 6.0 | 2.5 | – | – |
| 2 Bathrooms | 7.0 | 3.5 | – | – |
| 2½ Bathrooms | 8.0 | 3.6 | – | – |
| 3 Bathrooms | 9.0 | 4.5 | – | – |
| Each Additional ½ Bath | 0.5 | 0.1 | – | – |
| Each Additional Bathroom Group | 1.0 | 0.5 | – | – |
| Bathroom Group (1.6 GPF Flushometer Value) | 6.0 | 2.5 | 4.0 | 1.7 |
| Kitchen Group (Sink and Dishwasher) | 2.0 | 2.0 | 1.5 | 1.5 |
| Laundry Group (Sink and Clothes Washer) | 5.0 | 5.0 | 3.0 | 3.0 |

**Notes:**

[1] A bathroom group, for the purposes of this table, consists of one water closet, up to two lavatories, and either one bathtub or one shower.

[2] A half-bath or powder room, for the purposes of this table, consists of one water closet and one lavatory.

[3] Multi-unit dwellings with individual water heaters use the same WSFU as for individual dwellings.

**C 5.2 Drainage Fixture Units.** Drainage fixture unit values shall be sized in accordance with Table 702.1 and Section 702.0.

**C 5.3 Size of Building Drain and Building Sewer.** The maximum number of drainage fixture units allowed on the building drain or building sewer of a given size shall be in accordance with Table C 5.3. The size of a building drain or building sewer serving a water closet shall be not less than 3 inches (80 mm).

**C 5.4 Size of Horizontal Branch or Vertical Stack.** The maximum number of drainage fixture units allowed on a horizontal branch or vertical soil or waste stack of a given size shall be in accordance with Table C 5.4. Stacks shall be sized based on the total accumulated connected load at each story or branch interval.

**C 5.4.1 Horizontal Stack Offsets.** Horizontal stack offsets shall be sized in accordance with Table C 5.3 as required for building drains.

**C 5.4.2 Vertical Stack Offsets.** Vertical stack offsets shall be sized in accordance with Table C 5.4 as required for stacks.

**C 5.5 Horizontal Stack Offset and Horizontal Branch Connections.** Horizontal branch connections shall not connect to a horizontal stack offset or within 2 feet (610 mm) above or below the offset where such horizontal offset is located more than four branch intervals below the top of the stack.

**C 6.0 Vent System Sizing.**

**C 6.1 Size of Vents.** The size of vent piping shall be determined from the developed length and the total number of drainage fixture units connected in accordance with Table C 6.1. Vents shall be not less than one-half the required size of the drainage pipe size served as determined by Table C 5.4 for horizontal fixture branches and stacks nor less than 1¼ inches (32 mm) in diameter. The drainage system shall be vented by not less than one vent pipe which shall be not less than one-half the size of the required building drain and which shall extend from the building drain or extension of building drain to the outdoors. Vents shall be installed in accordance with Chapter 9.

**TABLE C 4.1(1)**
**DRAINAGE FIXTURE UNIT VALUES (DFU) FOR BATHROOM GROUPS[1, 2]**

| | PRIVATE USE BATHROOM GROUP | SERVING 3 OR MORE PRIVATE USE BATHROOM GROUP |
|---|---|---|
| Bathroom Groups having 1.6 GPF Gravity-Tank Water Closets | | |
| Half-Bath or Powder Room | 3.0 | 2.0 |
| 1 Bathroom Group | 5.0 | 3.0 |
| 1½ Bathrooms | 6.0 | – |
| 2 Bathrooms | 7.0 | – |
| 2½ Bathrooms | 8.0 | – |
| 3 Bathrooms | 9.0 | – |
| Each Additional ½ Bath | 0.5 | – |
| Each Additional Bathroom Group | 1.0 | – |
| Bathroom Groups having 1.6 GPF Pressure-Tank Water Closets | | |
| Half-Bath or Powder Room | 3.5 | 2.5 |
| 1 Bathroom Group | 5.5 | 3.5 |
| 1½ Bathrooms | 6.5 | – |
| 2 Bathrooms | 7.5 | – |
| 2½ Bathrooms | 8.5 | – |
| 3 Bathrooms | 9.5 | – |
| Each Additional ½ Bath | 0.5 | – |
| Each Additional Bathroom Group | 1.0 | – |
| Bathroom Groups having 3.5 GPF Gravity-Tank Water Closets | | |
| Half-Bath or Powder Room | 3.0 | 2.0 |
| 1 Bathroom Group | 6.0 | 4.0 |
| 1½ Bathrooms | 8.0 | – |
| 2 Bathrooms | 10.0 | – |
| 2½ Bathrooms | 11.0 | – |
| 3 Bathrooms | 12.0 | – |
| Each Additional ½ Bath | 0.5 | – |
| Each Additional Bathroom | 1.0 | – |
| Bathroom Group (1.6 GPF Flushometer Valve) | 3.0 | – |
| Bathroom Group (3.5 GPF Flushometer Valve) | 4.0 | – |

**Notes:**

[1] A bathroom group, for the purposes of this table, consists of not more than one water closet, up to two lavatories, and either one bathtub or one shower.

[2] A half-bath or powder room, for the purposes of this table, consists of one water closet and one lavatory.

**C 6.2 Vent Stack.** A vent stack shall be required for a drainage stack that extends five or more branch intervals above the building drain or horizontal branch. The developed length of the vent stack shall be measured from the lowest connection of a branch vent to the termination outdoors.

**C 6.3 Branch Vents.** Where branch vents exceed 40 feet (12 192 mm) in developed length, such vent shall be increased by one pipe size for the entire developed length of the vent pipe.

**C 6.4 Venting Horizontal Offsets.** Drainage stacks with horizontal offsets shall be vented where five or more branch intervals are located above the offset. The upper and lower section of the horizontal offset shall be vented in accordance with Section C 6.4.1 and Section C 6.4.2.

**C 6.4.1 Venting Upper Section.** The vent for the upper section of the stack shall be vented as a separate stack with a vent stack connection installed at the base of the drainage stack. Such vent stack shall connect below the lowest horizontal branch or building drain. Where vent stack connects to the building drain, the connection shall be located downstream of the drainage stack and within a distance of 10 times the diameter of the drainage stack.

**C 6.4.2 Venting Lower Section.** The vent for the lower section of the stack shall be vented by a yoke vent connecting between the offset and the next lower horizontal branch by means of a wye-branch fitting. The size of the yoke vent and connection shall be not less in diameter than the required size for the vent

**TABLE C 5.3**
**BUILDING DRAINS AND BUILDING SEWERS[1]**

| DIAMETER OF PIPE (inches) | MAXIMUM NUMBER OF DRAINAGE FIXTURE UNITS FOR SANITARY BUILDING DRAINS AND RUNOUTS FROM STACKS | | | |
|---|---|---|---|---|
| | SLOPE (inches per foot) | | | |
| | 1/16 | 1/8 | 1/4 | 1/2 |
| 2 | – | – | 21 | 26 |
| 2½ | – | – | 24 | 31 |
| 3 | – | 20 | 42[2] | 50[2] |
| 4 | – | 180 | 216 | 250 |
| 5 | – | 390 | 480 | 575 |
| 6 | – | 700 | 840 | 1000 |
| 8 | 1400 | 1600 | 1920 | 2300 |
| 10 | 2500 | 2900 | 3500 | 4200 |
| 12 | 2900 | 4600 | 5600 | 6700 |
| 15 | 7000 | 8300 | 10 000 | 12 000 |

For SI units: 1 inch = 25 mm, 1 inch per foot = 83.3 mm/m

**Notes:**

[1] On-site sewers that serve more than one building shall be permitted to be sized according to the current standards and specifications of the administrative authority for public sewers.

[2] A maximum of two water closets or two bathroom groups, except in single-family dwellings, where a maximum of three water closets or three bathroom groups shall be permitted to be installed.

**TABLE C 5.4**
**HORIZONTAL FIXTURE BRANCHES AND STACKS**

| DIAMETER OF PIPE (inches) | MAXIMUM NUMBER OF DRAINAGE FIXTURE UNITS | | | |
|---|---|---|---|---|
| | HORIZONTAL FIXTURE BRANCH[1] | ONE STACK OF THREE OR FEWER BRANCH INTERVALS | STACKS WITH MORE THAN THREE BRANCH INTERVALS | |
| | | | TOTAL FOR STACK | TOTAL AT ONE BRANCH INTERVAL |
| 1½ | 3 | 4 | 8 | 2 |
| 2 | 6 | 10 | 24 | 6 |
| 2½ | 12 | 20 | 42 | 9 |
| 3 | 20[2] | 48[2] | 72[2] | 20[2] |
| 4 | 160 | 240 | 500 | 90 |
| 5 | 360 | 540 | 1100 | 200 |
| 6 | 620 | 960 | 1900 | 350 |
| 8 | 1400 | 2200 | 3600 | 600 |
| 10 | 2500 | 3800 | 5600 | 1000 |
| 12 | 3900 | 6000 | 8400 | 1500 |
| 15 | 7000 | 6000 | 8400 | 1500 |

For SI units: 1 inch = 25 mm

**Notes:**

[1] Does not include branches of the building drain.

[2] A maximum of two water closets or bathroom groups within each branch interval or more than six water closets or bathroom groups on the stack.

serving the drainage stack. The yoke vent connection shall be permitted to be a vertical extension of the drainage stack.

## C 7.0 Vacuum Drainage Systems.

**C 7.1 General.** This section regulates the design and installation provisions for vacuum waste drainage systems. Plans for vacuum waste drainage systems shall be submitted to the Authority Having Jurisdiction for approval and shall be considered an engineered designed system. Such plans shall be prepared by a registered or licensed person to perform plumbing design work. Details are necessary to ensure compliance with the requirements of this section, together with a full description of the complete installation including quality, grade of materials, equipment, construction, and methods of assembly and installation. Components, materials, and equipment shall comply with standards and specifications listed in Table 1401.1 of this code or approved by the Authority Having Jurisdiction and other national consensus standards applicable to plumbing systems and materials. Where such standards and specifications are not avail-

**TABLE C 6.1**
**SIZE AND LENGTH OF VENTS**

| SIZE OF SOIL OR WASTE STACK (inches) | FIXTURE UNITS CONNECTED | DIAMETER OF VENT REQUIRED (inches) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 1¼ | 1½ | 2 | 2½ | 3 | 4 | 5 | 6 | 8 |
| | | MAXIMUM LENGTH OF VENT (feet) | | | | | | | | |
| 1½ | 8 | 50 | 150 | — | — | — | — | — | — | — |
| 2 | 12 | 30 | 75 | 200 | — | — | — | — | — | — |
| 2 | 20 | 26 | 50 | 150 | — | — | — | — | — | — |
| 2½ | 42 | — | 30 | 100 | 300 | — | — | — | — | — |
| 3 | 10 | — | 30 | 100 | 100 | 600 | — | — | — | — |
| 3 | 30 | — | — | 60 | 200 | 500 | — | — | — | — |
| 3 | 60 | — | — | 50 | 80 | 400 | — | — | — | — |
| 4 | 100 | — | — | 35 | 100 | 260 | 1000 | — | — | — |
| 4 | 200 | — | — | 30 | 90 | 250 | 900 | — | — | — |
| 4 | 500 | — | — | 20 | 70 | 180 | 700 | — | — | — |
| 5 | 200 | — | — | — | 35 | 80 | 350 | 1000 | — | — |
| 5 | 500 | — | — | — | 30 | 70 | 300 | 900 | — | — |
| 5 | 1100 | — | — | — | 20 | 50 | 200 | 700 | — | — |
| 6 | 350 | — | — | — | 25 | 50 | 200 | 400 | 1300 | — |
| 6 | 620 | — | — | — | 15 | 30 | 125 | 300 | 1100 | — |
| 6 | 960 | — | — | — | — | 24 | 100 | 250 | 1000 | — |
| 6 | 1900 | — | — | — | — | 20 | 70 | 200 | 700 | — |
| 8 | 600 | — | — | — | — | — | 50 | 150 | 500 | 1300 |
| 8 | 1400 | — | — | — | — | — | 40 | 100 | 400 | 1200 |
| 8 | 2200 | — | — | — | — | — | 30 | 80 | 350 | 1100 |
| 8 | 3600 | — | — | — | — | — | 25 | 60 | 250 | 800 |
| 10 | 1000 | — | — | — | — | — | — | 75 | 125 | 1000 |
| 10 | 2500 | — | — | — | — | — | — | 50 | 100 | 500 |
| 10 | 3800 | — | — | — | — | — | — | 30 | 80 | 350 |
| 10 | 5600 | — | — | — | — | — | — | 25 | 60 | 250 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm

able, alternate materials and equipment shall be approved in accordance with Section 301.2.

**C 7.2 System Design.** Vacuum waste drainage systems shall be designed and installed in accordance with the manufacturer's installation instructions. A vacuum waste drainage system shall include a vacuum generating system, waste collection center, piping network, vacuum valve, and control components used to isolate the vacuum piping network from atmospheric pressure and to collect waste at its point of origin. Where a vacuum system provides the only means of sanitation, duplicate vacuum generating equipment set to operate automatically shall be installed to allow the system to continue in operation during periods of maintenance.

**C 7.2.1 Vacuum Generating System.** The vacuum generating station shall include vacuum pumps to create a constant vacuum pressure within the piping network and storage tanks. The discharge from the tank shall be through an air gap in accordance with Table 603.3.1. Operation of pumps, collection tanks, and alarms shall be automated by controls. The vacuum pumps shall be activated on demand and accessible for repair or replacement. The vent from the vacuum pump shall be provided for vacuum pump air exhaust, and shall be of a size capable of handling the total air volume of the vacuum pump.

**C 7.2.2 Waste Collection Center or Storage Tanks.** Vacuum collection center or storage tanks shall be of such capacity as to provide storage of waste to prevent fouling of the system. Such collection or storage tank shall be capable of withstanding 150 percent of the rated vacuum (negative pressure) created by the vacuum source without leakage or collapse. Waste collection center or storage tanks shall be accessible for adjustment, repair, or replacement.

**C 7.2.3 Piping Network.** The piping network shall be under a continuous vacuum and shall be designed to withstand 150 percent of the vacuum (negative pressure) created by the vacuum source within the system without leakage or collapse. Sizing the piping network shall be in accordance with the manufacturer's instructions. The water closet outlet fitting shall connect with a piping network having not less than a 1½ inch (40 mm) nominal inside diameter.

**C 7.2.4 Vacuum Interface Valve.** A closed vacuum interface valve shall be installed to separate the piping network vacuum from atmospheric pressure. A control device shall open the vacuum interface valve where a signal is generated to remove waste from the plumbing fixture.

**C 7.2.5 Control Components.** Where a pneumatic signal is generated at the controller, a vacuum from the system to open the extraction valve shall be designed to operate where vacuum pressure exists to remove the accumulated waste. Each tank shall incorporate a level indicator switch that automatically controls the discharge pump and warns of malfunction or blockage as follows:

(1) Start discharge.

(2) Stop discharge.

(3) Activate an audible alarm where the level of effluent is usually high.

(4) Warning of system shutdown where tank is full.

**C 7.3 Fixtures.** Fixtures utilized in a vacuum waste drainage system shall be in accordance with referenced standards listed in Table 1401.1. Components shall be of corrosion resistant materials. The water closet outlet shall be able to pass a 1 inch (25 mm) diameter ball and shall have a smooth, impervious surface. The waste outlet and passages shall be free of obstructions, recesses, or chambers that are capable of permitting fouling. The mechanical valve and its seat shall be of such materials and design to provide a leak-free connection where at atmospheric pressure or under vacuum. The flushing mechanism shall be so designed as to ensure proper cleansing of the interior surfaces during the flushing cycle at a minimum operating flow rate. Mechanical seal mechanisms shall withdraw completely from the path of the waste discharge during flushing operation. Each mechanical seal vacuum water closet shall be equipped with a listed vacuum breaker. The vacuum breaker shall be mounted with the critical level or marking not less than 1 inch (25.4 mm) above the flood-level rim of the fixture. Vacuum breakers shall be installed on the discharge side of the last control valve in the potable water supply line and shall be located so as to be protected from physical damage and contamination.

**C 7.4 Drainage Fixture Units.** Drainage fixture units shall be determined by the manufacturer's instructions. The pump discharge load from the collector tanks shall be in accordance with this appendix.

**C 7.5 Water Supply Fixture Units.** Water supply fixture units shall be determined by the manufacturer's instructions.

**C 7.6 Materials.** Materials used for water distribution pipe and fittings shall be in accordance with Table 604.1. Materials used for aboveground drainage shall be in accordance with Table 701.1 and shall have a smooth bore, and be constructed of non-porous material.

**C 7.7 Traps and Cleanouts.** Traps and cleanouts shall be installed in accordance with Chapter 7 and Chapter 10.

**C 7.8 Testing.** The entire vacuum waste system shall be subjected to a vacuum test of 29 inches of mercury (98 kPa) or not less than the working pressure of the system for 30 minutes. The system shall be gastight and watertight at all points. Verification of test results shall be submitted to the Authority Having Jurisdiction.

**C 7.9 Manufacturer's Instructions.** Manufacturer's instructions shall be provided for the purpose of providing information regarding safe and proper operating instructions whether or not as part of the condition of listing in order to determine compliance. Such instructions shall be submitted and approved by the Authority Having Jurisdiction.

**C 8.0 Circuit Venting.**

**C 8.1 Circuit Vent Permitted.** Circuit venting shall be designed by a registered professional engineer as an engineered design. A maximum of eight fixtures connected to a horizontal branch drain shall be permitted to be circuit vented. Each fixture drain shall connect horizontally to the horizontal branch being circuit vented. The horizontal branch drain shall be classified as a vent from the most downstream fixture drain connection to the most upstream fixture drain connection to the horizontal branch.

**C 8.1.1 Multiple Circuit-Vented Branches.** Circuit-vented horizontal branch drains are permitted to be connected together. Each group of a maximum of eight fixtures shall be considered a separate circuit vent and shall be in accordance with the requirements of this section.

**C 8.2 Vent Size and Connection.** The circuit vent shall be not less than 2 inches (50 mm) in diameter and the connection shall be located between the two most upstream fixture drains. The vent shall connect to the horizontal branch on the vertical. The circuit vent pipe shall not receive the discharge of a soil or waste.

**C 8.3 Slope and Size of Horizontal Branch.** The maximum slope of the vent section of the horizontal branch drain shall be 1 inch per foot (83.3 mm/m). The entire length of the vented section of the horizontal branch drain shall be sized for the total drainage discharge to the branch.

**C 8.3.1 Size of Multiple Circuit Vent.** Multiple circuit vented branches shall be permitted to connect on the same floor level. Each separate circuit-vented horizontal branch that is interconnected shall be sized independently in accordance with Section C 8.3. The downstream circuit-vented horizontal branch shall be sized for the total discharge into the branch, including the upstream branches and the fixtures within the branch.

**C 8.4 Relief Vent.** A 2 inch (50 mm) relief vent shall be provided for circuit-vented horizontal branches receiving the discharge of four or more water closets and connecting to a drainage stack that receives the discharge of soil or waste from upper horizontal branches.

**C 8.4.1 Connection and Installation.** The relief vent shall connect to the horizontal branch drain between the stack and the most downstream fixture drain of the circuit vent. The relief vent shall be installed on the vertical to the horizontal branch.

**C 8.4.2 Fixture Drain or Branch.** The relief vent is permitted to be a fixture drain or fixture branch for a fixture located within the same branch interval as the circuit-vented horizontal branch. The discharge to a relief vent shall not exceed 4 fixture units.

**C 8.5 Additional Fixtures.** Fixtures, other than the circuit-vented fixtures, are permitted to discharge to the horizontal branch drain. Such fixtures shall be located on the same floor as the circuit-vented fixtures and shall be either individually or common vented.

**C 9.0 Single-Stack Vent System.**

**C 9.1 Where Permitted.** Single-stack venting shall be designed by a registered professional engineer as an engineered design. A drainage stack shall be permitted to serve as a single-stack vent system where sized and installed in accordance with Section C 9.2 through Section C 9.9. The drainage stack and branch piping in a single-stack vent system shall provide for the flow of liquids, solids, and air without the loss of fixture trap seals.

**C 9.2 Stack Size.** Drainage stacks shall be sized in accordance with Table C 9.2. Not more than two water closets shall be permitted to discharge to a 3 inch (80 mm) stack. Stacks shall be uniformly sized based on the total connected drainage fixture unit load, with no reductions in size.

**C 9.2.1 Stack Vent.** The drainage stack vent shall have a stack vent of the same size terminating to the outdoors.

**C 9.3 Branch Size.** Horizontal branches connecting to a single-stack vent system shall be sized in accordance with Table 703.2.

**Exceptions:**

(1) Not more than one water closet within 18 inches (457 mm) of the stack horizontally shall be permitted on a 3 inch (80 mm) horizontal branch.

(2) A water closet within 18 inches (457 mm) of a stack horizontally and one other fixture with up to 1½ inch (40 mm) fixture drain size shall be permitted on a 3 inch (80 mm) horizontal branch where connected to the stack through a sanitary tee.

**C 9.4 Length of Horizontal Branches.**

**C 9.4.1 Water Closets.** Water closets shall be not more than 4 feet (1219 mm) horizontally from the stack.

**Exception:** Water closets shall be permitted to be up to 8 feet (2438 mm) horizontally from the stack where connected to the stack through a sanitary tee.

**C 9.4.2 Other Fixtures.** Fixtures other than water closets shall be not less than 12 feet (3658 mm) horizontally from the stack.

**C 9.4.3 Length of Vertical Piping.** The length of a vertical piping from a fixture trap to a horizontal branch shall not be considered in computing the fixture's horizontal distance from the stack.

**C 9.5 Maximum Vertical Drops from Fixtures.** Vertical drops from fixture traps to horizontal branch piping shall be one size larger than the trap size, but not less than 2 inch (50 mm) in diameter. Vertical drops shall be 4 feet (1219 mm) maximum length. Fixture drains that are not increased in size, or have a vertical drop exceeding 4 feet (1219 mm) shall be individually vented.

**C 9.6 Additional Venting Required.** Additional venting shall be provided where more than one water closet is on a horizontal branch and where the distance from a fixture trap to the stack exceeds the limits in Section C 9.4. Where additional venting is required, the fixture(s) shall be vented by individual vents, common vents, wet vents, circuit vents, or a combination waste and vent pipe. The dry vent extensions for the additional venting shall connect to a branch vent, vent stack, stack vent, or be extended outdoors and terminate to the open air.

**C 9.7 Stack Offsets.** Where there are no fixture drain connections below a horizontal offset in a stack, the offset does not need to be vented. Where there are fixture drain connections below a horizontal offset in a stack, the offset shall be vented. There shall be no fixture connections to a stack within 2 feet (610 mm) above and below a horizontal offset.

**C 9.8 Separate Stack Required.** Where stacks are more than two stories high, a separate stack shall be provided for the fixtures on the lower two stories. The stack for the lower two stories shall be permitted to be connected to the branch of the building drain that serves the stack for the upper stories at a point that is not less than 10 pipe diameters downstream from the base of the upper stack.

**C 9.9 Sizing Building Drains and Sewers.** In a single-stack vent system, the building drain and branches thereof shall be sized in accordance with Table 703.2, and the building sewer shall be sized in accordance with Table 717.1.

## TABLE C 9.2
## SINGLE STACK SIZE*

| MAXIMUM CONNECTED DRAINAGE FIXTURE UNITS | | | |
|---|---|---|---|
| STACK SIZE (inches) | STACKS LESS THAN 75 FEET IN HEIGHT | STACK 75 FEET TO LESS THAN 160 FEET IN HEIGHT | STACK 160 FEET OR GREATER IN HEIGHT |
| 3 | 24 | NP | NP |
| 4 | 225 | 24 | NP |
| 5 | 480 | 225 | 24 |
| 6 | 1015 | 480 | 225 |
| 8 | 2320 | 1015 | 480 |
| 10 | 4500 | 2320 | 1015 |
| 12 | 8100 | 4500 | 2320 |
| 15 | 13 600 | 8100 | 4500 |

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm

* NP = Not permitted

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## APPENDIX D - SIZING STORM WATER DRAINAGE SYSTEMS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | X | | X | X | | | X | X | X | X | X | X | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |

# APPENDIX D

## SIZING STORM WATER DRAINAGE SYSTEMS

**D 1.0 Roof Drainage.**

**D 1.1 General.** The rainfall rates in Table D 1.1 shall be permitted to be used for design unless higher values are established locally.

**D 2.0 Sizing by Flow Rate.**

**D 2.1 General.** Storm drainage systems shall be permitted to be sized by storm water flow rates, using the gallons per minute per square foot (L/s/m$^2$) of rainfall listed in Table D 1.1 for the local area. Multiplying the listed gallons per minute per square foot (L/s/m$^2$) by the roof area being drained by each inlet (in square feet) (m$^2$) produces the gallons per minute (gpm) (L/s) of required flow for sizing each drain inlet. The flow rates shall be permitted to be added to determine the flows in each of the drainage systems. Required pipe sizes for various flow rates (gpm) (L/s) are listed in Table 1101.7 and Table 1101.11.

**D 3.0 Sizing by Roof Area.**

**D 3.1 General.** Storm drainage systems shall be permitted to be sized using the roof area served by each of the drainage system. Maximum allowable roof areas with various rainfall rates are listed in Table 1101.7 and Table 1101.11, along with the required pipe sizes. Using this method, it shall be permitted to interpolate between two listed rainfall rate columns (inches per hour) (mm/h). To determine the allowable roof area for a listed pipe size at a listed slope, divide the allowable square feet (m$^2$) of roof for a 1 inch per hour (in/h) (25.4 mm/h) rainfall rate by the listed rainfall rate for the local area. For example, the allowable roof area for a 6 inch (150 mm) drain at ⅛ inch per foot (10.4 mm/m) slope with a rainfall rate of 3.2 in/h (81 mm/h) is 21 400/3.2 = 6688 square feet (621.3 m$^2$).

**D 4.0 Capacity of Rectangular Scuppers.**

**D 4.1 General.** Table D 4.1 lists the discharge capacity of rectangular roof scuppers of various widths with various heads of water. The maximum allowable level of water on the roof shall be obtained from the structural engineer, based on the design of the roof.

**TABLE D 1.1**
**MAXIMUM RATES OF RAINFALL FOR VARIOUS CITIES***

| STATES AND CITIES | STORM DRAINAGE 60-MINUTE DURATION, 100-YEAR RETURN | |
|---|---|---|
| | inches per hour | gallons per minute per square foot |
| **ALABAMA** | – | – |
| Birmingham | 3.7 | 0.038 |
| Huntsville | 3.3 | 0.034 |
| Mobile | 4.5 | 0.047 |
| Montgomery | 3.8 | 0.039 |
| | | |
| **ALASKA** | – | – |
| Aleutian Islands | 1.0 | 0.010 |
| Anchorage | 0.6 | 0.006 |
| Bethel | 0.8 | 0.008 |
| Fairbanks | 1.0 | 0.010 |
| Juneau | 0.6 | 0.006 |
| | | |
| **ARIZONA** | – | – |
| Flagstaff | 2.3 | 0.024 |
| Phoenix | 2.2 | 0.023 |
| Tucson | 3.0 | 0.031 |
| | | |
| **ARKANSAS** | – | – |
| Eudora | 3.8 | 0.039 |
| Ft. Smith | 3.9 | 0.041 |
| Jonesboro | 3.5 | 0.036 |
| Little Rock | 3.7 | 0.038 |

TABLE D 1.1
MAXIMUM RATES OF RAINFALL FOR VARIOUS CITIES* (continued)

| STATES AND CITIES | STORM DRAINAGE 60-MINUTE DURATION, 100-YEAR RETURN | |
|---|---|---|
| | inches per hour | gallons per minute per square foot |
| **CALIFORNIA** | – | – |
| Eureka | 1.5 | 0.016 |
| Lake Tahoe | 1.3 | 0.014 |
| Los Angeles | 2.0 | 0.021 |
| Lucerne Valley | 2.5 | 0.026 |
| Needles | 1.5 | 0.016 |
| Palmdale | 3.0 | 0.031 |
| Redding | 1.5 | 0.016 |
| San Diego | 1.5 | 0.016 |
| San Francisco | 1.5 | 0.016 |
| San Luis Obispo | 1.5 | 0.016 |
| | | |
| **COLORADO** | – | – |
| Craig | 1.5 | 0.016 |
| Denver | 2.2 | 0.023 |
| Durango | 1.8 | 0.019 |
| Stratton | 3.0 | 0.031 |
| | | |
| **CONNECTICUT** | – | – |
| Hartford | 2.8 | 0.029 |
| New Haven | 3.0 | 0.031 |
| | | |
| **DELAWARE** | – | – |
| Dover | 3.5 | 0.036 |
| Rehobeth Beach | 3.6 | 0.037 |
| | | |
| **DISTRICT OF COLUMBIA** | – | – |
| Washington | 4.0 | 0.042 |
| | | |
| **FLORIDA** | – | – |
| Daytona Beach | 4.0 | 0.042 |
| Ft. Myers | 4.0 | 0.042 |
| Jacksonville | 4.3 | 0.045 |
| Melbourne | 4.0 | 0.042 |
| Miami | 4.5 | 0.047 |
| Palm Beach | 5.0 | 0.052 |
| Tampa | 4.2 | 0.044 |
| Tallahassee | 4.1 | 0.043 |
| | | |
| **GEORGIA** | – | – |
| Atlanta | 3.5 | 0.036 |
| Brunswick | 4.0 | 0.042 |
| Macon | 3.7 | 0.038 |
| Savannah | 4.0 | 0.042 |
| Thomasville | 4.0 | 0.042 |
| | | |
| **HAWAII** | – | – |
| Rainfall rates in the Hawaiian Islands vary from 1½ inches per hour to 8 inches per hour, depending on location and elevation. Consult local data. | | |
| | | |
| **IDAHO** | – | – |
| Boise | 1.0 | 0.010 |
| Idaho Falls | 1.2 | 0.012 |
| Lewiston | 1.0 | 0.010 |
| Twin Falls | 1.1 | 0.011 |

TABLE D 1.1
MAXIMUM RATES OF RAINFALL FOR VARIOUS CITIES* (continued)

| STATES AND CITIES | STORM DRAINAGE 60-MINUTE DURATION, 100-YEAR RETURN | |
|---|---|---|
| | inches per hour | gallons per minute per square foot |
| **ILLINOIS** | – | – |
| Chicago | 2.7 | 0.028 |
| Harrisburg | 3.1 | 0.032 |
| Peoria | 2.9 | 0.030 |
| Springfield | 3.0 | 0.031 |
| **INDIANA** | – | – |
| Evansville | 3.0 | 0.031 |
| Indianapolis | 2.8 | 0.029 |
| Richmond | 2.7 | 0.028 |
| South Bend | 2.7 | 0.028 |
| **IOWA** | – | – |
| Council Bluffs | 3.7 | 0.038 |
| Davenport | 3.0 | 0.031 |
| Des Moines | 3.4 | 0.035 |
| Sioux City | 3.6 | 0.037 |
| **KANSAS** | – | – |
| Goodland | 3.5 | 0.036 |
| Salina | 3.8 | 0.039 |
| Topeka | 3.8 | 0.039 |
| Wichita | 3.9 | 0.041 |
| **KENTUCKY** | – | – |
| Bowling Green | 2.9 | 0.030 |
| Lexington | 2.9 | 0.030 |
| Louisville | 2.8 | 0.029 |
| Paducah | 3.0 | 0.031 |
| **LOUISIANA** | – | – |
| Monroe | 3.8 | 0.039 |
| New Orleans | 4.5 | 0.047 |
| Shreveport | 4.0 | 0.042 |
| **MAINE** | – | – |
| Bangor | 2.2 | 0.023 |
| Kittery | 2.4 | 0.025 |
| Millinocket | 2.0 | 0.021 |
| **MARYLAND** | – | – |
| Baltimore | 3.6 | 0.037 |
| Frostburg | 2.9 | 0.030 |
| Ocean City | 3.7 | 0.038 |
| **MASSACHUSETTS** | – | – |
| Adams | 2.6 | 0.027 |
| Boston | 2.7 | 0.028 |
| Springfield | 2.7 | 0.028 |
| **MICHIGAN** | – | – |
| Detroit | 2.5 | 0.026 |
| Grand Rapids | 2.6 | 0.027 |
| Kalamazoo | 2.7 | 0.028 |

**TABLE D 1.1**
**MAXIMUM RATES OF RAINFALL FOR VARIOUS CITIES* (continued)**

| STATES AND CITIES | STORM DRAINAGE 60-MINUTE DURATION, 100-YEAR RETURN | |
|---|---|---|
| | inches per hour | gallons per minute per square foot |
| Sheboygan | 2.1 | 0.022 |
| Traverse City | 2.2 | 0.023 |
| | | |
| **MINNESOTA** | – | – |
| Duluth | 2.6 | 0.027 |
| Grand Forks | 2.5 | 0.026 |
| Minneapolis | 3.0 | 0.031 |
| Worthington | 3.4 | 0.035 |
| | | |
| **MISSISSIPPI** | – | – |
| Biloxi | 4.5 | 0.047 |
| Columbus | 3.5 | 0.036 |
| Jackson | 3.8 | 0.039 |
| | | |
| **MISSOURI** | – | – |
| Independence | 3.7 | 0.038 |
| Jefferson City | 3.4 | 0.035 |
| St. Louis | 3.2 | 0.033 |
| Springfield | 3.7 | 0.038 |
| | | |
| **MONTANA** | – | – |
| Billings | 1.8 | 0.019 |
| Glendive | 2.5 | 0.026 |
| Great Falls | 1.8 | 0.019 |
| Missoula | 1.3 | 0.014 |
| | | |
| **NEBRASKA** | – | – |
| Omaha | 3.6 | 0.037 |
| North Platte | 3.5 | 0.036 |
| Scotts Bluff | 2.8 | 0.029 |
| | | |
| **NEVADA** | – | – |
| Las Vegas | 1.5 | 0.016 |
| Reno | 1.2 | 0.012 |
| Winnemucca | 1.0 | 0.010 |
| | | |
| **NEW HAMPSHIRE** | – | – |
| Berlin | 2.2 | 0.023 |
| Manchester | 2.5 | 0.026 |
| | | |
| **NEW JERSEY** | – | – |
| Atlantic City | 3.4 | 0.035 |
| Paterson | 3.0 | 0.031 |
| Trenton | 3.2 | 0.033 |
| | | |
| **NEW MEXICO** | – | – |
| Albuquerque | 2.0 | 0.021 |
| Carlsbad | 2.6 | 0.027 |
| Gallup | 2.1 | 0.022 |
| | | |
| **NEW YORK** | – | – |
| Binghamton | 2.4 | 0.025 |
| Buffalo | 2.3 | 0.024 |

TABLE D 1.1
MAXIMUM RATES OF RAINFALL FOR VARIOUS CITIES* (continued)

| STATES AND CITIES | STORM DRAINAGE 60-MINUTE DURATION, 100-YEAR RETURN | |
|---|---|---|
| | inches per hour | gallons per minute per square foot |
| New York City | 3.1 | 0.032 |
| Schenectady | 2.5 | 0.026 |
| Syracuse | 2.4 | 0.025 |
| | | |
| **NORTH CAROLINA** | – | – |
| Asheville | 3.2 | 0.033 |
| Charlotte | 3.4 | 0.035 |
| Raleigh | 4.0 | 0.042 |
| Wilmington | 4.4 | 0.046 |
| | | |
| **NORTH DAKOTA** | – | – |
| Bismarck | 2.7 | 0.028 |
| Fargo | 2.9 | 0.030 |
| Minot | 2.6 | 0.027 |
| | | |
| **OHIO** | – | – |
| Cincinnati | 2.8 | 0.029 |
| Cleveland | 2.4 | 0.025 |
| Columbus | 2.7 | 0.028 |
| Toledo | 2.6 | 0.027 |
| Youngstown | 2.4 | 0.025 |
| | | |
| **OKLAHOMA** | – | – |
| Boise City | 3.4 | 0.035 |
| Muskogee | 4.0 | 0.042 |
| Oklahoma City | 4.1 | 0.043 |
| | | |
| **OREGON** | – | – |
| Medford | 1.3 | 0.014 |
| Ontario | 1.0 | 0.010 |
| Portland | 1.3 | 0.014 |
| | | |
| **PENNSYLVANIA** | – | – |
| Erie | 2.4 | 0.025 |
| Harrisburg | 2.9 | 0.030 |
| Philadelphia | 3.2 | 0.033 |
| Pittsburgh | 2.5 | 0.026 |
| Scranton | 2.8 | 0.029 |
| | | |
| **RHODE ISLAND** | – | – |
| Newport | 3.0 | 0.031 |
| Providence | 2.9 | 0.030 |
| | | |
| **SOUTH CAROLINA** | – | – |
| Charleston | 4.1 | 0.043 |
| Columbia | 3.5 | 0.036 |
| Greenville | 3.3 | 0.034 |
| | | |
| **SOUTH DAKOTA** | – | – |
| Lemmon | 2.7 | 0.028 |
| Rapid City | 2.7 | 0.028 |
| Sioux Falls | 3.4 | 0.035 |

## TABLE D 1.1
## MAXIMUM RATES OF RAINFALL FOR VARIOUS CITIES* (continued)

| STATES AND CITIES | STORM DRAINAGE 60-MINUTE DURATION, 100-YEAR RETURN | |
|---|---|---|
| | inches per hour | gallons per minute per square foot |
| **TENNESSEE** | – | – |
| Knoxville | 3.1 | 0.032 |
| Memphis | 3.5 | 0.036 |
| Nashville | 3.0 | 0.031 |
| | | |
| **TEXAS** | – | – |
| Corpus Christi | 4.6 | 0.048 |
| Dallas | 4.2 | 0.044 |
| El Paso | 2.0 | 0.021 |
| Houston | 4.6 | 0.048 |
| Lubbock | 3.3 | 0.034 |
| San Antonio | 4.4 | 0.046 |
| | | |
| **UTAH** | – | – |
| Bluff | 2.0 | 0.021 |
| Cedar City | 1.5 | 0.016 |
| Salt Lake City | 1.3 | 0.014 |
| | | |
| **VERMONT** | – | – |
| Bennington | 2.5 | 0.026 |
| Burlington | 2.3 | 0.024 |
| Rutland | 2.4 | 0.025 |
| | | |
| **VIRGINIA** | – | – |
| Charlottesville | 3.4 | 0.035 |
| Norfolk | 4.0 | 0.042 |
| Richmond | 4.0 | 0.042 |
| Roanoke | 3.3 | 0.034 |
| | | |
| **WASHINGTON** | – | – |
| Seattle | 1.0 | 0.010 |
| Spokane | 1.0 | 0.010 |
| Walla Walla | 1.0 | 0.010 |
| | | |
| **WEST VIRGINIA** | – | – |
| Charleston | 2.9 | 0.030 |
| Martinsburg | 3.0 | 0.031 |
| Morgantown | 2.7 | 0.028 |
| | | |
| **WISCONSIN** | – | – |
| Green Bay | 2.5 | 0.026 |
| Lacrosse | 2.9 | 0.030 |
| Milwaukee | 2.7 | 0.028 |
| Wausau | 2.5 | 0.026 |
| | | |
| **WYOMING** | – | – |
| Casper | 1.9 | 0.020 |
| Cheyenne | 2.5 | 0.026 |
| Evanston | 1.3 | 0.014 |
| Rock Springs | 1.4 | 0.015 |

For SI units: 1 inch per hour = 25.4 mm/h, 1 gallon per minute per square foot = 0.618 L/s/m$^2$

*The rainfall rates in this table are based on U.S. Weather Bureau Technical Paper No. 40, Chart 14: 100-Year 60-Minute Rainfall (inches).

## TABLE D 4.1
## DISCHARGE FROM RECTANGULAR SCUPPERS (gallons per minute)[1, 2, 3, 4]

| WATER HEAD (inches) | WIDTH OF SCUPPER (inches) | | | | | |
|---|---|---|---|---|---|---|
| | 6 | 12 | 18 | 24 | 30 | 36 |
| ½ | 6 | 13 | 19 | 25 | 32 | 38 |
| 1 | 17 | 35 | 53 | 71 | 89 | 107 |
| 1½ | 31 | 64 | 97 | 130 | 163 | 196 |
| 2 | – | 98 | 149 | 200 | 251 | 302 |
| 2½ | – | 136 | 207 | 278 | 349 | 420 |
| 3 | – | 177 | 271 | 364 | 458 | 551 |
| 3½ | – | – | 339 | 457 | 575 | 693 |
| 4 | – | – | 412 | 556 | 700 | 844 |

For SI units: 1 inch = 25.4 mm, 1 gallon per minute = 0.06 L/s

**Notes:**

1 Table D 4.1 is based on discharge over a rectangular weir with end contractions.

2 Head is the depth of water above bottom of the scupper opening.

3 The height of the scupper opening shall be not less than two times the design head.

4 Coordinate the allowable head of water with the structural design of the roof.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## APPENDIX E - MANUFACTURED/MOBILE HOME PARKS AND RECREATIONAL VEHICLE PARKS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |

# APPENDIX E

## MANUFACTURED/MOBILE HOME PARKS AND RECREATIONAL VEHICLE PARKS

### Part A
### Manufactured/Mobile Home (M/H) Park.

**E 1.0 General.**

**E 1.1 Applicability.** The M/H park plumbing and drainage systems shall be designed and installed in accordance with the requirements of this appendix and the requirements of this code.

**E 2.0 Definitions.**

For purposes of this chapter, the following definitions shall apply:

**Manufactured/Mobile Home.** A structure transportable in one or more sections, which in the traveling mode is 8 feet (2438 mm) or more in width and 40 feet (12 192 mm) or more in length or, where erected on site, is 320 square feet (29.73 $m^2$) or more, and which is built on a permanent chassis, and designed to be used as a dwelling with or without a permanent foundation where connected to the required utilities. It includes the plumbing, heating, air conditioning, and electrical systems contained therein. For further clarification of definition, see Federal Regulation 24 CFR.

**Manufactured/Mobile Home Accessory Building or Structure.** A building or structure that is an addition to or supplements the facilities provided to a M/H. It is not a self-contained, separate, habitable building or structure. Examples are awnings, cabanas, ramadas, storage structures, carports, fences, windbreaks, or porches.

**Manufactured/Mobile Home Lot.** A portion of a M/H park designed for the accommodation of one M/H and its accessory buildings or structures for the exclusive use of the occupants.

**Manufactured/Mobile Home Park.** A parcel (or contiguous parcels) of land that has been so designated and improved that it contains two or more M/H lots available to the general public for the placement thereon of M/H for occupancy.

**E 3.0 Plans and Specifications.**

**E 3.1 General Requirements.** Before plumbing or sewage disposal facilities are installed or altered in a M/H park, duplicate plans and specifications shall be filed and proper permits obtained from the department or departments having jurisdiction. Plans shall show in detail:

(1) Plot plan of the park drawn to scale, indicating elevations, property lines, driveways, existing or proposed buildings, and the sizes of M/H lots.

(2) Complete specification and piping layout of proposed plumbing systems or alteration.

(3) Complete specification and layout of proposed sewage disposal system or alteration.

(4) The nature and extent of the work proposed, showing clearly that such work will conform to the provisions of this code.

### Part B
### Manufactured/Mobile Home Park Drainage System Construction.

**E 4.0 Drainage Systems.**

**E 4.1 General.** A drainage system shall be provided in M/H parks for conveying and disposing of sewage. Where feasible, connection shall be made to a public system. New improvements shall be designed, constructed, and maintained in accordance with applicable laws and regulations. Where the drainage lines of the M/H park are not connected to a public sewer, proposed sewage disposal facilities shall be approved by the Authority Having Jurisdiction prior to construction.

**E 5.0 Materials.**

**E 5.1 General.** Pipe and fittings installed underground in M/H park drainage systems shall be of material approved for the purpose. M/H lot drainage inlets and extensions to grade shall be of material approved for underground use within a building.

**E 6.0 Drainage (Sewage) Lines.**

**E 6.1 General.** Drainage (sewage) collection lines shall be located in trenches at an approved depth to be free of breakage from traffic or other movements and shall be separated from the park water supply system as specified in this code. Drainage (sewage) lines shall have a minimum size and slope as specified in Table E 6.1 and Table E 6.1(1).

**E 7.0 M/H Lot Drainage Inlet and Lateral.**

**E 7.1 Size.** Each lot shall be provided with a drainage inlet not less than 3 inches (80 mm) in diameter.

**E 7.2 Lateral Line.** The lateral line from the inlet to the sewage drain line shall slope not less than ¼ inch per foot (20.8 mm/m). Joints shall be watertight.

**E 7.3 Materials.** Materials used for drainage connections between a M/H and the lot drainage inlet shall be semi-rigid, corrosion-resistant, non-absorbent, and durable. The inner surface shall be smooth.

**E 7.4 Inlet.** Provision shall be made for plugging or capping the sewage drain inlet where a M/H does not occupy the lot. Surface drainage shall be diverted away from the inlet. The rim of the inlet shall extend at a maximum of 4 inches (102 mm) aboveground elevation.

**TABLE E 6.1**
**DRAINAGE PIPE DIAMETER AND NUMBER OF FIXTURE UNITS ON DRAINAGE SYSTEM**

| SIZE OF DRAINAGE (inches) | MAXIMUM NUMBER OF FIXTURE UNITS |
|---|---|
| 2* | 8 |
| 3 | 35 |
| 4 | 256 |
| 5 | 428 |
| 6 | 720 |
| 8 | 2640 |
| 10 | 4680 |
| 12 | 8200 |

For SI units: 1 inch = 25 mm
* Except six unit fixtures

**TABLE E 6.1(1)**
**MINIMUM GRADE AND SLOPE OF DRAINAGE PIPE**

| PIPE SIZE | SLOPE (per 100 feet) | PIPE SIZE | SLOPE (per 100 feet) |
|---|---|---|---|
| inches | inches | inches | inches |
| 2 | 25 | 6 | 8 |
| 3 | 25 | 8 | 4 |
| 4 | 15 | 10 | 3½ |
| 5 | 11 | 12 | 3 |

For SI units: 1 inch = 25 mm, 1 inch per foot = 83.3 mm/m

**E 8.0 Location of Lot Drain Inlet.**

**E 8.1 General.** Each lot drainage inlet shall be located in the rear third section and within 4 feet (1219 mm) of the proposed location of the M/H.

**E 9.0 Pipe Size.**

**E 9.1 Inlet, System, and Lateral Sizing.** Each M/H lot drainage inlet shall be assigned a waste loading value of 12 drainage fixture units, and each park drainage system shall be sized in accordance with Table E 6.1 or as provided herein. Drainage laterals shall be not less than 3 inches (80 mm) in diameter.

**E 9.2 Engineered Design.** A park drainage system that exceeds the fixture unit loading of Table E 6.1 or in which the grade and slope of drainage pipe does not meet the minimum specified in Table E 6.1(1) shall be designed by a registered professional engineer.

**E 10.0 M/H Drain Connector.**

**E 10.1 General.** A M/H shall be connected to the lot drainage inlet by means of a drain connector consisting of approved pipe not less than Schedule 40, approved fittings and connectors, and not less in size than the M/H drainage outlet. An approved cleanout shall be provided between the M/H and the lot drainage inlet. The fitting connected to the lot drainage inlet shall be a directional fitting to discharge the flow into the drainage inlet.

**E 10.2 Grade and Gastightness.** A drain connector shall be installed or maintained with a grade not less than ¼ inch per foot (20.8 mm/m). A drain connector shall be gastight and no longer than necessary to make the connection between the M/H outlet and the drain inlet on the lot. A flexible connector shall be permitted to be used at the lot drainage inlet area. Each lot drainage inlet shall be capped gastight where not in use.

**Part C**
**M/H Park Water Supply.**

**E 11.0 Potable Water Supply.**

**E 11.1 General.** An accessible and approved supply of potable water shall be provided in each M/H park. Where a public supply of water of approved quantity, quality, and pressure is available at or within the boundary of the park site, connection shall be made thereto and its supply used exclusively. Where an approved public water supply is not available, a private water supply system shall be developed and used as approved by the Authority Having Jurisdiction.

**E 12.0 Lot Service Outlet Size.**

**E 12.1 General.** Each M/H lot shall be provided with a water service outlet delivering potable water. The water service outlet riser shall be not less than ¾ of an inch (20 mm) nominal pipe size and capable of delivering 12 water supply fixture units.

**E 13.0 Location of Water Service.**

**E 13.1 General.** Each lot water service outlet shall be located in the rear third section and within 4 feet (1219 mm) of the proposed location of the M/H.

**E 14.0 Pressure.**

**E 14.1 General.** Each M/H park water distribution system shall be so designed and maintained as to provide a pressure of not less than 20 pounds-force per square inch (psi) (138 kPa) at each M/H lot at maximum operating conditions.

**E 15.0 Water Distribution Piping.**

**E 15.1 General.** Park water distribution systems shall be designed to deliver a minimum of 12 water supply fixture units to each lot and installed with materials in accordance with Chapter 6, Appendix A, or both of this code.

**E 16.0 Shutoff Valve.**

**E 16.1 General.** A separate water shutoff valve shall be installed in each water service outlet at each M/H lot. Where a listed backflow protective device is installed, the service shutoff shall be located on the supply side of such device.

**E 17.0 Backflow Preventer.**

**E 17.1 General.** Where a condition exists in the plumbing of a M/H that creates a cross-connection, a listed backflow preventer shall be installed in the water service line to the M/H at or near the water service outlet. Where a hose bibb or outlet is installed on the supply outlet riser in addition to the service connector, a listed backflow preventer shall be installed on each additional outlet.

**E 18.0 Pressure-Relief Valve.**

**E 18.1 General.** Where it is required to install a backflow preventer at the M/H lot service outlet, a listed pressure-relief valve shall be installed in the water service line on the discharge side of the backflow preventer. Pressure-relief valves shall be set to release at a pressure at a maximum of 150 psi (1034 kPa). Pressure-relief valves shall discharge toward the ground. Backflow preventers and pressure-relief valves shall be not less than 12 inches (305 mm) above the ground.

**E 19.0 Mechanical Protection.**

**E 19.1 General.** Park water service outlets, backflow preventers, and pressure-relief valves shall be protected from damage by vehicles or other causes. Such protection shall be permitted to consist of posts, fencing, or other permanent barriers.

**E 20.0 M/H Water Connector.**

**E 20.1 General.** An M/H shall be connected to the park water service outlet by a flexible connector, such as copper tubing or other approved material not less than ¾ of an inch nominal (20 mm) interior diameter.

**E 21.0 Water-Conditioning Equipment.**

**E 21.1 Permit Required.** A permit shall be obtained from the Authority Having Jurisdiction prior to installing water-conditioning equipment on an M/H lot. Approval of the park operator is required on applications for a permit to install such equipment. Where the water-conditioning equipment is of the regenerating type, and the park drainage system discharges into a public sewer, approval of the sanitary district or agency having jurisdiction over the public sewer is required.

**E 21.2 Approval.** Regenerating water-conditioning equipment shall be listed and labeled by an approved listing agency.

**E 21.3 Installation.** Regenerating units shall discharge the effluent of regeneration into a trap not less than 1½ inches (40 mm) in diameter connected to the M/H park drainage system. An approved air gap shall be installed on the discharge line a minimum of 12 inches (305 mm) above the ground.

**E 22.0 Testing.**

**E 22.1 General.** Installations shall be tested and inspected in accordance with Chapter 3 of this code.

## Part D
## Fuel Supply.

**E 23.0 Fuel Gas Piping Systems.**

**E 23.1 General.** Fuel gas piping systems serving manufactured homes, accessory buildings, or structures and communities shall be designed and constructed in accordance with the applicable provisions of NFPA 54 and NFPA 58. NFPA 31 shall apply to oil fuel-burning systems and shall comply with the criteria of the Authority Having Jurisdiction. [NFPA 501A:4.1.1]

**E 23.2 Gas Supply Connections.** Gas supply connections at sites, where provided from an underground gas supply piping system, shall be located and arranged to permit attachment to a manufactured home (M/H) occupying the site in a work-like manner. For the installation of liquefied petroleum gas (LPG) storage systems, the applicable provisions of NFPA 58 shall be followed. [NFPA 501A:4.1.2]

**E 23.3 Location of Gas Supply Connection.** The gas supply to the M/H shall be located within 4 feet (1219 mm) of the M/H stand.

**Exception:** Gas supply connections for manufactured homes located on all-weather wood, concrete, concrete block foundation systems or on foundations constructed in accordance with the local building code or, in the absence of a local code, with a recognized model building code. [NFPA 501A:4.1.3]

**E 24.0 Single and Multiple Manufactured Home Site Fuel Supply Systems.**

**E 24.1 Gas Supply Connections – Underground Gas Piping.** Gas supply connections at sites, where provided from an underground gas supply piping system, shall be located and arranged to permit attachment in a work-like manner to a manufactured home occupying the site. For the installation of LPG storage systems, the provisions of NFPA 58 shall be followed. [NFPA 501A:4.1.2]

**E 24.1.1 Underground Installations.** Underground gas piping system installations shall comply with the building code and Section E 24.1.1.1 and Section E 24.1.1.2. [NFPA 501A:4.2.1]

**E 24.1.1.1 Open-Ended Gastight Conduit.** Underground gas piping shall not be installed beneath that portion of a M/H site reserved for the location of a manufactured home or M/H accessory building or structure unless installed in the open-ended gastight conduit of Section E 24.1.1.2. [NFPA 501A:4.2.1.1]

**E 24.1.1.2 Requirements.** The open-ended gastight conduit shall comply with the following:

(1) The conduit shall be not less than Schedule 40 pipe that is approved for underground installation beneath buildings.

(2) The interior diameter of the conduit shall be not less than ½ of an inch (15 mm) larger than the outside diameter of the gas piping.

(3) The conduit shall extend to a point not less than 4 inches (102 mm) beyond the outside wall of the M/H, accessory building, or structure, and the outer ends shall not be sealed.

(4) Where the conduit terminates within a M/H, accessory building, or structure, it shall be readily accessible, and the space between the conduit and the gas piping shall be sealed to prevent leakage of gas into the building. [NFPA 501A:4.2.1.2]

**E 25.0 Manufactured Home Site Gas Shutoff Valve.**

**E 25.1 General.** Each M/H site shall have a listed gas shutoff valve installed upstream of the M/H site gas outlet. The gas shutoff valve shall be located on the outlet riser at a height of not less than 6 inches (152 mm) above grade. A gas shutoff valve shall not be located under a M/H. The outlet shall be equipped with a cap or plug to prevent discharge of gas where the M/H site outlet is not connected to an M/H.

**Exception:** Gas shutoff valves for manufactured homes located on foundations constructed in accordance with the local building code or, in the absence of a local code, with a recognized model building code. [NFPA 501A:4.2.2]

**E 26.0 Gas Meters.**

**E 26.1 Support of Meters.** Where installed, gas meters shall be supported by a post or bracket placed on a firm footing or other means providing equivalent support and shall not depend on the gas outlet riser for support. [NFPA 501A:4.2.3.1]

**E 26.2 Location of Meters.** Each gas meter shall be installed in an accessible location and shall be provided with unions or other fittings so that the meter is removed easily and placed in an upright position. Meters shall not be installed in unventilated or inaccessible locations or closer than 3 feet (914 mm) to sources of ignition. [NFPA 501A:4.2.3.2]

**E 26.3 Meter Shutoff Valve or Cock.** Gas meter installations shall be provided with shutoff valves or cocks located adjacent to and on the inlet side of the meters. In the case of a single meter installation utilizing an LP-Gas container, the container service valve shall be permitted to be used in lieu of the shutoff valve or cock. Gas meter installations shall be provided with test tees located adjacent to and on the outlet side of the meters. [NFPA 501A:4.2.4]

**E 27.0 Multiple Manufactured Home Site Fuel Distribution and Supply Systems.** [NFPA 501A:4.1, 4.3.11, 4.4, and 4.4.5]

**E 28.0 Cathodic Protection Requirements.**

**E 28.1 General.** Cathodic protection shall be installed for corrosion control of buried or submerged metallic gas piping in accordance with the following requirements:

(1) Where amphoteric metals are included in a buried or submerged pipeline containing a metal of different anodic potential the following protection shall be provided:

(a) The buried or submerged pipeline shall be cathodically protected at a negative (cathodic) voltage of 0.85 volt measured between the structure surface and a saturated copper-copper sulfate half cell contacting the electrolyte.

(b) The amphoteric metals shall be electrically isolated from the remainder of the pipeline with insulating flanges, or equivalent, and cathodically protected.

(2) The amount of cathodic protection shall be such that the protective coating and the pipe are not damaged.

**E 29.0 Manufactured Home Community LPG Supply Systems.**

**E 29.1 General.** Where 10 or more customers are served by one LPG supply system, the installation of the gas supply system shall be in accordance with 49 CFR 192. Other liquefied petroleum gas supply systems and the storage and handling of LPG shall be in accordance with NFPA 58 (see Section E 34.0). [NFPA 501A:4.3.2]

**E 30.0 Required Gas Supply.**

**E 30.1 General.** The minimum hourly volume of gas required at each M/H site outlet or a section of the M/H community gas piping system shall be calculated as shown in Table E 30.1. [NFPA 501A:4.3.4.1]

**E 31.0 Gas Pipe Sizing and Pressure.**

**E 31.1 Size.** The size of each section of a gas piping system shall be determined in accordance with NFPA 54, or by other standard engineering methods acceptable to the Authority Having Jurisdiction. [NFPA 501A:4.3.5.1]

**E 31.2 Pressure.** Where connected appliances are operated at their rated capacity, the supply pressure shall be not less than 7 inches of water column (1.7 kPa). The gas supply pressure shall not exceed 14 inches of water column (3.5 kPa). [NFPA 501A:4.3.5.2]

**E 32.0 Gas Piping Materials.**

**E 32.1 Metal.** Metal gas pipe shall be standard-weight wrought iron or steel (galvanized or black), yellow brass containing not more than 75 percent copper, or internally tinned or treated copper of iron pipe size. Galvanizing shall not be considered protection against corrosion.

Seamless copper or steel tubing shall be permitted to be used with gases not corrosive to such material. Steel tubing shall comply with ASTM A 254. Copper tubing shall comply with ASTM B 88 or ASTM B 280. Copper

**TABLE E 30.1**
**DEMAND FACTORS FOR USE IN CALCULATING GAS PIPING SYSTEMS IN M/H COMMUNITIES***
**[NFPA 501A: TABLE 4.3.4.1]**

| NUMBER OF M/H SITES | BRITISH THERMAL UNITS PER HOUR PER M/H SITE |
|---|---|
| 1 | 125 000 |
| 2 | 117 000 |
| 3 | 104 000 |
| 4 | 96 000 |
| 5 | 92 000 |
| 6 | 87 000 |
| 7 | 83 000 |
| 8 | 81 000 |
| 9 | 79 000 |
| 10 | 77 000 |
| 11–20 | 66 000 |
| 21–30 | 62 000 |
| 31–40 | 58 000 |
| 41–60 | 55 000 |
| Over 60 | 50 000 |

For SI units: 1000 British thermal units per hour = 0.293 kW
* In extreme climate areas, additional capacities shall be considered.

tubing (unless tin-lined) shall not be used where the gas contains more than an average of 0.3 grains of hydrogen sulfide per 100 standard cubic feet (scf) of gas (0.7 mg/100 L). [NFPA 501A:4.3.6.1]

**E 32.2 Protection Coatings for Metal Gas Piping.** Buried or submerged metallic gas piping shall be protected from corrosion by approved coatings or wrapping materials. Gas pipe protective coatings shall be approved types, machine applied, and shall comply with recognized standards. Field wrapping shall provide equivalent protection and is restricted to those short sections and fittings that are stripped for threading or welding. Risers shall be coated or wrapped to a point of not less than 6 inches (152 mm) aboveground. [NFPA 501A:4.3.6.2]

**E 32.3 Plastic.** Plastic piping shall be used underground and shall be in accordance with the requirements of ASTM D 2513 or ASTM D 2517, as well as the design pressure and design limitations of 49 CFR 192.123, and shall otherwise comply with the installation requirements thereof. [NFPA 501A:4.3.6.3]

**E 33.0 Gas Piping Installations.**

**E 33.1 Minimum Burial Below Ground Level and Clearances.** Gas piping installed belowground level shall have an earth cover of not less than 18 inches (457 mm) and shall be installed with not less than 12 inches (305 mm) of clearance from other underground utility systems. [NFPA 501A:4.3.7.1]

**E 33.2 Metallic Gas Piping.** Metallic gas piping systems shall be installed in accordance with approved plans and specifications, including provisions for cathodic protection. Each cathodic protection system shall be designed and installed in accordance with the provisions of 49 CFR 192. [NFPA 501A:4.3.7.2.1, 4.3.7.2.2]

**E 33.2.1 Cathodic Protection.** Where the cathodic protection system is designed to protect the gas piping system, the gas piping system shall be electrically isolated from other underground metallic systems or installations. Where the gas piping system is cathodically protected against corrosion, a dielectric fitting shall be used in the M/H gas connection to insulate the M/H from the underground gas piping system. [NFPA 501A:4.3.7.2.3, 4.3.7.2.4]

**E 33.2.2 Underground Metallic Systems.** Where a cathodic protection system is designed to provide underground metallic systems and installations with protection against corrosion, such systems and installations shall be electrically bonded together and protected as a whole. [NFPA 501A:4.3.7.2.5]

**E 33.3 Plastic Gas Piping.** Plastic gas piping shall be used underground and shall be installed with an electrically conductive wire for locating the pipe. The wire used to locate the plastic pipe shall be copper, not less than No. 18 AWG, with insulation approved for direct burial. Portions of a plastic gas piping system consisting of metallic pipe shall be cathodically protected against corrosion. [NFPA 501A:4.3.7.3]

**E 33.4 Gas Piping System Shutoff Valve.** A readily accessible and identifiable shutoff valve controlling the flow of gas to the entire M/H community gas piping system shall be installed near the point of connection to the service piping or to the supply connection of an LPG container. [NFPA 501A:4.3.7.4]

**E 34.0 Liquefied Petroleum Gas Equipment.**

**E 34.1 General.** LPG equipment shall be installed in accordance with the applicable provisions of NFPA 58. [NFPA 501A:4.3.8]

**E 35.0 Oil Supply.**

**E 35.1 General.** The following three methods of supplying oil to an individual M/H site shall be permitted:

(1) Supply from an outside underground tank (see Section E 36.6).

(2) Supply from a centralized oil distribution system designed and installed in accordance with accepted engineering practices and in accordance with NFPA 31.

(3) Supply from an outside aboveground tank (see Section E 36.6). [NFPA 501A:4.3.9]

**E 35.2 Minimum Oil Supply Tank Size.** Oil supply tanks shall have a minimum capacity equal to 20 percent of the average annual oil consumption. [NFPA 501A:4.3.10]

**E 35.3 Oil Supply Connections.** Oil supply connections at M/H sites, where provided from a centralized oil distribution system, shall be located and arranged to permit attachment in a work-like manner to a M/H utilizing the stand. [NFPA 501A:4.3.11.1] The installation of such facilities shall comply with the following requirements:

(1) The main oil distribution pipeline shall be permitted to be connected to a tank or tanks having an aggregate capacity not to exceed 20 000 gallons (75 708 L) at a point below the liquid level.

(2) Where this piping is so connected, a readily accessible internal or external shutoff valve shall be installed in the piping as close as practicable to the tank.

(3) Where external and aboveground, the shutoff valve and its tank connections shall be made of steel.

(4) Connections between the tank(s) and the main pipeline shall be made with double swing joints or flexible connectors, or shall otherwise be arranged to permit the tank(s) to settle without damaging the system.

(5) Where located aboveground, the connections shall be located within the diked area.

(6) A readily accessible and identified manual shutoff valve shall be installed in each branch supply pipeline that enters a building, mobile home, travel trailer, or other structure. This valve shall be permitted to be either inside or outside of the structure. Where outside, the valve shall be protected from weather and damage. Where inside, the valve shall be located directly adjacent to the point at which the supply line enters the structure.

(7) A device shall be provided in the supply line at or ahead of the point where it enters the interior of the structure that will automatically shut off the oil supply, where the supply line between this device and the appliance is broken. This device shall be located on the appliance side of the manual shutoff valve. This device shall be solidly supported and protected from damage.

(8) Means shall be provided to limit the oil pressure at the appliance inlet to not exceed 3 pounds-force per square inch gauge (psig) (21 kPa). Where a pressure-reducing valve is used, it shall be a type approved for the service.

(9) A device shall be provided that automatically shuts off the oil supply to the appliance where the oil pressure at the appliance inlet exceeds 8 psig (55 kPa).

**Exceptions:**

(a) Where the distribution system is supplied from a gravity tank and the maximum hydrostatic head of oil in the tank is such that the pressure at the appliance inlet shall not exceed 8 psig (55 kPa).

(b) Where a means is provided to automatically shut off the oil supply where the pressure-regulating device fails to regulate the pressure as required.

(10) Appliances equipped with primary safety controls specifically listed for the appliance shall be connected to a centralized oil distribution system. [NFPA 31:9.2.10 – 9.2.15]

**E 36.0 Fuel Supply Systems Installation.**

**E 36.1 Flexible Gas Connector.** Each gas supply connector shall be listed for outside M/H use, shall be not more than 6 feet (1829 mm) in length, and shall have a capacity rating adequate to supply the connected load.

**Exception:** Gas supply connections for manufactured homes located on an all-weather wood, concrete, concrete block foundation system or on a foundation constructed in accordance with the local building code or, in the absence of a local code, with a recognized model building code. [NFPA 501A:4.4.1]

**E 36.2 Use of Approved Pipe and Fittings of Extension.** Where it is necessary to extend the M/H inlet to permit connection of the 6 foot (1829 mm) listed connector to the site gas outlet, the extension shall be of approved materials of the same size as the M/H inlet and shall be supported at not more than 4 foot (1219 mm) intervals to the M/H. [NFPA 501A:4.4.2]

**E 36.3 Mechanical Protection.** Gas outlet risers, regulators, meters, valves, or other exposed equipment shall be protected against accidental damage. [NFPA 501A:4.4.3]

**E 36.4 Special Rules on Atmospherically Controlled Regulators.** Atmospherically controlled regulators shall be installed in such a manner that moisture cannot enter the regulator vent and accumulate above the diaphragm. Where the regulator vent is obstructed due to snow and icing conditions; shields, hoods, or other approved devices shall be provided to guard against closing of the vent opening. [NFPA 501A:4.4.4]

**E 36.5 Fuel Gas Piping Test.** The M/H fuel gas piping system shall be tested with air before it is connected to the gas supply. The M/H gas piping system shall be subjected to a pressure test with appliance shutoff valves in their closed positions. [NFPA 501A:4.4.5]

**E 36.5.1 Procedures.** The fuel gas piping test shall consist of air pressure of not less than 10 inches water column or more than 14 inches water column (2.5 kPa to 3.5 kPa). The system shall be isolated from the air pressure source and shall maintain this pressure for not less than 10 minutes without perceptible leakage. Upon satisfactory completion of the test, the appliance valves shall be opened, and the gas appliance connectors shall be tested with soapy water or bubble solution while under the pressure remaining in the piping system. Solutions used for testing for leakage shall not contain corrosive chemicals. Pressure shall be measured with either a manometer, slope gauge, or gauge that is calibrated in either water inch (mm) or psi (kPa), with increments of either $\frac{1}{10}$ of an inch (2.5 mm) or $\frac{1}{10}$ psi (0.7 kPa gauge), as applicable. Upon satisfactory completion of the test, the M/H gas supply connector shall be installed, and the connections shall be tested with soapy water or bubble solution. [NFPA 501A:4.4.5.1]

**E 36.5.2 Warning.** The following warning shall be supplied to the installer:

**WARNING**

Do not overpressurize the fuel gas piping system. Damage to valves, regulators, and appliances is capable of occurring due to pressurization beyond the maximums specified. [NFPA 501A:4.4.5.2]

**E 36.5.3 Vents.** Gas appliance vents shall be visually inspected to ensure that they have not been dislodged in transit and are connected securely to the appliance. [NFPA 501A:4.4.5.3]

**E 36.6 Oil Tanks.** Not more than one 660 gallon (2498 L) tank or two tanks with aggregate capacity of 660 gallons (2498 L) or less shall be connected to one oil-burning appliance. Two supply tanks, where used, shall be cross-connected and provided with a single fill and vent in accordance with NFPA 31, and shall be on a common slab and rigidly secured one to the other. Tanks having a capacity of 660 gallons (2498 L) or less shall be supported by rigid, noncombustible supports to prevent settling, sliding, or lifting. [NFPA 501A:4.4.6]

**E 36.6.1 Installation.** Oil supply tanks shall be installed in accordance with the applicable provisions of NFPA 31. [NFPA 501A:4.4.6.1]

**E 36.6.2 Capacity.** A tank with a capacity not larger than 60 gallons (227 L) shall be permitted to be a DOT-5 shipping container (drum) and so marked, or a tank constructed in accordance with the provisions of UL 80. Tanks other than DOT-5 shipping containers having a capacity of not more than 660 gallons (2498 L) shall be constructed in accordance with the provisions of UL 80. Pressure tanks shall be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code. [NFPA 501A:4.4.6.2]

**E 36.6.3 Location.** Tanks, as described in Section E 36.6 and Section E 36.6.2, that are adjacent to buildings shall be located not less than 10 feet (3048 mm) from a property line that is permitted to be built upon. [NFPA 501A:4.4.6.3]

**E 36.6.4 Vent.** Tanks with a capacity not larger than 660 gallons (2498 L) shall be equipped with an open vent not smaller than a 1½ inch (40 mm) iron pipe size; tanks with a 500 gallon (1892 L) or less capacity shall have a vent of 1¼ inch (32 mm) iron pipe size. [NFPA 501A:4.4.6.4]

**E 36.6.5 Liquid Level.** Tanks shall be provided with a means of determining the liquid level. [NFPA 501A:4.4.6.5]

**E 36.6.6 Fill Opening.** The fill opening shall be a size and in a location that permits filling without spillage. [NFPA 501A:4.4.6.6]

**E 37.0 Manufactured Home Accessory Building Fuel Supply Systems.**

**E 37.1 General.** Fuel gas supply systems installed in a M/H accessory building or structure shall be in accordance with the applicable provisions of NFPA 54 and NFPA 58. Fuel oil supply systems shall comply with the applicable provisions of NFPA 31. [NFPA 501A:4.5]

**E 38.0 Community Building Fuel Supply Systems in Manufactured Home Communities.**

**E 38.1 Fuel Gas Piping and Equipment Installations.** Fuel gas piping and equipment installed within a permanent building in a M/H community shall be in accordance with nationally recognized appliance and fuel gas piping codes and standards adopted by the Authority Having Jurisdiction. Where the state or other political subdivision does not assume jurisdiction, such fuel gas piping and equipment installations shall be designed and installed in accordance with NFPA 54 or NFPA 58. [NFPA 501A:4.6.1]

**E 38.2 Oil Supply Systems in M/H Communities.** Oil-burning equipment and installation within a M/H community shall be designed and constructed in accordance with the applicable codes and standards adopted by the Authority Having Jurisdiction. Where the state or other political subdivision does not assume jurisdiction, such installation shall be designed and constructed in accordance with NFPA 31. [NFPA 501A:4.6.2]

**E 38.3 Oil-Burning Equipment and Installation.** Oil-burning equipment and installation within a building constructed in a M/H community in accordance with the local building code or a nationally recognized building code shall be in accordance with nationally recognized codes and standards adopted by the Authority Having Jurisdiction. Where the state or other political subdivision does not assume jurisdiction, such oil-burning equipment and installation shall be designed and installed in accordance with NFPA 31. [NFPA 501A:4.6.3]

**E 38.4 Inspections and Tests.** Inspections and tests for fuel gas piping shall be made in accordance with Chapter 1 and Chapter 12 of this code.

## Part E
## Recreational Vehicle Parks.

**E 39.0 Plumbing Systems.**

**E 39.1 General.** Plumbing systems shall be installed in accordance with the plumbing codes of the Authority Having Jurisdiction and with this appendix.

**E 40.0 Definitions.**

For purposes of this chapter, the following definitions shall apply:

**Recreational Vehicle (RV).** A vehicular-type unit primarily designed as temporary living quarters for recreational, camping, travel, or seasonal use, that either has its own motive power, or is mounted on or towed by another vehicle. The basic entities are camping trailer, fifth-wheel trailer, motor home, park trailer, travel trailer, and truck camper.

**Recreational Vehicle Park.** A plot of land upon which two or more recreational vehicle sites are located, established, or maintained for occupancy by recreational vehicles of the general public as temporary living quarters for recreation or vacation purpose.

**Recreational Vehicle Site.** Within a recreational vehicle park, a plot of ground intended for the accommodation of a recreational vehicle, a tent, or other individual camping unit on a temporary basis.

## Part F
## Recreational Vehicle Park Toilet and Shower Facilities.

### E 41.0 Water Closets and Urinals.

**E 41.1 General.** Water closets and urinals shall be provided at one or more locations in a recreational vehicle park. They shall be of convenient access and shall be located within a 500 foot (152.4 m) radius from a recreational vehicle site not provided with an individual sewer connection.

### E 42.0 Markings.

**E 42.1 General.** Facilities for males and females shall be appropriately marked.

### E 43.0 Number of Water Closets.

**E 43.1 General.** Not less than one water closet shall be provided for each sex up to the first 25 sites. For each additional 25 sites not provided with sewer connections, an additional water closet shall be provided.

### E 44.0 Interior Finish.

**E 44.1 General.** The interior finish of walls shall be moisture resistant to a height of not less than 4 feet (1219 mm) to facilitate washing and cleaning.

### E 45.0 Floors and Drains.

**E 45.1 General.** The floors shall be constructed of material impervious to water and shall be easily cleanable. A building having water-supplied water closets shall be provided with a floor drain in the toilet room. This drain shall be provided with means to protect the trap seal in accordance with this code.

### E 46.0 Lavatories.

**E 46.1 General.** Where water-supplied water closets are provided, an equal number of lavatories shall be provided for up to six water closets. One additional lavatory shall be provided for each two water closets where more than six water closets are required. Each lavatory basin shall have a piped supply of potable water and shall drain into the drainage system.

### E 47.0 Urinals.

**E 47.1 General.** Where separate facilities are provided for men and women, urinals shall be acceptable for not more than one-third of the water closets required in the men's facilities, except that one urinal shall be permitted to be used to replace a water closet in a minimum park. Individual stall or wall-hung types of urinals shall be installed. Floor-type trough units shall be prohibited.

### E 48.0 Approved Water Closets.

**E 48.1 General.** Water closets shall be of an approved, elongated bowl type and shall be provided with seats with open fronts.

### E 49.0 Water Closet Compartment.

**E 49.1 General.** Each water closet shall be in a separate compartment and shall be provided with a latched door for privacy. A holder or dispenser for toilet paper shall be provided. Dividing walls or partitions shall be not less than 5 feet (1524 mm) high and shall be separated from the floor by a space not exceeding 12 inches (305 mm).

### E 50.0 Compartment Size.

**E 50.1 General.** Water closet compartments shall be not less than 30 inches (762 mm) in width [no water closet shall be set closer than 15 inches (381 mm) from its center to a side wall] and shall be not less than 30 inches (762 mm) of clear space in front of each water closet.

### E 51.0 Receptacle.

**E 51.1 General.** Each toilet room for women shall be provided with a receptacle for sanitary napkins. The receptacle shall be of durable, impervious, readily cleanable material, and shall be provided with a lid.

### E 52.0 Shower Size.

**E 52.1 General.** Each shower, where provided, shall have a floor area of 36 inches by 36 inches (914 mm by 914 mm), shall be capable of encompassing a 30 inch (762 mm) diameter circle and shall be of the individual type. The shower area shall be visually screened from view with a minimum floor area of 36 by 36 inches (914 mm by 914 mm) per shower. Each shall be provided with individual dressing areas screened from view and shall contain a minimum of one clothing hook and stool (or bench area).

### E 53.0 Drainage System Connection.

**E 53.1 General.** Each shower area shall be designed to minimize the flow of water into the dressing area and shall be connected to the drainage system by means of a properly trapped and vented inlet. Each such area shall have an impervious, skid-resistant surface; wooden racks (duck boards) over shower floors shall be prohibited.

**E 54.0 Ceiling Height and Doors.**

**E 54.1 General.** A toilet facility shall have a ceiling height of not less than 7 feet (2134 mm) and, unless artificial light is provided, a window or skylight area equal to not less than 10 percent of the floor area shall be provided.

Doors to the exterior shall open outward, be self-closing, and shall be visually screened by means of a vestibule or wall to prevent direct view of the interior where the exterior doors are open. Such screening shall not be required on single toilet units.

**E 55.0 Ventilation.**

**E 55.1 General.** A toilet facility shall have permanent, non-closable, screened opening(s), having a total area not less than 5 percent of the floor area and opening directly to the exterior in order to provide proper ventilation. Listed exhaust fan(s), vented to the exterior, the rating of which in cubic feet per minute (L/s) is not less than 25 percent of the total volume of the room(s) served, shall be considered as meeting the requirements of this section. Openable windows and vents to the outside shall be provided with fly-proof screens of not less than number 16 mesh.

## Part G
## Recreational Vehicle Park Potable Water Supply and Distribution.

**E 56.0 Quality.**

**E 56.1 General.** The supply or supplies of water shall comply with the potable water standards of the state, local health authority or, in the absence thereof, with the Drinking Water Standard of the Federal Environmental Protection Agency.

**E 57.0 Sources.**

**E 57.1 General.** Water approved by a regulating agency shall be acceptable. Where an approved public water supply system is available, it shall be used. Where the park has its own water supply system, the components of the system shall be approved. A water supply system that is used on a seasonal basis shall be provided with means for draining.

**E 58.0 Prohibited Connections.**

**E 58.1 General.** The potable water supply shall not be connected to a nonpotable or unapproved water supply, nor be subjected to backflow or backsiphonage.

**E 59.0 Supply.**

**E 59.1 General.** The water supply system shall be designed and constructed in accordance with the following:

(1) A minimum of 25 gallons (95 L) per day per site for sites without individual water connections.

(2) A minimum of 50 gallons (189 L) per day per site for sites with individual water connections.

(3) A minimum of 50 gallons (189 L) per day per site where water-supplied water closets are provided in restrooms.

**E 60.0 Pressure and Volume.**

**E 60.1 General.** Where water is distributed under pressure to an individual site, the water supply system shall be designed to provide a minimum flow pressure of not less than 20 psi (138 kPa) with a minimum flow of 2 gallons per minute (gpm) (0.1 L/s) at an outlet. The pressure shall not exceed 80 psi (552 kPa).

**E 61.0 Outlets.**

**E 61.1 General.** Water outlets shall be convenient to access and, where not piped to individual RV sites, shall not exceed 300 feet (91 440 mm) from a site. Provisions shall be made to prevent accumulation of standing water or the creation of muddy conditions at each water outlet.

**E 62.0 Storage Tanks.**

**E 62.1 General.** Water storage tanks shall be constructed of impervious materials, protected against contamination, and provided with locked, watertight covers. Overflow or ventilation openings shall be down-facing and provided with corrosion-resistant screening of not less than number 24 mesh to prevent the entrance of insects and vermin. Water storage tanks shall not have direct connections to sewers.

## Part H
## Recreational Vehicle Park Water Connections for Individual Recreational Vehicles.

**E 63.0 Location.**

**E 63.1 General.** Where provided, the water connections for potable water to individual recreational vehicle sites shall be located on the left rear half of the site (left side of RV) within 4 feet (1219 mm) of the stand.

**E 64.0 Water Riser Pipe.**

**E 64.1 General.** Each potable water connection shall consist of a water riser pipe that shall be equipped with a threaded male spigot located not less than 12 inches (305 mm) but not more than 24 inches (610 mm) above grade level for the attachment of a standard water hose. The water riser pipe shall be protected from physical damage in accordance with this code. This connection shall be equipped with a listed antisiphon backflow prevention device.

**E 65.0 Drinking Fountains.**

**E 65.1 General.** Where provided, drinking fountains shall be in accordance with the requirements of this code.

## Part I
## Recreational Vehicle Park Drainage System.

### E 66.0 Where Required.

**E 66.1 General.** An approved drainage system shall be provided in RV parks for conveying and disposing of sewage. Where available, parks shall be connected to a public sewer system.

### E 67.0 Materials.

**E 67.1 General.** Pipe and fittings installed in the drainage system shall be of material listed, approved, and installed in accordance with this code.

### E 68.0 Pipe Sizes.

**E 68.1 General.** The minimum diameters of drainage laterals, branches, and mains serving RV sites shall be in accordance with Table E 68.1.

TABLE E 68.1
PIPE SIZES

| MAXIMUM NUMBER OF RECREATIONAL VEHICLE STANDS SERVED | MINIMUM PIPE SIZES (inches) |
|---|---|
| 5 | 3 |
| 36 | 4 |
| 71 | 5 |
| 120 | 6 |
| 440 | 8 |

For SI units: 1 inch = 25 mm

### E 69.0 Sewer Lines.

**E 69.1 General.** Sewer lines shall be located to prevent damage from vehicular traffic.

### E 70.0 Cleanouts.

**E 70.1 General.** Cleanouts shall be provided in accordance with Chapter 7 of this code.

## Part J
## Recreational Vehicle Site Drainage System Inlet.

### E 71.0 Sewer Riser Pipe.

**E 71.1 General.** Where provided, the site drainage system inlet connections for individual RVs shall be located so as to prevent damage by the parking of RVs or automobiles and shall consist of a sewer riser extending vertically to grade. The minimum diameter of the sewer riser pipe shall be not less than 3 inches (80 mm) in diameter, and shall be provided with a 4 inch (100 mm) inlet or not less than a 3 inch (80 mm) female fitting.

### E 72.0 Location.

**E 72.1 General.** Where provided, the sewer inlet to individual RV sites shall be located on the left rear half of the site (left side of the RV) within 4 feet (1219 mm) of the stand.

### E 73.0 Protection.

**E 73.1 General.** The sewer riser pipe shall be firmly imbedded in the ground and protected against damage from movement. It shall be provided with a tight-fitting plug or cap, which shall be secured by a durable chain (or equivalent) to prevent loss.

## Part K
## Recreational Vehicle Park Sanitary Disposal Stations.

### E 74.0 Where Required.

**E 74.1 General.** One RV sanitary disposal station shall be provided for each 100 RV sites, or part thereof, which are not equipped with individual drainage system connections.

### E 75.0 Access.

**E 75.1 General.** Each station shall be level and convenient of access from the service road and shall provide easy ingress and egress for recreational vehicles.

### E 76.0 Construction.

**E 76.1 General.** Unless other approved means are used, each station shall have a concrete slab with the drainage system inlet located so as to be on the road (left) side of the recreational vehicle. The slab shall be not less than 3 feet by 3 feet (914 mm by 914 mm), not less than 3½ inches (89 mm) thick and properly reinforced. The slab surface is to be troweled to a smooth finish and sloped from each side inward to a drainage system inlet.

The drainage system inlet shall consist of a 4 inch (102 mm), self-closing, foot-operated hatch of approved material with the cover milled to fit tight. The hatch body shall be set in the concrete of the slab with the lip of the opening flush with its surface to facilitate the cleansing of the slab with water. The hatch shall be properly connected to a drainage system inlet, which shall discharge to an approved sanitary sewage disposal facility.

### E 77.0 Flushing Device.

**E 77.1 General.** Where the recreational vehicle park is provided with a piped water supply system, means for flushing the recreational vehicle holding tank and the sanitary disposal station slab shall be provided that consists of a piped supply of water under pressure, terminating in an outlet located and installed so as to prevent damage by automobiles or recreational vehicles. The flushing device shall consist of a properly supported riser terminating not less than 2 feet (610 mm) above the ground surface, with a ¾ of an inch (20 mm) valved outlet adaptable for a flexible hose.

The water supply to the flushing device shall be protected from backflow by means of a listed vacuum breaker or backflow prevention device located downstream from the last shutoff valve.

Adjacent to the flushing arrangement shall be posted a sign of durable material not less than 2 feet by 2 feet (610 mm by 610 mm) in size. Inscribed thereon in clearly legible letters shall be the following:

"DANGER – NOT TO BE USED FOR DRINKING OR DOMESTIC PURPOSES."

## Part L
## Recreational Vehicle Park Water Supply Stations.

### E 78.0 Potable Watering Stations.

**E 78.1 General.** A potable watering station, where provided for filling recreational vehicle potable water tanks, shall be located not less than 50 feet (15 240 mm) from a sanitary disposal station. Where such is provided, adjacent to the potable water outlet there shall be a posted sign of durable material not less than 2 feet by 2 feet (610 mm by 610 mm) in size. Inscribed thereon in clear legible letters on a contrasting background shall be:

"POTABLE WATER. NOT TO BE USED FOR FLUSHING WASTE TANKS."

The potable water shall be protected from backflow by means of a listed vacuum breaker located downstream from the last shutoff valve.

## Part M
## Recreational Vehicle Park Fuel Gas Equipment and Installations.

### E 79.0 Fuel Gas Equipment.

**E 79.1 General.** Fuel gas equipment and installations shall comply with Part D of this appendix, except as otherwise permitted or required by this code.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## APPENDIX F - FIREFIGHTER BREATHING AIR REPLENISHMENT SYSTEMS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |

# APPENDIX F

## FIREFIGHTER BREATHING AIR REPLENISHMENT SYSTEMS

**F 1.0 General.**

**F 1.1 Applicability.** This chapter covers minimum requirements for the installation of firefighter breathing air replenishment systems.

**F 2.0 Definitions.**

For purposes of this chapter, the following definitions shall apply:

**High-Rise Building.** A building where the floor of an occupiable story exceeds 75 feet (22 860 mm) above the lowest level of fire department vehicle access. [NFPA 5000:3.3.64.10]

**Interior Cylinder Fill Panels.** Lockable interior panels that provide firefighters the ability to regulate breathing air pressure and refill SCBA cylinders.

**Interior Cylinder Fill Stations and Enclosures.** Free-standing fill containment stations that provide firefighters the ability to regulate breathing air pressure and refill SCBA cylinders.

**Open-Circuit Self-Contained Breathing Apparatus.** An SCBA in which exhalation is vented to the atmosphere and not rebreathed. [NFPA 1981:3.3.29]

**Self-Contained Breathing Apparatus (SCBA).** An atmosphere-supplying respirator that supplies a respirable air atmosphere to the user from a breathing source that is independent of the ambient environment and designed to be carried by the user. [NFPA 1981:3.3.40]

For the purposes of this appendix, where this term is used without a qualifier, it indicates an open-circuit self-contained breathing apparatus or combination SCBA/SARs. For the purposes of this appendix, combination SCBA/SARs are encompassed by the terms self-contained breathing apparatus or SCBA.

**Welding Procedure Specification (WPS).** A written qualified welding procedure prepared to provide direction for making production welds to code requirements. [ASME B31.1:100.2]

**F 3.0 System Components.**

**F 3.1 General.** Firefighter breathing air replenishment systems shall contain, as a minimum, the following components:

(1) Exterior fire department connection panel
(2) Interior fire department air fill panel or station
(3) Interconnected piping distribution system
(4) Pressure monitoring switch

**F 4.0 Required Installations.**

**F 4.1 General.** A firefighter air system shall be installed in the following buildings:

(1) High-rise buildings.
(2) Underground structures that are three or more floors below grade with an area greater than 20 000 square feet (1858 $m^2$).
(3) Large area structures with an area greater than 200 000 square feet (18 580 $m^2$) and where the travel distance from the building centerline to the closest exit is greater than 500 feet (152.4 m), such as warehouses, manufacturing complexes, malls, or convention centers.
(4) Underground transportation or pedestrian tunnels exceeding 500 feet (152.4 m) in length.

**F 5.0 Exterior Fire Department Connection Panel and Enclosure.**

**F 5.1 Purpose.** The exterior fire department connection panel shall provide the fire department's mobile air operator access to the system and shall be compatible with the fire department's mobile air unit.

**F 5.2 Number of Panels.** Each building or structure shall have a minimum of two panels.

**F 5.3 Location.** Each panel shall be attached to the building or on a remote monument at the exterior of the building with a minimum 6 foot (1829 mm) radius and 180-degree (3.14 rad) clear unobstructed access to the front of the panel. The panel shall be weather-resistant or secured inside of a weather-resistant enclosure. The panel shall be located on opposite sides of the building within 50 feet (15 240 mm) of an approved roadway or driveway, or other locations approved by the Authority Having Jurisdiction.

**F 5.4 Construction.** The fire department connection panel shall be installed in a metal cabinet constructed of not less than 18-gauge carbon steel or equivalent. The cabinet shall be provided with a coating or other means to protect the cabinet from corrosion.

**F 5.5 Vehicle Protection.** Where the panel is located in an area subject to vehicle traffic, impact protection shall be provided.

**F 5.6 Enclosure Marking.** The front of the enclosure shall be marked, "FIREFIGHTER AIR SYSTEM". The lettering shall be in a color that contrasts with the enclosure front and in letters that are not less than 2 inches (51 mm) high with ⅜ of an inch (9.5 mm) brush stroke.

**F 5.7 Enclosure Components.** The exterior fire department connection panel shall contain the necessary gauges, isolation valves, pressure-relief valves, pressure-regulating valves, check valves, tubing, fittings, supports, connectors, adapters, and other necessary components as required to allow the fire department's mobile air unit to connect and augment the system with a constant source of breathing air. Each fire department connection panel shall contain not less than two inlet air connections.

**F 5.8 Pressure-Relief Valve.** Pressure-relief valves shall be installed downstream of the pressure regulator inlet. The relief valve shall meet the requirements of CGA S-1.3 and shall not be field adjustable. The relief valve shall have a set-to-open pressure not exceeding 1.1 times the design pressure of the system. Pressure-relief valve discharge shall terminate so that the exhaust air stream cannot impinge upon personnel in the area. Valves, plugs, or caps shall not be installed in the discharge of a pressure-relief valve. Where discharge piping is used, the end shall not be threaded.

**F 5.9 Security.** The fire department connection panel enclosure shall be locked by an approved means.

**F 6.0 Interior Cylinder Fill Panels.**

**F 6.1 Cabinet Requirements.** Each cylinder fill panel shall be installed in a metal cabinet constructed of not less than 18-gauge carbon steel or equivalent. The depth of the cabinet shall not create an exit obstruction where installed in building stairwells. With the exception of the shutoff valve, pressure gauges, fill hoses, and ancillary components; no system components shall be visible and shall be contained behind a not less than 18-gauge interior panel.

**F 6.2 Clearance and Access.** The panel shall be located not less than 36 inches (914 mm) but not more than 60 inches (1524 mm) above the finished floor or a stairway landing. Clear unobstructed access shall be provided to each panel.

**F 6.3 Door.** The door shall be arranged such that where the door is open, it does not reduce the required exit width or create an obstruction in the path of egress.

**F 6.4 Cabinet Marking.** The front of each cylinder fill panel shall be marked, "FIREFIGHTER AIR SYSTEM". The lettering shall be in a color that contrasts with the cabinet front and in letters that are not less than 2 inches (51 mm) high with ⅜ of an inch (9.5 mm) brush stroke.

**F 6.5 Cabinet Components.** The cabinet shall be of a size to allow for the installation of the components in Section F 6.5.1.

**F 6.5.1 Cylinder Fill Panel.** The cylinder fill panel shall contain the gauges, isolation valves, pressure-relief valves, pressure-regulating valves, check valves, tubing, fittings, supports, connectors, hoses, adapters, and other components to refill SCBA cylinders.

**F 6.6 Cylinder Filling Hose.** The design of the cabinet shall provide a means for storing the hose to prevent kinking. Where the hose is coiled, the brackets shall be installed so that the hose bend radius is maintained at 4 inches (102 mm) or greater. Fill hose connectors for connection to SCBA cylinders shall comply with the requirements of CGA V-1, number 346 or 347. No other SCBA cylinder fill connections shall be permitted.

**F 6.7 Security.** Each panel cover shall be maintained and locked by an approved means.

**F 7.0 Interior Cylinder Fill Stations and Enclosures.**

**F 7.1 Location.** The location of the closet or room for each air fill station shall be approved by the Authority Having Jurisdiction. Where approved by the Authority Having Jurisdiction, the space shall be permitted to be utilized for other firefighting purposes. The door to each room enclosing the air filling station enclosure shall be readily accessible at all times. Not less than a 6 foot (1829 mm) radius and 180-degree (3.14 rad) clear unobstructed access to the front of the air filling station shall be provided. The enclosure shall have emergency lighting installed in accordance with NFPA 70.

**F 7.2 Security.** Each air fill station shall be installed within a lockable enclosure, closet, or room by an approved means. Access to fill equipment and controls shall be restricted to authorized personnel by key or other means.

**F 7.3 Components.** The air fill station shall contain the gauges, isolation valves, pressure-relief valves, pressure-regulating valves, check valves, tubing, fittings, supports, connectors, hoses, adapters, and other components to refill SCBA cylinders.

**F 7.4 Cylinder Filling Hose.** Where hoses are used, the design of the cabinet shall provide a means for storing the hose to prevent kinking. Where the hose is coiled, the brackets shall be installed so that the hose bend radius is maintained at 4 inches (102 mm) or greater. Fill hose connectors for connection to SCBA cylinders shall comply with the requirements of CGA V-1, no. 346 or 347. For high-pressure SCBA cylinders of 4500 pounds-force per square inch (psi) (31 026 kPa), no. 347 connectors shall be used. For low-pressure SCBA cylinders of 3000 psi (20 684 kPa) and 2200 psi (15 168 kPa), no. 346 connectors shall be used. No other SCBA cylinder fill connections shall be permitted.

**F 7.5 Enclosure and Air Filling Station Marking.** Each enclosure, closet, or room shall be marked, "FIREFIGHTERS AIR SYSTEM." The lettering shall be in a color that contrasts with the cabinet front and in letters that are not less than 2 inches (51 mm) high with ⅜ of an inch (9.5 mm) brush stroke.

**F 8.0 Materials.**

**F 8.1 General.** Pressurized components shall be compatible for use with high-pressure breathing air equipment and self-contained breathing air apparatus. Pressurized breathing air components shall be rated for not less than a working pressure of 5000 psi (34 474 kPa).

**F 8.2 Tubing.** Tubing shall be stainless steel in accordance with ASTM A 269, or other approved materials that are compatible with breathing air at the system pressure. Routing of tubing and bends shall be such as to protect the tubing from mechanical damage.

**F 8.3 Fittings.** Fittings shall be constructed of stainless steel in accordance with ASTM A 479, or other approved materials that are compatible with breathing air at the system pressure.

**F 8.4 Prohibited Materials.** The use of nonmetallic materials, carbon steel, iron pipe, malleable iron, high-strength gray iron, or alloy steel shall be prohibited for breathing air pipe and tubing materials.

**F 8.5 Pressure Monitoring Switch.** An electric low- pressure monitoring switch shall be installed in the piping system to monitor the air pressure. The pressure switch shall transmit a supervisory signal to the central alarm monitoring station where the pressure of the breathing air system is less than 80 percent of the system operating pressure. Activation of the pressure switch shall also activate an audible alarm and visual strobe located at the building annunciator panel. A weather-resistant sign shall be provided in conjunction with the audible alarm stating, "FIREFIGHTER AIR SYSTEM – LOW AIR PRESSURE ALARM." Where not part of a building annunciator panel, the lettering shall be in a contrasting color, and the letters shall be not less than 2 inches (51 mm) high with ⅜ of an inch (9.5 mm) brush stroke.

**F 8.6 Isolation Valve.** A system isolation valve shall be installed downstream of each air fill station and shall be located in the panel or within 3 feet (914 mm) of the station. The isolation valve shall be marked with its function in letters that are not less than 3⁄16 of an inch (4.8 mm) high with a 1⁄16 of an inch (1.6 mm) brushstroke.

**F 9.0 System Requirements.**

**F 9.1 Protection.** Components of the firefighter breathing air replenishment system installed in a building or structure shall be protected by not less than 2 hour fire-resistive construction. Components shall be protected from physical damage.

**F 9.2 Markings.** Components shall be clearly identified by means of stainless steel or plastic labels or tags indicating their function. This shall include not less than all fire department connection panels, air fill stations, air storage system, gauges, valves, air connections, air outlets, enclosures, and doors.

**F 9.3 Tubing Markings.** Tubing shall be clearly marked, "FIREFIGHTERS AIR SYSTEM" and "HIGH PRESSURE BREATHING AIR" by means of signs or self-adhesive labels. Signs shall be 1 inch (25.4 mm) high and shall be secured to the tubing. Signs shall be made of brass, stainless steel, or plastic and engraved with ⅜ of an inch (9.5 mm) letters with 1⁄16 of an inch (1.6 mm) stroke lettering. Signs or labels shall be placed at not less than 20 foot (6096 mm) intervals and at each fitting, whether the tubing is concealed or in plain view. Tubing shall have a sign or label at an accessible point.

**F 9.4 Support.** Pipe and tubing shall be supported at intervals not less than shown in Table 313.1 of this code. Pipe and tubing shall be supported in accordance with Section 313.0 of this code.

**F 10.0 Design Criteria.**

**F 10.1 Fill Time.** The system shall be designed to fill, at the most remote fill station or panel, not less than two 66 cubic foot ($ft^3$) (1.87 $m^3$) compressed breathing air cylinders to a pressure not to exceed 4500 psi (31 026 kPa) simultaneously in 3 minutes or less. Where greater capacity is required, the Authority Having Jurisdiction shall specify the required system capacity.

**F 10.2 Fill Panels or Stations Location.** Cylinder fill panels or stations shall be installed in the interior of buildings in accordance with Section F 10.2.1 through Section F 10.2.3.

**F 10.2.1 High-Rise Buildings.** An interior cylinder fill panel or station shall be installed commencing on the third floor and every third floor thereafter above grade. For underground floors in buildings with more than five underground floors, an interior cylinder fill panel or station shall be installed commencing on the third floor below grade and every three floors below grade thereafter, except for the bottom-most floor.

**F 10.2.2 Underground Structures.** For underground floors in buildings with more than five underground floors, an interior cylinder fill panel or station shall be installed commencing on the third floor below grade and every three floors below grade thereafter, except for the bottom-most floor.

**F 10.2.3 Installation Locations.** The specific location or locations on each floor shall be approved by the Authority Having Jurisdiction.

**F 11.0 System Assembly Requirements.**

**F 11.1 General.** The system shall be an all-welded system except where the tubing joints are readily accessible and at the individual air fill panels or stations. Where mechanical high-pressure tube fittings are used, they shall be approved for the type of materials to be joined and rated for the maximum pressure of the system.

**F 11.2 Welding Requirements.** Prior to and during the welding of sections of tubing, a continuous, regulated dry nitrogen or argon purge at 3 psi (21 kPa) shall be maintained to eliminate contamination with products of the oxidation or welding flux. The purge shall commence not less than 2 minutes prior to welding operations and continue until the welded joint is at ambient temperature. Welding procedures shall comply with the following requirements:

(1) Qualification of the WPS to be used, and of the performance of welders and operators, is required.

(2) No welding shall be done where there is impingement of rain, snow, sleet, or high wind on the weld area.

(3) Tack welds permitted to remain in the finished weld shall be made by a qualified welder. Tack welds made by an unqualified welder shall be removed. Tack welds which remain shall be made with an electrode and WPS which is the same as or equivalent to the electrode and WPS to be used for the first pass. The stopping and starting ends shall be prepared by grinding or other means so that they are capable of being satisfactory incorporated into the final weld. Tack welds which have cracked shall be removed.

(4) Arc strikes outside the area of the intended weld shall be avoided on a base material. [ASME B31.1:127.4.1]

**F 11.3 Prevention of Contamination.** The system components shall not be exposed to contaminants, including but not limited to, oils, solvents, dirt, and construction materials. Where contamination of system components has occurred, the affected component shall not be installed in the system.

**F 12.0 System Acceptance and Certification.**

**F 12.1 Static Pressure Testing.** Following fabrication, assembly, and installation of the piping distribution system, exterior connection panel, and interior cylinder fill panels, the Authority Having Jurisdiction shall witness the pneumatic testing of the complete system at a test pressure of not less than 7500 psi (51 711 kPa) using oil-free dry air, nitrogen, or argon. A pneumatic test of not less than 24 hours shall be performed. During this test, all fittings, joints, and system components shall be inspected for leaks. A solution compatible with the system component materials shall be used on each joint and fitting. Defects in the system or leaks detected shall be documented on an inspection report, repaired or replaced. As an alternate, a pressure-decay test in accordance with ASME B31.3 shall be permitted.

**F 12.2 Low Pressure Switch Test.** Upon successful completion of the 24 hour static pressure test, the system's low-pressure monitoring switch shall be calibrated to not less than 3000 psi (20 684 kPa) descending, and tested to verify that the signal is annunciated at the building's main fire alarm panel and by means of an audible alarm and visual strobe located in a visible location.

**F 12.3 Compatibility Check.** Each air fill panel and station, and each exterior fire department connection panel, shall be tested for compatibility with the fire department's SCBA fill fittings.

**F 12.4 Material Certifications.** The pipe or tubing material certifications shall be provided to the Authority Having Jurisdiction.

**F 12.5 Air Sampling.** Before the system is placed into service, a minimum of two samples shall be taken from separate air fill panels and submitted to an independent certified gas analysis laboratory to verify the system's cleanliness and that the air is in accordance with the following requirements for breathing air:

(1) Breathing air shall have oxygen content not less than 19.5 percent and not greater than 23.5 percent by volume.

(2) Breathing air shall not have a concentration of carbon monoxide exceeding 5.0 parts per million (ppm) by volume.

(3) Breathing air shall not have a concentration of carbon dioxide exceeding 1000 ppm by volume.

(4) Breathing air shall not have a concentration of condensed oil and particulate exceeding 7.2 E-11 pounds per cubic inch ($lb/in^3$) (2.0 $mg/m^3$) at 72°F (22°C) and 30 inches of Hg (102 kPa).

(5) Breathing air shall not have a concentration of water exceeding 24 ppm by volume.

(6) Breathing air shall not have a nonmethane VOC content exceeding 25 ppm as methane equivalents.

(7) Breathing air shall not have a pronounced or unusual odor.

(8) Breathing air shall have a concentration of nitrogen not less than 75 percent and not greater than 81 percent. [NFPA 1989:5.6]

The written report of the analysis shall be submitted to the Authority Having Jurisdiction, documenting that the breathing air is in accordance with this section.

**F 12.5.1 Air Quality Analysis.** During the period of air quality analysis, the air fill panel inlet shall be secured so that no air is capable of being introduced into the system and each air fill panel shall be provided with a sign stating, "AIR QUALITY ANALYSIS IN PROGRESS, DO NOT FILL OR USE ANY AIR FROM THIS SYSTEM." This sign shall be not less than 8½ inches (216 mm) by 11 inches (279 mm) with not less than 1 inch (25.4 mm) lettering.

**F 12.6 Annual Air Sampling.** The breathing air within the system shall be sampled and certified annually and inspected in accordance with the procedure in Section F 12.5.

**F 12.7 Final Proof Test.** The Authority Having Jurisdiction shall witness the filling of two empty 66 cubic foot ($ft^3$) (1.87 $m^3$) capacity SCBA cylinders in 3 minutes or less, using compressed air supplied by fire department equipment connected to the exterior fire department connection panel. The SCBA cylinders shall be filled at the air fill panel or station farthest from the exterior fire department connection panel. Following this, not less than two air samples shall then be taken from separate air filling stations and submitted to an independent certified gas analyst laboratory to verify the system's cleanliness and that the air is in accordance with the requirements of NFPA 1989. The written report shall be provided to the Authority Having Jurisdiction certifying that the air analysis is in accordance with the above requirements.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## APPENDIX G - SIZING OF VENTING SYSTEMS SERVING APPLIANCES EQUIPPED WITH DRAFT HOODS, CATEGORY I APPLIANCES, AND APPLIANCES LISTED FOR USE WITH TYPE B VENTS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |

# APPENDIX G

## SIZING OF VENTING SYSTEMS SERVING APPLIANCES EQUIPPED WITH DRAFT HOODS, CATEGORY I APPLIANCES, AND APPLIANCES LISTED FOR USE WITH TYPE B VENTS

(The content of this Appendix is based on Annex G of NFPA 54)

**G 1.0 Examples Using Single Appliance Venting Tables.** [See Figure G 1.0(a) through Figure G 1.0(n)]

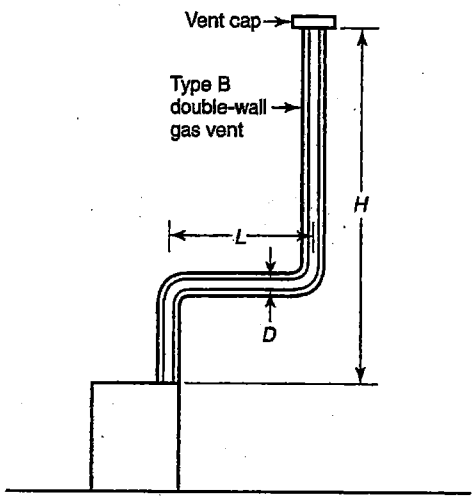



Table 510.1.2(1) is used where sizing a Type B double-wall gas vent connected directly to the appliance.

**Note:** The appliance is permitted to be either Category I draft hood-equipped or fan-assisted type.

**FIGURE G 1.0(a)**
**TYPE B DOUBLE-WALL VENT SYSTEM SERVING A SINGLE APPLIANCE WITH A TYPE B DOUBLE-WALL VENT**

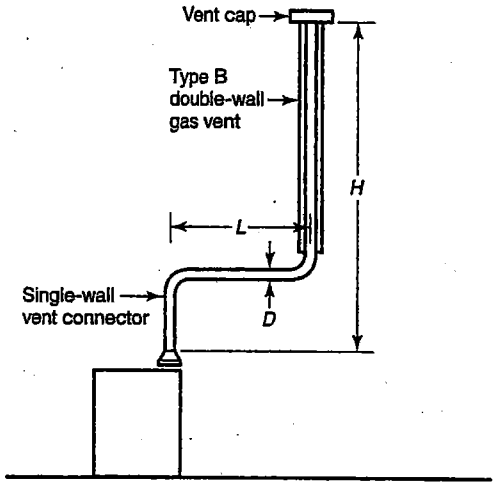



Table 510.1.2(2) is used where sizing a single-wall metal vent connector attached to a Type B double-wall gas vent.

**Note:** The appliance is permitted to be either Category I draft hood-equipped or fan-assisted type.

**FIGURE G 1.0(b)**
**TYPE B DOUBLE-WALL VENT SYSTEM SERVING A SINGLE APPLIANCE WITH A SINGLE-WALL METAL VENT CONNECTOR**

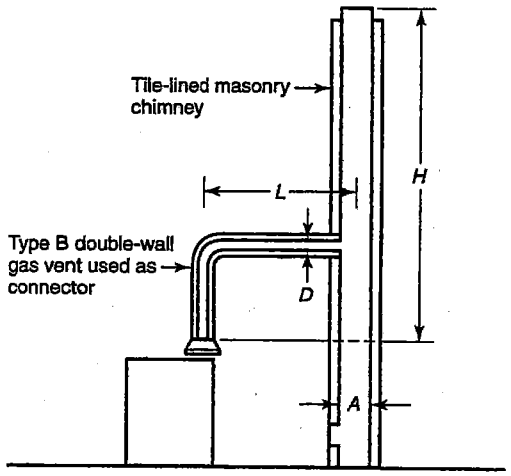



Table 510.1.2(3) is used where sizing a Type B double-wall gas vent connector attached to a tile-lined masonry chimney.

**Notes:**
1. *A* is the equivalent cross-sectional area of the tile liner.
2. The appliance is permitted to be either Category I draft hood-equipped or fan-assisted type.

**FIGURE G 1.0(c)**
**VENT SYSTEM SERVING A SINGLE APPLIANCE WITH A MASONRY CHIMNEY AND A TYPE B DOUBLE-WALL VENT CONNECTOR**

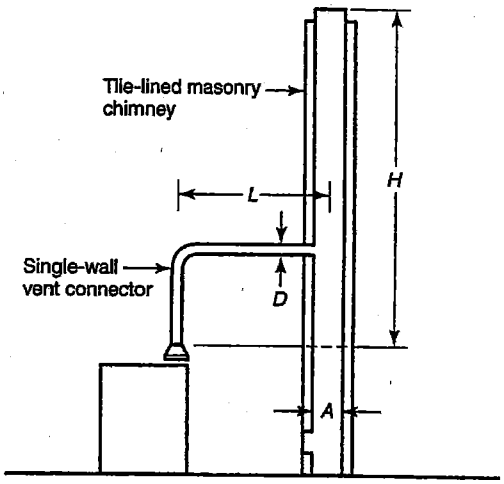
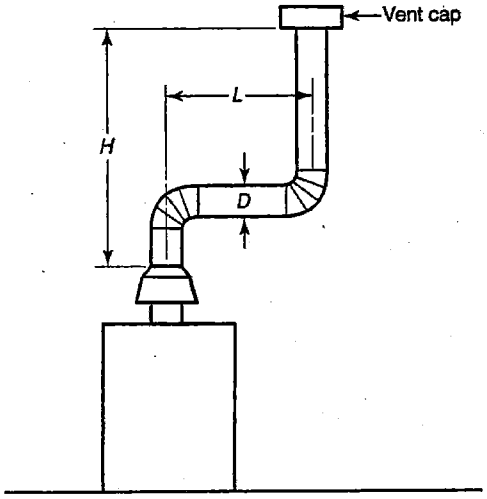



Table 510.1.2(4) is used where sizing a single-wall vent connector attached to a tile-lined masonry chimney.

**Notes:**
1. *A* is the equivalent cross-sectional area of the tile liner.
2. The appliance is permitted to be either Category I draft hood-equipped or fan-assisted type.

**FIGURE G 1.0(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 510.1.2(5)]

**FIGURE G 1.0(e)**
**ASBESTOS CEMENT TYPE B OR SINGLE-WALL METAL VENT SYSTEM SERVING A SINGLE DRAFT HOOD-EQUIPPED APPLIANCE**

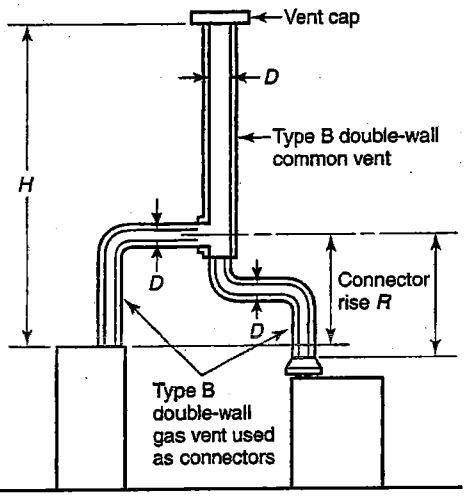



Table 510.2(1) is used where sizing Type B double-wall gas vent connectors attached to a Type B double-wall common vent.

**Note:** Each appliance is permitted to be either Category I draft hood-equipped or fan-assisted type.

**FIGURE G 1.0(f)**
**VENT SYSTEM SERVING TWO OR MORE APPLIANCES WITH TYPE B DOUBLE-WALL VENT AND TYPE B DOUBLE-WALL VENT CONNECTORS**

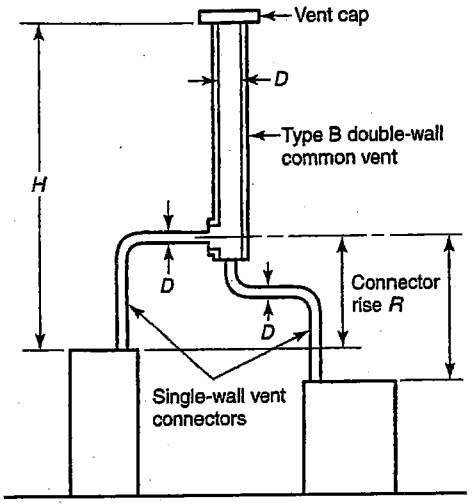



Table 510.2(2) is used where sizing single-wall vent connectors attached to a Type B double-wall common vent.

**Note:** Each appliance is permitted to be either Category I draft hood-equipped or fan-assisted type.

**FIGURE G 1.0(g)**
**VENT SYSTEM SERVING TWO OR MORE APPLIANCES WITH TYPE B DOUBLE-WALL VENT AND SINGLE-WALL METAL VENT CONNECTORS**

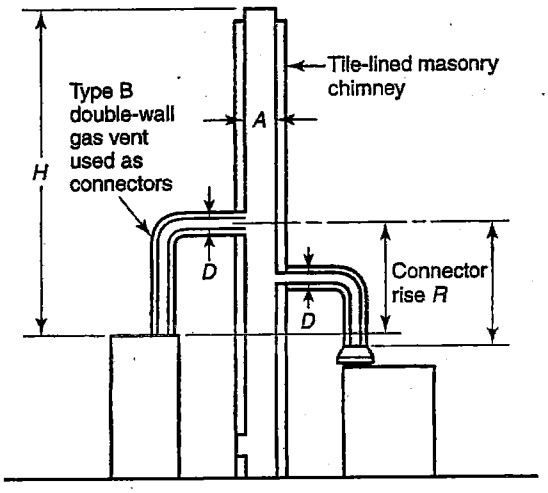



Table 510.2(3) is used where sizing Type B double-wall vent connectors attached to a tile-lined masonry chimney.

**Notes:**
1. *A* is the equivalent cross-sectional area of the tile liner.
2. The appliance is permitted to be either Category I draft hood-equipped or fan-assisted type.

**FIGURE G 1.0(h)**
**MASONRY CHIMNEY SERVING TWO OR MORE APPLIANCES WITH TYPE B DOUBLE-WALL VENT CONNECTORS**

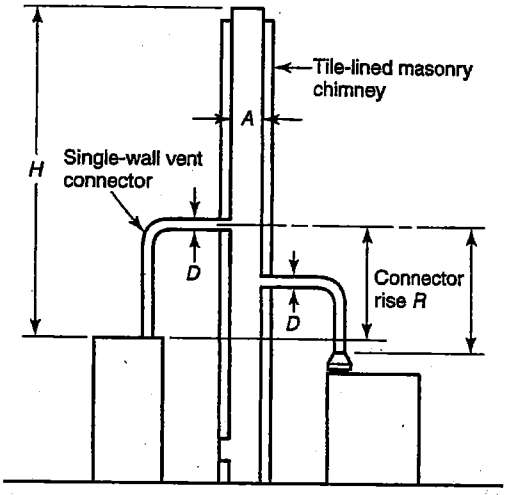


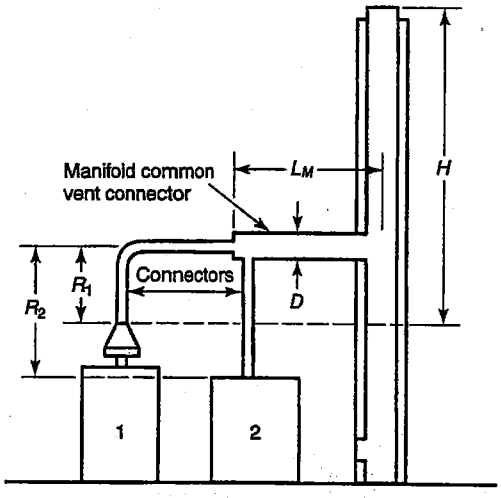

Table 510.2(4) is used where sizing single-wall metal vent connectors attached to a tile-lined masonry chimney.

**Notes:**

1 *A* is the equivalent cross-sectional area of the tile liner.

2. Each appliance is permitted to be either Category I draft hood-equipped or fan-assisted type.

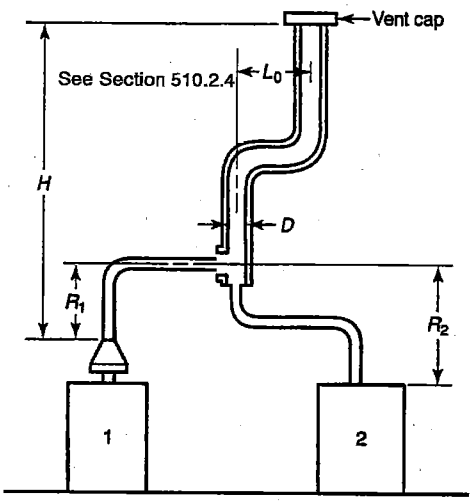
**FIGURE G 1.0(i)**
**MASONRY CHIMNEY SERVING TWO OR MORE APPLIANCES WITH SINGLE-WALL METAL VENT CONNECTORS**




Example: Manifolded common vent connector $L_M$ shall not exceed 18 times the common vent connector manifold inside diameter; that is, a 4 inch (102 mm) inside diameter common vent connector manifold shall not exceed 72 inches (1829 mm) in length.

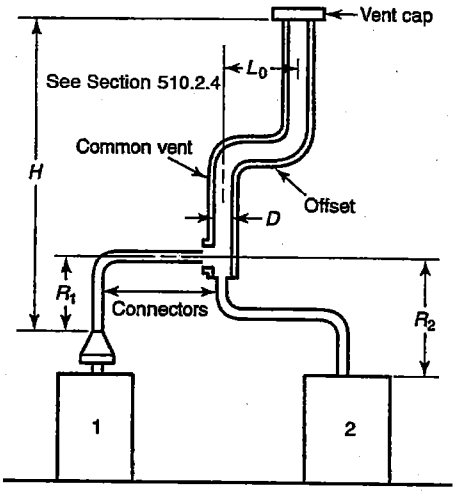
**Note:** This is an illustration of a typical manifolded vent connector. Different appliance, vent connector, or common vent types are possible.

**FIGURE G 1.0(k)**
**USE OF MANIFOLDED COMMON VENT CONNECTORS**




Asbestos cement Type B or single-wall metal pipe vent serving two or more draft hood-equipped appliances. [See Table 510.2(5)]

**FIGURE G 1.0(j)**
**ASBESTOS CEMENT TYPE B OR SINGLE-WALL METAL VENT SYSTEMS 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 1.0(l)**
**USE OF OFFSET COMMON VENT**

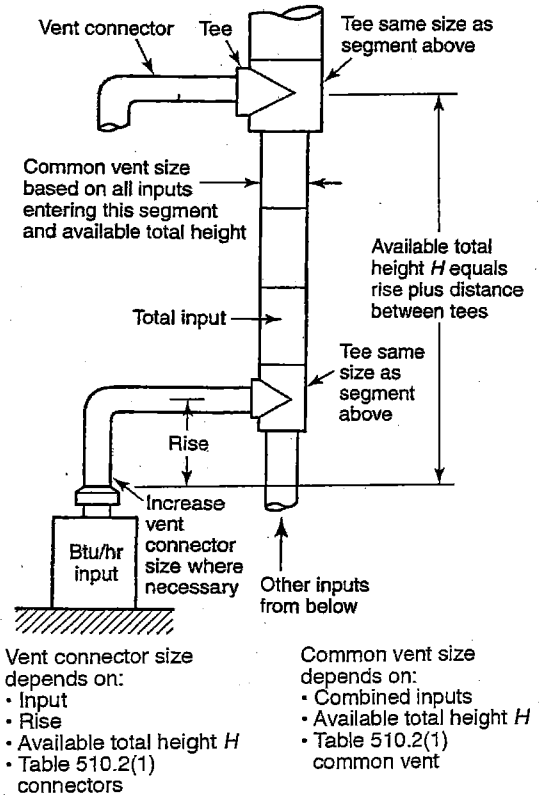



**FIGURE G 1.0(m)**
**MULTISTORY GAS VENT DESIGN PROCEDURE FOR EACH SEGMENT OF SYSTEM**

**G 1.1 Example 1: Single Draft Hood-Equipped Appliance.** An installer has a 120 000 British thermal units per hour (Btu/h) (35 kW) input appliance with a 5 inch (127 mm) diameter draft hood outlet that needs to be vented into a 10 foot (3048 mm) high Type B vent system. What size vent shall be used assuming: (1) a 5 foot (1524 mm) lateral single-wall metal vent connector is used with two 90 degree (1.57 rad) elbows or (2) a 5 foot (1524 mm) lateral single-wall metal vent connector is used with three 90 degree (1.57 rad) elbows in the vent system? (See Figure G 1.1)

Solution:

Table 510.1.2(2) shall be used to solve this problem because single-wall metal vent connectors are being used with a Type B vent, as follows:

(1) Read down the first column in Table 510.1.2(2) until the row associated with a 10 foot (3048 mm) height and 5 foot (1524 mm) lateral is found. Read across this row until a vent capacity exceeding 120 000 Btu/h (35 kW) is located in the shaded columns labeled NAT Max for draft hood-equipped appliances. In this case, a 5 inch (127 mm) diameter vent has a capacity of 122 000 Btu/h (35.7 kW) and shall be permitted to be used for this application.

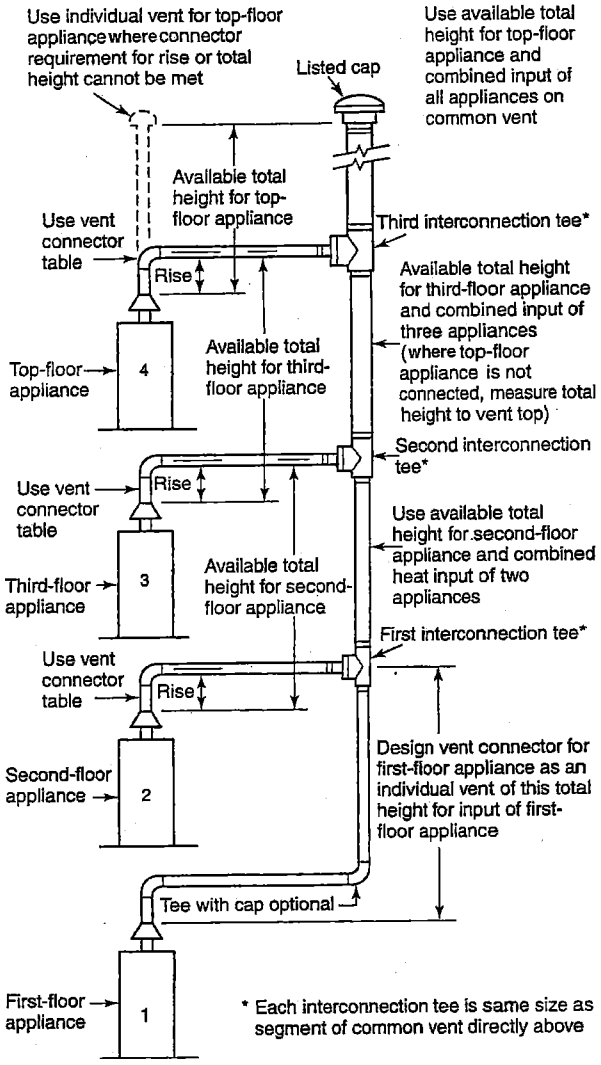



**FIGURE G 1.0(n)**
**PRINCIPLES OF DESIGN OF MULTISTORY VENTS USING VENT CONNECTOR AND COMMON VENT DESIGN TABLES**

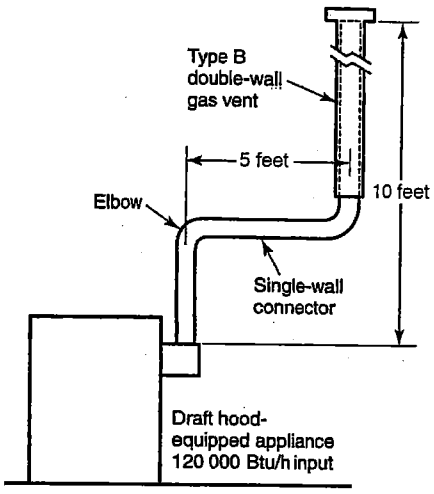
(2) Where three 90 degree (1.57 rad) elbows are used in the vent system, the maximum vent capacity listed in the tables shall be reduced by 10 percent. This implies that the 5 inch (127 mm) diameter vent has an adjusted capacity of 110 000 Btu/h (32 kW). In this case, the vent system shall be increased to 6 inches (152 mm) in diameter. See the following calculations:

122 000 Btu/h (35.7 kW) x 0.90 = 110 000 Btu/h (32 kW) for 5 inch (127 mm) vent

From Table 510.1.2(3), select 6 inch (152 mm) vent.

186 000 Btu/h (54.5 kW) x 0.90 = 167 000 Btu/h (49 kW)

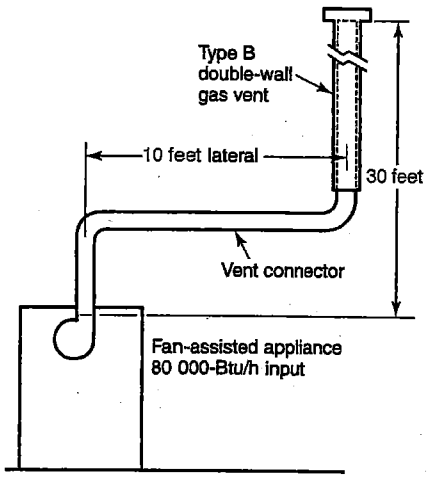
This figure is exceeding the required 120 000 Btu/h (35 kW). Therefore, use a 6 inch (152 mm) vent and connector where three elbows are used.




For SI units: 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW

**FIGURE G 1.1**
**SINGLE DRAFT HOOD-EQUIPPED APPLIANCE – EXAMPLE 1**

**G 1.2 Example 2: Single Fan-Assisted Appliance.** An installer has an 80 000 Btu/h (23.4 kW) input fan-assisted appliance that shall be installed using 10 feet (3048 mm) of lateral connector attached to a 30 foot high (9144 mm) Type B vent. Two 90 degree (1.57 rad) elbows are needed for the installation. Is a single-wall metal vent connector permitted to be used for this application? (See Figure G 1.2)




For SI units: 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW

**FIGURE G 1.2**
**SINGLE FAN-ASSISTED APPLIANCE – EXAMPLE 2**

Solution:

Table 510.1.2(2) refers to the use of single-wall metal vent connectors with Type B vent. In the first column find the row associated with a 30 foot (9144 mm) height and a 10 foot (3048 mm) lateral. Read across this row, looking at the FAN Min and FAN Max columns, to find that a 3 inch (76 mm) diameter single-wall metal vent connector is not recommended. Moving to the next larger size single-wall connector 4 inch (102 mm), we find that a 4 inch (102 mm) diameter single-wall metal connector has a recommended maximum vent capacity of 144 000 Btu/h (42 kW). The 80 000 Btu/h (23.4 kW) fan-assisted appliance is outside this range, so the conclusion is that a single-wall metal connector shall be used to vent the appliance. Table 510.1.2(2) shows the acceptable range of vent capacities for a 4 inch (102 mm) vent with 5 feet (1524 mm) of lateral to be between 72 000 Btu/h (21.1 kW) and 157 000 Btu/h (46 kW).

Where the appliance cannot be moved closer to the vertical vent, then a Type B vent shall be used as the connector material. In this case, Table 510.1.2(1) shows that, for a 30 foot (9144 mm) high vent with 10 feet (3048 mm) of lateral, the acceptable range of vent capacities for a 4 inch (102 mm) diameter vent attached to a fan-assisted appliance is between 37 000 Btu/h (10.8 kW) and 150 000 Btu/h (44 kW).

**G 1.3 Example 3: Interpolating Between Table Values.** An installer has an 80 000 Btu/h (23.4 kW) input appliance with a 4 inch (102 mm) diameter draft hood outlet that needs to be vented into a 12 foot (3658 mm) high Type B vent. The vent connector has a 5 foot (1524 mm) lateral length and is also Type B vent. Is this appliance permitted to be vented using a 4 inch (102 mm) diameter vent?

Solution:

Table 510.1.2(1) is used in the case of an all Type B Vent system. However, since there is no entry in Table 510.1.2(1) for a height of 12 feet (3658 mm), interpolation shall be used. Read down the 4 inch (102 mm) diameter NAT Max column to the row associated with a 10 foot (3048 mm) height and 5 foot (1524 mm) lateral to find the capacity value of 77 000 Btu/h (22.6 kW). Read further down to the 15 foot (4572 mm) height, 5 foot (1524 mm) lateral row to find the capacity value of 87 000 Btu/h (25.5 kW). The difference between the 15 foot (4572 mm) height capacity value and the 10 foot (3048 mm) height capacity value is 10 000 Btu/h (3 kW). The capacity for a vent system with a 12 foot (3658 mm) height is equal to the capacity for a 10 foot (3048 mm) height plus two-fifths of the difference between the 10 foot (3048 mm) and 15 foot (4572 mm) height values, or 77 000 Btu/h (22.6 kW) + ⅖ x 10 000 Btu/h (3 kW) = 81 000 Btu/h (23.7 kW). Therefore, a 4 inch (102 mm) diameter vent shall be used in the installation.

**G 2.0 Examples Using Common Venting Tables.**

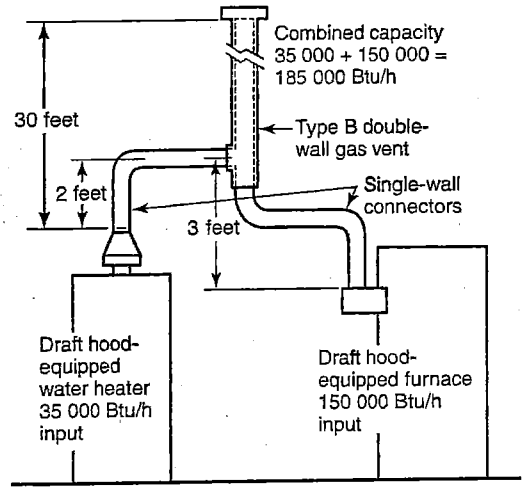
**G 2.1 Example 4: Common Venting Two Draft Hood-Equipped Appliances.** A 35 000 Btu/h (10.3 kW) water heater is to be common vented with a 150 000 Btu/h (44 kW) furnace, using a common vent with a total height of 30 feet (9144 mm). The connector rise is 2 feet (610 mm) for

the water heater with a horizontal length of 4 feet (1219 mm). The connector rise for the furnace is 3 feet (914 mm) with a horizontal length of 8 feet (2438 mm). Assume single-wall metal connectors will be used with Type B vent. What size connectors and combined vent should be used in this installation? (See Figure G 2.1)

Solution:

Table 510.2(2) shall be used to size single-wall metal vent connectors attached to Type B vertical vents. In the vent connector capacity portion of Table 510.2(2), find the row associated with a 30 foot (9144 mm) vent height. For a 2 foot (610 mm) rise on the vent connector for the water heater, read the shaded columns for draft hood-equipped appliances to find that a 3 inch (76 mm) diameter vent connector has a capacity of 37 000 Btu/h (10.8 kW). Therefore, a 3 inch (76 mm) single-wall metal vent connector shall be used with the water heater. For a draft hood-equipped furnace with a 3 foot (914 mm) rise, read across the row to find that a 5 inch (127 mm) diameter vent connector has a maximum capacity of 120 000 Btu/h (35 kW) (which is too small for the furnace), and a 6 inch (152 mm) diameter vent connector has a maximum vent capacity of 172 000 Btu/h (50 kW). Therefore, a 6 inch (152 mm) diameter vent connector shall be used with the 150 000 Btu/h (44 kW) furnace. Since both vent connector horizontal lengths are less than the maximum lengths listed in Section 510.2.1, the table values shall be used without adjustments.

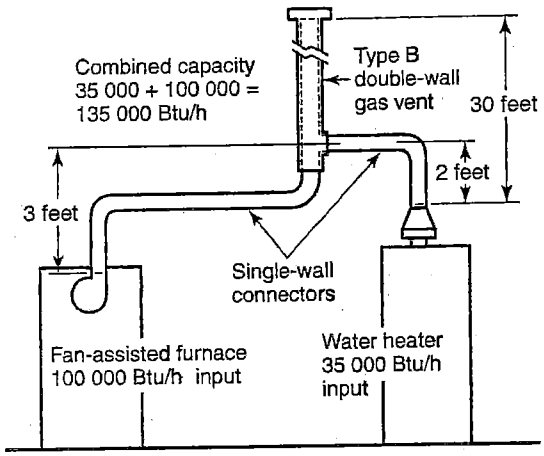
In the common vent capacity portion of Table 510.2(2), find the row associated with a 30 foot (9144 mm) vent height and read over to the NAT + NAT portion of the 6 inch (152 mm) diameter column to find a maximum combined capacity of 257 000 Btu/h (75 kW). Since the two appliances total 185 000 Btu/h (54 kW), a 6 inch (152 mm) common vent shall be used.




For SI units: 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW

**FIGURE G 2.1**
**COMMON VENTING TWO DRAFT HOOD-EQUIPPED APPLIANCES – EXAMPLE 4**

**G 2.2 Example 5(a): Common Venting a Draft Hood-Equipped Water Heater with a Fan-Assisted Furnace into a Type B Vent.** In this case, a 35 000 Btu/h (10.3 kW) input draft hood-equipped water heater with a 4 inch (102 mm) diameter draft hood outlet, 2 feet (610 mm) of connector rise, and 4 feet (1219 mm) of horizontal length is to be common vented with a 100 000 Btu/h (29 kW) fan-assisted furnace with a 4 inch (102 mm) diameter flue collar, 3 feet (914 mm) of connector rise, and 6 feet (1829 mm) of horizontal length. The common vent consists of a 30 foot (9144 mm) height of Type B vent. What are the recommended vent diameters for each connector and the common vent? The installer would like to use a single-wall metal vent connector. (See Figure G 2.2)




For SI units: 1 foot = 304.8 mm, 1000 British thermal units per hour = 0.293 kW

**FIGURE G 2.2**
**COMMON VENTING A DRAFT HOOD-EQUIPPED WATER HEATER WITH A FAN-ASSISTED FURNACE INTO A TYPE B DOUBLE-WALL COMMON VENT – EXAMPLE 5(a)**

Solution [see Table 510.2(2)]:

*Water Heater Vent Connector Diameter.* Since the water heater vent connector horizontal length of 4 feet (1219 mm) is less than the maximum value listed in Table 510.2(2), the venting table values shall be used without adjustment. Using the Vent Connector Capacity portion of Table 510.2(2), read down the Total Vent Height (*H*) column to 30 feet (9144 mm) and read across the 2 feet (610 mm) Connector Rise (*R*) row to the first Btu/h rating in the NAT Max column that is equal to or exceeding the water heater input rating. The table shows that a 3 inch (76 mm) vent connector has a maximum input rating of 37 000 Btu/h (10.8 kW). Although this rating is exceeding the water heater input rating, a 3 inch (76 mm) vent connector is prohibited by Section 510.2.20. A 4 inch (102 mm) vent connector has a maximum input rating of 67 000 Btu/h (19.6 kW) and is equal to the draft hood outlet diameter. A 4 inch (102 mm) vent connector is selected. Since the water

heater is equipped with a draft hood, there are no minimum input rating restrictions.

*Furnace Vent Connector Diameter.* Using the Vent Connector Capacity portion of Table 510.2(2), read down the Total Vent Height (*H*) column to 30 feet (9144 mm) and across the 3 feet (914 mm) Connector Rise (*R*) row. Since the furnace has a fan-assisted combustion system, find the first FAN Max column with a Btu/h rating exceeding the furnace input rating. The 4 inch (102 mm) vent connector has a maximum input rating of 119 000 Btu/h (34.9 kW) and a minimum input rating of 85 000 Btu/h (24.9 kW).

The 100 000 Btu/h (29 kW) furnace in this example falls within this range, so a 4 inch (102 mm) connector shall be permitted. Since the furnace vent connector horizontal length of 6 feet (1829 mm) is less than the maximum value listed in Section 510.2.1, the venting table values shall be used without adjustment. Where the furnace had an input rating of 80 000 Btu/h (23.4 kW), then a Type B vent connector shall be needed in order to meet the minimum capacity limit. [See Table 510.2(1)]

*Common Vent Diameter.* The total input to the common vent is 135 000 Btu/h (40 kW). Using the Common Vent Capacity portion of Table 510.2(2), read down the Vent Height (*H*) column to 30 feet (9144 mm) and across this row to find the smallest vent diameter in the FAN + NAT column that has a Btu/h rating equal to or exceeding 135 000 Btu/h (40 kW). The 4 inch (102 mm) common vent has a capacity of 132 000 Btu/h (39 kW) and the 5 inch (127 mm) common vent has a capacity of 202 000 Btu/h (59 kW). Therefore, the 5 inch (127 mm) common vent shall be used in this example.

Summary: In this example, the installer shall use a 4 inch (102 mm) diameter, single-wall metal vent connector for the water heater and a 4 inch (102 mm) diameter, single-wall metal vent connector for the furnace. The common vent shall be a 5 inch (127 mm) diameter Type B vent.

**G 2.3 Example 5(b): Common Venting into an Interior Masonry Chimney.** In this case, the water heater and fan-assisted furnace of Example 5(a) are to be common-vented into a clay-tile-lined masonry chimney with a 30 foot (9144 mm) height. The chimney is not exposed to the outdoors below the roof line. The internal dimensions of the clay tile liner are nominally 8 inches (203 mm) by 12 inches (305 mm). Assuming the same vent connector heights, laterals, and materials found in Example 5(a), what are the recommended vent connector diameters, and is this an acceptable installation?

Solution:

Table 510.2(4) is used to size common venting installations involving single-wall connectors into masonry chimneys.

*Water Heater Vent Connector Diameter.* Using Table 510.2(4), Vent Connector Capacity, read down the Vent Height (*H*) column to 30 feet (9144 mm), and read across

**TABLE G 2.3**
**MASONRY CHIMNEY LINER DIMENSIONS WITH CIRCULAR EQUIVALENTS***

| NOMINAL LINER SIZE (inches) | INSIDE DIMENSIONS OF LINER (inches) | INSIDE DIAMETER OR EQUIVALENT DIAMETER (inches) | EQUIVALENT AREA (square inches) |
|---|---|---|---|
| 4 x 8 | 2½ x 6½ | 4.0 | 12.2 |
| | | 5.0 | 19.6 |
| | | 6.0 | 28.3 |
| | | 7.0 | 38.3 |
| 8 x 8 | 6¾ x 6¾ | 7.4 | 42.7 |
| | | 8.0 | 50.3 |
| 8 x 12 | 6½ x 10½ | 9.0 | 63.6 |
| | | 10.0 | 78.5 |
| 12 x 12 | 9¾ x 9¾ | 10.4 | 83.3 |
| | | 11.0 | 95.0 |
| 12 x 16 | 9½ x 13½ | 11.8 | 107.5 |
| | | 12.0 | 113.0 |
| | | 14.0 | 153.9 |
| 16 x 16 | 13¼ x 13¼ | 14.5 | 162.9 |
| | | 15.0 | 176.7 |
| 16 x 20 | 13 x 17 | 16.2 | 206.1 |
| | | 18.0 | 254.4 |
| 20 x 20 | 16¾ x 16¾ | 18.2 | 260.2 |
| | | 20.0 | 314.1 |
| 20 x 24 | 16½ x 20½ | 20.1 | 314.2 |
| | | 22.0 | 380.1 |
| 24 x 24 | 20¼ x 20¼ | 22.1 | 380.1 |
| | | 24.0 | 452.3 |
| 24 x 28 | 20¼ x 24¼ | 24.1 | 456.2 |
| 28 x 28 | 24¼ x 24¼ | 26.4 | 543.3 |
| | | 27.0 | 572.5 |
| 30 x 30 | 25½ x 25½ | 27.9 | 607.0 |
| | | 30.0 | 706.8 |
| 30 x 36 | 25½ x 31½ | 30.9 | 749.9 |
| | | 33.0 | 855.3 |
| 36 x 36 | 31½ x 31½ | 34.4 | 929.4 |
| | | 36.0 | 1017.9 |

For SI units:1 inch = 25.4 mm, 1 square inch = 0.000645 $m^2$

* Where liner sizes differ dimensionally from those shown in this table, equivalent diameters shall be permitted to be determined from published tables for square and rectangular ducts of equivalent carrying capacity or by other engineering methods.

the 2 feet (610 mm) Connector Rise (*R*) row to the first Btu/h rating in the NAT Max column that is equal to or exceeding the water heater input rating. The table shows that a 3 inch (76 mm) vent connector has a maximum input of 31 000 Btu/h (9 kW), while a 4 inch (102 mm) vent connector has a maximum input of 57 000 Btu/h (16.7 kW). A 4 inch (102 mm) vent connector shall be used.

*Furnace Vent Connector Diameter.* Using the Vent Connector Capacity portion of Table 510.2(4), read down the total Vent Height (*H*) column to 30 feet (9144 mm) and across the 3 feet (914 mm) Connector Rise (*R*) row. Because the furnace has a fan-assisted combustion system, find the first FAN Max column with a Btu/h rating exceeding the furnace input rating. The 4 inch (102 mm) vent connector has a maximum input rating of 127 000 Btu/h (37 kW) and a minimum input rating of 95 000 Btu/h (27.8 kW). The 100 000 Btu/h (29 kW) furnace in this example falls within this range, so a 4 inch (102 mm) connector shall be permitted.

*Masonry Chimney.* From Table G 2.3, the equivalent area for a nominal liner size of 8 inches (203 mm) by 12 inches (305 mm) is 63.6 square inches (0.041 $m^2$). Using Table 510.2(4), Common Vent Capacity, read down the FAN + NAT column under the Minimum Internal Area of Chimney value of 63 to the row for 30 foot (9144 mm) height to find a capacity value of 739 000 Btu/h (217 kW). The combined input rating of the furnace and water heater, 135 000 Btu/h (40 kW), is less than the table value so this is an acceptable installation.

Section 510.2.16 requires the common vent area to not exceed seven times the smallest listed appliance categorized vent area, flue collar area, or draft hood outlet area. Both appliances in this installation have 4 inch (102 mm) diameter outlets. From Table G 2.3, the equivalent area for an inside diameter of 4 inches (102 mm) is 12.2 square inches (0.008 $m^2$). Seven times 12.2 equals 85.4, which is exceeding 63.6, so this configuration is acceptable.

**G 2.4 Example 5(c): Common Venting into an Exterior Masonry Chimney.** In this case, the water heater and fan-assisted furnace of Examples 5(a) and 5(b) are to be common-vented into an exterior masonry chimney. The chimney height, clay-tile-liner dimensions, and vent connector heights and laterals are the same as in Example 5(b). This system is being installed in Charlotte, North Carolina. Does this exterior masonry chimney need to be relined? Where so, what corrugated metallic liner size is recommended? What vent connector diameters are recommended? [See Table G 2.3 and Figure 510.1.2(6)]

Solution:

According to Section 510.2.19, Type B vent connectors are required to be used with exterior masonry chimneys. Use Table 510.2(8) and Table 510.2(9) to size FAN+NAT common venting installations involving Type-B double-wall connectors into exterior masonry chimneys.

The local 99 percent winter design temperature needed to use Table 510.2(8) and Table 510.2(9) shall be found in the ASHRAE Handbook – Fundamentals. For Charlotte, North Carolina, this design temperature is 19°F (-7.2°C).

*Chimney Liner Requirement.* As in Example 5(b), use the 63 square inches (0.04 $m^2$) column of Table 510.2(8) to the 30 foot (9144 mm) height row to find that the combined appliance maximum input is 747 000 Btu/h (218.9 kW). The combined input rating of the appliance in this installation, 135 000 Btu/h (40 kW), is less than the maximum value, so this criterion is satisfied. Table 510.2(9), at a 19°F (-7.2°C) design temperature, and at the same vent height and internal area used earlier, shows that the minimum allowable input rating of a space-heating appliance is 470 000 Btu/h (137.7 kW). The furnace input rating of 100 000 Btu/h (29 kW) is less than this minimum value. So this criterion is not satisfied, and an alternative venting design shall be used, such as a Type B vent shown in Example 5(a) or a listed chimney liner system shown in the rest of the example.

According to Section 510.2.18, Table 510.2(1) or Table 510.2(2) are used for sizing corrugated metallic liners in masonry chimneys, with the maximum common vent capacities reduced by 20 percent. This example will be continued assuming Type B vent connectors.

*Water Heater Vent Connector Diameter.* Using Table 510.2(1) Connector Capacity, read down the total Vent Height (*H*) column to 30 feet (9144 mm), and read across the 2 feet (610 mm) Connector Rise (*R*) row to the first Btu/hour rating in the NAT Max column that is equal to or exceeding the water heater input rating. The table shows that a 3 inch (76 mm) vent connector has a maximum capacity of 39 000 Btu/h (11.4 kW). Although this rating is exceeding the water heater input rating, a 3 inch (76 mm) vent connector is prohibited by Section 510.2.20. A 4 inch (102 mm) vent connector has a maximum input rating of 70 000 Btu/h (20.5 kW) and is equal to the draft hood outlet diameter. A 4 inch (102 mm) vent connector is selected.

*Furnace Vent Connector Diameter.* Using Table 510.2(1), Vent Connector Capacity, read down the total Vent Height (*H*) column to 30 feet (9144 mm), and read across the 3 feet (914 mm) Connector Rise (*R*) row to the first Btu/h rating in the FAN MAX column that is equal to or exceeding the furnace input rating. The 100 000 Btu/h (29 kW) furnace in this example falls within this range, so a 4 inch (102 mm) connector shall be permitted.

*Chimney Liner Diameter.* The total input to the common vent is 135 000 Btu/h (40 kW). Using the Common Vent Capacity portion of Table 510.2(1), read down the total Vent Height (*H*) column to 30 feet (9144 mm) and across this row to find the smallest vent diameter in the FAN + NAT column that has a Btu/h rating exceeding 135 000 Btu/h (40 kW). The 4 inch (102 mm) common vent has a capacity of 138 000 Btu/h (40.4 kW). Reducing

the maximum capacity by 20 percent results in a maximum capacity for a 4 inch (102 mm) corrugated liner of 110 000 Btu/h (32 kW), less than the total input of 135 000 Btu/h (40 kW). So a larger liner is needed. The 5 inch (127 mm) common vent capacity listed in Table 510.2(1) is 210 000 Btu/h (62 kW), and after reducing by 20 percent is 168 000 Btu/h (49.2 kW). Therefore, a 5 inch (127 mm) corrugated metal liner shall be used in this example.

*Single Wall Connectors.* Once it has been established that relining the chimney is necessary, Type B double-wall vent connectors are not specifically required. This example shall be permitted to be redone using Table 510.2(2) for single-wall vent connectors. For this case, the vent connector and liner diameters would be the same as found for Type B double-wall connectors.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## APPENDIX H - PRIVATE SEWAGE DISPOSAL SYSTEMS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | X | | X | X | | | X | X | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |

# APPENDIX H

## PRIVATE SEWAGE DISPOSAL SYSTEMS

**H 1.0 Private Sewage Disposal.**

**H 1.1 General Requirements.** Where permitted by Section 713.0, the building sewer shall be permitted to be connected to a private sewage disposal system in accordance with the provisions of this appendix. The type of system shall be determined on the basis of location, soil porosity, and groundwater level, and shall be designed to receive all sewage from the property. The system, except as otherwise approved, shall consist of a septic tank with effluent discharging into a subsurface disposal field, into one or more seepage pits, or into a combination of subsurface disposal field and seepage pits. The Authority Having Jurisdiction shall be permitted to grant exceptions to the provisions of this appendix for permitted structures that have been destroyed due to fire or natural disaster and that cannot be reconstructed in compliance with these provisions provided that such exceptions are the minimum necessary.

**H 1.2 Quantity and Quality.** Where the quantity or quality of the sewage is such that the above system cannot be expected to function satisfactorily for commercial, agricultural, and industrial plumbing systems; for installations where appreciable amounts of industrial or indigestible wastes are produced; for occupancies producing abnormal quantities of sewage or liquid waste; or where grease interceptors are required by other parts of this code, the method of sewage treatment and disposal shall be first approved by the Authority Having Jurisdiction. Special sewage disposal systems for minor, limited, or temporary uses shall be first approved by the Authority Having Jurisdiction.

**H 1.3 Septic Tank and Disposal Field Systems.** Disposal systems shall be designed to utilize the most porous or absorptive portions of the soil formation. Where the groundwater level extends to within 12 feet (3658 mm) or less of the ground surface or where the upper soil is porous and the underlying stratum is rock or impervious soil, a septic tank and disposal field system shall be installed.

**H 1.4 Flood Hazard Areas.** Disposal systems shall be located outside of flood hazard areas.

**Exception:** Where suitable sites outside of flood hazard areas are not available, disposal systems shall be permitted to be located in flood hazard areas on sites where the effects of inundation under conditions of the design flood are minimized.

**H 1.5 Design.** Private sewage disposal systems shall be so designed that additional seepage pits or subsurface drain fields, equivalent to not less than 100 percent of the required original system, shall be permitted to be installed where the original system cannot absorb all the sewage. No division of the lot or erection of structures on the lot shall be made where such division or structure impairs the usefulness of the 100 percent expansion area.

**H 1.6 Capacity.** No property shall be improved in excess of its capacity to properly absorb sewage effluent by the means provided in this code.

**Exception:** The Authority Having Jurisdiction shall be permitted to, at its discretion, approve an alternate system.

**H 1.7 Location.** No private sewage disposal system, or part thereof, shall be located in any lot other than the lot that is the site of the building or structure served by such private sewage disposal system, nor shall any private sewage disposal system or part thereof be located at any point having less than the minimum distances indicated in Table H 1.7.

Nothing contained in this code shall be construed to prohibit the use of all or part of an abutting lot to provide additional space for a private sewage disposal system or part thereof where proper cause, transfer of ownership, or change of boundary not in violation of other requirements has been first established to the satisfaction of the Authority Having Jurisdiction. The instrument recording such action shall constitute an agreement with the Authority Having Jurisdiction, which shall clearly state and show that the areas so joined or used shall be maintained as a unit during the time they are so used. Such agreement shall be recorded in the office of the County Recorder as part of the conditions of ownership of said properties and shall be binding on heirs, successors, and assigns to such properties. A copy of the instrument recording such proceedings shall be filed with the Authority Having Jurisdiction.

**H 1.8 Building Permit.** Where there is insufficient lot area or improper soil conditions for sewage disposal for the building or land use proposed, and the Authority Having Jurisdiction so finds, no building permit shall be issued and no private sewage disposal shall be permitted. Where space or soil conditions are critical, no building permit shall be issued until engineering data and test reports satisfactory to the Authority Having Jurisdiction have been submitted and approved.

**H 1.9 Additional Requirements.** Nothing contained in this appendix shall be construed to prevent the Authority Having Jurisdiction from requiring compliance with additional requirements than those contained herein, where such additional requirements are essential to maintain a safe and sanitary condition.

**H 1.10 Alternate Systems.** Alternate systems shall be permitted to be used by special permission of the Authority Having Jurisdiction after being satisfied of their adequacy. This authorization is based on extensive field and test data from conditions similar to those at the proposed site, or require such additional data as necessary to provide assurance that the alternate system will produce continuous and long-range results at the proposed site, not less than equivalent to systems which are specifically authorized.

Where demonstration systems are to be considered for installation, conditions for installation, maintenance, and

**TABLE H 1.7**
**LOCATION OF SEWAGE DISPOSAL SYSTEM**

| MINIMUM HORIZONTAL DISTANCE IN CLEAR REQUIRED FROM | BUILDING SEWER | SEPTIC TANK | DISPOSAL FIELD | SEEPAGE PIT OR CESSPOOL |
|---|---|---|---|---|
| Building or structures[1] | 2 feet | 5 feet | 8 feet | 8 feet |
| Property line adjoining private property | Clear[2] | 5 feet | 5 feet | 8 feet |
| Water supply wells | 50 feet[3] | 50 feet | 100 feet | 150 feet |
| Streams and other bodies of water | 50 feet | 50 feet | 100 feet[7] | 150 feet[7] |
| Trees | – | 10 feet | – | 10 feet |
| Seepage pits or cesspools[8] | – | 5 feet | 5 feet | 12 feet |
| Disposal field[8] | – | 5 feet | 4 feet[4] | 5 feet |
| On-site domestic water service line | 1 foot[5] | 5 feet | 5 feet | 5 feet |
| Distribution box | – | – | 5 feet | 5 feet |
| Pressure public water main | 10 feet[6] | 10 feet | 10 feet | 10 feet |

For SI units: 1 foot = 304.8 mm

**Notes:**

[1] Including porches and steps, whether covered or uncovered, breezeways, roofed porte cocheres, roofed patios, carports, covered walks, covered driveways, and similar structures or appurtenances.

[2] See Section 312.3.

[3] Drainage piping shall clear domestic water supply wells by not less than 50 feet (15 240 mm). This distance shall be permitted to be reduced to not less than 25 feet (7620 mm) where the drainage piping is constructed of materials approved for use within a building.

[4] Plus 2 feet (610 mm) for each additional 1 foot (305 mm) of depth in excess of 1 foot (305 mm) below the bottom of the drain line. (See Section H 6.0)

[5] See Section 720.0.

[6] For parallel construction – For crossings, approval by the Health Department shall be required.

[7] These minimum clear horizontal distances shall also apply between disposal fields, seepage pits, and the mean high-tide line.

[8] Where disposal fields, seepage pits, or both are installed in sloping ground, the minimum horizontal distance between any part of the leaching system and ground surface shall be 15 feet (4572 mm).

monitoring at each such site shall first be established by the Authority Having Jurisdiction.

Approved aerobic systems shall be permitted to be substituted for conventional septic tanks provided the Authority Having Jurisdiction is satisfied that such systems will produce results not less than equivalent to septic tanks, whether their aeration systems are operating or not.

### H 2.0 Capacity of Septic Tanks.

**H 2.1 General.** The liquid capacity of septic tanks shall comply with Table H 2.1 and Table H 2.1(1) as determined by the number of bedrooms or apartment units in dwelling occupancies and the estimated waste/sewage design flow rate or the number of plumbing fixture units as determined from Table 702.1 of this code, whichever is greater in other building occupancies. The capacity of any one septic tank and its drainage system shall be limited by the soil structure classification in Table H 2.1(2), and as specified in Table H 2.1(3).

### H 3.0 Area of Disposal Fields and Seepage Pits.

**H 3.1 General.** The minimum effective absorption area in disposal fields in square feet ($m^2$), and in seepage pits in square feet ($m^2$) of sidewall, shall be predicated on the required septic tank capacity in gallons (liters), estimated waste/sewage flow rate, or whichever is greater, and shall be in accordance with Table H 2.1(2) as determined for the type of soil found in the excavation, and shall be as follows:

(1) Where disposal fields are installed, not less than 150 square feet (13.9 $m^2$) of trench bottom shall be provided for each system exclusive of any hard pan, rock, clay, or other impervious formations. Sidewall area in excess of the required 12 inches (305 mm) and not exceeding 36 inches (914 mm) below the leach line shall be permitted to be added to the trench bottom area where computing absorption areas.

(2) Where leaching beds are permitted in lieu of trenches, the area of each such bed shall be not less than 50 percent greater than the tabular requirements for trenches. Perimeter sidewall area in excess of the required 12 inches (305 mm) and not exceeding 36 inches (914 mm) below the leach line shall be permitted to be added to the trench bottom area where computing absorption areas.

(3) No excavation for a leach line or leach bed shall be located within 5 feet (1524 mm) of the water table nor to a depth where sewage is capable of contaminating the underground water stratum that is usable for domestic purposes.

**Exception:** In areas where the records or data indicate that the groundwaters are grossly degraded, the 5 foot (1524 mm) separation requirement shall be permitted to be reduced by the Authority Having Jurisdiction.

## TABLE H 2.1
## CAPACITY OF SEPTIC TANKS[1, 2, 3, 4]

| SINGLE-FAMILY DWELLINGS - NUMBER OF BEDROOMS | MULTIPLE DWELLING UNITS OR APARTMENTS - ONE BEDROOM EACH | OTHER USES: MAXIMUM FIXTURE UNITS SERVED PER TABLE 702.1 | MINIMUM SEPTIC TANK CAPACITY (gallons) |
|---|---|---|---|
| 1 or 2 | – | 15 | 750 |
| 3 | – | 20 | 1000 |
| 4 | 2 units | 25 | 1200 |
| 5 or 6 | 3 | 33 | 1500 |
| – | 4 | 45 | 2000 |
| – | 5 | 55 | 2250 |
| – | 6 | 60 | 2500 |
| – | 7 | 70 | 2750 |
| – | 8 | 80 | 3000 |
| – | 9 | 90 | 3250 |
| – | 10 | 100 | 3500 |

For SI units: 1 gallon = 3.785 L

**Notes:**

[1] Extra bedroom, 150 gallons (568 L) each.

[2] Extra dwelling units over 10: 250 gallons (946 L) each.

[3] Extra fixture units over 100: 25 gallons (94.6 L) per fixture unit.

[4] Septic tank sizes in this table include sludge storage capacity and the connection of domestic food waste disposal units without further volume increase.

## TABLE H 2.1(1)
## ESTIMATED WASTE/SEWAGE FLOW RATES[1, 2, 3]

| TYPE OF OCCUPANCY | GALLONS PER DAY |
|---|---|
| 1. Airports | 15 per employee |
| | 5 per passenger |
| 2. Auto washers | Check with equipment manufacturer |
| 3. Bowling alleys (snack bar only) | 75 per lane |
| 4. Camps: | |
| Campground with central comfort station | 35 per person |
| Campground with flush toilets, no showers | 25 per person |
| Day camps (no meals served) | 15 per person |
| Summer and seasonal | 50 per person |
| 5. Churches (Sanctuary) | 5 per seat |
| with kitchen waste | 7 per seat |
| 6. Dance halls | 5 per person |
| 7. Factories | |
| no showers | 25 per employee |
| with showers | 35 per employee |
| Cafeteria, add | 5 per employee |
| 8. Hospitals | 250 per bed |
| kitchen waste only | 25 per bed |
| laundry waste only | 40 per bed |
| 9. Hotels (no kitchen waste) | 60 per bed (2 person) |
| 10. Institutions (Resident) | 75 per person |
| Nursing home | 125 per person |
| Rest home | 125 per person |
| 11. Laundries, self-service | |
| (minimum 10 hours per day) | 50 per wash cycle |
| Commercial | Per manufacturer's specifications |
| 12. Motel | 50 per bed space |
| with kitchen | 60 per bed space |
| 13. Offices | 20 per employee |

**TABLE H 2.1(1) (continued)**
**ESTIMATED WASTE/SEWAGE FLOW RATES[1, 2, 3]**

14. Parks, mobile homes ..... 250 per space
    Picnic parks (toilets only) ..... 20 per parking space
    Recreational vehicles
        without water hook-up ..... 75 per space
        with water and sewer hook-up ..... 100 per space
15. Restaurants – cafeterias ..... 20 per employee
    toilet ..... 7 per customer
    kitchen waste ..... 6 per meal
    add for garbage disposal ..... 1 per meal
    add for cocktail lounge ..... 2 per customer
    kitchen waste – disposable service ..... 2 per meal
16. Schools – Staff and office ..... 20 per person
    Elementary students ..... 15 per person
    Intermediate and high ..... 20 per student
        with gym and showers, add ..... 5 per student
        with cafeteria, add ..... 3 per student
    Boarding, total waste ..... 100 per person
17. Service station, toilets ..... 1000 for 1st bay
    500 for each additional bay
18. Stores ..... 20 per employee
    Public restrooms, add ..... 1 per 10 square feet of floor space
19. Swimming pools, public ..... 10 per person
20. Theaters, auditoriums ..... 5 per seat
    Drive-in ..... 10 per space

For SI units: 1 square foot = 0.0929 $m^2$, 1 gallon per day = 3.785 L/day

**Notes:**

[1] Sewage disposal systems sized using the estimated waste/sewage flow rates shall be calculated as follows:

(a) Waste/sewage flow, up to 1500 gallons per day (5678 L/day)

Flow x 1.5 = septic tank size

(b) Waste/sewage flow, over 1500 gallons per day (5678 L/day)

Flow x 0.75 + 1125 = septic tank size

(c) Secondary system shall be sized for total flow per 24 hours.

[2] See Section H 2.1.

[3] Because of the many variables encountered, it is not possible to set absolute values for waste/sewage flow rates for all situations. The designer should evaluate each situation and, where figures in this table need modification, they should be made with the concurrence of the Authority Having Jurisdiction.

**TABLE H 2.1(2)**
**DESIGN CRITERIA OF FIVE TYPICAL SOILS**

| TYPE OF SOIL | REQUIRED SQUARE FEET OF LEACHING AREA PER 100 GALLONS | MAXIMUM ABSORPTION CAPACITY IN GALLONS PER SQUARE FEET OF LEACHING AREA FOR A 24 HOUR PERIOD |
|---|---|---|
| Coarse sand or gravel | 20 | 5.0 |
| Fine sand | 25 | 4.0 |
| Sandy loam or sandy clay | 40 | 2.5 |
| Clay with considerable sand or gravel | 90 | 1.1 |
| Clay with small amount of sand or gravel | 120 | 0.8 |

For SI units: 1 square foot = 0.0929 $m^2$, 1 gallon = 3.785 L, 1 gallon per square foot = 40.7 $L/m^2$

TABLE H 2.1(3)
LEACHING AREA SIZE BASED ON SEPTIC TANK CAPACITY

| REQUIRED SQUARE FEET OF LEACHING AREA PER 100 GALLONS SEPTIC TANK CAPACITY (square feet per 100 gallons) | MAXIMUM SEPTIC TANK SIZE ALLOWABLE (gallons) |
|---|---|
| 20–25 | 7500 |
| 40 | 5000 |
| 90 | 3500 |
| 120 | 3000 |

For SI units: 1 square foot per 100 gallons = 0.000245 $m^2$/L, 1 gallon = 3.785 L

The applicant shall supply evidence of groundwater depth to the satisfaction of the Authority Having Jurisdiction.

(4) The minimum effective absorption area in any seepage pit shall be calculated as the excavated sidewall area below the inlet exclusive of any hardpan, rock, clay, or other impervious formations. The minimum required area of porous formation shall be provided in one or more seepage pits. No excavation shall extend within 10 feet (3048 mm) of the water table nor to a depth where sewage is capable of contaminating underground water stratum that is usable for domestic purposes.

**Exception:** In areas where the records or data indicate that the groundwaters are grossly degraded, the 10 foot (3048 mm) separation requirement shall be permitted to be reduced by the Authority Having Jurisdiction.

The applicant shall supply evidence of groundwater depth to the satisfaction of the Authority Having Jurisdiction.

(5) Leaching chambers shall be sized on the bottom absorption area (nominal unit width) in square feet. The required area shall be calculated using Table H 2.1(2) with a 0.70 multiplier.

## H 4.0 Percolation Test.

**H 4.1 Pit Sizes.** Where practicable, disposal field and seepage pit sizes shall be computed from Table H 2.1(2). Seepage pit sizes shall be computed by percolation tests, unless use of Table H 2.1(2) is approved by the Authority Having Jurisdiction.

**H 4.2 Absorption Qualities.** In order to determine the absorption qualities of seepage pits and of questionable soils other than those listed in Table H 2.1(2), the proposed site shall be subjected to percolation tests acceptable to the Authority Having Jurisdiction.

**H 4.3 Absorption Rates.** Where a percolation test is required, no private disposal system shall be permitted to serve a building where that test shows the absorption capacity of the soil is less than 0.83 gallons per square foot (gal/$ft^2$) (33.8 L/$m^2$) or more than 5.12 gal/$ft^2$ (208.6 L/$m^2$) of leaching area per 24 hours. Where the percolation test shows an absorption rate greater than 5.12 gal/$ft^2$ (208.6 L/$m^2$) per 24 hours, a private disposal system shall be permitted where the site does not overlie groundwaters protected for drinking water supplies, a minimum thickness of 2 feet (610 mm) of the native soil below the entire proposed system is replaced by loamy sand, and the system design is based on percolation tests made in the loamy sand.

## H 5.0 Septic Tank Construction.

**H 5.1 Plans.** Plans for septic tanks shall be submitted to the Authority Having Jurisdiction for approval. Such plans shall show dimensions, reinforcing, structural calculations, and such other pertinent data as required.

**H 5.2 Design.** Septic tank design shall be such as to produce a clarified effluent consistent with accepted standards and shall provide adequate space for sludge and scum accumulations.

**H 5.3 Construction.** Septic tanks shall be constructed of solid durable materials not subject to excessive corrosion or decay and shall be watertight.

**H 5.4 Compartments.** Septic tanks shall have not less than two compartments unless otherwise approved by the Authority Having Jurisdiction. The inlet compartment of any septic tank shall be not less than two-thirds of the total capacity of the tank, nor less than 500 gallons (1892 L) liquid capacity, and shall be not less than 3 feet (914 mm) in width and 5 feet (1524 mm) in length. Liquid depth shall be not less than 2½ feet (762 mm) nor more than 6 feet (1829 mm). The secondary compartment of a septic tank shall have a capacity of not less than 250 gallons (946 L) and a capacity not exceeding one-third of the total capacity of such tank. In septic tanks having a 1500 gallon (5678 L) capacity, the secondary compartment shall be not less than 5 feet (1524 mm) in length.

**H 5.5 Access.** Access to each septic tank shall be provided by not less than two manholes 20 inches (508 mm) in minimum dimension or by an equivalent removable cover slab. One access manhole shall be located over the inlet and one access manhole shall be located over the outlet. Where a first compartment exceeds 12 feet (3658 mm) in length, an additional manhole shall be provided over the baffle wall.

**H 5.6 Pipe Opening Sizes.** The inlet and outlet pipe openings shall not be larger in size than the connecting sewer pipe. The vertical leg of round inlet and outlet fittings shall not be less in size than the connecting sewer pipe nor less

than 4 inches (102 mm). A baffle-type fitting shall have the equivalent cross-sectional area of the connecting sewer pipe and not less than a 4 inch (102 mm) horizontal dimension where measured at the inlet and outlet pipe inverts.

**H 5.7 Pipe Extension.** The inlet and outlet pipe or baffle shall extend 4 inches (102 mm) above and not less than 12 inches (305 mm) below the water surface. The invert of the inlet pipe shall be at a level not less than 2 inches (51 mm) above the invert of the outlet pipe.

**H 5.8 Free Vent Area.** Inlet and outlet pipe fittings or baffles and compartment partitions shall have a free vent area equal to the required cross-sectional area of the house sewer or private sewer discharging therein to provide free ventilation above the water surface from the disposal field or seepage pit through the septic tank, house sewer, and stack to the outer air.

**H 5.9 Sidewalls.** The sidewalls shall extend not less than 9 inches (229 mm) above the liquid depth. The cover of the septic tank shall be not less than 2 inches (51 mm) above the back vent openings.

**H 5.10 Partitions and Baffles.** Partitions or baffles between compartments shall be of solid, durable material and shall extend not less than 4 inches (102 mm) above the liquid level. The transfer port between compartments shall be a minimum size equivalent to the tank inlet, but in no case less than 4 inches (102 mm) in size, shall be installed in the inlet compartment side of the baffle so that the entry into the port is placed 65 percent to 75 percent in the depth of the liquid. Wooden baffles are prohibited.

**H 5.11 Structural Design.** The structural design of septic tanks shall comply with the following requirements:

(1) Each such tank shall be structurally designed to withstand all anticipated earth or other loads. Septic tank covers shall be capable of supporting an earth load of not less than 500 pounds per square foot ($lb/ft^2$) (2441 $kg/m^2$) where the maximum coverage does not exceed 3 feet (914 mm).

(2) In flood hazard areas, tanks shall be anchored to counter buoyant forces during conditions of the design flood. The vent termination and service manhole of the tank shall be not less than 2 feet (610 mm) above the design flood elevation or fitted with covers designed to prevent the inflow of floodwater or the outflow of the contents of the tanks during conditions of the design flood.

**H 5.12 Manholes.** Septic tanks installed under concrete or blacktop paving shall have the required manholes accessible by extending the manhole openings to grade in a manner acceptable to the Authority Having Jurisdiction.

**H 5.13 Materials.** The materials used for constructing a septic tank shall be in accordance with the following:

(1) Materials used in constructing a concrete septic tank shall be in accordance with applicable standards in Table 1401.1.

(2) The minimum wall thickness of a steel septic tank shall be number 12 U.S. gauge (0.109) (2.77 mm), and each such tank shall be protected from corrosion both externally and internally by an approved bituminous coating or by other acceptable means.

(3) Septic tanks constructed of alternate materials shall be permitted to be approved by the Authority Having Jurisdiction where in accordance with approved applicable standards. Wooden septic tanks shall be prohibited.

**H 5.14 Prefabricated Septic Tanks.** Prefabricated septic tanks shall comply with the following requirements:

(1) Manufactured or prefabricated septic tanks shall comply with approved applicable standards and be approved by the Authority Having Jurisdiction.

(2) Independent laboratory tests and engineering calculations certifying the tank capacity and structural stability shall be provided as required by the Authority Having Jurisdiction.

**H 6.0 Disposal Fields.**

**H 6.1 Distribution Lines.** Distribution lines shall be constructed of clay tile laid with open joints, perforated clay pipe, perforated bituminous fiber pipe, perforated high-density polyethylene pipe, perforated ABS pipe, perforated PVC pipe, or other approved materials, provided that approved openings are available for distribution of the effluent into the trench area.

**H 6.2 Filter Material.** Before placing filter material or drain lines in a prepared excavation, smeared or compacted surfaces shall be removed from trenches by raking to a depth of 1 inch (25.4 mm) and the loose material removed. Clean stone, gravel, slag, or similar filter material acceptable to the Authority Having Jurisdiction, varying in size from ¾ of an inch to 2½ inches (19.1 mm to 64 mm), shall be placed in the trench to the depth and grade required by this section. Drain pipe shall be placed on filter material in an approved manner. The drain lines shall then be covered with filter material to the minimum depth required by this section, and this material covered with untreated building paper, straw, or similar porous material to prevent closure of voids with earth backfill. No earth backfill shall be placed over the filter material cover until after inspection and acceptance.

**Exception:** Listed or approved plastic leaching chambers shall be permitted to be used in lieu of pipe and filter material. Chamber installations shall follow the rules for disposal fields, where applicable, and shall be in accordance with the manufacturer's instructions.

**H 6.3 Grade Board.** A grade board staked in the trench to the depth of filter material shall be utilized where the distribution line is constructed with drain tile or a flexible pipe material that will not maintain alignment without continuous support.

**H 6.4 Seepage Pits.** Where seepage pits are used in combination with disposal fields, the filter material in the trenches shall terminate not less than 5 feet (1524 mm) from the pit excavation, and the line extending from such points to the seepage pit shall be approved pipe with watertight joints.

**H 6.5 Distribution Boxes.** Where two or more drain lines are installed, an approved distribution box of sufficient size to receive lateral lines shall be installed at the head of each disposal field. The inverts of outlets shall be level, and the invert of the inlet shall be not less than 1 inch (25.4 mm) above the outlets. Distribution boxes shall be designed to ensure equal flow and shall be installed on a level concrete slab in natural or compacted soil.

**H 6.6 Laterals.** Laterals from a distribution box to the disposal field shall be approved pipe with watertight joints. Multiple disposal field laterals, where practicable, shall be of uniform length.

**H 6.7 Connections.** Connections between a septic tank and a distribution box shall be laid with approved pipe with watertight joints on natural ground or compacted fill.

**H 6.8 Dosing Tanks.** Where the quantity of sewage exceeds the amount that is permitted to be disposed in 500 lineal feet (152.4 m) of leach line, a dosing tank shall be used. Dosing tanks shall be equipped with an automatic siphon or pump that discharges the tank once every 3 or 4 hours. The tank shall have a capacity equal to 60 to 75 percent of the interior capacity of the pipe to be dosed at one time. Where the total length of pipe exceeds 1000 lineal feet (304.8 m), the dosing tank shall be provided with two siphons or pumps dosing alternately and each serving one-half of the leach field.

**H 6.9 Construction.** Disposal fields shall be constructed in accordance with Table H 6.9.

Minimum spacing between trenches or leaching beds shall be not less than 4 feet (1219 mm) plus 2 feet (610 mm) for each additional foot (305 mm) of depth in excess of 1 foot (305 mm) below the bottom of the drain line. Distribution drain lines in leaching beds shall be not more than 6 feet (1829 mm) apart on centers, and no part of the perimeter of the leaching bed shall exceed 3 feet (914 mm) from a distribution drain line. Disposal fields, trenches, and leaching beds shall not be paved over or covered by concrete or a material that is capable of reducing or inhibiting a possible evaporation of sewer effluent.

**H 6.10 Joints.** Where necessary on sloping ground to prevent excessive line slope, leach lines or leach beds shall be stepped. The lines between each horizontal section shall be made with watertight joints and shall be designed so each horizontal leaching trench or bed shall be utilized to the maximum capacity before the effluent shall pass to the next lower leach line or bed. The lines between each horizontal leaching section shall be made with approved watertight joints and installed on natural or unfilled ground.

**H 7.0 Seepage Pits.**

**H 7.1 Capacity.** The capacity of seepage pits shall be based on the quantity of liquid waste discharging thereinto and on the character and porosity of the surrounding soil, and shall be in accordance with Section H 3.0 of this appendix.

**H 7.2 Multiple Installations.** Multiple seepage pit installations shall be served through an approved distribution box or be connected in series by means of a watertight connection laid on undistributed or compacted soil. The outlet from the pit shall have an approved vented leg fitting extending not less than 12 inches (305 mm) below the inlet fitting.

**H 7.3 Construction.** A seepage pit shall be circular in shape and shall have an excavated diameter of not less than 4 feet (1219 mm). Each such pit shall be lined with approved-type whole new hard-burned clay brick, concrete brick, concrete circular-type cesspool blocks, or other approved materials. Approval shall be obtained prior to construction for any pit having an excavated diameter greater than 6 feet (1829 mm).

**H 7.4 Lining.** The lining in a seepage pit shall be laid on a firm foundation. Lining materials shall be placed tight together and laid with joints staggered. Except in the case of approved-type precast concrete circular sections, no brick or block shall be greater in height than its width, and shall be laid flat to form not less than a 4 inch (102 mm) wall. Brick or block greater than 12 inches (305 mm) in length shall have chamfered matching ends and be scored to provide for seepage. Excavation voids behind the brick, block, or concrete liner shall have not less than 6 inches (152 mm) of clean ¾ of an inch (19.1 mm) gravel or rock.

**H 7.5 Brick and Block.** Brick or block used in seepage pit construction shall have a compressive strength of not less than 2500 pounds per square inch (lb/in$^2$) (1 757 674 kg/m$^2$).

**TABLE H 6.9**
**GENERAL DISPOSAL FIELD REQUIREMENTS**

| | MINIMUM | MAXIMUM |
|---|---|---|
| Number of drain lines per field | 1 | – |
| Length of each line | – | 100 feet |
| Bottom width of trench | 18 inches | 36 inches |
| Spacing of lines, center-to-center | 6 feet | – |
| Depth of earth cover of lines (preferred –18 inches) | 12 inches | – |
| Grade of lines | Level | 3 inches per 100 feet |
| Filter material under drain lines | 12 inches | – |
| Filter material over drain lines | 2 inches | – |

For SI units: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 inch per foot = 83.3 mm/m

**H 7.6 Sidewall.** A seepage pit shall have a minimum sidewall (not including the arch) of 10 feet (3048 mm) below the inlet.

**H 7.7 Arch and Dome.** The arch or dome of a seepage pit shall be permitted to be constructed in one of three ways:

(1) Approved-type hard-burned clay brick or solid concrete brick or block laid in cement mortar.

(2) Approved brick or block laid dry. In both of the above methods, an approved cement mortar covering of not less than 2 inches (51 mm) in thickness shall be applied, said covering to extend not less than 6 inches (152 mm) beyond the sidewalls of the pit.

(3) Approved-type one or two-piece reinforced concrete slabs of not less than 2500 lb/in$^2$ (1 757 674 kg/m$^2$) minimum compressive strength, not less than 5 inches (127 mm) thick, and designed to support an earth load of not less than 400 pounds per square foot (lb/ft$^2$) (1953 kg/m$^2$). Each such cover shall be provided with a 9 inch (229 mm) minimum inspection hole with plug or cover and shall be coated on the underside with an approved bituminous or other nonpermeable protective compound.

**H 7.8 Location.** The top of the arch or cover shall be not less than 18 inches (457 mm) but not exceed 4 feet (1219 mm) below the surface of the ground.

**H 7.9 Inlet Fitting.** An approved vented inlet fitting shall be provided in the seepage pit so arranged as to prevent the inflow from damaging the sidewall.

**Exception:** Where using a one- or two-piece concrete slab cover inlet, fitting shall be permitted to be a one-fourth bend fitting discharging through an opening in the top of the slab cover. On multiple seepage pit installations, the outlet fittings shall comply with Section H 7.2 of this appendix.

## H 8.0 Cesspools.

**H 8.1 Limitations.** A cesspool shall be considered as a temporary expedient pending the construction of a public sewer; as an overflow facility where installed in conjunction with an existing cesspool; or as a means of sewage disposal for limited, minor, or temporary uses, where first approved by the Authority Having Jurisdiction.

**H 8.2 Septic Tanks.** Where it is established that a public sewer system will be available in less than 2 years, and soil and groundwater conditions are favorable to cesspool disposal, cesspools without septic tanks shall be permitted to be installed for single-family dwellings or for other limited uses where first approved by the Authority Having Jurisdiction.

**H 8.3 Construction.** Each cesspool, where permitted, shall be in accordance with the construction requirements set forth in Section H 7.0 of this appendix for seepage pits and shall have a sidewall (not including arch) of not less than 20 feet (6096 mm) below the inlet, provided, however, that where a strata of gravel or equally pervious material of 4 feet (1219 mm) in thickness is found, the depth of such sidewall shall not exceed 10 feet (3048 mm) below the inlet.

**H 8.4 Existing Installations.** Where overflow cesspools or seepage pits are added to existing installations, the effluent shall leave the existing pit through an approved vented leg extending not less than 12 inches (305 mm) downward into such existing pit and having its outlet flow line not less than 6 inches (152 mm) below the inlet. Pipe between pits shall be laid with approved watertight joints.

## H 9.0 Commercial or Industrial Special Liquid-Waste Disposal.

**H 9.1 Interceptor.** Where liquid wastes contain excessive amounts of grease, garbage, flammable wastes, sand, or other ingredients that affect the operation of a private sewage disposal system, an interceptor for such wastes shall be installed.

**H 9.2 Installation.** Installation of such interceptors shall comply with Section 1009.0 of this code, and their location shall comply with Table H 1.7 of this appendix.

**H 9.3 Sampling Box.** A sampling box shall be installed where required by the Authority Having Jurisdiction.

**H 9.4 Design and Structural Requirement.** Interceptors shall be of approved design and be not less than two compartments. Structural requirements shall comply with Section H 5.0 of this appendix.

**H 9.5 Location.** Interceptors shall be located as close to the source as possible and be accessible for servicing. Necessary manholes for servicing shall be at grade level and be gastight.

**H 9.6 Waste Discharge.** Waste discharge from interceptors shall be permitted to be connected to a septic tank or other primary system or be disposed into a separate disposal system.

**H 9.7 Design Criteria.** A formula shall be permitted to be adapted to other types of occupancies with similar wastes. (See Chart H 9.7)

## H 10.0 Inspection and Testing.

**H 10.1 Inspection.** Inspection requirements shall comply with the following:

(1) Applicable provisions of Section 103.5 of this code and this appendix shall be required. Plans shall be required in accordance with Section 101.5 of this code.

(2) System components shall be properly identified as to manufacturer. Septic tanks or other primary systems shall have the rated capacity permanently marked on the unit.

(3) Septic tanks or other primary systems shall be installed on dry, level, well-compacted soil.

(4) Where design is predicated on soil tests, the system shall be installed at the same location and depth as the tested area.

**H 10.2 Testing.** Testing requirements shall comply with the following:

(1) Septic tanks or other primary components shall be filled with water to flow line prior to requesting

**CHART H 9.7**
**RECOMMENDED DESIGN CRITERIA**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **GREASE AND GARBAGE, COMMERCIAL KITCHENS** | | | | | | | | |
| Number of meals per peak hour | x | Waste flow rate[1] | x | Retention time[2] | x | Storage factor[3] | = | Interceptor size (liquid capacity) |
| **SAND-SILT OIL, AUTO WASHERS** | | | | | | | | |
| Number of vehicles per hour | x | Waste flow rate[1] | x | Retention time[2] | x | Storage factor[3] | = | Interceptor size (liquid capacity) |
| **SILT-LINT GREASE, LAUNDRIES, LAUNDROMATS** | | | | | | | | |
| Number of machines | x | 2 cycles per hour | x | Waste flow rate[1] | x | Retention time[2] | = | Storage factor[3] = Interceptor size (liquid capacity) |

**Notes:**

[1] Waste Flow Rate:
See Table H 2.1(1) of this appendix for estimated flow rates.

[2] Retention Times:
Commercial kitchen waste:
Dishwasher, disposal, or both ..... 2.5 hours
Single service kitchen:
Single serving with disposal ..... 1.5 hours
Sand-silt oil ..... 2.0 hours
Lint-silt (laundry) ..... 2.0 hours

[3] Storage Factors:
Fully equipped commercial kitchen ..... 8 hours operation: 1
16 hours operation: 2
24 hours operation: 3
Single service kitchen ..... 1.5
Auto washers ..... self-serve: 1.5
employee operated: 2
Laundries, laundromats ..... 1.5 (allows for rock filter)

inspection. Seams or joints shall be left exposed (except the bottom), and the tank shall remain watertight.

(2) A flow test shall be performed through the system to the point of effluent disposal. All lines and components shall be watertight. Capacities, required air space, and fittings shall comply with the provisions set forth in this appendix.

## H 11.0 Abandoned Sewers and Sewage Disposal Facilities.

**H 11.1 Plugged and Capped.** An abandoned building (house) sewer, or part thereof, shall be plugged or capped in an approved manner within 5 feet (1524 mm) of the property line.

**H 11.2 Fill Material.** A cesspool, a septic tank, or a seepage pit that has been abandoned or has been discontinued otherwise from further use, or to which no waste or soil pipe from a plumbing fixture is connected, shall have the sewage removed therefrom and be completely filled with the earth, sand, gravel, concrete, or other approved material.

**H 11.3 Filling Requirements.** The top cover or arch over the cesspool, septic tank, or seepage pit shall be removed before filling, and the filling shall not extend above the top of the vertical portions of the sidewalls or above the level of any outlet pipe until inspection has been called and the cesspool, septic tank, or seepage pit has been inspected. After such inspection, the cesspool, septic tank, or seepage pit shall be filled to the level of the top of the ground.

**H 11.4 Owner.** No person owning or controlling a cesspool, septic tank, or seepage pit on the premises of such person or in that portion of any public street, alley, or other public property abutting such premises shall fail, refuse, or neglect to be in accordance with the provisions of this section or upon receipt of notice so to be in accordance with the Authority Having Jurisdiction.

**H 11.5 Permittee.** Where disposal facilities are abandoned consequent to connecting any premises with the public sewer, the permittee making the connection shall fill all abandoned facilities in accordance with the Authority Having Jurisdiction within 30 days from the time of connecting to the public sewer.

## H 12.0 Drawings and Specifications.

**H 12.1 General.** The Authority Having Jurisdiction, Health Officer, or other department having jurisdiction shall be permitted to require the following information before a permit is issued for a private sewage disposal system or at a time during the construction thereof:

(1) Plot plan drawn to scale, completely dimensioned, showing direction and approximate slope of surface, location of present or proposed retaining walls, drainage channels, water supply lines or wells, paved areas and structures on the plot, number of bedrooms or plumbing fixtures in each structure, and location of

the private sewage disposal system with relation to lot lines and structures.

(2) Details of construction necessary to ensure compliance with the requirements of this appendix together with a full description of the complete installation including quality, kind, and grade of materials, equipment, construction, workmanship, and methods of assembly and installation.

(3) A log of soil formations and groundwater levels as determined by test holes dug in close proximity to a proposed seepage pit or disposal field, together with a statement of water absorption characteristics of the soil at the proposed site, as determined by approved percolation tests.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## APPENDIX I - INSTALLATION STANDARDS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | | | | | | | | X | X | X | X | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | X | | X | X | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |
| 2.2.6 IS 5-2006 | X | | X | X | | | | | | | | | | | | | | | |
| 1.2 IS 20-2010 | | | X | X | | | | | | | | | | | | | | | |
| 1.2.1 IS 20-2010 | | | X | X | | | | | | | | | | | | | | | |
| 1.2.2 IS 20-2010 | | | X | X | | | | | | | | | | | | | | | |

"The information contained in this appendix is not part of this American National Standard (ANS) and has not been processed in accordance with ANSI's requirements for an ANS. As such, this appendix may contain material that has not been subjected to public review or a consensus process. In addition, it does not contain requirements necessary for conformance to the standard."

## APPENDIX I
## INSTALLATION STANDARDS

The following IAPMO Installation Standards are included here for the convenience of the users of the Uniform Plumbing Code. They are not considered as a part of the Uniform Plumbing Code unless formally adopted as such. These Installation Standards are independent, stand-alone documents published by the International Association of Plumbing and Mechanical Officials and are printed herein by the expressed written permission of IAPMO.

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# INSTALLATION STANDARD FOR NON-METALLIC BUILDING SEWERS

# IAPMO IS 1-2006

**1.0 Scope.**

**1.1** Installation and material of non-metallic building sewer piping shall comply with this standard and the current edition of the Uniform Plumbing Code [UPC]™ published by the International Association of Plumbing and Mechanical Officials.

**Note:** The following sections of the Uniform Plumbing Code apply to non-metallic building sewer piping. The standard may include section numbers or may omit section numbers which pertain to non-metallic sewers.

| | |
|---|---|
| 103.5.6.3 | Exceptions |
| 301.1 | Minimum Standards |
| 309.0 | Workmanship |
| 310.0 | Prohibited Fittings and Practices |
| 312.0 | Protection of Piping, Materials, and Structures |
| 314.0 | Trenching, Excavation, and Backfill |
| 315.2 | Prohibited Joints and Connections |
| 316.0 | Increasers and Reducers |
| Chapter 7 | Sanitary Drainage |
| 705.0 | Joints and Connections |
| 705.11.3 | Plastic Pipe to Other Materials |
| 723.0 | Building Sewer Test |

**2.0 General Requirements.**

**2.1** After inspection of the sewer pipe, carefully backfill the trench as prescribed by Sections 314.0 of the Uniform Plumbing Code.

**2.2** The same water test procedure shall apply to all non-metallic house sewer materials as required in Section 723.0 of the Uniform Plumbing Code.

Before laying non-metallic sewer pipe, prepare the bottom trench so that the piping shall lay on a firm bed throughout its entire length as required by Section 718.0 of the Uniform Plumbing Code.

**3.0 Product Requirements.**

**3.1 ABS or PVC-DWV Pipe.**

**3.1.1 Minimum Standards.** ABS or PVC Schedule 40 DWV pipe for use in domestic sewage, excluding special waste, shall be installed in accordance with IAPMO Standards IS 5 and IS 9 (latest edition), whichever is applicable. ABS or PVC Schedule 40 DWV pipe, may be used in sizes 2 inch (51 mm) and larger. [UPC 301.1, 701.0]

**3.1.2 Markings.**

**3.1.2.1 ABS Pipe.** ABS pipe markings shall be in accordance with ASTM D 2661 or ASTM F 628. [UPC 716.0]

**3.1.2.2 ABS Fittings.** ABS fittings markings shall be in accordance with ASTM D 2661. [UPC 716.0]

**3.1.2.3 PVC Pipe.** PVC pipe markings shall be in accordance with ASTM D 2665. [UPC 716.0]

**3.1.2.4 PVC Fittings.** PVC fittings markings shall be in accordance with ASTM F 2135. [UPC 716.0]

**3.1.3 Protection of Building Sewers.** ABS or PVC Schedule 40 pipe shall be installed a minimum of 1 foot (305 mm) below the surface of the finished grade. Underground installation of thermoplastic sewer pipe shall be in accordance with ASTM D 2321. [UPC 718.0]

**3.1.4 Cleanouts.** Cleanouts, extended to within 1 foot (305 mm) of grade, shall be of materials listed for that use. [UPC 719.0]

**3.2 PVC Sewer Pipe.**

**3.2.1 Minimum Standards.**

**3.2.1.1 Pipe.** PVC, PSM, SDR 35, ASTM D 3034 and PVC, PS-46, ASTM F 789 Non-Pressure Pipe may be used in sizes four (4) inches (102 mm) and larger. [UPC 301.1, 701.1]

**3.2.1.2 Fittings.** All fittings shall be PVC or other listed non-metallic materials having equivalent durability and equal or greater strengths. [UPC 301.1, 701.2]

**3.2.2 Types of Joints.** PVC sewer pipe shall be joined by using compression joints or by other methods recognized in the UPC. Pipe and fitting ends shall be lubricated with an approved soap jelly or soap solution to permit easy assembly. [UPC 705.7]

**3.2.2.1 Use of Joints.** PVC sewer pipe shall be installed using the same type of jointing

throughout, except when connecting to existing piping, piping of other materials, in line repairs, and manholes. Transition connections to other materials shall be made by adapter fittings or a one-piece molded rubber coupling with appropriate bushings for the respective material. [UPC 705.7]

3.2.3 **Markings.**

3.2.3.1 PSM PVC pipe markings shall be in accordance with ASTM D 3034. [UPC 716.0]

3.2.3.2 PSM PVC fitting markings shall be in accordance with ASTM D 3034. [UPC 716.0]

3.2.3.3 PS-46 PVC pipe markings shall be in accordance with ASTM F 789. [UPC 716.0]

3.2.3.4 PS-46 PVC fitting markings shall be in accordance with ASTM F 789. [UPC 716.0]

3.2.4 PVC sewer pipe shall not be installed less than 1 foot (305 mm) below the surface of the finished grade and closer than twenty-four (24) inches (610 mm) from a building. Underground installation of thermoplastic sewer pipe shall be in accordance with ASTM D 2321. [UPC 718.0]

3.2.5 **Cleanouts.** Cleanouts, extended to within 1 foot (305 mm) of grade, shall be of materials listed for such use. [UPC 719.0]

3.3 **High Density Polyethylene Pipe.**

3.3.1 **Minimum Standards.**

3.3.1.1 Polyethylene pipe shall be manufactured in accordance with ASTM F 714 and installed in accordance with IAPMO IS 26. [UPC 301.1]

3.3.2 **Types of Joints.**

3.3.2.1 HDPE joints shall be made using the following method:

a) Heat Fusion made in accordance with ASTM D 2657 or ASTM D 3261. [UPC 705.1]

3.3.3 **Markings.**

3.3.3.1 Markings shall be in accordance with ASTM F 714. [UPC 716.0]

3.4 **Poly Vinyl Chloride (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings.**

3.4.1 **Minimum Standards.**

3.4.1.1 **Pipe.** Corrugated PVC sewer pipe may be used in sizes four (4) (102 mm), six (6) (152 mm), eight (8) (203 mm) and ten (10) (254 mm) diameters and shall conform to ASTM F 949. [UPC 301.1]

The profile wall pipe corrugated PVC sewer pipe as intended for underground use in non-pressure applications for sanitary sewers, storm sewer, and perforated and unperforated pipes for subdrainage. [UPC 301.1]

3.4.1.2 Fittings shall be PVC or other fittings having equivalent durability or equal or greater strengths in accordance with ASTM F 949. [UPC 301.1]

3.4.2 **Types and Use of Joints.** Corrugated PVC sewer pipe shall be joined by Molded or Elastomeric Compression Joints or by other approved methods. Elastomeric seals (gaskets) shall meet the requirements of ASTM F 477. The lubricant used for assembly shall be as recommended by the seller and shall have no detrimental affect on the gasket or on the pipe and fittings.

The PVC cement shall comply with ASTM D 2564 and shall be used in conjunction with a primer in compliance with ASTM F 656. The solvent cement shall be used only for bushings in accordance with ASTM D 2855. [UPC 705.7]

3.4.3 **Markings.**

3.4.3.1 Corrugated PVC sewer pipe markings shall be in accordance with ASTM F 949. [UPC 716.0]

3.4.3.2 Corrugated PVC fittings markings shall be in accordance with ASTM F 949. [UPC 716.0]

3.4.4 **Protection of Building Sewer.** Corrugated PVC sewer pipe shall not be installed less than 1 foot (305 mm) below the surface of the finished grade and closer than twenty-four (24) inches (610 mm) from a building. Underground installation of thermoplastic sewer pipe shall be in accordance with ASTM D 2321. [UPC 718.3]

3.4.5 **Cleanouts.** Cleanouts, extended to within 1 foot (305 mm) of grade, shall be of materials listed for such use. [UPC 719.0]

3.5 **Asbestos Cement Sewer Pipe.**

3.5.1 **Minimum Standards.** Asbestos cement sewer pipe shall be Type II only and may be used only in sizes four (4) inches (102 mm) and larger. Its use is limited to domestic sewage. [UPC 301.1]

3.5.2 All fittings used with asbestos cement sewer pipe shall be asbestos cement or other approved non-metallic materials having equivalent durability and providing fittings with equal or greater strengths. [UPC 701.2]

3.5.3 Asbestos cement sewer pipe and male end fittings shall be joined by means of a sleeve coupling and two rubber sealing rings suitable for the particular size of the pipe and fittings for which they will be used. The rubber sealing rings shall be positioned in interior grooves in the coupling.

The assembled joint shall provide the necessary compression of the rubber sealing rings to make a watertight joint. The crush

strength across the assembled joint shall be equivalent to the crush strength of the pipe with which it will be used. [UPC 705.2]

3.5.3.1 The use of unmachined field-cut asbestos cement sewer pipe is permitted for necessary length adjustments and at points of connection to other piping materials. These adaptions shall be made with either a one-piece molded rubber coupling with appropriate bushings or listed adapter fittings. [UPC 705.2]

3.5.3.2 Approved female fittings shall be provided with interior grooves in the bell ends in which rubber sealing rings, suitable for the particular size of pipe with which the fittings will be used, are placed. The compressed rubber sealing ring in the joined female (bell) fitting end shall provide a watertight joint. [UPC 705.2]

3.5.3.3 Pipe and fitting ends shall be lubricated with an approved jelly or soap solution to permit easy assembly. [UPC 705.2]

3.5.3.4 A listed one-piece molded rubber coupling with appropriate bushings may be used as an alternate means of connecting asbestos cement pipe and male end fittings. [UPC 705.2]

3.5.3.5 Transition from asbestos cement sewer pipe to another material shall be made by listed adapter fittings, or a one-piece molded coupling with appropriate bushings for the respective material. [UPC 705.2]

3.5.4 **Markings.**

3.5.4.1 Asbestos cement sewer pipe markings shall be in accordance with ASTM C 428. [UPC 716.0]

3.5.4.2 Each coupling sleeve of fitting markings shall be in accordance with ASTM C 428. [UPC 716.0]

3.5.5 No asbestos cement sewer pipe shall be installed less than 1 foot (305 mm) below the surface of the ground or closer than two (2) feet (610 mm) to a building. [UPC 718.3]

3.5.6 Cleanouts shall be asbestos cement or other approved materials of plug or cap type installed with rubber ring compression joints. Cleanouts, extended to within 1 foot (305 mm) of the surface, shall be of materials approved for such use. [UPC 719.0]

3.6 **Concrete Sewer Pipe.**

3.6.1 **Minimum Standards.**

3.6.1.1 **Pipe and Fittings.** Concrete sewer pipe may be used in sizes four (4) inches (102 mm) and larger. Concrete sewer pipe shall conform to ASTM C 14, Class 2. Transition to other types or sizes of pipe may be made with listed concrete pipe adapter fittings or listed one-piece molded rubber coupling with appropriate bushings or increasers. [UPC 301.1]

3.6.2 **Types of Joints.** Concrete sewer pipe and fittings shall be joined by means of flexible rubber sealing rings, compressed to provide water-tight joints conforming to ASTM C 443, or by listed one-piece molded rubber couplings, or hot-poured joints of listed hot-pour compounds. Portland cement joints are prohibited except for repairs or connections to existing lines constructed with such joints.

Concrete sewer pipe shall be joined by gaskets furnished by the pipe manufacturer and installed according to the manufacturer's instructions. Approved lubricant shall be used when required for the type of joint furnished. [UPC 301.1]

3.6.3 **Use of Joints.** Except for points of connection to existing piping at either end of the sewer, concrete sewer pipe shall be laid using the same type of jointing throughout. [UPC 301.1]

3.6.4 **Markings.**

3.6.4.1 Concrete sewer pipe and fittings markings shall be in accordance with ASTM C 14. [UPC 716.0]

3.6.5 **Grade, Support and Protection of Building Sewers.** Concrete sewer pipe shall be installed not less than 1 foot (305 mm) below the ground and not closer than two (2) feet (610 mm) to a building. [UPC 718.0]

3.6.6 **Cleanouts.** Cleanouts shall conform to type of jointing used and cleanouts extended to within 1 foot (305 mm) of grade, shall be of materials listed for that use. [UPC 719.0]

3.7 **Vitrified Clay Pipe.**

3.7.1 **Minimum Standards.**

3.7.1.1 **Materials.** Materials shall comply with the appropriate standard in Table 14-1 of the UPC. Vitrified clay sewer pipe, extra strength only, may be used in sizes three (3) inches (76 mm) and larger. [UPC 301.1, 701.0]

3.7.2 **Types of Joints.** Vitrified clay sewer pipe and fittings shall be joined by means of preformed flexible compression joints or listed one-piece molded rubber couplings. [UPC 705.9]

3.7.2.1 Except at point of connection to existing piping at either end of the sewer, vitrified clay sewer piping shall be laid using the same type of jointing throughout. [UPC 705.9]

3.7.2.2 When installing clay pipe with flexible compression joints, the mating surfaces shall

be wiped clean of dirt and foreign matter. An approved lubricant shall be applied to the joint surfaces. Spigot shall then be seated full depth into the bell. [UPC 705.9]

3.7.2.3 Listed one-piece molded rubber couplings shall be permitted for use on vitrified clay pipe and fittings, sizes three (3) inches (76 mm) through 1 foot (305 mm). [UPC 705.9]

3.7.2.4 Transition to other types of materials or sizes may be made with the use of listed one-piece molded rubber couplings with appropriate bushings or increasers. [UPC 705.9]

3.7.3 **Markings.**

3.7.3.1 Vitrified clay sewer pipe and fittings markings shall be in accordance with ASTM C 700. [UPC 716.0]

3.7.4 No vitrified clay sewer pipe shall be installed less than 1 foot (305 mm) below the surface of the ground. [UPC 718.3]

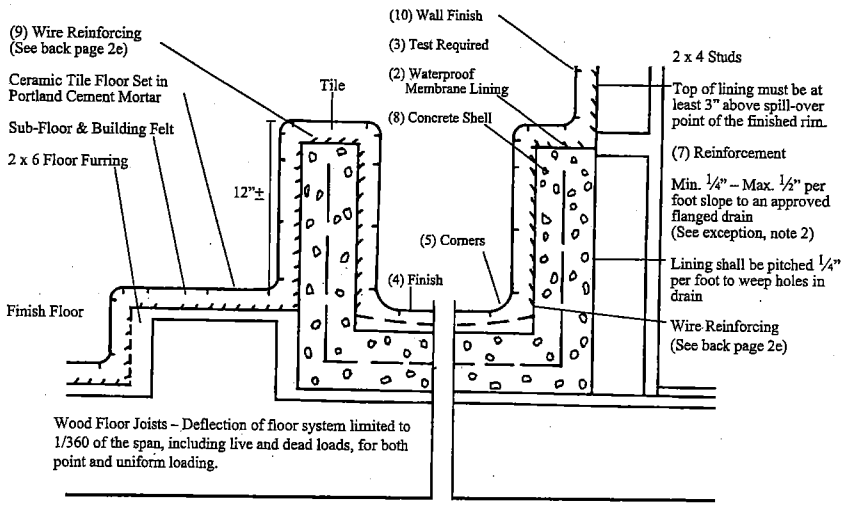
3.7.5 **Cleanouts.** Cleanouts shall conform to the type of jointing used and cleanouts extended to within 1 foot (305 mm) of grade shall be of materials approved for their use. [UPC 719.0]

**ADOPTED: 1957**

**REVISED: 1966, 1971, 1973, 1975, 1976, 1982, 1985, 1990, 1991, 2002, 2003, 2006**

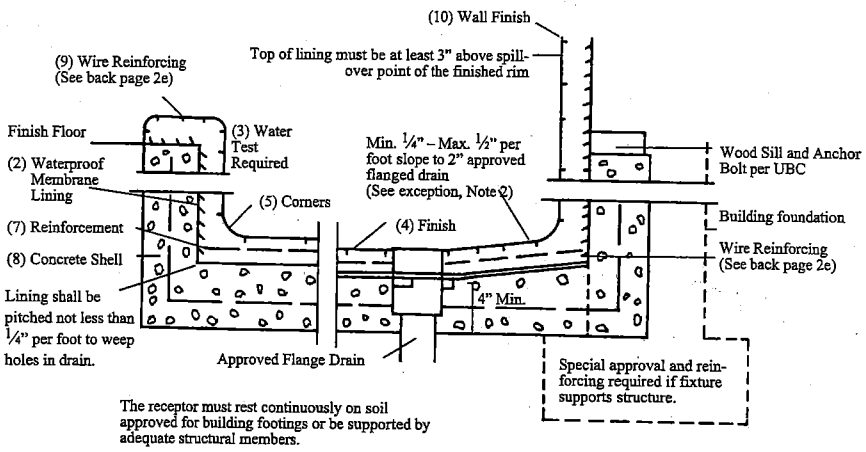
# INSTALLATION STANDARD
# FOR TILE-LINED ROMAN BATH TUBS

# IAPMO IS 2-2006




A vapor barrier consisting of at least one layer of 15 lb. type asphalt saturated felt shall be between wood surfaces and concrete.

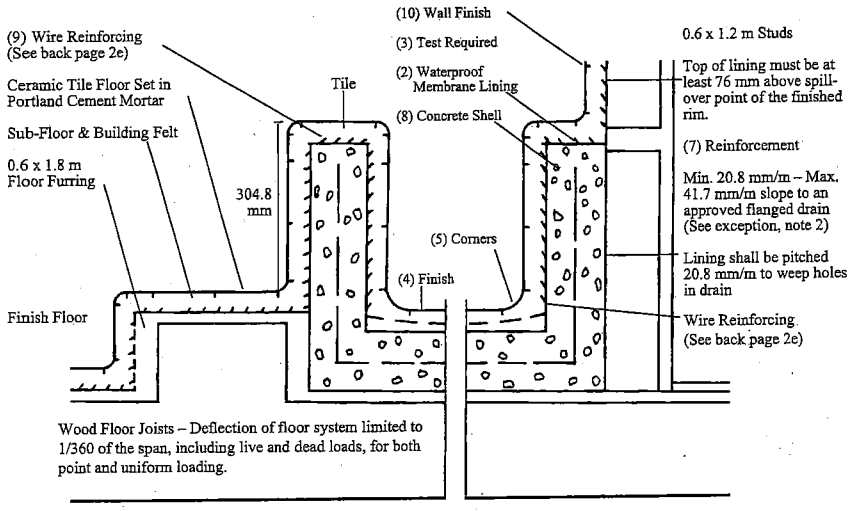
SCALE 1½" = 1' - 0"



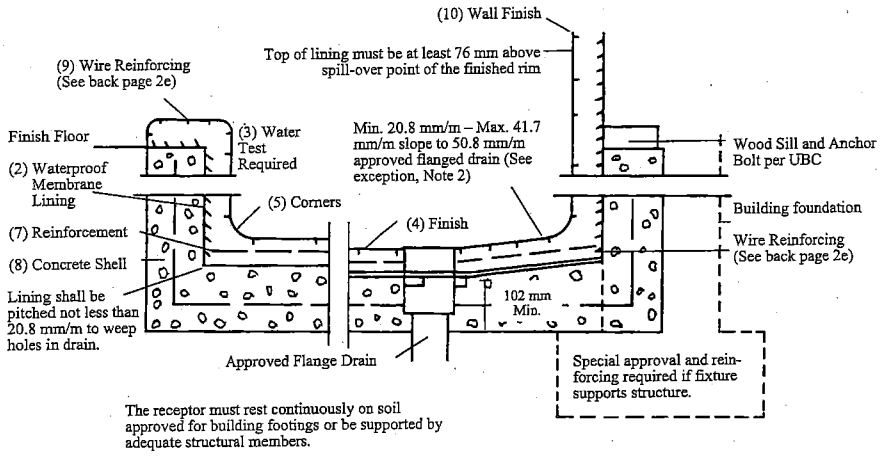

SCALE 1½" = 1' - 0"

Illustrations reprinted with permission of the Ceramic Tile Institute

## METRIC




SCALE 1.5 mm = 1 mm




SCALE 1.5 mm = 1 mm

Illustrations reprinted with permission of the Ceramic Tile Institute

**1.0 General Requirements.**

**1.1 Inspection of Work** – All surfaces prepared by others shall be inspected by the tile installer before starting tile work and all unsatisfactory conditions reported to the Administrative Authority. Starting tile work by the tile installer shall be considered as acceptance of surfaces prepared by others.

**1.2 Surfaces** – All surfaces to receive tile work shall be clean, structurally sound, and conform in every way to the local Building Code.

(**Note:** No tile work shall proceed until the pan and drain construction has been inspected and approved by the Administrative Authority, where required.)

**2.0 Materials.**

**2.1 Tile Quality and Grade** – Tile shall comply with American National Standard Specification for Ceramic Tile, A137.1 (equivalent to and incorporating U.S. Dept. of Commerce Simplified Practice Recommendation, R61-61 and Federal Specification SS-T-308b, Tile, Floor, Wall, and Trim Units, Ceramic).

**2.2 Cement** – Cement shall be portland cement type I or type II, conforming to ASTM C 150.

**2.3 Sand** – Sand shall be damp, clean and graded ASTM C 778.

**2.4 Water** – Water shall be potable.

**2.5 Reinforcing** – shall be 3 inch x 3 inch (76 mm x 76 mm), 13 x 13 gage or 1½ x 2 (38 mm x 51 mm) mesh, 16 x 13 gage steel wire, conforming to ASTM A 82 and A 185.

**2.6 Asphalt** – shall conform to Federal Specification A-A-50694 or ASTM D 1227.

**2.7 Plastic Roof Cement** – shall conform to Federal Specification SS-C153.

**2.8 Waterproof Felt Membrane** – The waterproof felt membrane shall be at least 15 lb. (6.8 kg) asphalt saturated felt, conforming to ASTM D 2626.

**2.9 Plastic Membrane** shall comply with ANSI A118.10.

**2.10 Other Membranes** – Where the Administrative Authority approves their use, non-metallic sub-pans or linings of lead sheets weighing not less than 4 lbs. per sq. foot (191.5 Pa) and copper pans of at least No. 24 B & S gage may be used.

**2.11 Waterproofing Admixture** – The mortar bed of the receptor shall be mixed with a waterproof admixture, approved by the Administrative Authority in the amounts allowed by such approval.

**2.11.1 Currently Approved Mortar Additives.**

Anti-Hydro – 1 qt. (0.95 I) per sack of cement.

Plastiment – 1 lb. (0.5 kg) of powder per sack of cement.

Plastiment – 2 oz. (56.7 g) of fluid per sack of cement.

Sika 3A – 1 qt. (0.95 I) per sack of cement

Suconem (Red Label) – 1 pint (0.47 I) per sack of cement.

**3.0 Installation.**

**3.1 Drains** – An approved type drain with sub-drain shall be installed with every such shower membrane. Flange of each sub-drain shall be accurately set exactly level with sloping sub-floor and shall be equipped with a clamping ring or other approved device to make a tight connection between the membrane and the sub-drain. The sub-drain shall have weep holes into the waste line. The drain shall be of such design that there will be not less than 2 inch (51 mm) depth from the top of the sub-drain flange to top of the strainer. A ring of absorbent material must be placed around the weep holes to keep them open when the finish materials are installed. [UPC 408.0]

**3.2 Sloping Sub-Floor and Membrane** – All lining materials shall be pitched not less than one quarter (¼) inch per foot (20.8 mm/m) to weep holes in the sub-drain by means of a smooth and solidly formed sloping sub-base. All such lining materials shall extend upward on the side walls of the tub to a point not less than four (4) inches (102 mm) above the top of the finished dam or threshold and shall extend outward over the top of the rough threshold and be turned over and fastened on the outside face of the rough threshold. All ledge tops within four (4) inches (102 mm) above the rough threshold shall be covered with the lining material. Non-metallic sub-pans or linings shall be built-up on the job site and shall consist of not less than three (3) layers of standard grade fifteen (15) pound (6.8 kg) asphalt impregnated roofing felt. The bottom layer shall be mopped to the formed sub-base with hot asphalt and each succeeding layer thoroughly hot-mopped to that below, on the basis of twenty (20) pounds (9.1 kg) of asphalt per layer per square. All corners shall

be carefully fitted and shall be made strong and watertight by folding or lapping, and each corner shall be reinforced with suitable woven glass fiber webbing hot-mopped in place. All folds, laps, and reinforcing webbing shall extend at least four (4) inches (102 mm) in all directions from the corner and all glass fiber webbing shall be of approved type and mesh, producing a tear strength of not less than fifty (50) pounds per square inch (344.5 kPa) in either direction. Non-metallic shower sub-pans or linings may also consist of multi-layers of other approved equivalent materials suitably reinforced with glass fibers and having each layer carefully fitted and hot mopped in place on the job site as elsewhere required in this section, according to manufacturer's recommended installation procedures.

Linings shall not be nailed or perforated at any point which will be less than one (1) inch (25.4 mm) above the finished dam or threshold.

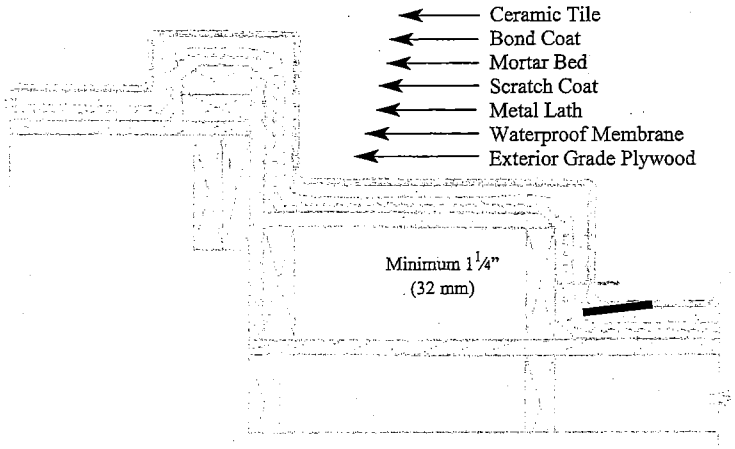
Where flexible plastic sheet membranes are used, corners shall be carefully constructed by folding or bonding of pre-fabricated reinforcing corner. Joints in flexible plastic sheeting shall be constructed with the appropriate solvent bonding liquid, bodied solvent cement, or thermal welding.

Where lead and copper pans are used as membranes, the installation shall be made in similar manner as required for felt membranes, except the asphalt moppings, and, in addition, the pans shall be insulated from all concrete and mortar surfaces and from all conducting substances, other than their connecting drain, by 15 lb. (6.8 kg) asphalt saturated felt or an approved equivalent, hot-mopped to the lead or copper pans. Joints in lead and copper pans shall not be soldered, but shall be burned or silver brazed, respectively.

**3.3** **Tests** – Upon installation, all concrete tub shells shall be tested for water tightness by being filled to the top of the rough threshold with water for 24-hours to establish their water tightness.

**3.4** **Roman Bath Tub** – Floor shall be of ceramic tile set in portland cement mortar, mixed in the proportion of one (1) part portland cement to four (4) parts of mortar sand by volume and shall be provided with an approved shower drain designed to make a water-tight joint at the floor. The mortar mixture shall be of such consistency that a troweled surface readily assumes a smooth, slickened surface. All concrete mortar bases shall be mixed with an approved waterproofing admixture and properly reinforced with 3 inch x 3 inch (76 mm x 76 mm) mesh, 13 x 13 gage or 1½ inch x 2 inch (38 mm x 51 mm) mesh, 16 x 13 gage cold drawn welded steel wire fabric located in the approximate center of the mortar bed and extending up the side walls but, in no case, less than 1 inch (25.4 mm) above the finished threshold. Corners shall be lapped and the reinforcing shall extend over the threshold and ledges.

The total thickness of the floor mortar shall not be less than 1¼ inch (32 mm) at any point. The tile floor shall have a minimum of ⅛ inch (3.2 mm/m) pitch and a maximum of ½ inch (12.7 mm/m) pitch toward the drain per foot. Bath tub walls to a minimum height to 3 inch (76 mm) and not less than 1 inch (25.4 mm) above the finished dam shall be lined with ceramic tile set in portland cement mortar, mixed with an approved waterproofing admixture.




**WOOD FORM**

**All wood framed bases shall be designed with a maximum deflection of 1/240 of the span, including live and dead loads.**

**3.4.1** **Note:** Two stages of construction are covered – the reinforced concrete shell and the wire reinforced tile lining over the water-proof membrane.

**3.4.2** Approved waterproofing membrane, mortar bed and finish construction shall conform to the general requirements of the Uniform Plumbing Code. Exception: In short sections where there is no foot traffic, the finished floor may exceed ½ inch per foot (12.7 mm/m) slope.

**3.4.3** Each concrete shell shall be filled to its overflow rim with water and shall remain watertight for not less than twenty-four (24) hours before inspection and before the finish surface is installed.

**3.4.4** The finish surface shall be ceramic tile installed with portland cement mortar mixed to a proper consistency in the proportion of one (1) part cement and four (4) parts mortar sand by volume and having an approved waterproofing admixture* included. Ceramic tile joints shall be thoroughly grouted with approved water-proofing grout containing an admixture.

**3.4.5** The concave interior surfaces shall be such as to permit ready cleansing and all corners shall be rounded or at angles not in excess of 45°. Grout is not acceptable for rounding corners. See details below on approved corners.

**3.4.6** Concealed overflow or built-in waste stopper may be used if designed and approved for this application.

**3.4.7** For reinforcement in center of pour, use #30 @ 8 inch (203 mm) O.C. both ways.

**3.4.8** 2000 P.S.I. (13,780 kPa) compressive strength concrete shall be poured monolithically and shall have an approved waterproofing admixture included*. Concrete to have not less than six (6) sacks of portland cement per batch.

**3.4.9** Reinforcing wire, as specified under materials in this standard or equal, shall be wired together in a self-supporting manner. Nails shall not be used through the waterproofing membrane to fasten wire reinforcing.

*Quantities of several approved waterproofing admixtures required per sack of cement:

Anti-Hydro – 1 qt. (0.95 l) per sack of cement.

Plastiment – 1 lb. (0.5 kg) of powder per sack of cement.

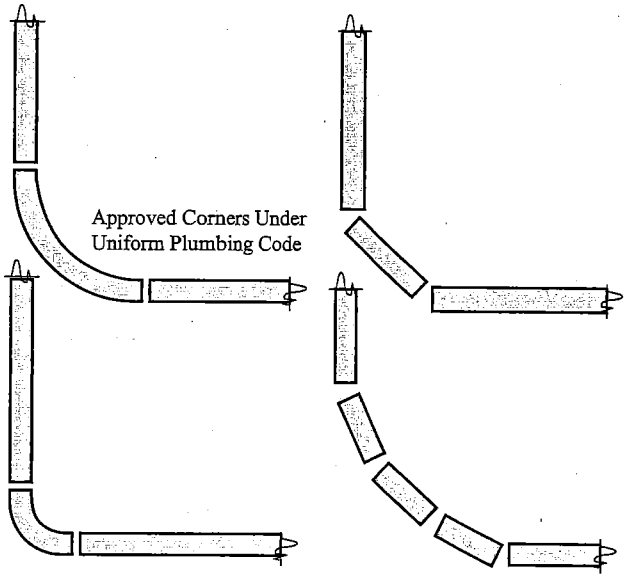
Plastiment – 2 oz. (56.7 g) of fluid per sack of cement.

Sika 3A – 1 qt. (0.95 l) per sack of cement.

Suconem (Red Label) – 1 pint (0.47 l) per sack of cement.

**ADOPTED: 1966**

**REVISED: 1977, 1982, 1990, 2003, 2006**



# INSTALLATION STANDARD
# FOR COPPER PLUMBING TUBE, PIPE, AND FITTINGS

# IAPMO IS 3-2006

**1.0 Scope.**

**1.1** Installation and material of copper tube, pipe and fittings in drainage, vent, and water systems shall comply with this standard and the current edition of the Uniform Plumbing Code [UPC]™, published by the International Association of Plumbing and Mechanical Officials (IAPMO).

**Note:** The following sections of the Uniform Plumbing Code shall apply.

| | |
|---|---|
| 103.5.6 | Testing of Systems |
| 301.1 | Minimum Standards |
| 309.0 | Workmanship |
| 310.0 | Prohibited Fittings and Practices |
| 312.0 | Protection of Piping, Materials, and Structures |
| 313.0 | Hangers and Supports |
| 315.2 | Prohibited Joints and Connections |
| 316.0 | Increasers and Reducers |
| 402.6.1 | Closet Rings (Closet Flanges) |
| 604.0 | Materials |
| 604.1 | Pipe, Tube, and Fittings |
| 604.2 | Copper Tube |
| 604.3 | Hard-Drawn Copper Tubing |
| 604.4 | Flexible Copper Connectors |
| 604.7 | Previously Used Piping and Tubing |
| 605.3 | Copper Pipe, Tubing, and Joints |
| 605.3.2 | Flared Joints |
| 605.17.1 | Copper Pipe or Tubing to Threaded Pipe Joints |
| 608.5 | Drains |
| 609.0 | Installation, Testing, Unions, and Location |
| 610.0 | Size of Potable Water Piping |
| 701.0 | Materials (drainage piping) |
| 701.1(4) | Drainage Piping |
| 705.10.3 | Ground Joint, Flared, or Ferrule Connections |
| 707.0 | Cleanouts |
| 811.0 | Chemical Wastes |
| 903.0 | Materials (vent piping) |
| 903.2 | Use of Copper Tubing |
| 1101.3 | Materials (rain water piping) |
| 1105.1 | Materials (roof drains) |

| Table 1401.1 | Referenced Standards |
|---|---|
| ASME B 16.18 | Cast Copper Alloy Solder-Joint Pressure Fittings |
| ASME B 16.22 | Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings |
| ASME B 16.23 | Cast Bronze Solder-Joint Drainage Fittings - DWV |
| ASME B 16.29 | Wrought Copper and Copper Alloy Solder-Joint Drainage Fittings |
| ASME B 16.50 | Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings |
| ASTM B 32 | Solder Metal |
| ASTM B 42 | Seamless Copper Pipe, Standard Sizes |
| ASTM B 75 | Seamless Copper Tubes |
| ASTM B 88 | Seamless Copper Water Tube |
| ASTM B 302 | Threadless Copper Pipe, Standard Sizes |
| ASTM B 306 | Copper Drainage Tube (DWV) |
| ASTM B 813 | Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube |
| ASTM B 828 | Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings |
| Appendix A | Chart A 4.1 Friction loss per 100 ft. (30.5 m) |

**2.0 Product Requirements.**

**2.1 Minimum Standards.**

**2.1.1 Materials.** Materials shall comply with the appropriate standard in Table 1401.1 of the UPC. [UPC 301.1]

**Note:** The nominal or standard size of copper plumbing tube is always 0.125 inch (3.175 mm) or one-eighth (⅛) inch (3.175 mm) smaller than the actual outside diameter dimension of the tube. For example, 3 inch (76 mm) nominal size copper plumbing tube measures 3⅛ inch (79 mm) O.D., ½ inch (12.7 mm) nominal size copper plumbing tube measures ⅝ inch (15.9 mm) O.D., etc.

2.1.2 **Markings.** Markings shall be visible for inspection. Products that are covered by this standard shall be identified in accordance with the standard found in Table 14-1. [UPC 301.1]

2.1.3 **Tube and Threadless Pipe.** Water tube (Types K, L, M), drainage tube (Type DWV), and threadless pipe (TP), shall bear the following incised marking at not over 18 inch (457 mm) intervals:

(a) Manufacturer's name or trademark; and

(b) Tube type

2.1.4 **Pipe (Copper and Copper Alloy).** Pipe shall bear the following incised marking at not over 18 inch (457 mm) intervals:

(a) Manufacturer's name or trademark; and

(b) Pipe type.

2.1.5 **Fittings.** Fittings shall bear the following markings:

(a) Manufacturer's name or trademark; and

(b) "DWV" on drainage fittings.

2.2 **Type of Joints.**

2.2.1 **General Information.** Copper tube and fittings may be joined in a number of ways, depending on the purpose of the system. Soldering and brazing with capillary fittings are the methods used most.

The American Welding Society (AWS) defines soldering as a joining process which takes place below 840°F (449°C) and brazing as a similar process which occurs above 840°F (449°C) but below the melting point of the base metals. In actual practice for copper systems, most soldering is done at temperatures from about 350°F (177°C) to 550°F (288°C), while most brazing is done at temperatures ranging from 1100°F (593°C) to 1500°F (816°C). The choice between soldering or brazing will generally depend on operating conditions. Solder joints are generally used where the service temperature does not exceed 250°F (121°C), while brazed joints are used where greater tensile strength is required to resist vibration, or pressure or temperature cycling, or where system temperatures are as high as 350°F (177°C). Although brazed joints offer higher joint strength in general, the annealing of the tube and fitting which results from the higher heat used in the brazing process can cause the rated pressure of the system to be less than that of a soldered joint. This fact should also be considered in choosing which joining process to use.

Mechanical joints are used frequently for some underground connections, for joints where the use of heat is impractical and for joints that may have to be disconnected from time to time. [UPC 605.3]

2.2.2 **Fittings for Soldered, Brazed, and Mechanical Joints.** Cast fittings are available in all standard tube sizes and in a wide variety of types to cover needs for plumbing. They can be either soldered or brazed, although brazing cast fittings requires care. Wrought copper pressure fittings are also available over a wide range of sizes and types. These, too, can be joined by either soldering or brazing and wrought fittings are preferred where brazing is the joining method. Otherwise, the choice between cast and wrought fittings is largely a matter of the user's preference and availability. According to the American Welding Society, the strength of a brazed joint will meet or exceed that of the tube and fitting being joined when the joint overlap and the depth of the filler metal penetration is a minimum of three times the thickness of the thinner base metals (tube or fitting) and a well-developed fillet (cap) is present. The strength of a brazed copper tube joint does not vary much with different filler metals but depends on maintaining the proper clearance between the outside of the tube and the socket (cup) of the fitting. Copper tube and solder-type pressure fittings are accurately made for each other, and the tolerances permitted for each assure the capillary space will be within the limits necessary for a joint of satisfactory strength. However, the depths of the socket are considerable deeper than the three times required by AWS. There are standards available for the manufacture of fittings made specifically for brazing, these include ASME B 16.50 and MSS SP 73. When fittings are made to these standards, they cannot be soldered. They must be brazed.

2.2.2.1 **Mechanical Joints.** Flared-tube fittings provide metal-to-metal contact similar to ground joint unions; both can be easily taken apart and reassembled. Grooved end mechanical fittings are also available in sizes 2-inches to 6-inches. Mechanical joint fittings are especially useful where residual water cannot be removed from the tube and soldering is difficult. Mechanical joints may be required where a fire hazard exists and the use of a torch to make soldered or brazed joints is not allowed. Also, soldering under wet conditions can be very difficult and mechanical joints may be preferred under such circumstances. [UPC 605.3.3]

2.2.3 **Solders.** Most solders referenced in ASTM B 32 can be used to join copper tube and fittings in potable water systems.

**Note:** Users of the Uniform Plumbing Code are reminded that provisions of the Federal Safe Drinking Water Act of 1986 (SDWA), which all must obey, forbid the use of solder which contains in excess of 0.2% of lead, in potable water systems. The provisions of the act are incorporated in all ordinances, statutes, state and municipal regulations by reference and by operation of law. [UPC 605.3.4]

The selection of a solder depends on the operating pressure and temperature of the system. Consideration should also be given to the stresses on the joint caused by thermal expansion and contraction. However, stresses due to temperature changes should not be significant in two commonly encountered cases: when tube lengths are short, or when expansion loops are used in long tube runs.

Solder is generally used in wire form, but paste-type solders are also available. These are finely granulated solders in suspension in a paste flux. These solder/flux pastes must meet the requirements of ASTM B 813. When using paste-type solders, observe these four rules:

1. Wire solder must be applied in addition to the paste to fill the voids and assist in displacing the flux, otherwise the surfaces may be well "tinned" and yet there may not be a good joint with a continuous bond. Use the same type of solder (e.g., 50-50 or 95-5) as that used in the paste.
2. The paste mixture must be thoroughly stirred if it has been standing in the can for more than a very short time, as the solder has a tendency to settle rapidly to the bottom.
3. The flux cannot be depended on to clean the tube. Cleaning should be done manually as is recommended for any other flux and solder.
4. Remove any excess flux.

Solders are available that contain small amounts of silver or other additives to impart special properties. Such solders may require special fluxes. The manufacturer's recommendations should be consulted regarding proper procedures and fluxes for such solders and about the expected properties.

2.2.4 **Soldering Flux.** The functions of the soldering flux are to remove residual traces of oxides, to promote wetting and to protect the surfaces to be soldered from oxidation during heating. The flux should be applied to clean surfaces and only enough should be used to lightly coat the areas to be joined.

An oxide film may reform quickly on copper after it has been cleaned. Therefore, the flux should be applied as soon as possible after cleaning.

**CAUTION**

Careless workmanship, especially during flux applications, can result in corrosion of the tube long after the system has been installed. If excessive flux is used, the residue inside the tube can cause corrosion. In an extreme case, such residual flux can actually lead to perforation through the tube wall causing leakage. To guard against this danger, it is important (1) to choose a flux that is manufactured to ASTM B 813, and (2) to use only the minimum amount actually needed to make the joint.

2.3 **Solder Joints.**

2.3.1 Soldering and brazing both involve basic steps, based on ASTM Standard Practice B 828, which must be executed with care and craftsmanship. The steps are:

(1) Measuring
(2) Cutting
(3) Reaming
(4) Cleaning
(5) Fluxing
(6) Assembly and support
(7) Heating
(8) Applying the filler metal
(9) Cooling and cleaning

Each step contributes to a strong, dependable joint.

2.3.2 **Measuring.** Measuring the length of each tube segment must be accurate. Inaccuracy can compromise joint quality. If the tube is too short it will not reach all the way into the socket of the fitting and a proper joint cannot be made. If the tube segment is too long there is a danger of cocking the tube in the fitting and putting strain on the system which could affect service life.

2.3.3 **Cutting.** Once the tube is measured, it can be cut. Cutting can be accomplished in a number of different ways to produce a satisfactory square end. The tube can be cut with a disc-type tube cutter, a hacksaw, an abrasive wheel, or with a stationary or portable bandsaw. Care must be taken that the tube is not deformed while being cut. Regardless of the method, the cut must be square with the run of the tube so that the tube will seat properly in the fitting socket.

2.3.4 **Reaming.** All pipe and tube shall be reamed to the full I.D. of the pipe and tube to remove the small burr created by the cutting operation. If this rough, inside edge is not removed erosion-corrosion may occur due to localized turbulence and high velocity.

Tools used to ream tube ends include the reaming blade on the tube cutter, half-round or round files, a pocket knife, or a suitable deburring tool. With annealed tube, care must be taken not to deform the tube end by applying too much pressure. Both the inside and the outside of the tube may require removal of the burr, especially in large diameters.

2.3.5 **Cleaning.** The removal of all oxides and surfaces soil is crucial if filler metal is to flow properly into the joint. Failure to remove them can interfere with capillary action and may lessen the strength of the joint and cause failure.

Mechanical cleaning is a simple operation. The end of the tube should be lightly abraded using sand cloth or nylon abrasive pads for a distance only slightly more than the depth of the fitting socket. The socket of the fitting should also be cleaned using sand cloth, abrasive pads, or a properly sized fitting brush.

Copper is a relatively soft metal. If too much material is removed, a loose fit will result and interfere with satisfactory capillary action in making the joint. The capillary space between tube and fitting is approximately 0.004 inch (0.10 mm). Solder or brazing filler metal can fill this gap by capillary action. This spacing is critical for the filler metal to flow into the gap and form a strong joint.

Surfaces once cleaned should not be touched with bare hands or oily gloves. Skin oils, lubricating oils, and grease impair filler metal flow and wetting.

2.3.6 **Fluxing.** Stir the flux before use. Flux will dissolve and remove traces of oxide from the cleaned surfaces to be joined, protect the cleaned surfaces from reoxidation during heating, and promote wetting of the surfaces by the solder. A thin, even coating of flux should be applied with a brush to both tube and fitting as soon as possible after cleaning. Do not apply with fingers. Chemicals in the flux can be harmful if carried to the eyes, mouth, or open cuts.

2.3.7 **Assembly and Support.** After both tube and fitting surfaces are properly fluxed, they should be assembled, making sure the tube seats against the base of the fitting socket. A slight twisting motion ensures even distribution by the flux. Remove any excess flux. Care must be taken to assure that the tube and fittings are properly supported to ensure a uniform capillary space around the entire circumference of the joint. Uniformity of capillary space will ensure good filler metal penetration if the guidelines of successful joint making are followed. Excessive joint clearance can cause the filler metal to crack under stress or vibration.

The joint is now ready for soldering. Joints prepared and ready for soldering should be completed the same day and not left unfinished overnight.

2.3.8 **Heating.**

**WARNING:** When dealing with an open flame, high temperatures, and flammable gases, safety precautions must be observed as described in the ANSI /ASC Z49.1 Standard.

Heat is generally applied using an air/fuel torch. Such torches use acetylene or an LP gas. Electric resistance tools can also be used.

Begin heating with the flame perpendicular to the tube on the bottom. The copper tube conducts the initial heat into the fitting socket for even distribution of heat in the joint area. The extent of this preheating depends upon the size of the joint. Experience will indicate the amount of time needed. Preheating of the assembly should include the entire circumference of the tube in order to bring the entire assembly up to a suitable preheat condition. However, for joints in the horizontal position, avoid directly preheating the top of the joint to avoid burning the soldering flux. The natural tendency of heat to rise will ensure adequate preheat of the top of the assembly. Next, move the flame onto the fitting socket. Sweep the flame alternately from the fitting socket back onto the tube a distance equal to the depth of the fitting socket. Touch the solder to the joint. If the solder does not melt, remove it and continue the heating process. Be careful not to overheat or to direct the flame into the fitting cup. This could cause the flux to burn and destroy its effectiveness. When the solder begins to melt, the heat should be directed to the base of the cup to aid capillary action in drawing the molten solder into the fitting socket towards the heat source.

2.3.9 **Applying the Filler Metal.** For joints in the horizontal position, start applying the solder slightly off-center at the bottom of the joint. When the solder metal begins to melt from the heat of the tube and fitting do not use the torch to melt the solder; push the solder straight into the joint while keeping the torch at the base of the fitting socket and slightly ahead of the point of application of the solder. Continue

this technique across the bottom of the fitting and up the side to the top of the fitting. Return to the beginning, overlapping slightly by re-melting the solder at the point and proceed up the other side to the top, again overlapping slightly.

For joints in the vertical position, a similar sequence of overlapping passes should be made, starting wherever is convenient. Molten solder will be drawn into the joint by capillary action regardless of whether the solder is being fed upward, downward or horizontally. **IMPORTANT:** Always remember to let the heat lead the alloy. Do not apply the filler metal in front of the heat.

2.3.10 **Cooling and Cleaning.** After the joint has been completed, natural cooling is best. Shock cooling with water may cause unnecessary stress on the joint and result in eventual failure. When cool, clean off any remaining flux with a wet rag.

2.3.11 **Testing.** Test all completed assemblies for joint integrity following the procedures described in the body of this code. Completed systems should be flushed to remove excess flux and debris as soon as possible after completion.

2.4 **Brazed Joints.**

2.4.1 Brazing is another commonly used method for joining copper tube. Making brazed joints is similar to making soldered joints with respect to measuring, cutting, reaming, cleaning, assembly, and support. And as in soldering, the brazing filler metal is melted by the heat of the tube and fitting and drawn into the joint by capillary action.

The major differences between soldering and brazing are the:

- Type of flux used;
- Composition of filler metal; and
- Amount of heat required to melt the filler metal.

2.4.2 **Brazing Flux.** The fluxes used for brazing copper joints are different in composition from soldering fluxes. The two types cannot be used interchangeably. Unlike soldering fluxes, brazing fluxes are water based. Similar to soldering fluxes, brazing fluxes dissolve and remove residual oxide from the metal surfaces, protect the metal from reoxidation during heating and promote wetting of the surfaces to be joined by the brazing filler metal.

Fluxes also provide the craftsman with an indication of temperature. Application of the flux is the same as when soldering. If the outside of the fitting and the heat-affected area of the tube are covered with flux (in addition to the end of the tube and the cup), oxidation will be prevented and the appearance of the joint will be greatly improved.

2.4.3 **Brazing Filler Metals.** Brazing filler metals suitable for joining copper tube systems are of two classes. Classified according to their components, they are: BCuP (Brazing-Copper-Phosphorus) and BAg (Brazing-Silver).

BCuP filler metals are preferred for joining copper tube and fittings if codes and construction specifications allow it. The phosphorus in them acts as a fluxing agent and the lower percentage of silver makes them relatively low cost. When using copper tube, wrought copper fittings, and BCuP brazing filler metal, fluxing is optional. However, when cast fittings are brazed, flux must be used.

2.4.4 **Heating.**

**WARNING:** When dealing with an open flame, high temperatures, and flammable gases, safety precautions must be observed as described in the ANSI/ASC Z49.1 Standard. Oxy/fuel torches are generally used for brazing because of their higher temperatures. However, recent innovations in tip design make air/fuel torches useful for brazing on a wide range of sizes for brazing.

The heating operation is the same as for soldering. Heat the tube first, beginning about one inch from the edge of the fitting, sweeping the flame around the tube in short strokes at right angles to the axis of the tube. It is very important that the flame be in motion and not remain on any one point long enough to damage the tube. Switch the flame to the fitting at the base of the fitting socket. Heat uniformly, sweeping the flame from the fitting to the tube. Avoid excessive heating of cast fittings or they may crack.

2.4.5 **Applying Brazing Filler Metal.** Apply the brazing filler metal at the point where the tube enters the socket of the fitting. When the proper temperature is reached, the filler metal will flow readily into the space between the tube and fitting socket, drawn in by the natural force of capillary action.

Keep the flame away from the filler metal itself as it is fed into the joint. The temperature of the tube and fitting at the joint should be high enough to melt the filler metal. Keep both the tube and fitting heated by moving the flame back and forth from one to the other as the filler metal is drawn into the joint.

When the joint is properly made the filler metal will be drawn into the fitting socket by capillary action, and a continuous fillet (cap) of filler metal will be visible completely around the joint. To aid in the development of this fillet during brazing, the flame should be kept slightly ahead of the pint of filler metal application.

When brazing horizontal joints, it is preferable to first apply the filler metal slightly off-center of the bottom of the joint, proceeding across the bottom of the joint and continuing up the side to the top of the joint. The return to the beginning point, overlapping slightly. This procedure is identical to that used for soldering. Also, similar to the soldering process, make sure the operations overlap.

On vertical joints, it is immaterial where the joint is made. If the opening of the fitting socket is pointing down, care should be taken to avoid overheating the tube, as this may cause the brazing filler metal to run down the outside of the tube.

If the filler metal fails to flow, or has the tendency to ball-up, it indicates either that there is oxide on the surfaces being joined or that the parts to be joined are not hot enough. If the filler metal refuses to enter the joint, the fitting cup is not hot enough. Most poorly made braze joints result from either the tube or the fitting not being hot enough. If filler metal tends to flow over the outside of either part of the joint, it indicates that part is overheated in comparison to the other. When the joint is completed, a continuous fillet should be visible completely around the joint.

Larger diameter tube is more difficult to heat to the desired temperature. The use of a heating tip or rosebud may be necessary to maintain the proper temperature over the area being brazed. Once total heat control is attained, follow the same procedures used for smaller tube.

**2.4.6** **Cooling and Cleaning.** When the brazed joint is finished, allow it to cool naturally. Flux residues and some oxides formed by heating can be removed by washing with hot water and brushing with a stainless steel wire brush.

**2.4.7** **Testing.** Test all completed assembles for joint integrity following the procedures described in the body of this code. Completed systems should be flushed to remove excess flux and debris as soon as possible after completion.

**2.4.8** **Purging.** Some installations, such as medical gas, high-purity gas, and ACR systems, require the use of an inert gas during the brazing process. The purge gas displaces oxygen from the interior of the system while it is being subjected to the high temperatures of brazing and therefore eliminates the possibility of oxide formation on the interior of the tube surface.

**2.5** **Flared Joints.**

**2.5.1** **Flared Joints with Impact Flaring Tools.**

Step 1 Cut the tube to the required length.

Step 2 Remove all burrs. This is very important to assure metal-to-metal contact.

Step 3 Soft temper tube, if deformed, should be brought back to roundness with a sizing tool. This tool consists of a plug and sizing ring.

Step 4 Slip the coupling nut over the end of the tube.

Step 5 Insert flaring tool into the tube end.

Step 6 Drive the flaring tool by hammer strokes, expanding the end of the tube to the desired flare. This requires a few moderately light strokes.

Step 7 Assemble the joint by placing the fitting squarely against the flare. Engage the coupling nut with the fitting threads. Tighten with two wrenches, one on the nut and one on the fitting.

**2.5.2** **Flared Joints with Screw-Type Flaring Tools.**

Steps 1 - 4 Same as for impact flaring previously described.

Step 5 Clamp the tube in the flaring block so that the end of the tube is slightly above the face of the block.

Step 6 Place the yoke of the flaring tool on the block so that the beveled end of the compressor cone is over the tube end.

Step 7 Turn the compressor screw down firmly, forming the flare between the chamber in the flaring block and the beveled compressor cone.

Step 8 Remove the flaring tool. The joint can now be assembled as in Step 6 for impact flaring.

2.6 **Sizing, Velocity.** To avoid excess system noise and the possibility of erosion-corrosion, flow through copper tube systems should not exceed velocities of 8 feet per second for cold water and 5 feet per second in hot water up to approximately 140°F (60°C) [UPC 610.0]

In systems where water temperatures routinely exceed 140°F (60°C), lower velocities such as 2 to 3 feet per second should not be exceeded. In addition, where ½ inch and smaller tube sizes are used, to guard against localized high velocity turbulence due to possible faulty workmanship (e.g. burrs at tube ends which were not properly removed) or unusually numerous, abrupt changes in flow direction, lower velocities should be considered.

Due to constant circulation and elevated water temperatures, particular attention should be paid to velocities in circulation hot water systems. Both the supply and return piping should be sized such that the maximum velocity does not exceed the above recommendations. Care should be taken to ensure that the circulating pump is not oversized and the return piping is not undersized, both common occurrences in installed copper piping systems.

3.0 **General Information.**

3.1 It is not possible to cover all the variables of a plumbing system; however, the following information may prove helpful:

**Expansion Loops** – Copper tube, like all piping materials, expands and contracts with temperature changes. Therefore, in a copper tube system subjected to excessive temperature changes, the line tends to buckle or bend when it expands unless compensation is built into the system. Severe stresses on the joints may also occur. Such stresses, buckles, or bends are prevented by the use of expansion joints or by installing offsets, "U" bends, coil loops, or similar arrangements in the tube assembly. These specially shaped tube segments take up expansion and contraction without excessive stress. The expansion of a length of copper tube may be calculated from the formula:

Temperature Rise (°F) x Length (feet) x
12 (inches per foot) x
Expansion Coefficient (in. per in. per °F) =
Expansion (inches), or

Temperature Rise (°C) x Length (meter) x
1000 (mm per meter) x
Expansion Coefficient (mm per mm per °C) =
Expansion (mm).

Calculations for expansion and contraction should be based on the average coefficient of expansion of copper, which is 0.0000094 per °F (1.692 x $10^{-5}$ per °C), between 70°F (21°C) and 212°F (100°C). For example, the expansion of each 100 feet (3048 mm) of length of any size tube heated from room temperature (70°F) (21°C) to 170°F (77°C) (a 100°F (38°C) rise) is 1.128 inches (28.7 mm).

100° x 100 ft x 12 in./ft x
0.0000094 in./in./°F = 1.128 in., or

55.6° x 30.48 m x 1000 mm/m x 1.692 x
$10^{-5}$ mm/mm/°C = 28.7 mm

3.2 **Tube Supports** – See Table 313.1 and Section 313.0 in the Uniform Plumbing Code.

3.3 **Bending.**

3.3.1 Copper tube, properly bent, will not collapse on the outside of the bend and will not buckle on the inside of the bend. Tests demonstrate that the bursting strength of a bent copper tube can be greater than it was before bending. Because copper is readily formed, expansion loops and other bends necessary in an assembly are quickly and simply made if the proper method and equipment are used. Simple hand tools employing mandrels, dies, forms, and fillers, or power-operated bending machines are used.

Both annealed tube and bending-temper tube can be bent with hand benders. The proper size bender for each size tube must be used. Usually the size of the tool corresponds to the nominal outside diameter of the tube, not the standard tube size. For a guide to the typical bend radii, see the following bending guide for copper tube.

**ADOPTED: 1969**

**REVISED: 1973, 1975, 1987, 1989, 1993, 2000, 2003, 2006**

## BENDING GUIDE FOR COPPER TUBE

| TUBE SIZE, | | TUBE TYPE | TEMPER | MINIMUM BEND RADIUS, | | TYPE OF BENDING EQUIPMENT |
|---|---|---|---|---|---|---|
| Inches | (mm) | | | Inches | (mm) | |
| ¼ | (6.4) | K, L | Annealed | ¾ | (19.1) | Lever type |
| ⅜ | (9.5) | K, L | Annealed | 1½ | (38) | Lever or gear type |
| | | | | 3 | (76) | None; by hand* |
| | | K, L, M | Drawn | 1¾ | (44) | Gear type |
| ½ | (12.7) | K, L | Annealed | 2¼ | (57) | Lever or gear type |
| | | | | 4½ | (114) | None; by hand* |
| | | K, L, M | Drawn | 2½ | (64) | Gear type |
| ¾ | (19.1) | K, L | Annealed | 3 | (76) | Lever or gear type |
| | | K | | 4½ | (114) | None; by hand* |
| | | L | | 6 | (152) | None; by hand* |
| | | K | Drawn | 3 | (76) | Gear type |
| | | K, L | | 4 | (102) | Heavy-duty gear type |
| 1 | (25.4) | K, L | Annealed | 4 | (102) | Gear type |
| | | | | 7½ | (191) | None; by hand* |
| 1¼ | (32) | K, L | Annealed | 9 | (229) | None; by hand* |

* When bending by hand, without the use of bending equipment, a circular wooden disc is used. The radius of the disc should be about ¼ to ½ inch less than the minimum bend radius shown.

# INSTALLATION STANDARD
# FOR TILE-LINED SHOWER RECEPTORS (AND REPLACEMENTS)

# IAPMO IS 4-2006

**Forward.**

This standard specification for the installation of tile-lined shower receptors is the result of extensive study and research by the following:

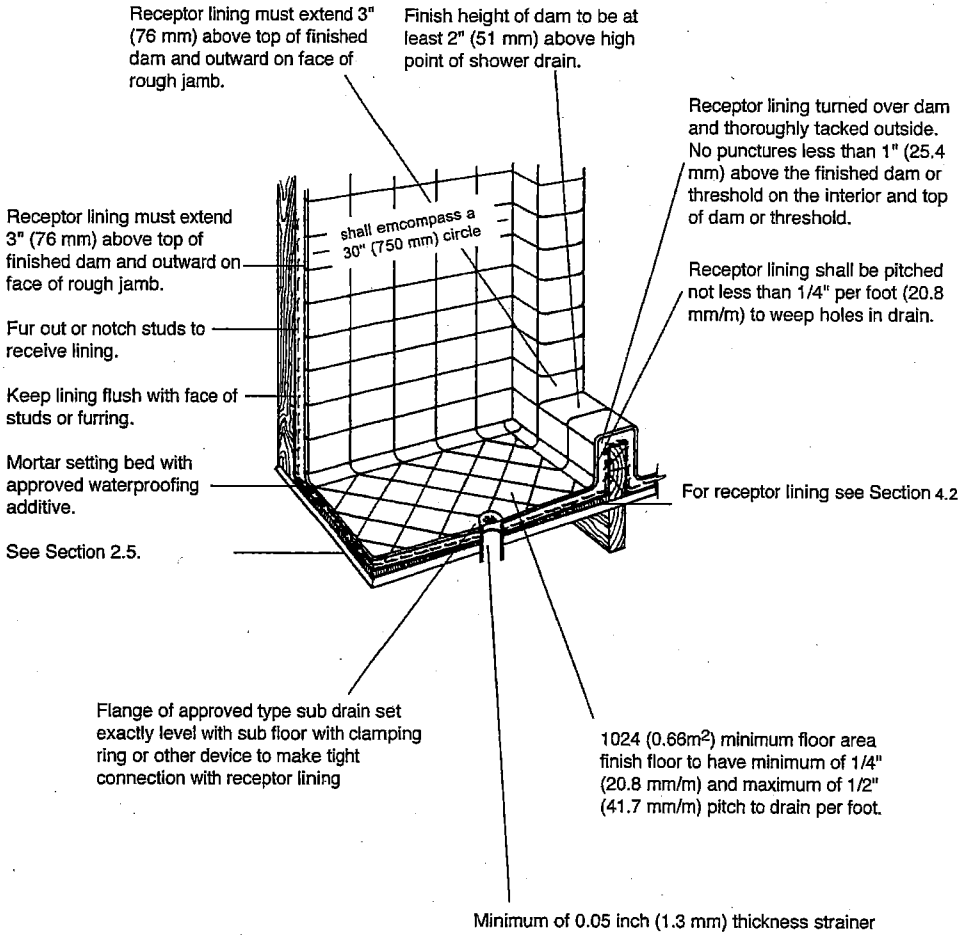
Ceramic Tile Institute of America

Associated Tile Contractors of Southern California, Inc.

Tile Layers Local No. 18 of I.U.B.A.C, United States and Canada

Tile Helpers Local No. 18 of I.U.B.A.C., of the United States and Canada

**APPROVED CONSTRUCTION OF TILE-LINED SHOWER RECEPTORS**
**STANDARD SPECIFICATION FOR THE INSTALLATION OF**
**TILE-LINED SHOWER RECEPTORS**



**1.0 Scope.**

**1.1** Installation and material of tile-lined shower receptors shall comply with this standard and the current edition of the Uniform Plumbing Code [UPC]™, published by the International Association of Plumbing and Mechanical Officials (IAPMO).

**Note:** The following sections of the Uniform Plumbing Code shall apply.

| | |
|---|---|
| 408.6 | Shower Compartments |
| 408.7 | Linings for Showers and Receptors |
| 408.8 | Public Shower Rooms |
| 418.0 | Floor Drains |

**2.0 General Requirements.**

**2.1** **Inspection of Work.** All surfaces prepared by others shall be inspected by the tile installer before starting tile work and all unsatisfactory conditions reported to the Administrative Authority. Starting tile work by the tile installer shall be considered as acceptance of surfaces prepared by others.

**2.2** **Surface.** All surfaces to receive tile work shall be clean, structurally sound, and conform in every way to the local building code.

(**Note:** No tile work shall proceed until the pan and drain construction has been inspected and approved by the Administrative Authority, where required.)

**3.0 Product Requirements.**

**3.1 Materials.**

**3.1.1** **Tile Quality and Grade** – Tile shall comply with American National Standard Specification for Ceramic Tile, A137.1 (equivalent to and incorporating U.S. Dept. of Commerce Simplified Practice Recommendation, R61-61 and Federal Specification SS-T-308b, Tile, Floor, Wall, and Trim Units, Ceramic), or CTI 69.5.

**3.1.2** **Cement.** Cement shall be portland cement type I or type II, conforming to ASTM C 150.

**3.1.3** **Sand.** Sand shall be damp, clean and graded ASTM C 778.

**3.1.4** **Water.** Water shall be potable.

**3.1.5** **Reinforcing** shall be 2.5 lbs. per sq. yard (1.1 kg per $m^2$) or greater galvanized metal lath conforming to ANSI A42.3 or 2 inches x 2 inches (51 mm x 51 mm), 16/16 gage or 3 inches x 3 inches (76 mm x 76 mm) mesh, 13 x 13 gage or 1-½ inches x 2 inches (38 mm x 51 mm) mesh, 16 x 13 gage steel, wire conforming to ASTM A 82 and A 185.

**3.1.6** **Asphalt** shall conform to Federal Specification A-A-50694 OR ASTM D 1227.

**3.1.7** **Plastic Roof Cement** shall conform to Federal Specifications SS-C-153.

**3.1.8** **Water Resistant Felt Membrane.** The water resistant felt membrane shall be at least 15 lb. (6.8 kg) asphalt saturated felt conforming to ASTM D 2626.

**3.1.9** **Plastic Membrane** shall comply with ANSI A118.10.

**3.1.10** **Other Membranes** – Where the Administrative Authority approves their use, non-metallic sub-pans or linings or lead sheets weighing not less than 4 lbs. per sq. foot (191.5 Pa) and copper pans of at least No. 24 B & S gage (Brown & Sharp 0.0201 inches) or greater in thickness may be used.

**3.1.11** **Waterproofing Admixture** – The mortar bed of the receptor shall be mixed with a waterproof admixture approved by the Administrative Authority in the amounts allowed by such approval.

**3.2 Currently Approved Mortar Additives.**

Anti-Hydro—1 qt. (0.95 l) per sack of cement

Plastiment—1 lb. (0.5 kg) of powder per sack of cement

Plastiment—2 oz. (56.7 g) of fluid per sack of cement

Sika 3A—1 qt. (0.95 l) per sack of cement

Suconem (Red Label)—1 pint (0.47 l) per sack of cement

**4.0 Installation Requirements.**

**4.1** **Shower Drains** – An approved type shower floor drain with sub-drain shall be installed with every such shower membrane. Flange of each sub-drain shall be accurately set exactly level with sloping sub-floor and shall be equipped with a clamping ring or other approved device to make a tight connection between the membrane and the sub-drain. The sub-drain shall have weep holes into the waste line. The weep holes located in the subdrain clamping ring shall be protected from becoming clogged during the placement of finish materials. The drain shall be of such design that there will be not less than 2" (51 mm) depth from the top of the sub-drain flange to top of the strainer. Unless otherwise approved by the Administrative Authority, drains shall be located in the approximate center of the shower area. [UPC 408.7]

4.2 **Sloping Sub-Floor and Shower Membrane.** All lining materials shall be pitched one quarter (¼) inch per foot (20.8 mm/m) to weep holes in the sub-drain by means of a smooth and solidly formed sloping sub-base. All such lining materials shall extend upward on the side walls and rough jambs of the shower opening to a point not less than three (3) inches (76 mm) above the top of the finished dam or threshold and shall extend outward over the top of the rough threshold and be turned over and fastened on the outside face of both the rough threshold and the jambs.

4.2.1 Non-metallic shower sub-pans or linings may be built-up on the job site of not less than three (3) layers of standard grade fifteen (15) pound (6.8 kg) asphalt impregnated roofing felt. The bottom layer shall be fitted to the formed sub-base and each succeeding layer thoroughly hot-mopped to that below, with hot asphalt conforming to Fed. Spec. SS-A0666 Type Z, Grade 2, Class A on the basis of twenty (20) pounds (9.1 kg) of asphalt per layer per square. All corners shall be carefully fitted and shall be made strong and water-tight by folding or lapping, and each corner shall be reinforced with suitable webbing hot-mopped in place. All folds, laps, and reinforcing webbing shall extend at least four (4) inches (102 mm) in all directions from the corner and all webbing shall be of approved type and mesh, producing a tensile strength of not less than fifty (50) pounds per square inch (344.5 kPa per square meter) in either direction.

4.2.2 Non-metallic shower sub-pans or linings may also consist of single or multi-layers of other approved equivalent materials, suitably reinforced and carefully fitted in place on the job site, as elsewhere required in this section according to manufacturer's recommended installation procedures.

Where flexible plastic sheet membranes are used, corners shall be carefully constructed by folding or bonding of prefabricated reinforcing corner. Joints in flexible plastic sheeting shall be constructed with the appropriate solvent bonding liquid, bodied solvent cement, or thermal welding.

4.2.3 Where lead and copper pans are used as membranes, the installation shall be made in similar manner as required for felt membranes except the asphalt moppings, and in addition the pans shall be insulated from all concrete and mortar surfaces and from all conducting substances other than their connecting drain by 15 lb. (6.8 kg) asphalt saturated felt or an approved equivalent hot mopped to the lead or copper pan. Joints in lead and copper pans shall not be soldered, but shall be burned or silver brazed respectively.

4.2.4 All linings shall be properly recessed and fastened to approved backing so as not to occupy the space required for the wall covering and shall not be nailed or perforated at any point which will be less than one (1) inch (25.4 mm) above the finished dam or threshold.

4.3 **Tests.** Upon installation, all linings shall be tested for water tightness by being filled to the top of the rough threshold with water for a period of time sufficient to establish their water tightness. (Usually twenty-four (24) hours with no loss of water. See the local Administrative Authority for exact time limit.)

A test plug shall be so placed that both the upper and under sides of the lining shall be subjected to test at its point of contact with the sub-drain. When the test plug is removed, all of the test water shall drain out by gravity through the weep holes. A ring of non-absorbent material must be placed around the weep holes to keep them open when the finish materials are installed.

4.4 **Receptor.** Shower floor shall be of ceramic tile set in portland cement mortar mixed in the proportion of one (1) part portland cement to four (4) parts of mortar sand by volume and shall be provided with an approved shower drain designed to make a water-tight joint at the floor. The mortar mixture shall be of such consistency that a troweled surface readily assumes a smooth screeded surface. All concrete mortar bases shall be mixed with an approved waterproofing admixture and properly reinforced with 2.5 lbs. per square yard (1.1 kg per square m) or more galvanized metal lath or 2 inches x 2 inches (51 mm x 51 mm), 16/16 gage or 3 inches x 3 inches (76 mm x 76 mm) mesh, 13 x 13 gage or 1½ inches x 2 inches (38 mm x 51 mm) mesh, 16 x 13 gage cold drawn welded steel wire fabric located in the approximate center of the mortar bed and extending at least 3 inches (76 mm) at any point. The finished floor shall be not less than 2 inches (51 mm) measured from the top surface of the membrane. The high point of the tile floor shall be not less than 2 inches (51 mm) or more than 9 inches (229 mm) below the top of the finished dam and shall have a minimum of ¼ inch (6.4 mm/m) and a maximum of ½ inch (19.1 mm/m) pitch

per foot toward the drain. Shower walls to a minimum height of 3 inch (76 mm) and not less than 1 inch (25.4 mm) above the finished dam shall be lined with ceramic tile set in portland cement mortar.

**4.5** Floors of public shower rooms shall have a non-skid surface and shall be drained in such a manner that waste water from one bather will not pass over areas occupied by other bathers. Gutters in public or gang shower rooms shall have rounded corners for easy cleaning and shall be sloped not less than two (2) percent toward drains. Drains in such gutters shall be spaced not more than eight (8) feet (2,438 mm) from side walls or more than sixteen (16) feet (4,877 mm) apart

**4.6** Shower walls, including shower walls over bathtubs, shall be constructed of dense, non-absorbent waterproof materials, such as ceramic tile set in portland cement mortar or approved cementitious backer unit when no materials are adversely affected by moisture to a height of not less than six (6) feet (1,829 mm) above the floor.

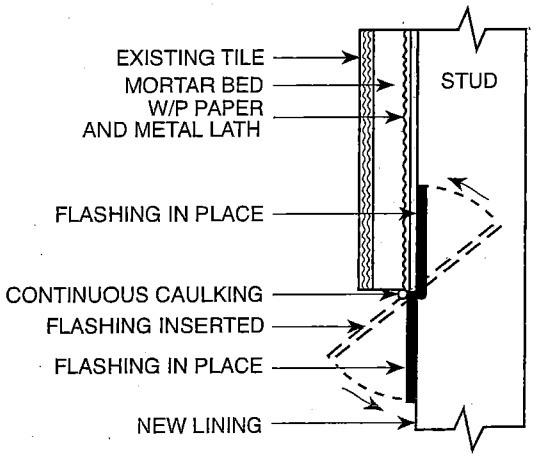



**FIGURE 2**

**ADOPTED: 1966**
**REVISED: 1977, 1982, 1990, 1992, 1996, 2003, 2006**

# INSTALLATION STANDARD
# FOR ABS BUILDING DRAIN, WASTE, AND VENT PIPE AND FITTINGS

# IAPMO IS 5-2006

**1.0 Scope.**

**1.1** This installation standard shall apply to ABS building drain, waste and vent systems as governed by the Uniform Plumbing Code. Material Standard ASTM D 2661, "Standard Specification of Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste and Vent Pipe and Fittings," or ASTM F 628, "Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic, Drain, Waste and Vent Pipe with a Cellular Core," shall form a part of this standard.

**1.2** Installation, material and inspection shall comply with the current edition of the Uniform Plumbing Code [UPC]™ as published by the International Association of Plumbing and Mechanical Officials and shall also comply with this standard.

**Note:** The Building Official shall be consulted about penetration of fire separations, height and area or other limitations.

**Note:** The following sections of the Uniform Plumbing Code apply.

| | |
|---|---|
| 101.6 | Repairs and Alterations |
| 103.5 | Inspections |
| 203.0 | Definition of ABS |
| 301.1 | Minimum Standards |
| 309.0 | Workmanship |
| 310.0 | Prohibited Fittings and Practices |
| 310.8 | Screwed Fittings |
| 312.0 | Protection of Piping, Materials, and Structures |
| 313.0 | Hangers and Supports |
| 315.2 | Prohibited Joints and Connections |
| 316.0 | Increasers and Reducers |
| 402.6 | Flanged Fixture Connections |
| 402.6.1 | Closet Rings (Closet Flanges) |
| 701.0 | Materials (drainage) |
| 705.1.2 | Solvent Cement Joints |
| 705.1.3 | Threaded Joints |
| 705.11.3 | Plastic Pipe to Other Materials |
| 707.1 | Plugs |
| 903.0 | Materials (venting) |
| 903.3 | Changes in Direction |
| 1003.0 | Traps – Described |
| 1101.3 | Material Uses |
| Table 1401.1 | Referenced Standards |

Pipe and Fittings:

ASTM D 2661
ASTM D 3311
ASTM D 2122
ASTM F 402
ASTM F 628

**Abbreviations.**

| | |
|---|---|
| ASTM | American Society for Testing and Materials |
| IAPMO | International Association of Plumbing and Mechanical Officials |
| UPC | Uniform Plumbing Code |

**2.0 Product Requirements.**

**2.1 Minimum Standards.**

**2.1.1 Pipe.** ABS pipe is furnished in straight lengths. The pipe is black in color. The pipe wall is the same thickness as that of Schedule 40 (IPS) standard steel pipe.

ABS pipe markings shall be in accordance with ASTM D 2661 or ASTM F 628. [UPC 301.1.1, 716.0]

**2.1.2 Fittings.** Fittings are black. Refer to Tables in ASTM D 2661 and ASTM D 3311 for dimensions and tolerances for pipe, fitting sockets, and laying lengths.

ABS fitting markings shall be in accordance with ASTM D 2661 or ASTM F 628. [UPC 301.1.1, 701.0, 903.0]

**2.1.3 Solvent Cement.** Solvent cement shall be as specified in ASTM D 2235. Solvent cement labels shall be in accordance with ASTM D 2235.

**2.2 Protection of Piping.**

**2.2.1 Storage.** Pipe and fittings should not be stored in direct sunlight. However, exposure

*Although referenced in this standard, some of the fittings shown in the standard are not acceptable under the Uniform Plumbing Code.

to direct sunlight during normal construction periods is not considered harmful. Pipe shall be stored in such a manner as to prevent sagging or bending.

2.2.2 **Expansion And Contraction.** Thermal expansion and contraction of plastic drain waste and vent systems shall be taken into consideration. Thermal expansion and contraction may be controlled by several methods: offset, expansion joints, or restraints. Regardless of method utilized, certain conditions shall be met.

(a) Support, but do not rigidly restrain piping at changes of direction.

(b) Do not anchor pipe rigidly in walls.

(c) Holes through framing members must be adequately sized to allow for free movement.

DWV installations with frequent changes in direction will compensate for thermal expansion and contraction. Expansion joints may be utilized in vertical straight runs in excess of thirty (30) feet (9,144 mm) provided they are installed per manufacturer's installation instructions.

Except piping buried below ground, horizontal and vertical piping should be installed with restraint fittings or a minimum twenty-four (24) inches (610 mm) 45° offset every thirty (30) feet (9144 mm).

Thermal expansion for installations subject to temperature changes may be determined from Table 1. The linear expansion shown is independent of the diameter of the pipe. [UPC 314.0]

2.2.3 **Exposed Piping.** Piping shall not be exposed to direct sunlight. Exception: Vent piping through roof. Plumbing vents through roof, exposed to sunlight, shall be protected by water base synthetic latex paints. Adequate support shall be provided where ABS piping is exposed to wind, snow, and ice loading.

2.2.4 **Protection From Damage.** Piping passing through wood studs or plates shall be protected from puncture by steel nail plates not less than 18 gauge. Piping shall be protected from concrete form oil. [UPC 312.10]

2.2.5 **Anti-Freeze Protection.** Anti-Freeze Protection – ABS pipe and traps can be protected from freezing by the use of one of the following solutions or mixtures:

(a) 4 quarts (3.8 liters) of water mixed with 5 quarts (4.8 liters) of glycerol.

(b) 2½ lbs. (1.1 kg) of magnesium chloride dissolved in one gallon (3.8 liters) of water.

(c) 3 lbs. (1.4 kg) of table salt dissolved in one gallon (3.8 liters) of water.

The salt solutions are effective to approximately 10°F (-12°C). If lower temperatures are anticipated, the pipe should be drained or the glycerol solution should be used. [UPC 312.6]

2.2.6 **Piping Installed in Fire Resistive Construction.** 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 *California* Building Code and IAPMO Installation Standards. [UPC 312.7]

2.3 **Hangers and Supports.**

2.3.1 **Abrasion.** Hangers and straps shall not compress, distort, cut, or abrade the piping and shall allow free movement of pipe. Pipe exposed to damage by sharp surfaces shall be protected.[UPC 313.0]

2.3.2 **Support.** Support all piping at intervals of not more than four (4) feet (1,219 mm), at end of branches, and at change of direction or elevation. Supports shall allow free movement, but shall restrict upward movement of lateral runs so as not to create reverse grade. Vertical piping shall be supported at each story or floor level. Alignment of vertical piping shall be maintained between floors with the use of a mid-story guide. Support trap arms in excess of three (3) feet (914 mm) in length as close as possible to the trap. Closet rings shall be securely fastened with corrosive resistant fasteners to the floor with the top surface one-quarter (¼) inch (6.4 mm) above the finish floor. [UPC 313.0]

2.4 **Traps.**

2.4.1 **Connection to Traps.** Traps shall be connected by means of listed trap adapters.[UPC 1003.0]

2.5 **Joints.**

2.5.1 **Caulked Joints.** Make connections or transitions to bell-and-spigot cast iron soil pipe and fittings, and to bell-and-spigot pipe and fittings of other materials with listed mechanical compression joints designed for this use, or caulked joints made in an approved manner. In caulking, pack the joint with oakum or hemp and fill with molten lead to a depth of not less than (1) inch (25.4 mm). Allow a period of four (4) minutes for cooling, following which, caulk the lead at the inside and outside edges of the joint. Lead shall not be overheated. Heat lead to melting point only. [UPC 705.1]

**TABLE 1**
**THERMAL EXPANSION TABLE**

| Chart Shows Length Changes in Inches vs. Degrees Temperature Change<br>Coefficient of Linear Expansion: e = 5.5 x 10-5 in/in °F | | | | | | | |
|---|---|---|---|---|---|---|---|
| **LENGTH (feet)** | **40°F** | **50°F** | **60°F** | **70°F** | **80°F** | **90°F** | **100°F** |
| 20 | 0.536 | 0.670 | 0.804 | 0.938 | 1.072 | 1.206 | 1.340 |
| 40 | 1.070 | 1.340 | 1.610 | 1.880 | 2.050 | 2.420 | 2.690 |
| 60 | 1.609 | 2.010 | 2.410 | 2.820 | 3.220 | 3.620 | 4.020 |
| 80 | 2.143 | 2.680 | 3.220 | 3.760 | 4.290 | 4.830 | 5.360 |
| 100 | 2.680 | 3.350 | 4.020 | 4.700 | 5.360 | 6.030 | 6.700 |

**TABLE 1 (METRIC)**
**THERMAL EXPANSION TABLE**

| Chart Shows Length Changes in Millimeters vs. Degrees Temperature Change<br>Coefficient of Linear Expansion: e = 0.3 mm / mm °C | | | | | | | |
|---|---|---|---|---|---|---|---|
| **LENGTH (mm)** | **4°C** | **10°C** | **16°C** | **21°C** | **27°C** | **32°C** | **38°C** |
| 6096 | 13.6 | 17.0 | 20.4 | 23.8 | 27.2 | 30.6 | 34.0 |
| 12 192 | 27.2 | 34.0 | 40.8 | 47.8 | 52.1 | 61.5 | 68.3 |
| 18 288 | 40.9 | 51.1 | 61.2 | 71.6 | 81.8 | 92.0 | 102.1 |
| 24 384 | 54.4 | 68.1 | 81.8 | 95.5 | 110.0 | 122.7 | 136.1 |
| 30 480 | 68.1 | 85.1 | 102.1 | 119.4 | 136.1 | 153.2 | 170.2 |

Example:

| | |
|---|---|
| Highest Temperature expected | 100°F (38°C) |
| Lowest Temperature expected | - 50°F (10°C) |
| | 50°F (10°C) |

Length of run – 60 feet (18 288 mm) from chart, read 2.010 inches (51 mm) linear expansion that must be provided for.

**Note**: Caulked joints should be avoided if possible.

**2.5.2 Solvent Cement Joints.**

**2.5.2.1 Selection.** Solvent cement shall be recommended for ABS by the manufacturer. Follow manufacturer's recommendations for types of solvent cement for such conditions as temperature over 100°F (38°C), or humidity over 60%. [UPC 705.1.2]

**2.5.2.2 Handling (to maintain effectiveness).** Solvent cement containers no larger than 1 gallon (3.8 liters) should be used in the field (to avoid thickening due to evaporation). Keep container closed and in the shade when not in use. Keep applicator submerged in solvent cement between applications. When solvent cement becomes thicker, THROW IT AWAY. Solvent cement shall NOT be thinned.

**2.5.2.3 Size of Applicator.** Applicator should be about one half the pipe diameter. Do not use small applicator on large pipes. Ordinary pure bristle paint brush or applicators furnished with product are satisfactory.

**2.5.2.4 Application.** Solvent cement shall be applied deliberately, but without delay (two people may be needed to make large joints). Use special care when temperature is over 100°F (38°C) or humidity is over 60%.

**2.5.3 Safety Requirements and Precautions.**

**2.5.3.1 General.** Solvents contained in ABS plastic pipe cements are classified as airborne contaminants and flammable and combustible liquids. Precautions listed in this appendix should be followed to avoid injury to personnel and the hazard of fire.

2.5.3.2 **Safety Precautions.** Prolonged breathing of solvent vapors should be avoided. When pipe and fittings are being joined in partially enclosed areas, a ventilating device should be used in such a manner to minimize the entry of vapors into the breathing areas.

2.5.3.3 Solvent cements should be kept away from all sources of ignition, heat, sparks and open flame.

2.5.3.4 Containers for solvent cements should be kept tightly closed except when the cement is being used.

2.5.3.5 All rags and other materials used for mopping up spills should be kept in a safety waste receptacle which should be emptied daily.

2.5.3.6 Most of the solvents used in ABS pipe cements can be considered eye irritants and contact with the eye should be avoided for it may cause eye injury. Proper eye protection and the use of chemical goggles or face shields is advisable where the possibility of splashing exists in handling solvent cements. In case of eye contact, flush with plenty of water for 15 minutes and call a physician immediately.

2.5.3.7 Repeated contact with the skin should be avoided. Proper gloves impervious to and unaffected by the solvents should be worn when frequent contact with the skin is likely. Application of the solvents or solvent cements with rags and bare hand is not recommended. Brushes and other suitable applicators can be used effectively for applying the solvent cement, thus avoiding skin contact. In the event of excessive contact, remove contaminated clothing and wash skin with soap and water.

Step 1 Cut pipe square with hand saw and miter box, mechanical cut-off saw, or tube cutter designed for plastic.

Step 2 Ream inside and chamfer outside of pipe (to eliminate all burrs).

Step 3 Clean all dirt, moisture, and grease from pipe and socket. Use a clean, dry rag.

Step 4 Check dry fit of pipe in fitting. Pipe should enter fitting socket from ⅓ to ¾ depth of socket.

Step 5 Apply a light coat of ABS solvent cement to inside of socket using straight outward strokes (to keep excess solvent out of socket). This is also to prevent solvent cement damage to pipe. For loose fits, apply a second coat of solvent cement. Time is important at this stage. See Section 2.5.2.4.

Step 6 While both the inside socket surface and the outside surface of the pipe are SOFT and WET with solvent cement, forcefully bottom the pipe in the socket, giving the pipe a one-quarter turn, if possible. The pipe must go to the bottom of the socket.

Step 7 Hold the joint together until tight (partial set).

Step 8 Wipe excess cement from the pipe. A properly made joint will normally show a bead around its entire perimeter. Any gaps may indicate insufficient cement or the use of light bodied cement on larger diameters where heavy bodied cement should have been used.

Step 9 The system shall not be tested until the joints have cured (set) at least as long as recommended by the manufacturer.

2.5.4 **Threaded Joints.**

Threads on iron pipe size (IPS) pipe and fittings shall be standards listed in Table 14-1. Threads on tubing shall be approved types. Threads on plastic pipe 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 approved types, insoluble in water and nontoxic. Cleanout plugs and caps shall be lubricated with water-insoluble, non-hardening material or tape. Only listed 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 base products, and unknown lubricants and sealants shall not be used on plastic threads. [UPC 705.1.3]

2.5.5 **Special Joints.**

2.5.5.1 **Plastic Pipe to Other Materials.**

When connecting plastic pipe to other types of piping, use only listed fittings and adapters, designed for the specific transition intended. [UPC 705.11.3]

2.6 **Prohibited Joints and Connections.**

(a) Drainage system – Any fitting or connection which has an enlargement, chamber, or recess with a ledge, shoulder, or reduc-

tion of pipe area, that offers an obstruction to flow through the drain is prohibited.

(b) No fitting or connection that offers abnormal obstruction to flow shall be used. The enlargement of a three (3) inch (76 mm) closet bend or stub to four (4) inches (102 mm) shall not be considered an obstruction. [UPC 315.2]

**ADOPTED: 1966**

**REVISED: 1971, 1974, 1975, 1976, 1977, 1981, 1982, 1983, 1987, 1989, 1990, 1992, 2003, 2006**

# INSTALLATION STANDARD
# FOR HUBLESS CAST IRON SANITARY AND RAINWATER SYSTEMS

# IAPMO IS 6-2006

**1.0 Scope.**

**1.1** This installation standard is for use with listed systems of hubless cast iron pipe and fittings, utilizing listed couplings.

**1.2** This standard shall serve to supplement any existing applicable standards and requirements of appropriate codes and laws regulating use of hubless cast iron pipe and fittings in building sewer, drainage, waste, vent, and rainwater systems, and to provide the necessary requirements for installation, use and inspection of piping and fittings for this purpose. This system may be used in any location where cast iron pipe is acceptable under the Uniform Plumbing Code.

**1.3** The provisions of this standard are not intended to prevent the use of any alternate material or method of construction, provided it meets the requirements of the standard.

**Note**: The following sections of the Uniform Plumbing Code apply to this standard:

| | |
|---|---|
| 101.6 | Repairs and Alterations |
| 301.1 | Minimum Standards |
| 309.0 | Workmanship |
| 310.0 | Prohibited Fittings and Practices |
| 312.0 | Protection of Piping, Materials, and Structures |
| 313.0 | Hangers and Supports |
| 315.2 | Prohibited Joints and Connections |
| 316.0 | Increasers and Reducers |
| Table 313.1 | Hanger and Support Spacing |
| Table 313.6 | Hanger Rod Sizes |
| 402.6.1 | Closet Rings (Closet Flanges) |
| 701.0 | Materials (drainage) |
| 705.4 | Cast-Iron Pipe and Joints |
| 705.4.2 | Mechanical Joints |
| 707.13 | Hubless Blind Plugs |
| 712.2 | Water Test |
| 712.3 | Air Test |
| Table 702.1 | Drainage Fixture Unit Values (DFU) |
| Table 703.2 | Maximum Unit Loading and Maximum Length of Drainage and Vent Piping |
| 903.0 | Materials (venting) |
| 1003.0 | Traps – Described |
| Chapter 11 | Storm Drainage |
| 1101.3 | Material Uses |
| 1101.11 | Roof Drainage |
| Table 1401.1 | Referenced Standards |

**2.0 Product Requirements.**

**2.1** **Minimum Standards.** Hubless pipe, fittings, and couplings shall be manufactured in strict compliance with appropriate standards acceptable to IAPMO. [UPC 301.1]

**2.2** **Markings.**

**2.2.1** All hubless system components shall be clearly marked with the following:

(a) Manufacturer's name or manufacturer's registered trademark; the markings shall be adequate to readily identify the maker or manufacturer to the end user of the product;

(b) Products listed by IAPMO that are covered by this standard shall be labeled with the designated IAPMO certification mark;

(c) Country of origin; and

(d) Any other markings required by law.

**2.2.2** Pipe shall be legibly and continuously marked along the full length of the barrel. [UPC 301.1.1]

**2.2.3** Markings on fittings shall be cast raised letters and not be located in the W dimension as found in the product standard. With the exception of the fittings with notations in the standards allowing for optional positioning lugs fittings have a raised lug. When properly positioned, the gasket in other than wider body couplings will rest against but will not cover the lug. Gaskets for wider body couplings will cover the lug. [UPC 301.1.1]

**2.3** All installations shall be made so that the components can be readily identified. When laying hubless pipe in a ditch, the identification shall be on the top side of the pipe. When

in walls, the identification shall be on a side readily visible to the inspector.

**2.4** **Workmanship.** All piping systems shall be installed and supported in a workmanlike manner. [UPC 309.0]

**2.5** **Hangers and Supports.** Support and stability of all components of a hubless cast iron sanitary and rainwater system shall be given prime consideration. [UPC 313.0]

**2.5.1** Vertical hubless systems shall be supported per Table 313.1 of the Uniform Plumbing Code.

**2.5.2** Horizontal hubless systems shall be supported per Table 313.1 of the Uniform Plumbing Code. Supports shall be adequate to maintain alignment and prevent sagging and shall be placed within eighteen (18) inches (457 mm) of the joint.

**2.5.3** Joints shall be supported at least at every other joint except that when the developed length between supports exceeds four (4) feet (1,219 mm) they shall be provided at each joint. Supports shall also be provided at each horizontal branch connection. Such support shall be placed immediately adjacent to the coupling.

**2.5.4** Suspended lines shall be suitably braced to prevent horizontal movement.

**2.5.5** Closet bends, trap arms, and similar branches shall be secured against movement in any direction.

**2.5.6** Hubless systems, in the ground shall be laid on a firm bed for its entire length except where support is otherwise provided which is adequate in the judgement of the Administrative Authority. [UPC 313.3]

Vertical sections and their connecting branches shall be adequately staked and fastened to driven steel pipe or reinforcing bars so as to remain stable while backfill is placed or concrete is poured.

**2.6** **Joints.** During installation assembly, hubless pipe and fittings shall be inserted into the gasket and firmly seated against a center stop. Center stop ring or fittings shall not create an enlargement chamber or recess with a ledge, shoulder, or reduction of pipe area or offer an obstruction to flow. In order to provide a sound joint with field cut lengths of pipe, the ends shall be cut square. Coupling assemblies shall be properly positioned and uniformly tightened to the torque required. The use of an adequate torque wrench recommended by the manufacturer of the coupling assemblies shall be used. [UPC 705.1]

**2.6.1** Listed adapters designed for the specific transition intended shall be used for the intermembering transition of different piping materials.

**2.6.2** The connection of closet rings, floor and shower drains, and similar "slip over" fittings to hubless pipe and fittings and the connection of hubless pipe and fittings to conventional pipe hubs shall be accomplished by the use of caulked lead joints, or other listed connections.

**ADOPTED: 1966**

**REVISED: 1972, 1974, 1975, 1982, 1989, 1991, 1993, 1995, 2000, 2003, 2006**

# INSTALLATION STANDARD
# FOR POLYETHYLENE (PE) COLD WATER BUILDING SUPPLY AND YARD PIPING

# IAPMO IS 7-2008

**1.0 Scope.**

**1.1** This standard shall govern the installation of polyethylene (PE) cold water building supply and yard piping. (See Section 604.1 of the Uniform Plumbing Code and Section 2.7 of this standard for allowable location and pressure). Installation, material and inspection shall comply with the current edition of the Uniform Plumbing Code [UPC]™ published by the International Association of Plumbing and Mechanical Officials, and shall also comply with this standard. The terms pipe and piping are used throughout this document and are intended to include both polyethylene tubing and polyethylene pipe.

**Note:** The following sections of the Uniform Plumbing Code apply to polyethylene piping.

| | |
|---|---|
| 103.5.6 | Testing of Systems |
| 218.0 | Definition of PE |
| 309.0 | Workmanship |
| 312.0 | Protection of Piping, Materials, and Structures |
| 313.3 | Underground Piping |
| 314.0 | Trenching, Excavation, and Backfill |
| Chapter 6 | Water Supply and Distribution |
| 605.17.2 | Plastic Pipe to Other Materials |
| 609.0 | Installation, Testing, Unions, and Location |
| 609.1 | Installation |
| 609.4 | Testing |

Table 1401.1 Referenced Standards

| | |
|---|---|
| Metallic Fittings | IAPMO PS 25 |
| Plastic Insert Fittings | ASTM D 2609 |
| Butt Heat Fusion PE Plastic Fittings | ASTM D 3261 |
| PE Pipe | ASTM D 2239 |
| | ASTM D 3035 |
| | ASTM F 714 |
| PE Tubing | ASTM D 2737 |
| Heat Fusing Joining | ASTM F 2620 |

**Abbreviations.**

| | |
|---|---|
| ASTM | American Society for Testing and Materials |
| IAPMO | International Association of Plumbing and Mechanical Officials |
| PS | Material and Property Standard published by IAPMO |
| UPC | Uniform Plumbing Code published by IAPMO |

**2.0 Product Requirements.**

**2.1 Minimum Standards.**

**2.1.1** **Material.** Material shall conform to the appropriate standard in Table 1401.1.

**2.1.2** **Pipe.** PE pipe is plastic and typically colored black. It is not mandatory to use color to identify piping service.

**2.1.3** **Fittings.** Fittings are copper alloy or nylon barbed insert fittings for D 2239 PE piping or butt fusion fittings for D 2737, D 3035 or F 714 PE piping.

**2.2 Markings.**

**2.2.1** **Piping.** PE pipe markings shall be in accordance with either D 2239, D 2737, D 3035 or F 714. [UPC 301.1.1]

**2.2.2 Fittings.**

**2.2.2.1** Plastic insert fittings for joining D 2239 PE pipe shall be marked in accordance with D 2239. [UPC 301.1.1]

**2.2.2.2** Butt fusion fittings for joining D 2737, D 3035 or F 714 PE pipe shall be marked in accordance with D 3261. [UPC 301.1.1]

**2.2.3** **Bands.** Bands for plastic insert fittings shall be marked with at least the following:

(a) Manufacturer's name or trademark;

(b) Model;

(c) Stainless steel, Series 300; and

(d) Bands listed by IAPMO that are covered by this standard shall be labeled with the UPC logo to show compliance with this standard.

**2.2.4** **Position of Markings.** The identifying markings on pipe and fittings shall be visible for inspection without moving materials.

**2.3 Protection of Piping.**

**2.3.1** **Storage.** Unprotected pipe should not be stored in direct sunlight. The pipe shall be stored in a way to protect it from mechanical damage (slitting, puncturing, etc.).

2.3.2 **Thermal Expansion.** The pipe shall be snaked in the trench bottom with enough slack to provide for thermal expansion and contraction. The normal slack created by residual coiling is generally sufficient for this purpose. If, however, the pipe has been allowed to straighten before it is placed in the trench, six (6) inches (152 mm) per one hundred (100) feet (30,480 mm) of length shall be allowed for this purpose. [UPC 312.0]

2.3.3 **Exposed Piping.** Vertical piping may extend a maximum of twenty-four (24) inches (610 mm) above grade when located on the exterior of the building or structure and protected from mechanical damage to the satisfaction of the Administrative Authority. Where exposed to sunlight, the pipe shall be wrapped with at least 0.040 in. (1.02 mm) of tape.

2.4 **Trenching and Cover.** Trench bottoms shall be uniformly graded and shall be of either undisturbed soil or shall consist of a layer or layers of compacted backfill so that minimum settlement will take place. [UPC 314.0]

2.5 **Joints.**

2.5.1 **General.** Polyethylene pipe joints shall be made as follows (see Section 2.2.1). ASTM D 2239 polyethylene piping shall be joined only through the use of mechanical fittings. ASTM D 2737, D 3035 or F 714 polyethylene pipes shall be joined by butt fusion of pipe to pipe or through the use of butt fusion fittings.

2.5.2 **Procedure.**

2.5.2.1 Mechanical fittings for joining only D 2239 PE pipes shall be made as follows:

Step 1 Pipe shall be cut square, using a cutter designed for plastic pipe, and chamfer ends to remove sharp edges.

Step 2 Place two strap-type stainless steel bands over the pipe.

Step 3 Check that fittings are properly sized for pipe, as tubing fittings are not of proper size.

Step 4 Force the end of the pipe over the barbed insert fittings, making contact with the fitting shoulder (the end of the pipe may be softened by placing in hot water).

Step 5 Position the clamps 180° apart and tighten evenly, so as to make a leak-proof joint. [UPC 605.7.2]

2.5.2.2 Butt fusion for joining only D 2737, D 3035, or F 714 PE pipes shall be made as follows:

Step 1 Install the pipe/fitting in the fusion machine.

Step 2 Face the pipe/fitting ends to mechanical stops.

Step 3 Align the OD's of the ends to be fused.

Step 4 Heat the ends using in accordance with ASTM F 2620.

Step 5 Remove the heater and apply the fusion force specified in ASTM F 2620.

Step 6 Maintain the fusion force on the joint until it is cool per ASTM F 2620.

2.5.3 **Other Joints.** Polyethylene pipe shall not be threaded. Joints in polyethylene pipe made with adhesives or "solvent cementing" techniques are prohibited.

2.6 **Materials.**

2.6.1 **Location.** Polyethylene piping shall be installed only outside the foundation of any building or structure or parts thereof. It shall be buried in the ground for its entire length except vertical piping may be extended above grade per Section 604.1. It shall not be installed within or under any building or structure or mobile home or commercial coach, or parts thereof. The term "building or structure or parts thereof" shall include structures such as porches and steps, whether covered or uncovered, roofed porte-cocheres, roofed patios, carports, covered walks, covered driveways, and similar structures or appurtenances. [UPC 604.1]

2.6.2 **Harmful Materials.** Polyethylene that has been in contact with gasoline, lubricating oil, or aromatic compounds, shall not be installed.

2.7 **Installation.**

2.7.1 **Pipe.** Kinked pipe shall not be used. PE pipe shall not be flared. [UPC 609.0]

2.7.2 **Fittings.**

2.7.2.1 Compression type couplings and fittings shall be used only when installing one and on-half (1½) inch (38 mm) and larger pipe. Stiffeners that extend beyond the clamp or nut shall not be used. [UPC 605.7.2]

2.7.2.2 Butt fusion fittings shall comply with ASTM D 3261.

2.7.3 **Bends.** Changes in direction may be made by bends. The installed radius of pipe curvature shall be not less than thirty (30) pipe diameters, or the coil radius when bending with the

coil. Coiled pipe shall not be bent beyond straight. Bends shall not be permitted closer than ten (10) pipe diameters of any fitting or valve.

2.7.4 **Maximum Working Pressure.** Working pressure shall not exceed 160 psi (1.10 mPa).

2.7.5 **Identification.** A label shall be fastened to the main electric meter panel stating "This structure has a non-metallic water service".

2.8 **Sizing.**

2.8.1 Piping shall be sized in accordance with UPC Section 610.0. When UPC Appendix A is applicable, use UPC Chart A 4.1 (Copper Tubing Type L). Flow velocity shall not exceed 8 fps (2.4 m/s). [UPC 610.1]

**ADOPTED: 1968**

**REVISED: 1969, 1971, 1972, 1973, 1975, 1978, 1981, 1982, 1983, 1989, 1990, 2003, 2006, 2008**

# INSTALLATION STANDARD
# FOR PVC COLD WATER BUILDING SUPPLY AND YARD PIPING

# IAPMO IS 8-2006

**1.0 Scope.**

**1.1** This standard shall govern the installation of PVC piping (with solvent cemented or elastomeric gasketed joints) in cold water building supply and yard piping. (See Section 2.7 and 2.8 for allowable location and pressure.) Installation, material and inspection shall comply with the current edition of the Uniform Plumbing Code [UPC]™ published by the International Association of Plumbing and Mechanical Officials, and shall also comply with this standard.

**Note:** The following sections of the Uniform Plumbing Code apply to PVC water piping.

| | |
|---|---|
| 218.0 | Definition of PVC |
| 309.0 | Workmanship |
| 312.0 | Protection of Piping, Materials, and Structures |
| 313.0 | Hangers and Supports |
| 314.0 | Trenching, Excavation, and Backfill |
| Chapter 6 | Water Supply and Distribution |
| 604.0 | Materials (water piping) |
| 605.13 | PVC Plastic Pipe and Joints |
| 605.13.2 | Solvent Cement Joints |
| 605.17.2 | Plastic Pipe to Other Materials |
| 609.0 | Installation, Testing, Unions, and Location |

**Chapter 14.**

| | |
|---|---|
| ASTM | American Society for Testing and Materials |
| IAPMO | International Association of Plumbing and Mechanical Officials |
| UPC | Uniform Plumbing Code published by IAPMO |

**Applicable Standards.**

| Type of PVC for Pipe and Fittings | ASTM Standard |
|---|---|
| PVC 1120 or 1220 | D 1784 |
| Pipe | |
| Bell-End Poly (vinyl chloride) | |
| PVC Pipe | D 2672 |
| PVC Schedule 40 | D 1785 |
| PVC Schedule 80 | D 1785 |
| PVC 160 psi (1102.4 kPa) (SDR 26) | D 2241 |
| PVC 200 psi (1378 kPa) (SDR 21) | |
| PVC 250 psi (1722.5 kPa) (SDR 17) | |
| PVC 315 psi (2170.4 kPa) (SDR 13.5) | |
| Fittings | |
| Schedule 40 (Socket) | D 2466 |
| Schedule 80 (Socket) | D 2467 |
| Schedule 80 (Threaded) | D 2464 |
| Solvent Cement | |
| PVC Solvent Cement | D 2564 |
| Primers | |
| PVC Primers | F 656 |

**2.0 Product Requirements.**

**2.1 Minimum Standards.**

**Material.** Materials shall conform to the appropriate standard in Table 1401.1 of the Uniform Plumbing Code. [UPC 301.1]

**2.2 Pipe and Fittings.** Pipe and fittings are manufactured from PVC plastic.

**2.3 Markings.**

**2.3.1 Pipe.** PVC pipe markings shall be in accordance with ASTM D 1785 or ASTM D 2241. [UPC 301.1.1]

**2.3.2 Fittings.** PVC fitting markings shall be in accordance with ASTM D 2464 or ASTM D 2466 or ASTM D 2467. [UPC 301.1.1]

*Note: Size and material designation may be omitted on smaller fittings.

**2.3.3 Solvent Cement.** Solvent cement container markings shall be in accordance with ASTM D 2564.

**2.3.3.1 Color.** Solvent cement shall not be purple in color.

**2.3.4 Primers.** Primer container markings shall be in accordance with ASTM F 656.

**2.3.4.1 Color.** Primer shall be purple.

**2.3.4.2 Position of Markings.** The identifying markings on pipe and fittings shall be visible for inspection without moving materials.

**2.4 Protection of Piping.**

**2.4.1 Storage.** Unprotected pipe should not be stored in direct sunlight. The pipe shall be stored in a way to protect it from mechanical damage (slitting, puncturing, etc.). Exposure to sunlight during normal construction periods is not harmful. PVC solvent cements should be stored in a cool place, except when actually in use at the job site. The solvent cement manufacturer's specific storage recommendations should be followed. [UPC 312.0]

**2.4.2 Alignment.** Pipe and fittings shall be aligned properly without strain.

**2.4.3 Thermal Expansion.** Pipe (except pipe with elastomeric gasketed joints) shall be "snaked" in the trench bottom with enough slack, at least 6 inches (152.4 mm) per 100 feet (30,480 mm), to compensate for thermal expansion and contraction before stabilizing piping. Stabilize piping by bringing it approximately to operating temperature before testing and backfilling by one of the following methods:

(a) Shade backfill. Leave all joints exposed so that they can be examined during pressure test.

(b) Fill with water at operating temperature.

(c) Allow to stand overnight.

**2.4.4 Exposed Piping.** Vertical piping may extend a maximum of 24 in. (610 mm) above grade when located on the exterior of the building or structure and protected from mechanical damage to the satisfaction of the Administrative Authority. Where exposed to sunlight, the pipe shall be wrapped with at least 0.040 in. (1.0 mm) of tape or otherwise protected from UV degradation.

**2.5 Trenching, Cover and Backfill.**

**2.5.1 Trenching and Cover.** Trench bottoms shall be uniformly graded and shall be of either undisturbed soil or shall consist of a layer or layers of compacted backfill so that minimum settlement will take place. [UPC 314.0]

**2.5.2 Backfill.** Selected backfill shall be used. Tamp the backfill that is placed around the pipe so as to provide firm continuous support and proper compaction. Backfill at least 12 inches (305 mm) over pipes, except that joints shall be left exposed. After inspection and pressure test, complete backfill. [UPC 314.4]

**2.5.3 Elastomeric Joints.** Backfill immediately after installing pipe.

**Note:** This is to maintain equal spaces within the joints for contraction and expansion.

**2.6 Joints.**

**2.6.1 Solvent Cement Joints.**

**2.6.1.1 Selection.** Follow manufacturer's recommendations for types of solvent cement for such conditions as temperature over 100°F (38°C), humidity over 60% or use of Schedule 80 fittings. [UPC 605.13.2]

**2.6.1.2 Handling (to maintain effectiveness).** Package solvent cement in containers no larger than 1 quart (1 liter). Keep solvent cement can closed and in the shade when not in use. Keep applicator submerged in solvent cement between applications. When solvent cement becomes thicker, THROW IT AWAY. Solvent cement shall NOT be thinned.

**2.6.1.3 Size of Applicator.** Applicator should be about one half the pipe diameter. Do not use small applicator on large pipes.

**2.6.1.4 Primers.** All solvent cement PVC joints shall be made using a listed primer in compliance with ASTM F 656 and as specified in Section 605.13.2 of the UPC.

**2.6.1.5 Application.** Solvent cement shall be applied deliberately, but without delay (two men may be needed to make large joints). Use special care when temperature is over 100°F (38°C) or humidity is over 60%.

**2.6.1.6 Procedure.**

**Note:** Do not take SHORT CUTS. Most failures are caused by short cuts. DON'T TAKE A CHANCE.

**2.6.2 Safety Requirements and Precautions[1].**

**2.6.2.1 General.** Solvents contained in PVC plastic pipe cements are classified as airborne contaminants and flammable and combustible liquids. Precautions listed in this appendix should be followed to avoid injury to personnel and the hazard of fire.

**2.6.2.2 Safety Precautions.** Prolonged breathing of solvent vapors should be avoided. When pipe and fittings are being joined in partially enclosed areas, a ventilating device should be used in such a manner to minimize the entry of vapors into the breathing areas.

**2.6.2.3** Solvent cements should be kept away from all sources of ignition, heat, sparks, and open flame.

**2.6.2.4** Containers for solvent cements should be kept tightly closed except when the cement is being used.

**2.6.2.5** All rags and other materials used for mopping up spills should be kept in a safety waste receptacle which should be emptied daily.

**2.6.2.6** Most of the solvents used in PVC pipe cements can be considered eye irritants and contact with the eye should be avoided for it may cause eye injury. Proper eye protection and the use of chemical goggles or face shields is advisable where the possibility of splashing exists in handling solvent cements. In case of eye contact, flush with plenty of water for 15 minutes and call a physician immediately.

**2.6.2.7** Repeated contact with the skin should be avoided. Proper gloves impervious to and unaffected by the solvents should be worn when frequent contact with the skin is likely. Application of the solvents or solvent cements with rags and bare hands is not recommended. Brushes and other suitable applicators can be used effectively for applying the solvent cement, thus avoiding skin contact. In the event of excessive contact, remove contaminated clothing and wash skin with soap and water.

**CAUTION:** Primers are toxic. Don't allow them to touch skin. Suitable gloves are advised.

Step 1 Cut pipe square with hand saw and miter box, mechanical cut-off saw or tube cutter designed for plastic.

Step 2 Ream and chamfer pipe (to eliminate sharp edges, beads, and all burrs).

Step 3 Clean all dirt, moisture and grease from pipe and fitting socket. Use a clean, dry rag.

Step 4 Check dry fit of pipe in fitting. Pipe should enter fitting socket from ⅓ to ¾ depth of socket.

Step 5 Soften inside socket surface by applying an aggressive primer.

Step 6 Soften mating outside surface of pipe to depth of socket by applying a liberal coat of the (aggressive) primer. Be sure entire surface is softened.

Step 7 Again coat inside socket surface with the (aggressive) primer. Then, without delay, apply solvent cement liberally to outside of pipe. Use more than enough to fill any gaps.

Step 8 Apply a light coat of PVC solvent cement to inside of socket using straight outward strokes (to keep excess solvent out of socket). This is also to prevent solvent cement damage to pipe. For loose fits, apply a second coat of solvent cement. Time is important at this stage. See Section 2.6.1.5.

Step 9 While both the inside socket surface and the outside surface of the pipe are SOFT and WET with solvent cement, forcefully bottom the pipe in the socket, giving the pipe a one-quarter turn, if possible. The pipe must go to the bottom of the socket.

Step 10 Hold the joint together until tight.

Step 11 Wipe excess cement from the pipe. A properly made joint will normally show a bead around its entire perimeter. Any gaps may indicate insufficient cement or the use of light bodied cement on larger diameters where heavy bodied cement should have been used.

Step 12 Do not disturb joint for the following periods:

30 minutes minimum at 60°F to 100°F (16°C to 38°C).

1 hour minimum at 40°F to 60°F (4°C to 16°C).

2 hours minimum at 20°F to 40°F (-7°C to 4°C).

4 hours minimum at 0°F to 20°F (-18°C to -7°C).

Handle the newly assembled joints carefully during these periods. If gaps (step 11) or loose fits are encountered in the system, double these periods.

Step 13 The system shall not be pressurized until the joints have cured (set) at least as long as recommended by the manufacturer. If manufacturer's recommendation is not available, the following cure times are required:

**2.6.3** **Threaded Joints.** Joints shall be tightened approximately ½ turn past hand tight, using a strap wrench.

**CAUTION:** Handtight refers to number of threads to reach handtight with metal pipe. Pipe can be bottomed in small sizes of PVC by hand pressure alone. Do not overtighten.

**2.6.4** **Elastomeric Gasketed Joints, Procedure:**

Step 1 For field cuts, cut end of pipe square with handsaw and miter

box, mechanical saw or a tube cutter designed for plastic.

Step 2 Ream and bevel end of pipe (unless already done by manufacturer).

Step 3 If dirty, remove gasket, clean gasket and groove and replace ring.

Step 4 Mark pipe in a contrasting color to indicate the proper insertion depth as recommended by the manufacturer (unless already done by manufacturer).

Step 5 Apply lubricant recommended by pipe manufacturer to end of pipe. Do not apply lubricant to gasket or the groove unless otherwise specifically recommended by the manufacturer.

Step 6 Insert pipe into fitting until mark on pipe is even with fitting.

**Note:** This depth of insertion is required to properly allow for thermal expansion and contraction. During joint assembly, the previously installed length of pipe should be held so that the existing joints are not pushed together or pulled apart. DO NOT USE METAL STRAPS, CHAINS (OR THE LIKE) FOR ASSEMBLY.

**2.7 Material.**

**2.7.1 Location.** PVC piping shall be installed only outside the foundation of any building or structure or parts thereof. It shall be buried in the ground for its entire length except vertical piping may be extended above grade per Section 2.4.4. It shall not be installed within or under any building or structure or mobile home or commercial coach or parts thereof. The term "building or structure or parts thereof" shall include structures such as porches and steps, whether roofed or not, roofed porte-cocheres, roofed patios, carports, covered walks, covered driveways and similar structures or appurtenances. [UPC 604.1]

**2.8 Installation, Testing, and Identification.**

**2.8.1 Deflection.** Elastomeric gasketed pipe may be deflected in accordance with the manufacturer's recommendations provided that it shall not be permanently staked or blocked to maintain this deflection. [UPC 609.0]

**2.8.2 Maximum Working Pressure.** Maximum working pressure shall be as follows (see chart on following page).

**2.8.3 Saddles.** PVC pressure pipe saddles are limited to underground use outside the building. The branch of the saddle shall be a minimum of two pipe sizes smaller than the main. Saddles shall be installed as required by their listings.

**2.8.4 Thrust Blocking.** In lines with rubber gasketed joints, thrust blocks shall be installed at all:

(a) Changes in direction, as at tees and bends

(b) Changes in size, as at reducers

(c) Stops, as at dead ends

(d) Valves, where thrusts may be expected.

Thrust block sizes shall be based on the maximum line pressure, pipe size and kind of soil. Refer to Table 2 for thrust at fittings for a pressure of 100 psi (689 kPa).

**TABLE 1**
**MINIMUM CURE TIME, IN HOURS***
**TEST PRESSURE FOR PIPE**

| | SIZES ½" TO 1¼" | | SIZES 1½" TO 3" | | SIZES 3½" TO 8" | |
|---|---|---|---|---|---|---|
| | (12.7 mm) | (32 mm) | (38 mm) | (76 mm) | (89 mm) | (203 mm) |
| TEMPERATURE RANGE DURING CURE PERIOD | UP TO 180 psi (1240.2 kPa) | ABOVE 180 TO 370 psi (1240.2 TO 2549.3 kPa) | UP TO 180 psi (1240.2 kPa) | ABOVE 180 TO 315 psi (1240.2 TO 2170.4 kPa) | UP TO 180 psi (1240.2 kPa) | ABOVE 180 TO 315 psi (1240.2 TO 2170.4 kPa) |
| 60°F-100°F (16°C-38°C) | 1 hr | 6 hr | 2 hr | 12 hr | 6 hr | 24 hr |
| 40°F-60°F (4°C-16°C) | 2 hr | 12 hr | 4 hr | 24 hr | 12 hr | 48 hr |
| 10°F-40°F (-12°C+4°C) | 8 hr | 48 hr | 16 hr | 96 hr | 48 hr | 8 days |

* If gaps or loose fits are encountered in the system, double these cure times.

TABLE 2

THRUST AT FITTINGS IN POUNDS AT 100 psi

| PIPE SIZE Inches | 90° BENDS | 45° BENDS | 22½° BENDS | DEAD ENDS AND TEES |
|---|---|---|---|---|
| 1½ | 415 | 225 | 115 | 295 |
| 2 | 645 | 350 | 180 | 455 |
| 2½ | 935 | 510 | 260 | 660 |
| 3 | 1395 | 755 | 385 | 985 |
| 3½ | 1780 | 962 | 495 | 1260 |
| 4 | 2295 | 1245 | 635 | 1620 |
| 5 | 3500 | 1900 | 975 | 2490 |
| 6 | 4950 | 2710 | 1385 | 3550 |
| 8 | 8300 | 4500 | 2290 | 5860 |
| 10 | 12,800 | 6900 | 3540 | 9050 |
| 12 | 18,100 | 9800 | 5000 | 12,800 |

TABLE 3

THRUST AT FITTINGS IN PASCALS AT 689 kPa OF WATER PRESSURE

| PIPE SIZE mm | 90° BENDS | 45° BENDS | 22½° BENDS | DEAD ENDS AND TEES |
|---|---|---|---|---|
| 38 | 1846.8 | 1001.3 | 511.8 | 1312.8 |
| 51 | 2870.3 | 1557.5 | 801.0 | 2024.8 |
| 64 | 4160.8 | 2269.5 | 1157.0 | 3937.0 |
| 76 | 6207.8 | 3359.8 | 1713.3 | 4383.3 |
| 89 | 7921.0 | 4280.9 | 2202.8 | 5607.0 |
| 102 | 10,212.8 | 5540.3 | 2815.8 | 7209.0 |
| 127 | 15,575.0 | 8455.0 | 4338.8 | 11,080.5 |
| 152 | 22,027.5 | 12,059.5 | 6163.3 | 15,797.5 |
| 203 | 36,935.0 | 20,025.0 | 10,190.5 | 26,077.0 |
| 254 | 56,960.0 | 30,705.0 | 15,753.0 | 40,272.5 |
| 305 | 80,545.0 | 43,610.0 | 22,250.0 | 56,960.0 |

**Example for Table 2:**

For a pressure of 150 psi (1,033.5 kPa) on a 4 inch (102 mm) tee, Table 2 indicates 1,620 pounds (7,209 N) for 100 psi (689 kPa). Therefore, total thrust for 150 psi (1033.5 kPa) will equal 1½ times 1620 pounds (7,209 N) for a total thrust of 2430 pounds (10,810 N).

To determine the bearing area of thrust blocks, refer to Table 4 for the safe bearing load of the soil and divide the total thrust by this safe bearing load.

TABLE 4

SAFE BEARING LOADS OF VARIOUS SOILS

| | SAFE BEARING LOAD | |
|---|---|---|
| SOIL | Lbs./sq. ft. | kPa |
| Mulch, Peat, etc. | 0 | 0 |
| Soft Clay | 1000 | 6890 |
| Sand | 2000 | 13,780 |
| Sand and Gravel | 3000 | 20,670 |
| Sand and Gravel Cement with Clay | 4000 | 27,360 |
| Hard Shale | 10,000 | 68,900 |

**Example:** Assume a 4,000 pound (17,800 N) total thrust was computed. The soil condition is sand. The required bearing area of the thrust block is 4,000 lbs. (17,800 N) divided by 2,000 lbs. (13,780 kPa) or 2 square feet (0.19 $m^2$).

**2.9 Testing.**

**2.9.1 Rubber Gasketed Joints.** Properly sized thrust blocks, either permanent or temporary, shall be installed at all required points before testing. See Section 2.8.4. When concrete thrust blocks are installed, wait at least 24 hours before pressure testing.

**2.9.2 Solvent Cement Joints.** The entire system shall be purged before testing to eliminate all solvent cement vapors and air.

**CAUTION:** Water test only.

**2.9.3 Identification.** A label shall be fastened to the main electrical meter panel stating, "This structure has a nonmetallic water service".

**2.10 Sizing.**

**2.10.1** Piping shall be sized in accordance with UPC Section 610.0. When UPC Appendix A is applicable, use UPC Chart A 4.1(1) (Fairly smooth). Flow velocity shall not exceed 8 fps (2.4 m/s). [UPC 610.0]

This standard is a combination of sections from the previous standards IS 8 and IS 14. IS 8 was originally adopted in 1968 and revised in 1971, 1972, 1973, and 1975. IS 14 was originally adopted in 1972 and revised in 1975. Upon adoption of this rewrite, IS 14 was deleted.

**Rewrite ratified by membership: 1978**

**Revised: 1980, 1981, 1984, 1986, 1989, 1991, 1992, 1995, 2003, 2006**

[1] Appendix XI, Safety Requirements and Precautions from ASTM D 2564 Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings is reprinted with permission from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103, copyright.

**TABLE 5**

| PIPE | FITTINGS | | MAXIMUM WORKING PRESSURE |
|---|---|---|---|
| | SCHEDULE | SIZES | |
| 160 psi (SDR 26) (1102.4 kPa) | 40 | ½" thru 8" incl. (12.7 mm - 203 mm) | 160 psi - 1102.4 kPa |
| | 80 | ½" thru 8" incl. (12.7 mm - 203 mm) | 160 psi - 1102.4 kPa |
| 200 psi (SDR 21) (1378 kPa) | 40 | ½" thru 4" incl. (12.7 mm - 102 mm) | 200 psi - 1378 kPa |
| | 80 | ½" thru 8" incl. (12.7 mm - 203 mm) | 200 psi - 1378 kPa |
| 250 psi (SDR 17) (1722.5 kPa) | 40 | ½" thru 3" incl. (12.7 mm - 76 mm) | 250 psi - 1722.5 kPa |
| | 80 | ½" thru 8" incl. (12.7 mm - 203 mm) | 250 psi - 1722.5 kPa |
| 315 psi (SDR 13.5) (2170.4 kPa) | 40 | ½" thru 1½" incl. (12.7 mm - 38 mm) | 315 psi - 2170.4 kPa |
| | 80 | ½" thru 4" incl. (12.7 mm - 102 mm) | 315 psi - 2170.4 kPa |
| Schedule 40 | 40<br>80 | ½" thru 1½" incl. (12.7 mm - 38 mm) | 320 psi - 2204.8 kPa |
| | 40<br>80 | 2" thru 4" incl. (51 mm - 102 mm) | 220 psi - 1515.8 kPa |
| | 40 | 5" thru 8" incl. (127 mm - 203 mm) | 160 psi - 1102.4 kPa |
| Schedule 80 | 40 | ½" thru 1½" incl. (12.7 mm - 38 mm) | 320 psi - 2204.8 kPa |
| | 40 | 2" thru 4" incl. (51mm - 102 mm) | 220 psi - 1515.8 kPa |
| | 40 | 5" thru 8" incl. (127 mm - 203 mm) | 160 psi - 1102.4 kPa |
| | 80 | ½" thru 4" incl. (12.7 mm - 102 mm) | 320 psi - 2204.8 kPa |
| | 80 | 5" thru 8" incl. (127 mm - 203 mm) | 250 psi - 1722.5 kPa |

LOCATION OF THRUST BLOCKS
(STANDARD AND METRIC COMBINED)
A COMPARISON OF THRUST-BLOCK AREAS

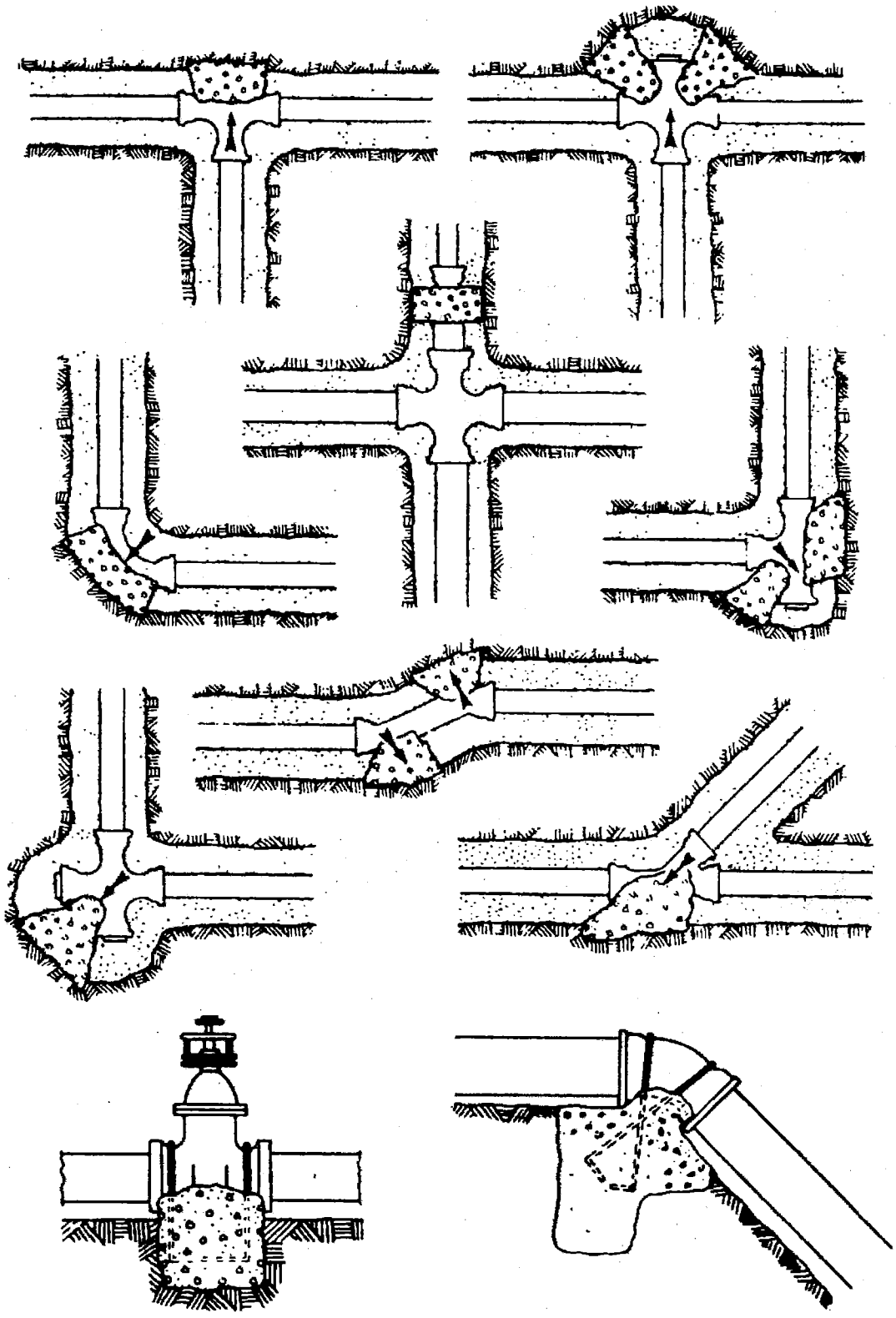


FIGURE 1

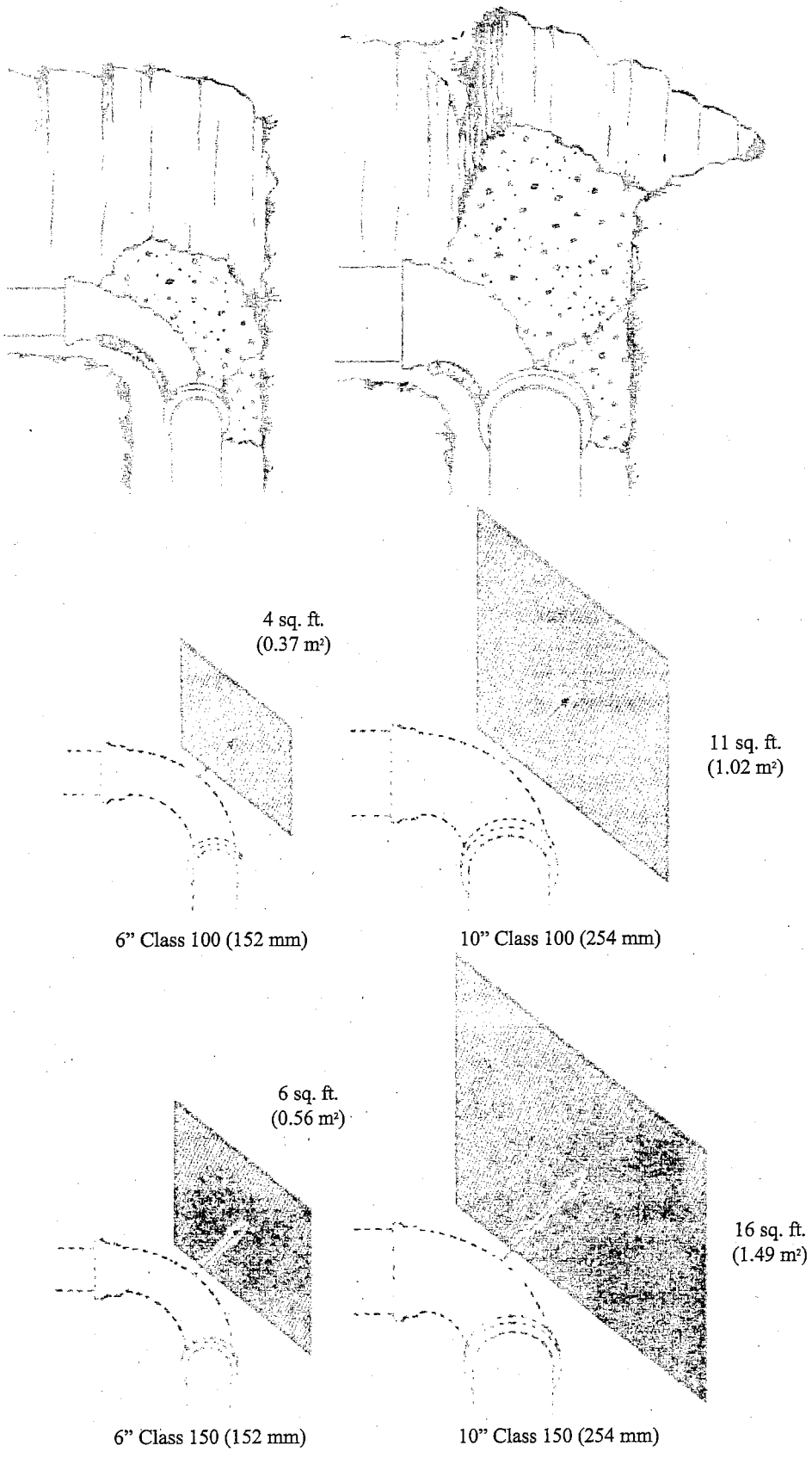



**FIGURE 2**

6400

# INSTALLATION STANDARD
# FOR PVC BUILDING DRAIN, WASTE, AND VENT PIPE AND FITTINGS

# IAPMO IS 9-2006

**1.0 Scope.**

**1.1** This installation standard shall apply to PVC building drain, waste, and vent systems as governed by the Uniform Plumbing Code. Material Standard ASTM D 2665, "Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste and Vent Pipe and Fittings", shall form part of this installation standard.

**1.2** Installation, material and inspection shall comply with the current edition of the Uniform Plumbing Code [UPC]™ published by the International Association of Plumbing and Mechanical Officials and shall also comply with this standard.

**Note:** The Building Official shall be consulted about penetration of fire separations, height and area, or other limitations.

**Note:** The following sections of the Uniform Plumbing Code apply.

| | |
|---|---|
| 101.6 | Repairs and Alterations |
| 103.5 | Inspections |
| 103.5.6 | Testing of Systems |
| 218.0 | Definition of PVC |
| 301.1 | Minimum Standards |
| 309.0 | Workmanship |
| 310.0 | Prohibited Fittings and Practices |
| 310.8 | Screwed Fittings |
| 312.0 | Protection of Piping, Materials, and Structures |
| 313.0 | Hangers and Supports |
| 315.2 | Prohibited Joints and Connections |
| 316.0 | Increasers and Reducers |
| 402.6 | Flanged Fixture Connections |
| 402.6.1 | Closet Rings (Closet Flanges) |
| 701.0 | Materials (drainage) |
| 705.7.2 | Solvent Cement Joints |
| 705.11 | Joints Between Various Materials |
| 707.1 | Plugs |
| 903.0 | Materials (venting) |
| 903.3 | Changes in Direction |
| 1003.0 | Traps - Described |
| 1101.3 | Materials Uses |
| Table 1401.1 | Referenced Standards |
| Pipe and Fittings: | |
| | ASTM D 2665 |
| | ASTM D 2122 |
| | ASTM D 3311 |

**Abbreviations.**

| | |
|---|---|
| ASTM | American Society for Testing and Materials |
| IAPMO | International Association of Plumbing and Mechanical Officials |
| UPC | Uniform Plumbing Code |

**2.0 Product Requirements.**

**2.1 Minimum Standards.**

**2.1.1** **Pipe.** PVC pipe markings shall be in accordance with ASTM D 2665. [UPC 301.1.1]

**2.1.2** **Fittings.** PVC fitting markings shall be in accordance with ASTM D2665 or ASTM D 3311. [UPC 301.1.1]

**2.1.3** **Solvent Cement.** Solvent cement label markings shall be in accordance with ASTM D 2564.

**2.1.3.1** Solvent cements shall not be purple in color.

**2.1.4** **Primers.** Primer container markings shall be in accordance with F 656.

**2.1.4.1** Primer shall be purple.

**2.2 Workmanship.**

**2.2.1** **Alignment.** All piping systems components shall be aligned properly without strain. Pipe shall not be bent or pulled into position. Vertical piping shall be maintained in straight alignment between floors with midstory guides.

[1] Although referenced in this standard, some of the fittings shown in the standard are not acceptable under the Uniform Plumbing Code.

[2] It is common practice to dual mark Schedule 40 DWV and potable water piping in which compliance with each applicable standard is met.

Pipe and fittings shall be so positioned that identifying markings shall be readily visible for inspection. [UPC 309.0]

**2.3 Protection of Piping.**

**2.3.1 Storage.** Pipe and fittings should not be stored in direct sunlight; however, exposure to sunlight during normal construction periods is not considered harmful. Pipe shall be stored in such a manner as to prevent sagging or bending.

**2.3.2 Expansion and Contraction.** Thermal expansion and contraction of plastic drain waste and vent systems shall be taken into consideration. Thermal expansion and contraction may be controlled by several methods: offset, expansion joints, or restraints.

Regardless of method utilized, certain conditions shall be met:

(a) Support, but do not rigidly restrain piping at changes of direction.

(b) Do not anchor pipe rigidly in walls.

(c) Holes through framing members must be adequately sized to allow for free movement.

DWV installation with frequent changes in direction will compensate for thermal expansion and contraction.

Expansion joints may be utilized in vertical straight runs in excess of 30 feet (9,144 mm) provided they are installed per manufacturer's installation instructions.

Except piping buried below ground, horizontal and vertical piping should be installed with restraint fittings or a minimum of 24 inches (610 mm) 45° offset every 30 feet (9,144 mm). Thermal expansion for installation subject to temperature changes may be determined from Table 1. The linear expansion shown is independent of the diameter of the pipe. [UPC 312.0]

**2.3.3 Exposed Piping.** Piping shall not be exposed to direct sunlight.

Exception: Vent piping through roof. Plumbing vents through roof, exposed to sunlight, shall be protected by water base synthetic latex paints.

Adequate support shall be provided where PVC piping is exposed to wind, snow, and ice loading.

**2.3.4 Protection from Damage.** Piping passing through wood studs or plates shall be protected from puncture by minimum 1/16 inch (1.6 mm) thick steel plate.

Piping shall be protected from concrete form oil. [UPC 312.10]

**2.3.5 Anti-Freeze Protection.** PVC pipe and traps can be protected from freezing by the use of one of the following solutions of mixtures:

(a) 4 quarts (3.8 liters) of water mixed with 5 quarts (4.8 liters) of glycerol

(b) 2½ lbs. (1.1 kg) of magnesium chloride dissolved in one (1) gallon (3.8 liters) of water

(c) 3 lbs. (1.4 kg) of table salt dissolved in one (1) gallon (3.8 liters) of water.

The salt solutions are effective to approximately 10°F (-12°C). If lower temperatures are anticipated, the pipe should be drained or the glycerol solution should be used. [UPC 312.6]

**2.4 Piping Installed in Fire Resistive Construction.** Where piping is installed and penetrates required fire resistive construction, the fire resistive integrity of the construction shall be as required by the Administrative Authority, or when not established by the Building Code, by qualified testing methods approved by the Administrative Authority. Approval shall be obtained prior to installing any such piping. [UPC 312.7]

**2.5.0 Hangers and Supports.**

**2.5.1 Abrasion.** Hangers and straps shall not compress, distort, cut, or abrade the piping and shall allow free movement of pipe. Pipe, exposed to damage by sharp surfaces, shall be protected. [UPC 313.0]

**2.5.2 Support.** Support all horizontal piping at intervals of not more than four (4) feet (1,219 mm), at end of branches, and at change of direction or elevation. Supports shall allow free movement, but shall restrict upward movement of lateral runs so as not to create reverse grade. Vertical piping shall be supported at each story or floor level. Alignment of vertical piping shall be maintained between floors with the use of a mid-story guide. Support trap arms in excess of three (3) feet (915 mm) in length as close as possible to the trap. Closet flanges shall be securely fastened with corrosive resistant fasteners to the floor with top surface one-quarter (¼) inch (6.4 mm) above finish floor. [UPC 313.0]

**2.6 Traps.**

**2.6.1 Connection to Traps.** Traps shall be connected by means of listed trap adapters. [UPC 1003.0]

**2.7 Joints.**

**2.7.1 Caulked Joints.** Make connections or transitions to bell-and-spigot cast iron soil pipe fit-

**TABLE 1**
**PVC-DWV TYPE I**
**THERMAL EXPANSION TABLE**

Chart Shows Length Change in Inches vs. Degrees Temperature Change
Coefficient of Linear Expansion: $e = 2.9 \times 10^{-5}$ in/in °F

| LENGTH (feet) | 40°F | 50°F | 60°F | 70°F | 80°F | 90°F | 100°F |
|---|---|---|---|---|---|---|---|
| 20 | 0.278 | 0.348 | 0.418 | 0.487 | 0.557 | 0.626 | 0.696 |
| 40 | 0.557 | 0.696 | 0.835 | 0.974 | 1.114 | 1.235 | 1.392 |
| 60 | 0.835 | 1.044 | 1.253 | 1.462 | 1.670 | 1.879 | 2.088 |
| 80 | 1.134 | 1.392 | 1.670 | 1.949 | 2.227 | 2.506 | 2.784 |
| 100 | 1.392 | 1.740 | 2.088 | 2.436 | 2.784 | 3.132 | 3.480 |

**TABLE 1 (METRIC)**
**PVC-DWV TYPE I**
**THERMAL EXPANSION TABLE**

Chart Shows Length Change in Millimeters vs. Degrees Temperature
Coefficient of Linear Expansion: $e = \frac{0.2 \text{ mm}}{\text{mm °C}}$

| LENGTH (mm) | 4°C | 10°C | 16°C | 21°C | 27°C | 32°C | 38°C |
|---|---|---|---|---|---|---|---|
| 6096 | 7.1 | 8.8 | 10.6 | 12.4 | 14.2 | 15.9 | 17.7 |
| 12192 | 14.2 | 17.7 | 21.2 | 24.7 | 28.3 | 31.4 | 35.4 |
| 18288 | 21.2 | 26.5 | 31.8 | 37.1 | 42.4 | 47.7 | 53.0 |
| 24384 | 28.8 | 35.4 | 42.4 | 49.5 | 56.6 | 63.7 | 70.7 |
| 30480 | 35.4 | 44.2 | 53.0 | 61.9 | 70.7 | 79.6 | 88.4 |

Example:

| | | |
|---|---|---|
| Highest Temperature expected | 100°F | (38°C) |
| Lowest Temperature expected | -50°F | (10°C) |
| | 50°F | (10°C) |

Length of run – 60 feet (18,288 mm) from chart, read 1.044 inches (26.5 mm) linear expansion that must be provided for.

tings, and to bell-and-spigot pipe and fittings of other materials with listed mechanical compression joints designed for this use, or caulked joints made in an approved manner. In caulking, pack the joint with oakum or hemp and fill with molten lead to a depth of not less than one (1) inch (25.4 mm). Allow a period of four (4) minutes for cooling, following which, caulk the lead at the inside and outside edges of the joint. Lead shall not be overheated. [UPC 705.4.1]

**2.7.2** **Solvent Cement Joints.** (Additional information is available in ASTM D 2855.)

**2.7.3** **Selection.** Follow manufacturer's recommendations for type of solvent cement for such conditions as temperature over 100°F (38°C), or humidity over 60%.

**2.7.4** **Handling (to maintain effectiveness).** Solvent cement and primer containers no larger than 1 quart (1 liter) should be used in the field (to avoid thickening due to evaporation). Keep containers closed and in the shade when not in use. Keep applicator submerged in solvent cement between applications. When solvent cement becomes thicker, THROW IT AWAY. Solvent cement shall NOT be thinned.

**2.7.5** **Size of Applicator.** Applicator should be about one-half the pipe diameter. Do not use small applicator on large pipes. Ordinary pure bristle paint brushes or applicators furnished with product are satisfactory. [UPC 705.7.2]

**2.7.6** **Primers.** A listed primer in compliance with ASTM F 656 shall be used on all PVC DWV joints.

**2.7.7** **Application.** Solvent cement and primer shall be applied deliberately, but without delay (two men may be needed to make large joints). Use

special care when temperature is over 100°F (38°C) or humidity is over 60%.

**2.7.8 Safety Requirements and Precautions.**

**2.7.8.1 General.** Solvents contained in PVC plastic pipe cements are classified as airborne contaminants and flammable and combustible liquids. Precautions listed in this appendix should be followed to avoid injury to personnel and the hazard of fire.

**2.7.8.2 Safety Precautions.** Prolonged breathing of solvent vapors should be avoided. When pipe and fittings are being joined in partially enclosed areas, a ventilating device should be used in such a manner to minimize the entry of vapors into the breathing areas.

**2.7.8.3** Solvent cements should be kept away from all sources of ignition, heat, sparks and open flame.

**2.7.8.4** Containers for solvent cements should be kept tightly closed except when the cement is being used.

**2.7.8.5** All rags and other materials used for mopping up spills should be kept in a safety waste receptacle which should be emptied daily.

**2.7.8.6** Most of the solvents used in PVC pipe cements can be considered eye irritants and contact with the eye should be avoided for it may cause eye injury. Proper eye protection and the use of chemical goggles or face shields is advisable where the possibility of splashing exists in handling solvent cements. In case of eye contact, flush with plenty of water for 15 minutes and call a physician immediately.

**2.7.8.7** Repeated contact with the skin should be avoided. Proper gloves impervious to and unaffected by the solvents should be worn when frequent contact with the skin is likely. Application of the solvents or solvent cements with rags and bare hand is not recommended. Brushes and other suitable applicators can be used effectively for applying the solvent cement, thus avoiding skin contact. In the event of excessive contact, remove contaminated clothing and wash skin with soap and water.

Step 1 Cut pipe square with hand saw and miter box, mechanical cut-off saw or tube cutter designed for plastic.

Step 2 Ream inside and chamfer outside of pipe (to eliminate all burrs).

Step 3 Clean all dirt, moisture, and grease from pipe and socket. Use a clean, dry rag.

Step 4 Check dry fit of pipe in fitting. Pipe should enter fitting socket from ⅓ to ¾ depth of socket.

Step 5 Soften inside socket surface by applying an aggressive primer.

Step 6 Soften mating outside surface of pipe to depth of socket by applying a liberal coat of the (aggressive) primer. Be sure the entire surface is softened.

Step 7 Again coat inside socket surface with the (aggressive) primer. Then, without delay, apply solvent cement liberally to outside of pipe. Use more than enough to fill any gaps.

Step 8 Apply a light coat of PVC solvent cement to inside of socket using straight outward strokes (to keep excess solvent out of socket). This is also to prevent solvent cement damage to pipe. For loose fits, apply a second coat of solvent cement. Time is important at this stage. See Section 2.7.6.

Step 9 While both the inside socket surface and the outside surface of the pipe are SOFT and WET with solvent cement, forcefully bottom the pipe in the socket, giving the pipe a one-quarter turn, if possible. The pipe must go to the bottom of the socket.

Step 10 Hold the joint together until tight. (Partial set).

Step 11 Wipe excess cement from the pipe. A properly made joint will normally show a bead around its entire perimeter. Any gaps may indicate insufficient cement or the use of light bodied cement on larger diameters where heavy bodied cement should have been used.

Step 12 The system shall not be tested until the joints have cured (set) at least as long as recommended by the manufacturer.

**2.7.9 Threaded Joints.** Listed adapter fittings shall be used for the transition to threaded connections. No threaded PVC female fitting(s) or joint(s) shall be located in a non-accessible location. The joint between the PVC pipe and

adapter fittings shall be of the solvent cement type.

Only listed thread tape or thread lubricant, specifically intended for use with plastics, shall be used. Conventional pipe thread compounds, putty, linseed oil base products, and unknown mixtures shall not be used. Pipe and fittings which have come in contact with the above non-approved mixtures shall be removed and replaced with new materials.

Where a threaded joint is made, obtain tightness by maximum hand tightening plus additional tightening with a strapwrench not to exceed one full turn.

**2.7.10 Special Joints.**

**2.7.10.1 Connection to Non-Plastic Pipe.** When connecting plastic pipe to other types of piping, use listed fittings and adapters designed for the specific use intended. [UPC 705.11.3]

**2.7.11 Prohibited Joints and Connections.**

(a) Drainage System – Any fitting or connection which has an enlargement, chamber or recess with a ledge, shoulder, or reduction of pipe area, that offers an obstruction to flow through the drain is prohibited.

(b) No fitting or connection that offers abnormal obstruction to flow shall be used. The enlargement of a three (3) inch (76 mm) closet bend or stub to four (4) inches (102 mm) shall not be considered an obstruction. [UPC 310.5]

**ADOPTED: 1968**

**REVISED: 1971, 1974, 1975, 1976, 1977, 1981, 1982, 1983, 1987, 1989, 1990, 1991, 1992, 1995, 2003, 2006**

# INSTALLATION STANDARD FOR ABS SEWER PIPE AND FITTINGS

# IAPMO IS 11-2006

**1.0 Scope.**

**1.1** This Installation Standard shall apply to ABS Building Sewer Pipe and Fittings as governed by the Uniform Plumbing Code. Material Standard ASTM D 2751, Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings shall form part of this Installation Standard. Materials shall be limited to building sewers receiving domestic sewage excluding special and industrial waste.

**Note:** The following sections of the Uniform Plumbing Code apply.

| | |
|---|---|
| 101.6 | Repairs and Alterations |
| 103.5 | Inspection |
| 203.0 | Definition of ABS |
| 206.0 | Domestic Sewage |
| 301.1 | Minimum Standards |
| 309.0 | Workmanship |
| 311.0 | Independent Systems |
| 312.0 | Protection of Piping, Materials, and Structures |
| 313.0 | Hangers and Supports |
| 314.0 | Trenching, Excavation, and Backfill |
| 316.0 | Increasers and Reducers |
| 705.1 | ABS and ABS Co-Extruded Plastic Pipe and Joints |
| 705.1.1 | Mechanical Joints |
| 705.4.1 | Caulked Joints |
| 713.0 | Sewer Required |
| 715.0 | Building Sewer Materials |
| 718.0 | Grade, Support, and Protection of Building Sewers |
| 719.0 | Cleanouts |
| 720.0 | Sewer and Water Pipes |
| 723.0 | Building Sewer Test |
| Table 1401.1 | Referenced Standards |
| ASTM D 2751[1] | |

[1] Although this standard is referenced in Table 1401.1, some of the tube or fittings shown in the standard are not acceptable for use under the Uniform Plumbing Code.

**2.0 Product Requirements.**

**2.1 Minimum Standards.**

**2.1.1 Pipe.** ABS pipe is furnished in straight lengths. Refer to Tables in ASTM D 2751 for dimensions and tolerances for pipe and pipe sockets.

ABS pipe markings shall be in accordance with ASTM D 2751. [UPC 301.1.1]

**2.1.2 Fittings.** Refer to Tables in ASTM D 2751 for dimensions and tolerances for fitting sockets, spigots, and laying lengths.

ABS fitting markings shall be in accordance with ASTM D 2751. [UPC 301.1.1]

**2.1.3 Solvent Cement.** Solvent cement shall be as specified in ASTM D 2235.

Solvent cement label markings shall be in accordance with ASTM D 2235. [UPC 705.1.2]

**2.2 Workmanship.** All piping system components shall be aligned properly without strain. Pipe shall not be bent or pulled into position after being solvent cemented. Pipe and fittings shall be so positioned that identifying markings shall be readily visible for inspection. [UPC 309.0]

**2.3 Protection of Piping.**

**2.3.1 Storage.** Pipe and fittings should not be stored for long periods in direct sunlight. However, exposure to direct sunlight during normal construction periods is not harmful. Pipe shall be stored in such a manner as to prevent sagging or bending.

**2.4 Trenching, Excavation, and Backfill.**

**2.4.1 Trenching.** The width of the trench at any point below the top of the pipe should not be greater than necessary to provide adequate room for joining the pipe and compacting the side fills. [UPC 314.0]

**2.5 Alignment and Grade.** The pipe should be bedded true to line and grade, uniformly and continuously supported on firm, stable material. Blocking shall not be used to bring the pipe to grade. The bedding shall conform to Section 718.0 of the Uniform Plumbing Code.

**2.6 Backfill.** The backfill shall conform to Section 314.4 of the Uniform Plumbing Code.

2.7 **Joints.**

2.7.1 **Caulked Joints.** Make connections or transitions to bell-and-spigot cast iron soil pipe and fittings, and to bell-and-spigot pipe and fittings of other materials with approved mechanical compression joints designed for this use, or caulked joints made in an approved manner. In caulking, pack the joint with oakum or hemp and fill with molten lead to a depth of not less than one (1) inch (25.4 mm). Allow a period of four (4) minutes for cooling, following which, caulk the lead at the inside and outside edges of the joint. Lead shall not be overheated. [UPC 705.4.1]

**Note:** Caulked joints should be avoided if possible.

2.7.2 **Gasket-Type Joints.** Pipe shall be cut square with saws or pipe cutters designed specifically for plastic pipe; protect pipe and fittings from serrated holding devices and abrasion. [UPC 705.1.1]

1. Wipe the pipe spigot, rubber gasket, and inside of the socket clean of all dirt and moisture.
2. Coat the socket and gasket evenly with a vegetable base paste lubricant.
3. Slide the gasket on the spigot and against the backup ring and snap it to remove any twist.
4. Force the spigot into the socket. Check that the joint is properly connected by using any thin feeler gauge that the gasket is not looped back over the backup ring.

2.7.3 **Solvent Cement Joints.**

2.7.3.1 **Selection.** Solvent cement shall be recommended for ABS by the manufacturer. Follow manufacturer's recommendations for types of solvent cement for such conditions as temperature over 100°F (38°C), or humidity over 60%.

2.7.3.2 **Handling (to maintain effectiveness).** Solvent cement containers no larger than 1 quart (1 liter) should be used in the field (to avoid thickening due to evaporation). Keep container closed and in the shade when not in use. Keep applicator submerged in solvent cement between applications. When solvent cement becomes thicker, THROW IT AWAY. Solvent cement shall NOT be thinned.

2.7.3.3 **Size of Applicator.** Applicator should be about one half the pipe diameter. Do not use small applicator on large pipes. Ordinary pure bristle paint brush or applicators furnished with product are satisfactory.

2.7.3.4 **Application.** Solvent cement shall be applied deliberately, but without delay (two men may be needed to make large joints). Use special care when temperature is over 100°F (38°C) or humidity is over 60%.

2.7.4 **Safety Requirements and Precautions.**

2.7.4.1 **General.** Solvents contained in ABS plastic pipe cements are classified as airborne contaminants and flammable and combustible liquids. Precautions listed in this appendix should be followed to avoid injury to personnel and the hazard of fire.

2.7.4.2 **Safety Precautions.** Prolonged breathing of solvent vapors should be avoided. When pipe and fittings are being joined in partially enclosed areas, a ventilating device should be used in such a manner to minimize the entry of vapors into the breathing areas.

2.7.4.3 Solvent cements should be kept away from all sources of ignition, heat, sparks, and open flame.

2.7.4.4 Containers for solvent cements should be kept tightly closed except when the cement is being used.

2.7.4.5 All rags and other materials used for mopping up spills should be kept in a safety waste receptacle which should be emptied daily.

2.7.4.6 Most of the solvents used in ABS pipe cements can be considered eye irritants and contact with the eye should be avoided for it may cause eye injury. Proper eye protection and the use of chemical goggles or face shields is advisable where the possibility of splashing exists in handling solvent cements. In case of eye contact, flush with plenty of water for 15 minutes and call a physician immediately.

2.7.4.7 Repeated contact with the skin should be avoided. Proper gloves impervious to and unaffected by the solvents should be worn when frequent contact with the skin is likely. Application of the solvents or solvent cements with rags and bare hand is not recommended. Brushes and other suitable applicators can be used effectively for applying the solvent cement, thus avoiding skin contact. In the event of excessive contact, remove contaminated clothing and wash skin with soap and water.

Step 1 Cut pipe square with hand saw and miter box, mechanical cut-off saw, or tube cutter designed for plastic.

Step 2 Ream inside and chamfer outside of pipe (to eliminate all burrs).

Step 3 Clean all dirt, moisture, and grease from pipe and socket. Use a clean, dry rag.

Step 4 Check dry fit of pipe in fitting. Pipe should enter fitting socket from ⅓ to ¾ depth of socket.

Step 5 Apply a light coat of ABS solvent cement to inside of socket using straight outward strokes (to keep excess solvent out of socket). This is also to prevent solvent cement damage to pipe. For loose fits, apply a second coat of solvent cement. Time is important at this stage. See Section 2.7.3.4.

Step 6 While both the inside socket surface and the outside surface of the pipe are SOFT and WET with solvent cement, forcefully bottom the pipe in the socket, giving the pipe a one-quarter turn, if possible. The pipe must go to the bottom of the socket.

Step 7 Hold the joint together until tight (partial set).

Step 8 Wipe excess cement from the pipe. A properly made joint will normally show a bead around its entire perimeter. Any gaps may indicate insufficient cement or the use of light bodied cement on larger diameters where heavy bodied cement should have been used.

Step 9 The system shall not be tested until the joints have cured (set) at least as long as recommended by the manufacturer.

**2.7.5 Special Joints.**

**2.7.5.1 Connection to Non-Plastic Pipe.** When connecting plastic pipe to other types piping, use only approved types of fittings and adapters, designed for the specific transition intended.

**ADOPTED: 1976**

**REVISED: 1981, 1987, 2003, 2006**

# INSTALLATION STANDARD
# FOR POLYETHYLENE (PE) FOR GAS YARD PIPING

# IAPMO IS 12-2006

**1.0 Scope.**

**1.1** This standard shall govern the installation of polyethylene (PE) natural and liquified petroleum gas yard piping. Installation, material and inspection shall comply with the current edition of the Uniform Plumbing Code [UPC]™ published by the International Association of Plumbing and Mechanical Officials and shall also comply with this standard.

**Note:** The following sections of the Uniform Plumbing Code apply to PE gas piping:

| | |
|---|---|
| 218.0 | Definition of PE |
| 309.0 | Workmanship |
| 310.0 | Protection of Piping, Materials, and Structures |
| 313.0 | Hangers and Supports |
| 314.0 | Trenching, Excavation, and Backfill |
| Chapter 12 | Fuel Gas Piping |
| 1203.3.2 | Final Piping Inspection |
| 1208.5.4 | Plastic Pipe, Tubing, and Fittings |
| 1210.0 | Gas Piping Installation |
| 1210.1.7.2 | Tracer Wire |
| 1212.0 | Liquified Petroleum Gas Facilities and Piping |
| Table 1401.1 | Referenced Standards |
| Pipe and Tube: | |
| PE3408 | ASTM D 2513 |
| PE2406 | |
| Fittings: | |
| Copper Alloy | ANSI B16.26 |
| PE3408 | ASTM D 2513 |
| PE2406 | |
| Plastic Mechanical | ASTM F 1924 |
| Metallic Mechanical | ASTM F 1948 |

**Abbreviations.**

| | |
|---|---|
| ANSI | American National Standards Institute |
| ASTM | American Society for Testing and Materials |
| IAPMO | International Association of Plumbing and Mechanical Officials |
| UPC | Uniform Plumbing Code published by IAPMO |

**2.0 Product Requirements.**

**2.1 Minimum Standards.**

**2.1.1 Materials.** Pipe, tubing and fittings shall conform to the appropriate standards in Table 1401.1 of the Uniform Plumbing Code. See note ahead of Chapter 2 of this standard. [UPC 301.1]

**2.2 Pipe.** PE pipe is plastic of ½ inch (12.7 mm) or larger size. One-half inch (12.7 mm) pipe shall be SDR 9. Pipe sizes less than 3 inches (76 mm) shall be SDR 11. Pipes 3 inches (76 mm) and larger shall be SDR 11.5 or lower*.

**2.13 Tubing.** PE tubing is plastic and shall be limited to the following:

| TUBING SIZE | | |
|---|---|---|
| Inches | (mm) | SDR* |
| ¼ | (6.4) | 6 |
| ⅜ | (9.5) | 8 |
| ½ | (12.7) | 7 |

***Note:** The lower the SDR number, the thicker the wall.

**2.1.4 Fittings.** Heat fusion fittings shall be PE 2406, PE 3408, or other listed materials. Mechanical connectors for PE pipe and tubing and for transition fittings shall be approved compression type couplings or other special listed joints.

**2.2 Markings.**

**2.2.1 Pipe and Tubing.** Pipe and tubing markings shall be in accordance with ASTM D 2513. [UPC 301.1.1]

**2.2.2 Fittings.** Fitting markings shall be in accordance with ASTM D 1924, ASTM D 1948, ASTM D 2513 or ASME B16.26. [UPC 301.1.1]

**2.2.3 Position of Markings.** The identifying markings on pipe, tubing and fittings shall be visible for inspection without moving materials.

**2.3 Protection of Piping.**

**2.3.1 Storage.** Unprotected pipe should not be stored in direct sunlight. The pipe shall be stored in a way to protect it from mechanical damage (slitting, puncturing, etc.). Exposure to sunlight during normal construction periods is not harmful.

2.4 **Thermal Expansion.**

2.4.1 **Snaking.** The pipe and tubing shall be "snaked" in the trench bottom with enough slack to provide for thermal expansion and contraction before stabilizing. The normal slack created by residual coiling is generally sufficient for this purpose. If, however, the pipe has been allowed to straighten before it is placed in the trench, 6 inches (152 mm) per 100 feet (30,480 mm) of pipe length shall be allowed for this purpose.

2.4.2 **Stabilizing.** Pipe and tubing temperature shall be stabilized by one of the following methods:

(a) Shade backfill. Leave all joints exposed so they can be examined during the pressure test.

(b) Allow to stand overnight.

2.5 **Trenching and Backfill.**

2.5.1 **Trenching.** Trenching bottoms shall be smooth and regular of either undisturbed soil or a layer of compacted backfill so that minimum settlement will take place. Pipe or tubing shall not be wedged or blocked. Voids shall be filled and compacted to level of trench bottom. The minimum cover shall be 18 inches (457 mm) below finish grade. [UPC 314.0, 1210.1]

**Exceptions:**

(1) Tubing for gas lights shall be buried a minimum of 12 inches (305 mm) below finish grade where gas flow is restricted to 10 cubic feet per hour ($8 \times 10^{-5} m^3/s$) at its source by a mechanical means or a fixed orifice.

**Note:** Local climatic conditions may affect required burial depth.

(2) Piping may terminate a maximum of one foot above ground when encased in a listed anodeless transition riser.

2.5.2 **Backfill.** The pipe and tubing temperature shall be stabilized before backfilling. See Section 2.4.2. [UPC 314.4, 1210.1]

2.6 **Types of Joints.** PE joints shall be made as follows:

2.6.1 **Heat Fusion Joints.** Heat fusion joints shall be made according to the manufacturer's procedures using recommended heat times, temperature and joining pressures. [UPC 1208.5.9.2]

2.6.2 **Mechanical Joints.** Mechanical joints shall be assembled in an approved manner with tools recommended by the fitting manufacturer. Mechanical joints shall be made with listed mechanical fittings. [UPC 1208.5.9.3]

2.7 **Special Joints.**

2.7.1 Listed transition fittings or listed mechanical fittings shall be used when making joints between PE and steel or PE and copper.

2.7.2 Transition fittings shall be installed outside of meter vaults with metallic piping extending into the vaults a sufficient distance to permit the use of backup wrenches.

2.8 **Inspections.**

2.8.1 **Temperature.** Pipe temperatures shall be stabilized before testing. See Section 2.4.2. [UPC 1213.0]

2.8.2 Piping shall be subjected to the pressure test required in Section 1213.0 of the Uniform Plumbing Code. [UPC 1213.0]

2.9 **Materials.**

2.9.1 **Location.** PE pipe and tubing shall be installed only outside the foundation of any building or structure or parts thereof. It shall be buried in the ground for its entire length with cover as provided in Section 2.5.1. It shall not be installed within or under any building or structure or mobile home or commercial coach or parts thereof. The term "building or structure or parts thereof" shall include structures such as porches and steps, whether covered or uncovered, roofed porte-cocheres, roofed patios, carports, covered walks, covered driveways and similar structures or appurtenances. [UPC 1210.0]

**Exception:** Tubing may extend into gas light support columns provided it is not exposed to external damage.

2.9.2 **Maximum Working Pressure.** Gas pressure shall not be more than 5 psi (34.5 kPa) for natural gas nor more than 10 psi (69 kPa) for liquified petroleum gas.

2.9.3 **Gas Supplier.** Installation shall be acceptable to the serving gas supplier.

2.10 **Installation of Gas Piping.**

2.10.1 **Types of Joints.** See Sections 2.6 and 2.7 of this standard. [UPC 1208.5.9]

2.10.2 **Prohibited Joints.** PE pipe shall not be joined by a threaded joints. Joints made with adhesives or solvent cement shall be prohibited.

2.10.3 **Identification.** Plastic gas yard piping shall be permanently identified by attaching a metal tag to the meter end of the piping system stating, "Plastic Yard Piping".

2.11 **Sizing.**

2.11.1 **Pipe.** Pipe shall be sized as required by Section 1216.0 of the UPC. [UPC 1216.0]

**2.11.2** **Tubing.** Tubing shall be sized from Table 1. [UPC 1216.0]

**ADOPTED: 1971**

**REVISED: 1975, 1977, 1978, 1981,1983, 1985, 1989, 1990, 1991, 1993, 2003, 2006**

**TABLE 1**
**SIZE OF PLASTIC GAS TUBING**
Maximum Delivery Capacity in Cubic Feet of Gas per Hour (CFH)
of Tubing Carrying Natural Gas of 0.60 Specific Gravity

| NOMINAL TUBING SIZE | INTERNAL DIAMETER | LENGTH IN FEET | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inches | Inches | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 125 |
| 1/4 | 0.250 | 18 | 12 | 10 | 8 | 7 | 7 | 6 | 6 | 5 | 5 | 4 |
| 3/8 | 0.375 | 51 | 35 | 28 | 24 | 21 | 19 | 18 | 16 | 16 | 15 | 13 |
| | | | | | | | | | | | | |
| | | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 550 | 600 | |
| 1/4 | 0.250 | 4 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | |
| 3/8 | 0.375 | 12 | 10 | 9 | 8 | 7 | 7 | 6 | 6 | 6 | 6 | |

**TABLE 1 (Metric)**
**SIZE OF PLASTIC GAS TUBING**
Maximum Delivery Capacity in Cubic Meters of Gas per Second ($m^3/s$)
of Tubing Carrying Natural Gas of 0.60 Specific Gravity

| NOMINAL TUBING SIZE | INTERNAL DIAMETER | LENGTH IN METERS | | | | | | |
|---|---|---|---|---|---|---|---|---|
| mm | mm | 3.0 | 6.1 | 9.1 | 12.2 | 15.2 | 18.3 | 21.3 |
| 6.4 | 6.4 | 1.4 | 1.0 | 0.8 | 0.6 | 0.56 | 0.56 | 0.5 |
| 9.5 | 9.5 | 4.1 | 2.8 | 2.2 | 1.9 | 1.7 | 1.5 | 1.4 |
| | | | | | | | | |
| | | 24.4 | 27.4 | 30.5 | 38.1 | 45.7 | 61.0 | 76.2 |
| 6.4 | 6.4 | 0.5 | 0.4 | 0.4 | 0.3 | 0.3 | 0.2 | 0.2 |
| 9.5 | 9.5 | 1.3 | 1.2 | 1.2 | 1.0 | 0.96 | 0.8 | 0.7 |
| | | | | | | | | |
| | | 91.4 | 106.7 | 121.9 | 137.2 | 152.4 | 167.6 | 182.9 |
| 6.4 | 6.4 | 0.2 | 0.2 | 0.16 | 0.16 | 0.16 | 0.16 | 0.16 |
| 9.5 | 9.5 | 0.6 | 0.56 | 0.56 | 0.5 | 0.5 | 0.5 | 0.5 |

# INSTALLATION STANDARD FOR PROTECTIVELY COATED PIPE

# IAPMO IS 13-2006

**1.0 Scope.**

**1.1** Installation and material of protective pipe coatings shall comply with this Standard and the current edition of the Uniform Plumbing Code [UPC]™, published by the International Association of Plumbing and Mechanical Officials (IAPMO).

**Note:** The following sections of the Uniform Plumbing Code shall apply to protectively coated pipe.

| | |
|---|---|
| 301.1.1 | Marking |
| 302.0 | Iron Pipe Size (IPS) Pipe |
| 309.0 | Workmanship |
| 310.0 | Prohibited Fittings and Practices |
| 312.5 | Protectively Coated Pipe |
| 313.0 | Hangers and Supports |
| 604.0 | Materials (water piping) |
| 609.3 | Under Concrete Slab |
| 1208.5.1 | Materials (gas piping) |
| 1208.5.6 | Protective Coating |

**2.0 Product Requirements.**

**2.1 Minimum Standards.**

**2.1.1 Materials.**

**2.1.1.1 Coating.** Piping shall be coated by a listed coating applicator in accordance with AWWA C203, AWWA C213, or AWWA C215.

**2.1.1.2 Tape.** Tape for field application shall comply with IAPMO PS 37, Black Plastic PVC or PE Pressure-Sensitive Corrosion Preventive Tape.

**2.1.1.3 Primer.** Primer for field application shall be compatible with the tape and be as recommended by the tape manufacturer.

**2.1.2 Markings.**

**2.1.2.1 Pipe.** Protectively coated pipe shall be legibly marked at least every two (2) feet (610 mm) as follows:

(a) Applicator's name or trademark;

(b) Pipe manufacturer's name;

(c) Pipe Standard designation i.e., ASTM or API;

(d) Pipe material type i.e., Black, Galvanized;

(e) Pipe size and schedule;

(f) Coating material;

(g) Holiday test voltage;

(h) Products listed by IAPMO that are covered by this standard shall be labeled with the designated IAPMO certification mark; and

(i) Any other required markings. [UPC 301.1.1]

**2.1.2.2 Tape.** Tape for field applications should be legibly marked at least every two (2) feet (610 mm) with the manufacturer's name and tape model identification.

**2.2 Protection of Piping and Fittings.**

**2.2.1 Field Joints.** Field joints shall be made as follows, except as specified in 2.2.2. Clean and dry surfaces to be protected. [UPC 312.0]

Step 1 Oil and grease, if present, shall be removed with suitable non-oily type solvent such as Heptane or Trichlorethylene. Materials, such as kerosene and gasoline, shall not be used.

Step 2 For coated pipe, remove coating approximately 3 inches (76 mm) from end of pipe or from repair area and bevel to expose shoulder of coating at area to be field wrapped.

Step 3 For taped pipe, remove tape and overwrapping so as to expose approximately 3 inches (76 mm) of pipe at area to be field wrapped.

Step 4 For welded pipe, grind down sharp welds and weld spatter to a minimum 1/8 inch (3.2 mm) radius. Wire brush the weld area thoroughly taking care to remove as much mil scale and surface rust as possible. Remove any loose or charred coating caused during welding.

Step 5 Apply listed primer, as recommended by the manufacturer of

the tape being applied, over the protected area and adjacent 1 inch (25.4 mm) of protected area.

Step 6 Spirally wrap listed tape by a half overlap double wrap of minimum 10 mil tape stretched around the fitting, thread, and other unprotected areas to provide a minimum 40 mil thickness. A maximum of two (2) inch (51 mm) wide tape shall be used for field application.

**Exception:** Unless otherwise listed by IAPMO, a maximum of one (1) inch (25.4 mm) wide tape shall be used on change of direction fittings for piping sizes up to and including two (2) inch (51 mm).

2.2.2 **Other Methods.** Other materials approved for field joints or repair shall be applied as per manufacturer's recommendations and the listing requirements.

2.3 **Damage in Shipment.** Coated piping shall be protected against damage in shipment.

2.3.1 **Handling and Storage.** Coated piping shall be handled and stored in a manner to prevent damage.

2.3.2 **Handling by Installer.** Movement of pipe from truck or into trench shall be done in such a manner as to avoid abrasion, or damage from dropping.

2.4 **Backfill.** All excavations shall be completely backfilled as soon after inspection as possible. [UPC 314.0]

2.5 **Inspection.** All coated piping shall be inspected and tested and any visible void, damage or imperfection to the pipe coating shall be repaired as to comply with Section 2.2.

2.5.1 **Equipment.** 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.

**ADOPTED:** 1971

**REVISED:** 1975, 1978, 1982, 1984, 1991, 2000, 2003, 2006

# INSTALLATION STANDARD
# FOR ASBESTOS CEMENT PRESSURE PIPE FOR WATER SERVICE AND YARD PIPING

# IAPMO IS 15-2006

**1.0 Scope.**

**1.1** This standard shall govern the installation of asbestos cement pressure pipe and fittings with elastomeric gasketed joints in hot and cold water building supply and yard piping. For allowable location and pressure, see Sections 2.4 and 2.5.2 of this standard. Installation, material, and inspection shall comply with the current edition of the Uniform Plumbing Code [UPC]™ published by the International Association of Plumbing and Mechanical Officials, and shall also comply with this standard.

**Note:** The following sections of the Uniform Plumbing Code apply to asbestos cement pressure piping systems.

| | |
|---|---|
| 309.0 | Workmanship |
| 312.0 | Protection of Piping, Materials, and Structures |
| 313.0 | Hangers and Supports |
| 314.0 | Trenching, Excavation, and Backfill |
| Chapter 6 | Water Supply and Distribution |
| Table 1401.1 | Referenced Standards |

**Chapter 2 Definitions.**

| | | |
|---|---|---|
| 202.0 | AC | Asbestos Cement |
| Chapter 14 | ASTM | American Society for Testing and Materials |
| | IAPMO | International Association of Plumbing and Mechanical Officials |
| | UPC | Uniform Plumbing Code published by IAPMO |

**2.0 Product Requirements.**

**2.1 Minimum Standards.**

**2.1.1 Material.** Materials shall conform to the appropriate standard in Table 1401.1 of the Uniform Plumbing Code.

Applicable Standards

| | |
|---|---|
| AC Pipe | ASTM C 296 |
| Fittings | AWWA/ANSI A21.10 |
| Rings | ASTM D 1869 |
| Joints | AWWA/ANSI A21.11 |

**2.1.2 Pipe.** Pipe is asbestos cement.

**2.1.3 Fittings.** Fittings are cast iron or other listed materials.

**2.1.4 Markings.**

**2.14.1 Pipe.** Pipe markings shall be in accordance with ASTM C 296. [UPC 301.1.1]

**2.1.4.2 Fittings.** Fitting markings shall be in accordance with AWWA A21.10. [UPC 301.1.1]

**2.1.4.3 Couplings.** Couplings shall be marked with at least the following:

(a) Manufacturers name or trademark;

(b) Class and nominal size; and

(c) Letter "T".

**2.1.4.4 Position of Markings.** The identifying markings on pipe and fittings shall be visible for inspection without moving materials unless otherwise acceptable to the Administrative Authority.

**2.2 Trenching, Cover, and Backfill.**

**2.2.1 Trenching and Cover.** Trench bottoms shall be uniformly graded and shall be of either undisturbed soil or shall consist of a layer or layers of compacted backfill so that minimum settlement will take place.

The trench bottoms shall be at least 12 inches (305 mm) below the average local frost depth. The minimum cover shall be 18 inches (458 mm) below the finish grade. [UPC 314.0]

**2.2.2 Backfill.** After finishing pressure testing of the line, backfill a minimum of twelve (12) inches (305 mm) deep over the top of the pipe and fittings. Backfill should be select material placed around the pipe in a manner to provide a firm continuous support. Tamp well to secure proper compaction.

**Note:** All joints shall be exposed during test.

**2.3 Joints.**

**2.3.1** Joints in asbestos cement pipe shall be a sleeve coupling of the same composition as the pipe, or of other listed materials, and sealed with rubber rings or joined by other listed compression type coupling. [UPC 605.1]

**2.3.2** Joints between asbestos cement pipe and other approved pipes shall be made by means of

listed adapter couplings. Special heat resistant rings as recommended by the manufacturer must be used for temperatures in excess of 140°F (60°C).

2.3.3 Before assembling the joint, the coupling grooves, pipe ends, and rubber gasket must be cleaned. The rubber gaskets are then positioned in the grooves.

2.3.4 Use the pipe manufacturer's joint lubricant recommended for potable water application. Apply lubricant to the machined end of the pipe only, never to the rubber gasket or groove, unless specifically recommended otherwise by the manufacturer.

2.3.5 The end of the pipe and the coupling or fitting bell shall be assembled using a bar and wood block or a pipe puller. "Stabbing" or "popping" the pipe into the coupling (pipe is suspended and swung into the bell) is not recommended.

2.3.6 When a field cut is made, cut the pipe square, using hand pipe-cutters which use a cutting edge, or hand saws. To properly enter the rubber gasketed joint, the end of the pipe must be machined before insertion, using hand machining tools.

**2.4 Materials.**

2.4.1 **Location.** Asbestos cement piping shall be installed only outside the foundation of any building or structure or parts thereof. It shall be buried in the ground for its entire length except vertical piping may be extended above grade per Section 604.1 of the Uniform Plumbing Code. It shall not be installed within or under any building or structure or mobile home or commercial coach or parts thereof. The term "building or structure or parts thereof" shall include structures such as porches and steps, roofed porte-cocheres, roofed patios, carports, covered walks, covered driveways, and similar structures or appurtenances. [UPC 604.1]

**2.5 Installation, Testing, and Identification.**

2.5.1 **Alignment and Deflection.** Pipe and fittings shall be aligned properly without strain. Pipe may be deflected in accordance with the manufacturer's recommendations provided that it shall not be permanently staked or blocked to maintain this deflection. If soft soil conditions exist, deflected joints may be permanently blocked or staked to maintain the deflection. The amount of deflection shall be: 5° for sizes 4 inch (101.6 mm) through 12 inch (305 mm); 4° for 14 inch (356 mm) and 16 inch (407 mm); 3½° for 18 inch (457 mm) through 24 inch (610 mm) for pipe belled on the job site. For factory-belled couplings, one half (½) the above deflections by size shall be allowed.

2.5.2 **Working Pressure.** Maximum working pressure shall be as follows:

**MATERIALS, SIZES AND MAXIMUM WORKING PRESSURES**

| PIPE | SIZES | MAXIMUM PRESSURE |
|---|---|---|
| Class 100 | 4 – 24 inch incl. (102 – 610 mm incl.) | 100 psi (689 kPa) |
| Class 150 | 4 – 24 inch incl. (102 – 610 mm incl.) | 150 psi (1,033 kPa) |
| Class 200 | 4 – 24 inch incl. (102 – 610 mm incl.) | 200 psi (1,378 kPa) |

2.5.3 **Laterals and Saddles.** Installation of laterals, saddles, or tapped couplings in AC piping shall be as required by their listings.

2.5.4 **Thrust Blocking.** Thrust blocks shall be installed at:

(a) Changes in direction, as at tees and bends;

(b) Changes in size, as at reducers;

(c) Stops, as at dead ends; and

(d) Valves, where thrusts may be expected.

The size and type of thrust block shall be based on the pressure rating of the pipe (or line test pressure, if greater than piping rating), pipe size and kind of soil 2.5.4(b). Refer to Table 1 for thrust at fittings for a pressure of one hundred (100) pounds per square inch (689 kPa).

2.5.5 To determine the bearing area of thrust blocks, refer to Table 2 for the safe bearing load of the soil and divide the total thrust by this safe bearing load.

2.5.6 Thrust blocks shall be located as shown on Chart 1.

2.5.7 **Testing.**

2.5.7.1 The portion of the line being tested should be complete with thrust blocks or properly sized temporary thrust blocking. The line may be pressure tested immediately after installation, provided however, that if poured concrete thrust blocks have been utilized, they have had a 24-hour period to attain an initial cure. [UPC 609.4]

2.5.7.2 The entire system shall be filled with water, purged of air, and tested at a pressure at least

**TABLE 1**
**THRUST AT FITTINGS IN POUNDS AT 100 PSI OF WATER PRESSURE**

| PIPE SIZE | CLASS | DEAD ENDS AND TEES | 90° BEND | 45° BEND | 22½° BEND |
|---|---|---|---|---|---|
| 4" | 100 | 1,720 | 2,440 | 1,320 | 660 |
| | 150 | 1,850 | 2,610 | 1,420 | 720 |
| | 200 | 1,850 | 2,610 | 1,420 | 720 |
| 6" | 100 | 3,800 | 5,370 | 2,910 | 1,470 |
| | 150 | 3,800 | 5,370 | 2,910 | 1,470 |
| | 200 | 3,800 | 5,370 | 2,910 | 1,470 |
| 8" | 100 | 6,580 | 9,300 | 5,040 | 2,550 |
| | 150 | 6,580 | 9,300 | 5,040 | 2,550 |
| | 200 | 6,580 | 9,300 | 5,040 | 2,550 |
| 10" | 100 | 9,380 | 13,270 | 7,190 | 3,640 |
| | 150 | 10,750 | 15,200 | 8,240 | 4,170 |
| | 200 | 10,750 | 15,200 | 8,240 | 4,170 |
| 12" | 100 | 13,330 | 18,860 | 10,240 | 5,170 |
| | 150 | 15,310 | 21,640 | 11,720 | 5,940 |
| | 200 | 15,310 | 21,640 | 11,720 | 5,940 |
| 14" | 100 | 17,930 | 23,360 | 13,740 | 6,960 |
| | 150 | 20,770 | 29,360 | 15,910 | 8,060 |
| | 200 | 20,770 | 29,360 | 15,910 | 8,060 |
| 16" | 100 | 23,210 | 32,820 | 17,880 | 9,000 |
| | 150 | 26,880 | 38,010 | 20,590 | 10,430 |
| | 200 | 26,880 | 38,010 | 20,590 | 10,430 |
| 18" | 100 | 31,000 | 44,200 | 23,850 | 11,950 |
| | 150 | 34,400 | 48,500 | 26,400 | 13,400 |
| | 200 | 38,600 | 54,400 | 29,650 | 14,900 |
| 20" | 100 | 38,400 | 54,200 | 29,500 | 14,700 |
| | 150 | 42,600 | 60,000 | 32,600 | 16,500 |
| | 200 | 47,800 | 67,400 | 36,700 | 18,600 |
| 24" | 100 | 55,000 | 78,000 | 42,200 | 21,100 |
| | 150 | 61,500 | 86,700 | 47,200 | 23,900 |
| | 200 | 69,000 | 97,200 | 52,900 | 26,800 |

**TABLE 1 (Metric)**
**THRUST AT FITTINGS IN NEWTONS AT 689 kPa OF WATER PRESSURE**

| PIPE SIZE | CLASS | DEAD ENDS AND TEES | 90° BEND | 45° BEND | 22½° BEND |
|---|---|---|---|---|---|
| 102 | 100 | 7,654 | 10,858 | 5,874 | 2,937 |
| | 150 | 8,232.5 | 11,614.5 | 6,319 | 3,204 |
| | 200 | 8,232.5 | 11,614.5 | 6,319 | 3,204 |
| | | | | | |
| 152 | 100 | 16,910 | 23,896.5 | 12,949.5 | 6,541.5 |
| | 150 | 16,910 | 23,896.5 | 12,949.5 | 6,541.5 |
| | 200 | 16,910 | 23,896.5 | 12,949.5 | 6,541.5 |
| | | | | | |
| 203 | 100 | 29,281 | 41,385 | 22,428 | 11,347.5 |
| | 150 | 29,281 | 41,385 | 22,428 | 11,347.5 |
| | 200 | 29,281 | 41,385 | 22,428 | 11,347.5 |
| | | | | | |
| 254 | 100 | 41,741 | 59,051.5 | 31,995.5 | 16,198 |
| | 150 | 47,837.5 | 67,640 | 36,668 | 18,556.5 |
| | 200 | 47,837.5 | 67,640 | 36,668 | 18,556.5 |
| | | | | | |
| 305 | 100 | 59,318.5 | 83,927 | 45,568 | 23,006.5 |
| | 150 | 68,129.5 | 96,298 | 52,154 | 26,433 |
| | 200 | 68,129.5 | 96,298 | 52,154 | 26,433 |
| | | | | | |
| 356 | 100 | 79,788.5 | 103,952 | 61,143 | 30,973 |
| | 150 | 92,426.5 | 130,652 | 70,799.5 | 35,867 |
| | 200 | 92,426.5 | 130,652 | 70,799.5 | 35,867 |
| | | | | | |
| 406 | 100 | 103,284.5 | 146,049 | 79,566 | 40,050 |
| | 150 | 119,616 | 169,144.5 | 91,625.5 | 46,413.5 |
| | 200 | 119,616 | 169,144.5 | 91,625.5 | 46,413.5 |
| | | | | | |
| 457 | 100 | 137,950 | 196,690 | 106,132.5 | 53,177.5 |
| | 150 | 153,080 | 215,825 | 117,480 | 59,630 |
| | 200 | 171,770 | 242,080 | 131,942.5 | 66,305 |
| | | | | | |
| 508 | 100 | 170,880 | 241,190 | 131,275 | 65,415 |
| | 150 | 189,570 | 267,000 | 145,070 | 73,425 |
| | 200 | 212,710 | 299,930 | 163,315 | 82,770 |
| | | | | | |
| 610 | 100 | 244,750 | 347,100 | 187,790 | 93,895 |
| | 150 | 273,675 | 385,815 | 210,040 | 106,355 |
| | 200 | 307,050 | 432,540 | 235,405 | 119,260 |

equal to the eventual operating pressure for at least one (1) hour before inspection and backfilling of trench. It is recommended that the test pressure not exceed the working pressure of the pipe.

**CAUTION: Air testing is prohibited.**

2.5.7.3 **Identification.** A label shall be fastened to the main electrical meter panel stating, "This structure has a non-metallic water service."

2.6 **Sizing.** Piping shall be sized in accordance with UPC Section 610.0. When UPC Appendix A is applicable, Chart A 4.1(1) (Fairly Smooth Pipe) may be used. Flow velocities shall be limited to a maximum of 8 fps (2.4 m/s). When using UPC, Table 610.3, required by UPC Section 610.0, velocities shall also be checked and limited using UPC Chart A 4.1(1). [UPC 610.0]

**Example:** For a pressure of 150 psi (1,033.5 kPa) on a 4 inch (102 mm) tee, Table 1 indicates 1850 pounds (8,232.5 N) for 100 psi (689 kPa). Therefore, total thrust for 150 psi (1,033.5 kPa) will equal 1½ times 1,850 pounds (82,32.5 N).

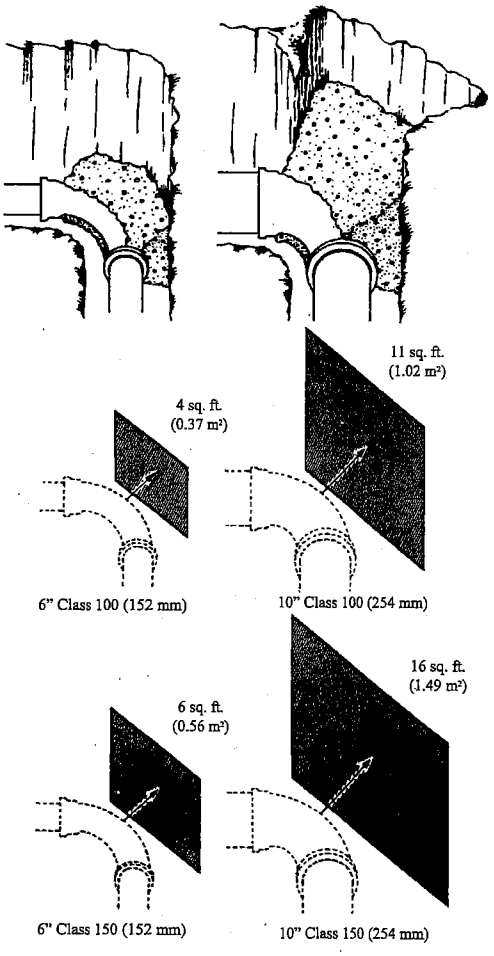
**TABLE 2**
**SAFE BEARING LOADS FOR VARIOUS SOILS**

| SOIL | SAFE BEARING LOAD | |
|---|---|---|
| | Lbs./Sq. Ft. | (kPa) |
| Mulch, Peat, etc. | 0 | 0 |
| Soft Clay | 1,000 | 6,890 |
| Sand | 2,000 | 13,780 |
| Sand and Gravel | 3,000 | 20,670 |
| Sand and Gravel Cemented w/Clay | 4,000 | 27,360 |
| Hard Shale | 10,000 | 68,900 |

**Example:** Assume a 4,000 pound (17,800 N) total thrust was computed. The soil condition is sand. The required bearing area of the thrust block is 4,000 lbs. (17,800 N) divided by 2,000 lbs. (13,780 kPa) or 2 sq. ft. (0.19 m2)

**ADOPTED: 1975**
**REVISED: 1981, 1982, 2003, 2006**

**CHART 1**



# INSTALLATION STANDARD
# FOR EXTRA STRENGTH VITRIFIED CLAY PIPE IN BUILDING DRAINS

# IAPMO IS 18-2006

**1.0 Scope.**

**1.1** This standard shall govern the installation of extra strength vitrified clay pipe in gravity building drains. (See Section 2.2 for allowable location.) Installation, material, and inspection shall comply with the current edition of the Uniform Plumbing Code [UPC]™ published by the International Association of Plumbing and Mechanical Officials and this standard.

**Note:** The following sections of the Uniform Plumbing Code apply to vitrified clay pipe.

| | |
|---|---|
| 103.5 | Inspections |
| 103.5.6 | Testing of Systems |
| 103.5.6.3 | Exceptions |
| 103.5.7.2 | Responsibility |
| 204.0 | Definition of Building Drain |
| 309.0 | Workmanship |
| 312.0 | Protection of Piping, Materials, and Structures |
| 313.3 | Underground Piping |
| 314.0 | Trenching, Excavation, and Backfill |
| Chapter 7 | Sanitary Drainage |
| 701.1(3) | Drainage Piping |
| 705.9 | Vitrified Clay Pipe and Joints |
| 712.2 | Water Test |
| 712.3 | Air Test |
| 720.0 | Sewer and Water Pipes |
| Table 1401.1 | Referenced Standards |
| Vitrified Clay Pipe | ASTM C 700 |
| Fittings, Couplings, Molded Rubber | ASTM C 425 |

**Chapter 2 Definitions.**

Chapter 14

| | |
|---|---|
| ASTM | American Society for Testing and Materials |
| IAPMO | International Association of Plumbing and Mechanical Officials |
| UPC | Uniform Plumbing Code published by IAPMO |

**2.0 Product Requirements.**

**2.1 Minimum Standards.**

**2.1.1 Materials.** Pipe and fittings shall be a minimum 3 inch (76 mm) in size, "Extra Strength" and couplings shall be molded rubber sewer couplings. They shall conform to the applicable standards in Table 1401.1 of the UPC. [UPC 301.1]

**2.1.2 Markings.**

**2.1.2.1 Pipe and Fittings.** Pipe and fitting markings shall be in accordance with ASTM C 700. [UPC 301.1.1]

**2.1.2.2 Couplings.** Couplings assemblies shall be marked with at least the following:

(a) Manufacturer's name or trademark on rubber couplings and take-up band or screw take-up housing;

(b) Size, on rubber coupling;

(c) Year of manufacture on rubber coupling;

(d) Grade of material on take-up band or screw take-up housing; and

(e) Couplings and components listed by IAPMO that are covered by this standard shall be labeled with the designated IAPMO certification mark to show compliance with this standard.

**2.2 Burial and Separation.**

**2.2.1 Burial.** Pipe and fittings shall be buried 12 inches (305 mm) minimum.

**2.2.2 Separation.** Pipe and fittings shall not be run or laid in the same trench with water piping unless **both** the following conditions are met:

(1) The bottom of the water pipe, at all points, shall be at least 12 inches (305 mm) above the top of the drain line; and

(2) The water pipe shall be placed on a solid shelf excavated at one side of the common trench. [UPC 720.0]

**2.3 Type of Joints.** Joints shall be made with couplings or with flexible compression factory fabricated joints. [UPC 705.9]

2.3.1 **Use of Joints.** Transitions between clay and other materials shall be made with molded rubber sewer couplings and appropriate bushings or reducers. [UPC 705.9]

**ADOPTED: 1980**
**REVISED: 1982, 1985, 2003, 2006**

# INSTALLATION STANDARD
# FOR CPVC SOLVENT CEMENTED HOT AND COLD WATER DISTRIBUTION SYSTEMS

# IAPMO IS 20-2010

**1.0 Scope.**

**1.1** This standard shall govern the installation of CPVC piping (IPS pipe and SDR-11 tubing) in potable hot and cold water distributing systems within buildings. (For allowable locations and pressure, see Sections 2.9.2 and 2.9.4) Installation, material and inspection shall comply with the current edition of the UPC [UPC]™, published by the International Association of Plumbing and Mechanical Officials, and shall also comply with this standard.

**Note:** The following sections of the Uniform Plumbing Code apply to CPVC IPS piping and SDR-11 tubing.

| | |
|---|---|
| 103.5 | Inspections |
| 301.1 | Minimum Standards |
| 309.0 | Workmanship |
| 310.0 | Prohibited Fittings and Practices |
| 312.0 | Protection of Piping, Materials, and Structures |
| 313.0 | Hangers and Supports |
| Chapter 6 | Water Supply and Distribution |
| 605.17.2 | Plastic Pipe to Other Materials |

Chapter 2* Definitions.

205.0 CPVC Chlorinated Poly (Vinyl Chloride)

Pipe or tubing - "Pipe" or "Piping" includes both pipe and piping, unless specified as "IPS Pipe" or "tubing".

| Table 1401.1 | Referenced Standards |
|---|---|
| ASTM D 2846 | Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot and Cold Water Distribution System |
| ASTM F 441 | Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80 |
| ASTM F 438 | Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings Schedule 40 |
| ASTM F 439 | Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings Schedule 80 |
| ASTM F 493 | Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings |

**Abbreviations.**

| | |
|---|---|
| ASTM | American Society for Testing and Materials |
| IAPMO | International Association of Plumbing and Mechanical Officials |
| UPC | Uniform Plumbing Code published by IAPMO |

*1.2* ***Special Requirements for CPVC Installation within Residential Structures. [HCD 1]*** *In addition to the other requirements in the California Plumbing Code and this Appendix for the installation of CPVC Solvent Cemented Hot and Cold Water Distributions Systems, all installations of CPVC pipe within residential structures shall meet the following:*

*1.2.1* ***Flushing Procedures.*** *All installations of CPVC pipe within residential structures shall be flushed twice over a period of at least one (1) week. The pipe system shall be first flushed for at least 10 minutes and then filled and allowed to stand for no less than 1 week, after which all the branches of the pipe system must be flushed long enough to fully empty the contained volume. At the time of the fill, each fixture shall have a removable tag applied stating:*

*"This new plumbing system was first filled on (date) by (name). The California Department of Housing and Community Development requires that the system be flushed after standing at least one week after the fill date specified above. If the system is used earlier than one week after the fill date, the water must be allowed to run for at least two minutes prior to use for human consumption. This tag may not be removed prior to flushing, except by the homeowner."*

*1.2.2* ***Worker Safety Measures.*** *Mechanical ventilation sufficient to maintain exposures below the relevant exposure limits established by state regulation shall be provided in enclosed spaces. This ventilation shall be directed at the breathing zone of the worker installing the pipe. Where mechanical ventilation is not practical, respirators, suitable for organic vapors, shall be used. For the purpose of this subdivision, an enclosed space is defined as:*

*(a) A space less than 100 square feet of floor area under a ceiling with a height of 10 feet or less, and which does not have openings (consisting of doors, windows, or unfinished walls) on at least two sides;*

*(b) Crawl spaces having a height of less than three feet;*

*(c) Enclosed attics that have a roof and ceiling; or*

*(d) Trenches having a depth greater than 24 inches.*

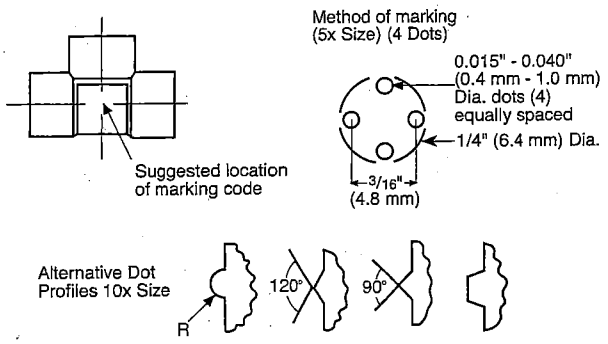
*Installers of CPVC pipe within residential structures shall use non-latex thin gauge (4 millimeters) nitrile gloves, or other gloves providing an equivalent or better degree of protection during the installation of the CPVC plumbing system. Gloves shall be provided to all workers by the contractor, or plumbing subcontractor, and shall be replaced upon contamination by cements.*

**2.0 Product Requirements.**

**2.1 Minimum Standards.**

**2.1.1 Materials.** Materials shall comply with the following:

| Materials | ASTM Standard |
|---|---|
| Raw Material-CPVC 23447 | D 1784 |
| IPS Pipe | |
| Sch. 40 (½ in., ¾ in. and 1 in.) (12.7 mm, 19.1 mm, and 25.4 mm) | F 441 |
| Sch. 80 (½ in. – 10 in.) (12.7 mm – 51 mm) | F 441 |
| Tubing | |
| SDR 11 (½ in. thru 2 in.) (12.7 mm – 51mm) | D 2846 |
| Fittings | |
| Sch. 40 (½ in., ¾ in. & 1 in.) (12.7 mm, 19.1 mm, and 25.4 mm) | F 438 |
| Sch. 80 (½ in. – 10 in.) (12.7 mm – 51mm) | F 439 |
| Tube Fittings (½ in. – 2 in.) (12.7 mm – 51 mm) | D 2846 |




**2.1.2 Primer.** Listed primers shall be used that are compatible with the type of listed CPVC cement and pipe used. The primer shall be a true solvent for CPVC, containing no slow drying ingredient. Cleaners shall not be allowed to be used as a substitute or equivalent for a listed primer.

**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 D 2846, ½ inch through 2 inches in diameter.

**Note:** Manufacturer shall provide test data from an independent testing laboratory acceptable to the Administrative Authority that their CPVC pipe, together with recommended fittings has a Short Term Working Pressure (STWP) and Temperature Rating of 150 psi (1030 kPa) at 210°F (99°C) for 48 hours or more.

**2.1.3 Material.** Pipe and fittings are plastic and are usually light gray for IPS pipe and fittings, and tan for SDR 11 tubing and fittings.

**2.2 Markings.**

**2.2.1 Pipe and Tubing.** IPS pipe and tubing markings shall be in accordance with F 441 or D 2846. [UPC 301.1.1]

**2.2.2 Fittings.** Fitting markings shall be in accordance with F 438 or F 439 or D 2846. [UPC 301.1.1]

**Note:** Standard number may be omitted on smaller fittings when marked thus with four raised dots.

**2.2.3 Solvent Cement.** Container labeling of CPVC solvent cement shall be in accordance with F 493.

**2.2.3.1 Color.** Solvent cements requiring the use of a primer shall be colored orange or gray. Solvent cements that do not require the use of a primer shall be colored yellow.

**2.2.4 Primer.** Primer container markings shall be in accordance with F 656.

**2.2.4.1 Color.** Primer shall be colored so as to make its use obvious on a finished joint, but shall not be colored orange, yellow or gray.

**2.2.5 Position of Markings.** Identification markings shall be visible for inspection without moving materials.

**2.2.6 Alignment.** Piping and fittings shall be aligned properly without strain.

**2.3 Protection of Materials.**

**2.3.1 Abrasion.** Pipe or tubing passing through drilled or notched metal studs or joists or hollow shell masonry walls shall be protected from abrasion due to thermal expansion and contraction by elastomeric or plastic sleeves or grommets or other approved means.

Straight runs may have protection at maximum 3 feet (915 mm) intervals. [UPC 312.0]

2.3.2 **Puncture.** Steel plate protection shall be installed when required by the Administrative Authority or section 312.9 of the Uniform Plumbing Code.

2.3.3 **Storage and Handling.** Pipe shall be stored in a way to protect it from mechanical damage (slitting, puncturing, etc.). It shall be stored under cover to keep it clean and avoid long term exposure to sunlight. Exposure to sunlight during normal construction periods is not harmful. CPVC solvent cements should be stored in a cool place except when actually in use on the job site. The solvent cement manufacturer's specific storage instruction should be followed.

2.3.4 **Freezing.** In areas where the system must be drained to protect it from freezing, horizontal lines shall be graded to drain.

2.3.5 **Overheating:**

(a) Tubing shall not be positioned or closer to devices that generate heat such that the temperature around the CPVC tubing is greater than 180°F.

(b) Do not apply direct flame onto CPVC.

2.3.6 **Chemical Compatibility:** Pipe and Fitting materials can be damaged by contact with chemicals found in some construction products. The chemical compatibility of such products with the particular pipe of fitting material must be verified prior to use.

Otherwise, contact between the construction product and the pipe of fitting must be avoided.

2.4 **Thermal Expansion.**

2.4.1 **General.** Allowance for thermal expansion and contraction shall be provided by approved means. Thermal Expansion is mainly a concern on hot water lines. In vertical piping loops are not required when the temperature change (ΔT) is 120 °F or less. Allowance shall be based on an expansion rate formula listed below (See Table 1) or per the manufacturer's installation instructions.

£ = [ 3ED (ΔL) / 2S ] ½

$\Delta L = L_p \times C \times \Delta T$

ΔL = change in length of pipe in inches

Lp = length of pipe in inches

C = coefficient of thermal expansion for CPVC, 3.8 X 10-5 in/in/°F

ΔT = change in temperature in °F

**Note:** Expansion rate is independent of the size of the pipe.

2.4.2 **Offsets and Loops.** Thermal expansion may be provided for by use of expansion loops, offsets, or changes of direction. From Table 1 determine the length "L" that is required. Note that "L" is based on length of run, diameter of pipe, and maximum temperature of water.

2.5 **Clearance.** Adequate clearance shall be provided between piping and structure (such as bored holes and sleeves) to allow for free longitudinal movement.

2.6 **Hangers and Supports.**

2.6.1 **Vertical Piping.** Vertical piping shall be supported at each floor or as specified by the design engineer to allow for expansion/contraction. Piping shall have a mid-story guide. [UPC 313.0]

2.6.2 **Horizontal Piping.** Unless an engineered design is provided and approved by the Administrative Authority, the following provisions shall apply. Horizontal piping 1 inch (25.4 mm) or smaller shall be supported at maximum 3 foot (914 mm) intervals or per manufacturer's installation instructions. Piping 1-¼ inch (32 mm) or larger shall be supported at maximum 4 foot (1219 mm) intervals or per manufacturers installation instructions.

2.6.3 **Hangers and Anchors.** Piping shall not be anchored rigidly to a support, but rather secured with smooth hangers or straps that provide for a degree of movement and that prevent damage to the pipe. Hangers or straps with sharp or abrasive edges shall not be used. Hangers that pinch the piping shall not be used.

2.7 **Solvent Cement Joints.**

2.7.1 **Safety Requirements and Precautions[1].**

(a) General. Solvents contained in CPVC plastic pipe cements are classified as airborne contaminants and flammable and combustible liquids. Precautions listed in this appendix should be followed to avoid injury to personnel and the hazard of fire.

(b) Prolonged breathing of solvent vapors should be avoided. When pipe and fittings are being joined in partially enclosed areas, a ventilating device should be used in such a manner to minimize the entry of vapors into the breathing areas.

(c) Solvent cements should be kept away from all sources of ignition, heat, sparks and open flame.

(d) Containers for solvent cements should be kept tightly closed except when the cement is being used.

(e) All rags and other materials used for mopping up spills should be kept in a safety waste receptacle which should be emptied daily.

(f) Most of the solvents used in CPVC pipe cements can be considered eye irritants

and contact with the eye should be avoided for it may cause eye injury. Proper eye protection and the use of chemical goggles or face shields are advisable where the possibility of splashing exists in handling solvent cements. In case of eye contact, flush with plenty of water for 15 minutes and call a physician immediately.

(g) Repeated contact with the skin should be avoided. Proper gloves impervious to and unaffected by the solvents should be worn when frequent contact with the skin is likely. Application of the solvents or solvent cements with rags and bare hands is not recommended. Brushes and other suitable applicators can be used effectively for applying the solvent cement, thus avoiding skin contact. In the event of excessive contact, remove contaminated clothing and wash skin with soap and water.

2.7.2 **Selection.** Follow the manufacturer's recommendations for type of solvent cements for such conditions as temperatures over 100°F (38°C), or humidity over 60%.

2.7.3 **Handling (to maintain effectiveness).** Package solvent cement in containers no larger than 1 quart (1 liter). Keep solvent cement can closed and in the shade when not in use. Keep applicator submerged in solvent cement between applications. Discard solvent cement when it thickens appreciably or gels. Solvent cement shall not be thinned.

2.7.4 **Primer.** A listed primer in compliance with ASTM F 656 shall be used with CPVC solvent cements that require the use of a primer. CPVC solvent cements that do not require the use of a primer are permitted for joints up to 2 inches in size.

2.7.5 **Size of Applicator.** Applicator should be about one half the pipe diameter. Do not use small applicator on large pipes.

2.7.6 **Procedures.**

Step 1 Cut pipe square with, mechanical cutoff saw or tube cutter designed for plastic.

Step 2 Ream and chamfer pipe (to eliminate sharp edges, beads and all burrs).

Step 3 Clean all dirt, moisture and grease from pipe and fitting socket. Use a clean, dry rag.

Step 4 Check dry fit of pipe in fittings. Pipe should enter fitting socket ¼ to ¾ of socket depth. On larger sizes of Sch. 80 fittings, a looser fit may be expected. This is a normal condition, and requires care to apply an adequate amount of cement.

Step 5 Apply CPVC primer, if required (see Section 2.7.4) to inside of fitting socket. Take care to avoid puddling.

Step 6 Apply CPVC primer, if required to outside surface of pipe to depth of fitting socket.

Step 7 When using solvent cements requiring a primer wait until primer surface is tacky. DO NOT attempt to soften (dissolve) the surface as is required for PVC.

Step 8 Apply a liberal coat of CPVC solvent cement to the outside surface of the pipe to the depth of the fitting socket.

Step 9 Apply a light coat of CPVC solvent cement to inside of fitting socket. Apply a second liberal coat of cement to the pipe end. Take particular care in cementing larger sizes of Sch. 80 fittings. Be sure all surfaces are coated.

Step 10 While both the inside socket surface and the outside surface of the pipe are WET with solvent cement, forcefully bottom the pipe in the socket, giving the pipe a quarter turn while inserting, if possible.

Step 11 Hold the joint together for 10 to 30 seconds depending on pipe size to assure that the pipe remains bottomed against the pipe stop.

Step 12 Do not disturb the joint for at least 30 minutes.

**Note:** The joint is weak until the cement is dry. If the joint is adjusted after it is set, the joint will be ruined. See Table 2 for recommended set time.

Step 13 Wipe excess cement from the pipe. A properly made joint will show a bead of cement around its entire perimeter. Any gaps may indicate insufficient cement.

[1] Appendix X1. Safety Requirements And Precautions, from ASTM D 2564-88 Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings is reprinted with permission from the American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103, copyright.

Step 14 The system shall not be pressurized until the joints have cured (set) at least as long as recommended by the manufacturer. If the manufacturer's recommendation is not available, the cure times outlined in Table 2 are required.

2.7.7 **Prohibited Joints.** Piping shall not be threaded. Female screwed fittings, with CPVC threads, shall be prohibited. Joints made with adhesives shall be prohibited.

2.7.8 **Threaded Joints.** When threads are required, molded male adapters shall be used.

2.7.9 **Location.** CPVC threaded joints shall be accessible.

2.7.10 **Lubricants.** Only thread tape or thread lubricant approved specifically for use with CPVC shall be used. Conventional pipe thread compounds, putty, linseed oil based products, and unknown mixtures are prohibited.

2.7.11 **Tightening.** Joints shall be tightened approximately 1-½ turns past hand tight.

**CAUTION:** Hand tight refers to the number of threads to reach hand tight with metal pipe. Small sizes of CPVC can be bottomed by hand pressure alone. DO NOT overtighten.

2.7.12 **Special Joints.**

2.7.12.1 **Transition Joints.** Transitions from CPVC tubing to metal piping and valves shall be made only with listed transition fittings suitable for that purpose. When required, the transition fittings shall be designed in such a manner that it can be anchored to a building member to prevent rotation. [UPC 605.17.2]

2.7.12.2 **Soldering.** Soldered metal joints shall not be made closer than 18 inches (457 mm) to any already installed plastic to metal adapter in the same water line.

2.7.12.3 **Hose Bibbs.** Hose bibbs shall be connected only to metal system components which are adequately anchored to the building structure. The CPVC plastic system shall terminate in wall.

2.7.12.4 **Mechanical Joint.** Mechanical joints shall be installed in accordance with the manufacturer's instructions.

2.8 **Pressure Relief Valves.**

2.8.1 **CPVC Piping.** CPVC piping used for temperature and/or pressure relief valve drain lines shall be graded to the outlet end and shall be supported at 3 foot (914 mm) intervals both vertically and horizontally. CPVC can be connected directly to temperature and or pressure relief valves.

2.9 **Installation, Inspection and Testing.**

2.9.1 **Finish Nipples.** Finish nipples shall be connected to drop ear elbows or other fittings listed for preventing rotation. Finish nipples shall not be CPVC but CPVC stub outs for fixture connections shall be permitted. [UPC 609.0]

2.9.2 **Location.** CPVC tubing shall not be installed so as to be subjected to direct sunlight after installation, and shall not be installed on the surface of the building unless it is protected by paint or a protective covering.

2.9.3 **Water Heaters.** There shall be a minimum of six (6) inches (152 mm) of metallic piping between a gas water heater connection and CPVC tubing. CPVC tubing may be installed downstream of instantaneous (coil or immersion) water heaters provided that the water heater temperature controls are maintained for maximum temperature of 180° F.

2.9.4 **Under Slab.** Pipe shall be installed in trench with uniform support. Trenches shall be backfilled to a depth of six (6) inches (152 mm) with clean earth, sand or other approved material which shall not contain sharp rocks, boulders, cinder fill or other materials which would damage or break the piping. Pipe shall be stubbed up and all ends shall be capped. The system shall be filled with water and all air shall be bled off. The system shall be pressure tested under a water pressure which is not less than the working pressure which is not less than the working pressure under which it is to be used for a minimum of two (2) hours. All leaks shall be corrected. Foam pipe insulation shall be installed on all stub ups to prevent damage during concrete pour and finishing.

2.9.5 **Identification.** A permanent sign with the legible words "This building has non-metallic interior water piping" shall be fastened on or inside the main electric service panel.

2.9.6 **Position of Marking.** When installed, piping and fittings shall be positioned so that when practical, identifying markings shall be readily visible for inspection.

2.9.7 **Testing.** Air testing is prohibited.

2.10 **Sizing.**

2.10.1 **Method.** Piping shall be sized in accordance with UPC Section 610.0. When Appendix A is applicable, use Chart 1, 2, or 3 as appropriate. Flow velocities shall be limited to a maximum of 8 feet per second (2.4 m/s). See Table 3. [UPC 610.0]

## TABLE 1

| CPVC Pipe SDR 11 (ASTM D 2846) Calculated Loop (offset) Lengths with ΔT of approx. 80°F | | | | | |
|---|---|---|---|---|---|
| Nominal Pipe Size | Length of Run in Feet | | | | |
| | 20 | 40 | 60 | 80 | 100 |
| | Loop Length (£) in inches | | | | |
| ½" | 16 | 23 | 28 | 33 | 36 |
| ¾" | 19 | 27 | 33 | 39 | 43 |
| 1" | 22 | 31 | 38 | 44 | 49 |
| 1¼" | 24 | 34 | 42 | 48 | 54 |
| 1½" | 26 | 37 | 45 | 53 | 59 |
| 2" | 30 | 42 | 52 | 60 | 67 |

Assume Modulus & Stress at 160°F

| CPVC Pipe Schedule 80 (ASTM F 441) Calculated Loop (offset) Lengths with ΔT of approx. 80°F | | | | |
|---|---|---|---|---|
| Nominal Pipe Size | Length of Run in Feet | | | |
| | 40 | 60 | 80 | 100 |
| | Loop Length (£) in inches | | | |
| 2½" | 49 | 61 | 70 | 78 |
| 3" | 55 | 67 | 77 | 86 |
| 4" | 62 | 76 | 87 | 98 |
| 6" | 75 | 92 | 106 | 119 |
| 8" | 86 | 105 | 121 | 135 |
| 10" | 96 | 117 | 135 | 151 |

Assume Modulus & Stress at 160°F

| CPVC Pipe SDR 11 (ASTM D 2846) Calculated Loop (offset) Lengths with ΔT of approx. 100°F | | | | | |
|---|---|---|---|---|---|
| Nominal Pipe Size | Length of Run in Feet | | | | |
| | 20 | 40 | 60 | 80 | 100 |
| | Loop Length (£) in inches | | | | |
| ½" | 18 | 26 | 32 | 36 | 41 |
| ¾" | 22 | 30 | 37 | 43 | 48 |
| 1" | 24 | 35 | 42 | 49 | 55 |
| 1¼" | 27 | 38 | 47 | 54 | 60 |
| 1½" | 29 | 42 | 51 | 59 | 66 |
| 2" | 34 | 47 | 58 | 67 | 75 |

Assume Modulus & Stress at 160°F

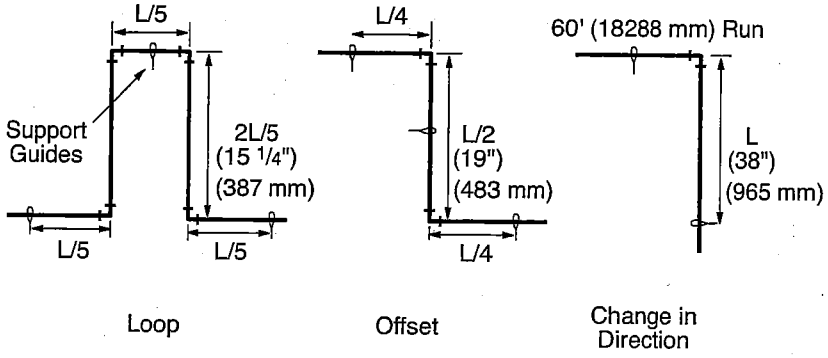
$£ = \sqrt{3}ED(\Delta L)/2S$

Where £ = loop length in inches
E = modulus of elasticity at maximum temperature, psi
D = outside diameter of pipe, inches
ΔL = change in length due to change in temperature, inches
S = working stress at maximum temperature, psi

| CPVC Pipe Schedule 80 (ASTM F 441) Calculated Loop (offset) Lengths with ΔT of approx. 100°F | | | | |
|---|---|---|---|---|
| Nominal Pipe Size | Length of Run in Feet | | | |
| | 40 | 60 | 80 | 100 |
| | Loop Length (£) in inches | | | |
| 2½" | 55 | 68 | 78 | 87 |
| 3" | 61 | 75 | 86 | 96 |
| 4" | 69 | 85 | 98 | 109 |
| 6" | 84 | 103 | 119 | 133 |
| 8" | 96 | 117 | 135 | 151 |
| 10" | 107 | 131 | 151 | 169 |

Assume Modulus & Stress at 160°F

**Example:** Pipe Size – ½ inch (12.7 mm) Length of Run – 60 feet (18288 mm): (38") (965 mm) (from table).




Where

£ = loop length in inches
E = modulus of elasticity at maximum temperature, psi
D = outside diameter of pipe, inches
ΔL = change in length due to change in temperature, inches
S = working stress at maximum temperature, psi

**THERMAL EXPANSION (inches)**

| LENGTH OF RUN (feet) | ΔT 80°F | ΔT 100°F |
|---|---|---|
| 20 | 0.73 | 0.91 |
| 40 | 1.46 | 1.82 |
| 60 | 2.19 | 2.74 |
| 80 | 2.92 | 3.65 |
| 100 | 3.65 | 4.56 |

£ = $[\,3ED\,(\Delta L) / 2S\,]^{1/2}$
ΔL = Lp x C x ΔT
ΔL = change in length of pipe in inches
Lp = length of pipe in inches
C = coefficient of thermal expansion for CPVC, $3.8 \times 10^{-5}$ in/in/°F
ΔT = change in temperature in °F

**TABLE 2**

| JOINT CURE SCHEDULE | | | | | |
|---|---|---|---|---|---|
| TEMPERATURE RANGE OF PIPE AND FITTINGS DURING ASSEMBLY AND CURE | | MINIMUM JOINT SET TIME, hrs (STEP 12) | MINIMUM CURE TIME BEFORE TESTING, hrs (STEP 14) | | MINIMUM TIME BEFORE PUTTING SYSTEM INTO SERVICE AT 80 psi/160°F (71°C), hrs |
| | | | PIPE SIZE | | |
| F° | C° | | ½ - 1 in. (12.7 - 25.4 mm) | 1¼ - 2 in. (32 - 51 mm) | |
| 60-100 | 16-38 | ½ | 1 | 2 | 24 |
| 40-60 | 4-16 | 1 | 2 | 4 | 48 |

**TABLE 3**
**8 FEET PER SECOND**

| PIPE SIZE | PIPE | Sch. 40 | | PIPE | Sch. 80 | | TUBING | SDR 11 | |
|---|---|---|---|---|---|---|---|---|---|
| | GPM | Ft.* | FV** | GPM | Ft.* | FV** | GPM | Ft.* | FV** |
| | | FU | FU | | FU | FU | | FU | FU |
| ½ | 8 | 9 | — | 6 | 7 | — | 5 | 6 | — |
| ¾ | 13 | 19 | — | 11 | 15 | — | 10 | 13 | — |
| 1 | 22 | 33 | — | 18 | 26 | — | 17 | 24 | — |
| 1¼ | 37 | 74 | 5 | 32 | 55 | 15 | 25 | 42 | 8 |
| 1½ | 51 | 129 | 50 | 44 | 104 | 36 | 35 | 66 | 20 |
| 2 | 81 | 295 | 170 | 74 | 245 | 124 | 59 | 170 | 73 |

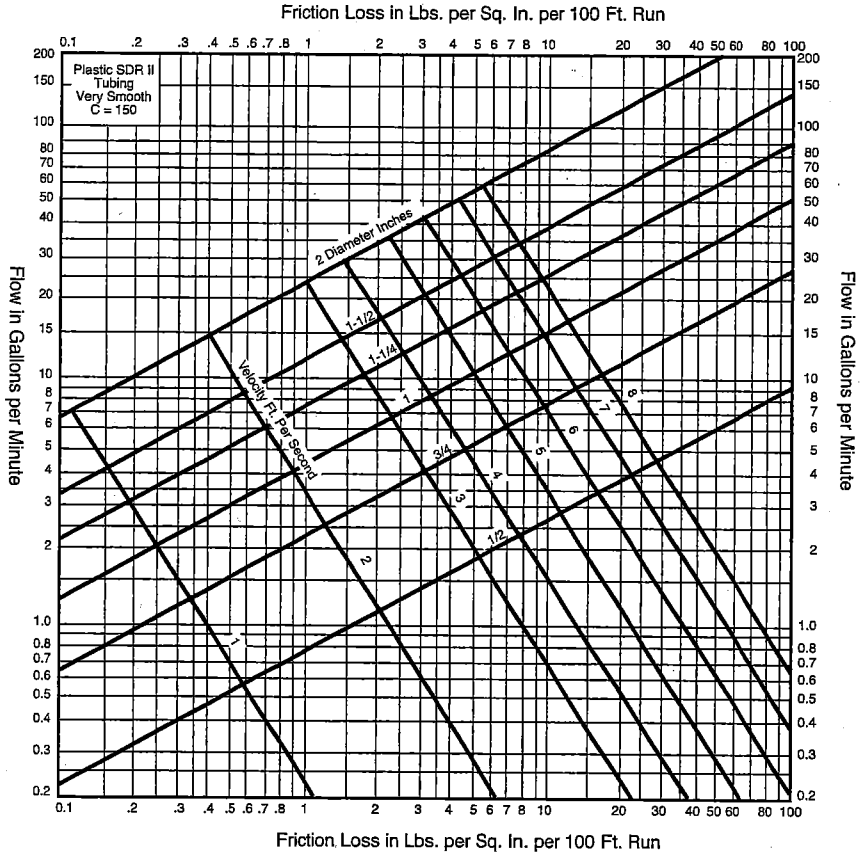
* Flush Tank Fixture Units
** Flush Valve Fixture Units

**TABLE 3 (Metric)**
**2.4 METERS PER SECOND**

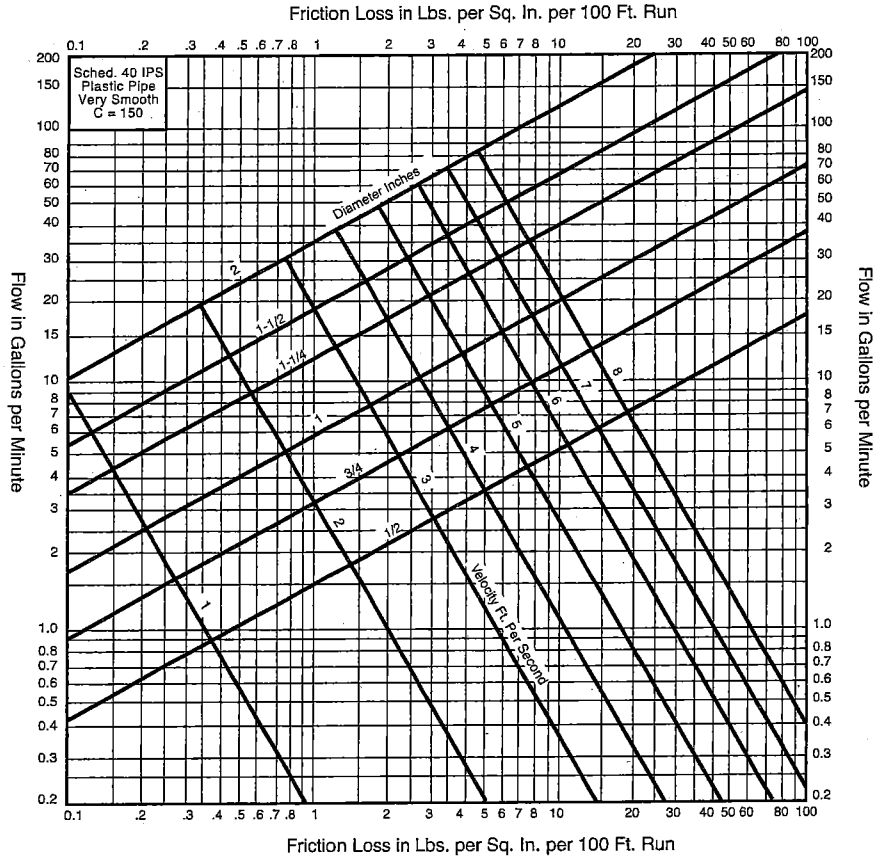
| PIPE SIZE | PIPE | Sch. 40 | | PIPE | Sch. 80 | | TUBING | SDR 11 | |
|---|---|---|---|---|---|---|---|---|---|
| | L/min | Ft.* | FV** | L/min | Ft.* | FV** | L/min | Ft.* | FV** |
| | | FU | FU | | FU | FU | | FU | FU |
| 12.7 | 30.3 | 9 | — | 22.7 | 7 | — | 18.9 | 6 | — |
| 19.7 | 49.2 | 19 | — | 14.6 | 15 | — | 37.9 | 13 | — |
| 25.4 | 83.3 | 33 | — | 68.1 | 26 | — | 64.3 | 24 | — |
| 32 | 140.0 | 74 | 5 | 121.1 | 55 | 15 | 94.3 | 42 | 8 |
| 38 | 193.0 | 129 | 50 | 166.5 | 104 | 36 | 132.5 | 66 | 20 |
| 51 | 306.0 | 295 | 170 | 280.1 | 245 | 124 | 223.3 | 170 | 73 |

* Flush Tank Fixture Units
** Flush Valve Fixture Units

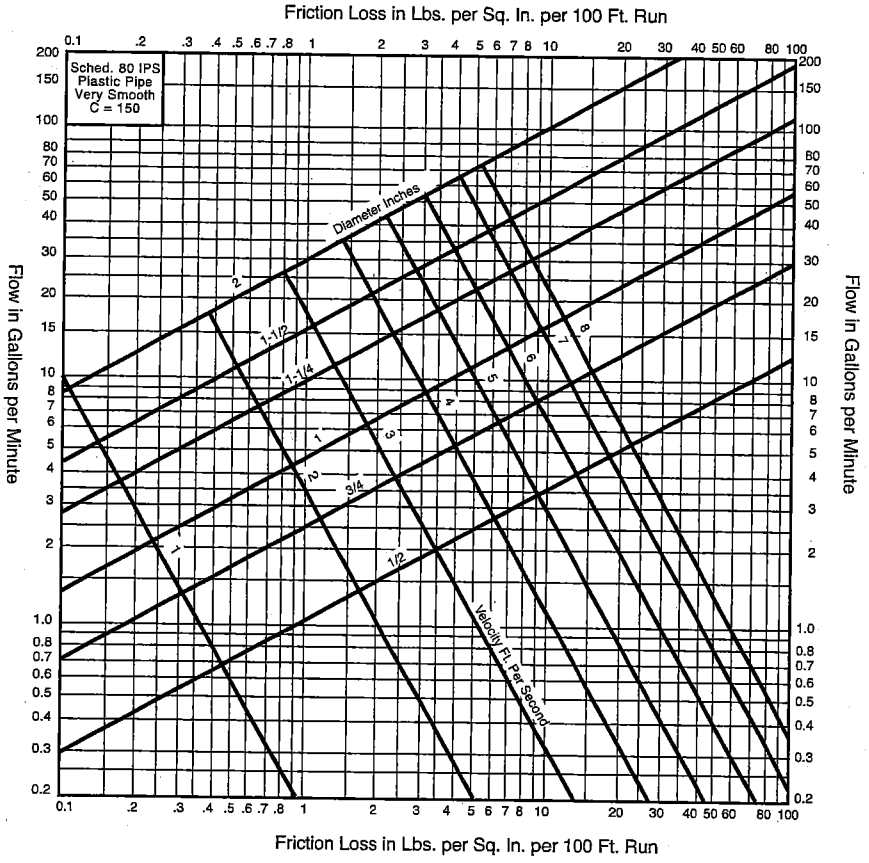
## CHART 1


Friction Loss in Lbs. per Sq. In. per 100 Ft. Run
Plastic SDR II Tubing Very Smooth C = 150
2 Diameter Inches
1-1/2
1-1/4
1
3/4
1/2
Velocity Ft. Per Second
Flow in Gallons per Minute
Flow in Gallons per Minute
Friction Loss in Lbs. per Sq. In. per 100 Ft. Run

## CHART 2


Friction Loss in Lbs. per Sq. In. per 100 Ft. Run
Sched. 40 IPS Plastic Pipe Very Smooth C = 150
Diameter Inches
Velocity Ft. Per Second
Flow in Gallons per Minute
Flow in Gallons per Minute
Friction Loss in Lbs. per Sq. In. per 100 Ft. Run

## CHART 3


Friction Loss in Lbs. per Sq. In. per 100 Ft. Run
Sched. 80 IPS Plastic Pipe Very Smooth C = 150
Diameter Inches
Velocity Ft. Per Second
Flow in Gallons per Minute
Flow in Gallons per Minute
Friction Loss in Lbs. per Sq. In. per 100 Ft. Run

# Appendix A

The following formula should be used for Schedule 80 IPS CPVC sizes 2 ½" through 10":

Head loss formula: $HL = 0.2083 (100/C)^{1.852} \times F_R^{1.852} / d_I^{4.8655}$

Where
HL = frictional head loss (feet of water per 100 feet)
C = Hazen-Williams factor (150 for CPVC)
$F_R$ = flow rate (gal/min)
$d_I$ = inside diameter of pipe (inches)

**Note:** head loss in feet of water per 100 feet can be multiplied by 0.4335 to obtain pressure drop in psi

Velocity formula: $VW = 0.4085 FR / d_I^2$

Where
VW = velocity of water (feet per second)

**ADOPTED: 1982**
**REVISED: 1984, 1985, 1989, 1990, 1991, 1992, 1993, 1995, 1996, 1997, 2000, 2003, 2005, 2006, 2010**

# INSTALLATION STANDARD
# FOR WELDED COPPER AND COPPER ALLOY WATER TUBE

# IAPMO IS 21-2006

**1.0 Scope.**

This standard shall govern the installation of welded copper and copper alloy water tube in potable hot and cold water systems.Installation, material, and inspection shall comply with the current edition of the Uniform Plumbing Code [UPC]™ published by the International Association of Plumbing and Mechanical Officials and this standard.

**Note:** The following sections of the Uniform Plumbing Code apply to welded copper and copper alloy water tube.

| | |
|---|---|
| 103.5.6 | Testing of Systems |
| 301.1 | Minimum Standards |
| 309.0 | Workmanship |
| 310.0 | Prohibited Fittings and Practices |
| 312.0 | Protection of Piping, Materials, and Structures |
| 313.0 | Hangers and Supports |
| 316.0 | Increasers and Reducers |
| Chapter 6 | Water Supply and Distribution |
| 604.0 | Materials |
| 604.1 | Pipe, Tube, and Fittings |
| 604.2 | Copper Tube |
| 604.3 | Hard-Drawn Copper Tubing |
| 604.4 | Flexible Copper Connectors |
| 604.7 | Previously Used Piping and Tubing |
| 605.3 | Copper Pipe, Tubing, and Joints |
| 605.3.2 | Flared Joints |
| 605.3.4 | Soldered Joints |
| 605.17 | Joints Between Various Materials |
| 605.17.1 | Copper Pipe or Tubing to Threaded Pipe Joints |
| 608.5 | Drains |
| 609.0 | Installation, Testing, Unions, and Location |
| 610.0 | Size of Potable Water Piping |
| 705.10.3 | Ground Joint, Flared, or Ferrule Connections |
| 811.0 | Chemical Wastes |
| 903.2 | Use of Copper Tubing |

| | |
|---|---|
| Table 1401.1 | Referenced Standards |
| ANSI B 16.18 | Cast Copper Alloy Solder Joint Pressure Fittings |
| ANSI B 16.22 | Wrought Copper and Copper Alloy Solder Joint Pressure Fittings |
| ASTM B 447 | Welded Copper Tube |
| Appendix A | Chart A 4.1 Friction Loss |

**2.0 Product Requirements.**

**2.1 Minimum Standards.**

**2.1.1 Materials.** Materials shall comply with the appropriate standard in Table 1401.1 of the UPC.

**Note:** The nominal or standard size of copper and copper alloy welded water tube is always 0.125 inch (3.8 mm) or ⅛ inch (3.8 mm) smaller than the actual outside diameter dimension of the tube. For example, 3 inch (76 mm) nominal size copper plumbing, tube measures 3⅛ inch (79.2 mm) O.D., ½ inch (12.7 mm) nominal size copper plumbing tube measures ⅝ inch (15.9 mm) O.D., etc.

**2.2 Use of Copper Tubing.**

**2.2.1 Markings.** Markings shall be visible for inspection.

**2.2.1.1** Water tube shall bear the following incised marked at not over 18 inch (457 mm) intervals:

(a) Manufacturer's name or trademark;

(b) Tube type; and

(c) Country of origin.

**2.2.1.2** All hard drawn tube shall be identified throughout its entire length by a colored marking not less than 3/16 inch in height, including legend repeated at intervals not greater than 3 feet (914 mm). The legend shall include the type of tube, welded, ASTM specification, name or trademark of the manufacturer or both, and the country of origin. [UPC 604.3]

(a) Tube listed by IAPMO that is covered by this standard shall be labeled with the designated IAPMO certification mark to show compliance with this standard.

2.3 **Joints.**

2.3.1 **General Information.** Copper tube and fittings maybe joined in a number of ways, depending on the purpose of the system. Soldering and brazing with capillary fittings are the methods used most.

The American Welding Society defines soldering as a joining process which takes place below 840°F (449°C) and brazing as a similar process which occurs above 840°F (449°C) but below the melting point of the base metals. In actual practice for copper systems, most soldering is done at temperatures ranging from about 350°F to 550°F (177° to 288°C), while most brazing is done at temperatures ranging from 1100° F to 1500°F (593°C to 816°C). The choice between soldering or brazing will generally depend on operating conditions. Solder joints are generally used where the service temperature does not exceed 205°F (96°C), while brazed joints can be used where greater strength is required, or where system temperatures are as high as 400°F (204°C). [UPC 605.3]

2.3.2 **Fittings for Soldered, Brazed, and Flared Joints.** Fittings are available in all standard tube sizes and in a wide variety of types to cover needs for plumbing. They can be either soldered or brazed, although brazing cast fittings requires care. Wrought copper pressure fittings are also available over a wide range of sizes and types. These, too, can be joined by either soldering or brazing, and wrought fittings are preferred where brazing is the joining method. Otherwise, the choice between cast and wrought fittings is largely a matter of the user's preference. Flared-tube fittings provide metal-to-metal contact similar to ground joint unions; both can be easily taken apart and reassembled. They are especially useful where residual water cannot be removed from the tube and soldering is difficult. Flared joints may be required where a fire hazard exists and the use of a torch to make soldered or brazed joints is not allowed.

2.3.3 **Solders.**

**Note:** Users of the Uniform Plumbing Codes are reminded that provisions of the Federal Clean Drinking Act of 1986, which all must obey, forbid the use of solder which contains in excess of 0.2% of lead, by weight in potable water systems. The provisions of the act are incorporated in all ordinances, statutes, state and municipal regulations by reference and by operation of law.

The selection of a solder depends on the operating pressure and temperature of the line. Consideration should also be given to the stresses on the joint caused by thermal expansion and contraction. However, stresses due to temperature changes should not be significant in two commonly encountered cases: when tube lengths are short, or when expansion loops are used in long tube runs.

Solder is generally used in wire form, but paste-type solders are also available. These are finely granulated solders in suspension in a paste flux. When using paste-type solders, observe these four rules:

1. Wire solder must be applied in addition to the paste to fill the voids and assist in displacing the flux, otherwise the surfaces may be well "tinned" and yet there may not be a good joint with a continuous bond.
2. The paste mixture must be thoroughly stirred if it has been standing in the can for more than a very short time, as the solder has a tendency to settle rapidly to the bottom.
3. The flux cannot be depended on to clean the tube. Cleaning should be done manually as is recommended for any other flux and solder.
4. Remove any excess flux.

Solders are available containing small amounts of silver or other additives to impart special properties. Such solders may require special fluxes. The manufacturer's recommendations should be consulted regarding proper procedures and fluxes for such solders and about the expected properties.

2.3.4 **Soldering Flux.** The functions of the soldering flux are to remove residual traces of oxides, to promote wetting, and to protect the surfaces to be soldered from oxidation during heating. The flux should be applied to clean surfaces and only enough should be used to lightly coat the areas to be joined.

An oxide film may reform quickly on copper after it has been cleaned. Therefore, the flux should be applied as soon as possible after cleaning.

**CAUTION**

Careless workmanship, especially during flux applications, can result in corrosion of the tube long after the system has been installed. If excessive flux is used, the residue inside the tube can cause corrosion. In an extreme case, such residual flux can actually lead to perforation through the tube wall causing leakage. To guard against this danger, it is important (1) to choose a flux that is not too corrosive, and (2) to use only the minimum amount actually needed to make the joint.

2.3.5 **Solder Joints.** Soldering and brazing both involve basic steps, which must be executed with care and craftsmanship. The steps are:

(1) Measuring
(2) Cutting
(3) Reaming
(4) Cleaning
(5) Fluxing
(6) Assembly and support
(7) Heating
(8) Applying the filler metal
(9) Cooling and cleaning

Each step contributes to a strong, dependable joint.

2.3.5.1 **Measuring.** Measuring the length of each tube segment must be accurate. Inaccuracy can compromise joint quality. If the tube is too short it will not reach all the way into the socket of the fitting and a proper joint cannot be made. If the tube segment is too long, there is danger of cocking the tube in the fitting and putting strain on the system which could affect service life.

2.3.5.2 **Cutting.** Once the tube is measured it can be cut. Cutting can be accomplished in a number of different ways to produce a satisfactory square end. The tube can be cut with a disc-type tube cutter, a hacksaw, an abrasive wheel, or with a stationary or portable bandsaw. Care must be taken that the tube is not deformed while being cut. Regardless of method, the cut must be square with the run of the tube so that the tube will seat properly in the fitting socket.

2.3.5.3 **Reaming.** All pipe and tube shall be reamed to the full I.D. of the pipe and tube.

Tools used to ream tube ends include the reaming blade on the tube cutter, half-round or round files, a pocket knife, and a suitable deburring tool. With annealed tube, care must be taken not to deform the tube end by applying too much pressure. Both the inside and the outside of the tube may require removal of the burr.

2.3.5.4 **Cleaning.** The removal of oxides and surface soil is crucial if filler metal is to flow properly into the joint. Unremoved oxide, surface soil, and oil can interfere with the strength of the joint and cause failure.

Mechanical cleaning is a simple operation. The end of the tube should be abraded lightly using sand cloth or nylon abrasive pads for a distance only slightly more than the depth of the fitting socket. The socket of the fitting should also be cleaned using sand cloth, abrasive pads, or a properly sized fitting brush.

Copper is a relatively soft metal. If too much material is removed, a loose fit will result and interfere with satisfactory capillary action in making the joint. The capillary space between the tube and fitting is approximately 0.004 inch (0.1 mm). Solder or brazing filler metal can fill this gap by capillary action. This spacing is critical for the filler metal to flow into the gap and form a strong joint.

Surfaces, once cleaned, should not be touched with bare hands or oily gloves. Skin oils, lubricating oils, and grease impair solder flow and wetting.

2.3.5.5 **Fluxing.** Stir the flux before use. A good flux will dissolve and remove traces of oxide from the cleaned surfaces to be joined, protect the cleaned surfaces from reoxidation during heating and promote wetting of the surfaces by the solder. A thin, even coating of flux should be applied with a brush to both tube and fitting. Do not apply with fingers. Chemicals in the flux can be harmful if carried to the eyes or open cuts.

2.3.5.6 **Assembly and Support.** After both tube and fitting surfaces are properly fluxed, they should be assembled, making sure the tube seats against the base of the fitting socket. A slight twisting motion ensures even distribution by the flux. Remove excess flux. Care must be taken to assure that the tube and fittings are properly supported with a uniform capillary space around the entire circumference of the joint. Uniformity of capillary space will ensure good filler metal penetration if the guidelines of successful joint making are followed. Excessive joint clearance can cause the filler metal to crack under stress or vibration.

The joint is now ready for soldering. Joints prepared and ready for soldering should be completed the same day and not left unfinished overnight.

2.3.5.7 **Heating.** Because an open flame may be used for soldering, and because flammable gases are used, safety precautions must be observed. The heat is generally applied using an air/fuel torch. Such torches use acetylene or an LP gas. Electric resistance tools can also be used.

Heating should begin with the flame perpendicular to the tube. The copper tube conducts the initial heat into the fitting socket for even distribution of heat inside and out. The extent of this preheating depends upon the size of the joint. Experience will indicate the amount of time needed. The flame should now be moved onto the fitting. Then move the flame from the

fitting socket back onto the tube a distance equal to the depth of the fitting socket. Touch the solder to the joint. If the solder does not melt, remove it and continue the heating process. Be careful not to overheat or to direct the flame into the fitting cup. This could cause the flux to burn and destroy its effectiveness. When the melting temperature of the solder has been reached, heat may be applied to the base of the cup to aid capillary action in drawing the solder into the cup.

2.3.5.8 **Applying the Filler Metal.** For tube in a horizontal position, start applying the solder slightly off-center at the bottom of the joint. Proceed across the bottom of the fitting and up to the top center position. Return to the point of beginning, overlap the starting point, and then proceed up the incompleted side to the top, again, overlapping the solder.

For joints in the vertical position, a similar sequence of overlapping passes should be made, starting wherever is convenient. Molten solder will be drawn into the joint by capillary action regardless of whether the solder is being fed upward, downward, or horizontally.

2.3.5.9 **Cooling and Cleaning.** After the joint has been completed, natural cooling is best. Shock cooling with water may cause unnecessary stress on the joint and result in eventual failure. When cool, clean off any remaining flux with a wet rag.

2.3.6 **Brazed Joints.** Brazing is the second most commonly used method for joining copper tube. Making brazed joints is similar to making soldered joints with respect to measuring, cutting, reaming, cleaning, assembly and support. And as in soldering, the brazing filler metal is melted by the heat of the tube and fitting and drawn into the joint by capillary action. [UPC 605.3.1]

The major differences between soldering and brazing are the:

- Type of flux used,
- Composition of filler metal, and
- Amount of heat required to melt the filler metal.

2.3.6.1 **Brazing Flux.** The fluxes used for brazing copper joints are different in composition from soldering fluxes. The two types cannot be used interchangeably. Brazing fluxes are water based, whereas most soldering fluxes are petroleum based. Similar to soldering fluxes, brazing fluxes dissolve and remove residual oxide from the metal surface, protect the metal from reoxidation during heating and promote wetting of the surfaces to be joined by the brazing filler metal.

Fluxes also provide the draftsman with an indication of temperature. Application of the flux is the same as when soldering. If the outside of the fitting and the heat-affected area of the tube are covered with flux (in addition to the end of the tube and the cup), oxidation will be prevented and the appearance of the joint will be greatly improved.

2.3.6.2 **Brazing Filler Metals.** There are two general types of brazing filler metal used for joining copper tube. Classified according to their components, they are: BCuP (Brazing-Copper-Phosphorous) and BAg (Brazing-Silver).

BCuP filler metals are preferred for joining copper tube and fittings. The phosphorous in them acts as a fluxing agent and the lower percentage of silver makes them relatively low cost. When using copper tube, wrought copper fittings, and BCuP brazing filler metal, fluxing is optional. However, when cast fittings are brazed, flux must be used.

2.3.6.3 **Heating.** Oxy/fuel torches are generally used for brazing because of the higher temperatures required.

Recent innovations in tip design make air/fuel torches useful on a wider range of sizes for brazing.

When working at brazing temperatures, safety precautions must be followed and care taken to protect both the operator and the materials being used.

The heating operation is the same as for soldering. First preheat the tube and then the tube and fitting. When the filler metal starts to melt, apply heat at the base of the fitting socket to help draw the brazing filler metal in by capillary action.

2.3.6.4 **Applying Brazing Filler Metal.** Remember to allow the heat of the joint, not the flame, to melt the filler metal. The melted filler metal will be drawn into the joint by capillary action. It is very important that the flame be in continuous motion. It must not be allowed to remain on any one point long enough to burn through the tube or fitting.

If the filler metal fails to flow, or has the tendency to ball-up, it indicates either that there is oxide on the surfaces being joined or that the parts to be joined are not hot enough. If the filler metal refuses to enter the joint, the fitting cup is not hot enough. If it tends to flow over the outside of either part of the joint it indicates that part is overheated. When the joint is completed, a continuous fillet should be visible completely around the joint.

Large diameter tube is more difficult to heat to the desired temperature. The use of a heating

tip or rosebud may be necessary to maintain the proper temperature over the area being brazed. Once total heat control is attained, follow the same procedures used for smaller tube.

2.3.6.5 **Cooling and Cleaning.** When the brazed joint is finished, allow it to cool naturally. Flux residues and some oxides formed by heating can be removed by washing with hot water and brushing with a stainless steel wire brush.

2.3.7 **Flared Joints.**

2.3.7.1 **Flared Joints with Impact Flaring Tools:**

Step 1 Cut the tube to the required length.

Step 2 Remove all burrs. This is very important to assure metal-to-metal contact.

Step 3 Slip the coupling nut over the end of the tube.

Step 4 Insert flaring tool into the tube end.

Step 5 Drive the flaring tool by hammer strokes, expanding the end of the tube to the desired flare. This requires a few moderately light strokes.

Step 6 Assemble the joint by placing the fitting squarely against the flare. Engage the coupling nut with the fitting threads. Tighten with two wrenches, one on the nut and one on the fitting. [UPC 605.3.2]

2.3.7.2 **Flared Joints with Screw-Type Flaring Tools:**

Steps 1-3 Same as for impact flaring previously described.

Step 4 Clamp the tube in the flaring block so that the end of the tube is slightly above the face of the block.

Step 5 Place the yoke of the flaring tool on the block so that the beveled end of the compressor cone is over the tube end.

Step 6 Turn the compressor screw down firmly, forming the flare between the chamber in the flaring block and the beveled compressor cone.

Step 7 Remove the flaring tool. The joint can now be assembled as in Step 6 for impact flaring. [UPC 605.3.2]

2.4 **Sizing.**

2.4.1 **Velocity.**

**Note:** There are various hydraulic formulas for the flow of water in pipe. With high velocity and attendant turbulent flow, there can be excessive noise and piping wear.

The designer should aim for maximum flow velocities in the range of 5 to 8 feet per second (1.5 – 2.4 meters per second) to minimize noise and erosion problems. For the smallest tube sizes, the designer is wise to work at the bottom of this range, as a maximum, to guard against local high velocities building up due to faulty workmanship (e.g. burrs at tube ends which are not properly reamed) or unusually numerous changes in flow direction.

3.0 **General Information.**

3.1 It is not possible to cover all the variables of a plumbing system; however, the following information may prove helpful:

3.2 **Expansion Loops** – Copper tube, like all piping materials, expands and contracts with temperature changes. Therefore, in a copper tube system subjected to excessive temperature changes, the line tends to buckle or bend when it expands unless compensation is built into the system. Severe stresses on the joints may also occur. Such stresses, buckles, or bends are prevented by the use of expansion joints or by installing offsets, "U" bends, coil loops, or similar arrangements in the tube assembly. These specially shaped tube segments take up expansion and contraction without excessive stress. The expansion of a length of copper tube may be calculated from the formula:

Temperature Rise (°F) x length (feet) x 12 (inches per foot) x Expansion Coefficient (inch per inch per °F) = Expansion (inches), or

Temperature Rise (°C) x Length (meter) x 1000 (mm per meter) x Expansion Coefficient (mm per mm per °C) = Expansion (mm).

Calculations for expansion and contraction should be based on the average coefficient of expansion of copper which is 0.0000094 per degree F (1.692 x 10-5 per degree C), between 70°F and 212°F (21°C and 100°C). For example, the expansion of each 100 feet (30.5 meters) of length of any size tube heated from room temperature (70°F) to 170°F (a 100°F (55.6°C) rise) is 1.128 inches (28.7 mm).

100°F x 100 feet x 12 inch/foot x 0.0000094 inch/inch/°F = 1.128 inch, or

55.6°C x 30.48 mm x 1000 mm/m x 1.692 x 10-5 mm/mm/°C = 28.7 mm

3.3 **Tube Supports** – See Section 313.0 and Table 313.1 of the Uniform Plumbing Code.

3.4 **Bending** – Copper tube, properly bent, will not collapse on the outside of the bend and will not buckle on the inside of the bend. Tests demonstrate that the bursting strength of a bent copper tube can be greater than it was before bending. Because copper is readily formed, expansion loops and other bends necessary in an assembly are quickly and simply made if the proper method and equipment are used. Simple hand tools employing mandrels, dies, forms, and fillers, or power-operated bending machines, are used.

3.4.1 Both annealed tube and bending-temper tube can be bent with hand benders. The proper size bender for each size tube must be used. Usually the size of the tool corresponds to the nominal outside diameter of the tube, not the standard tube size. For a guide to the typical bend radii, see the following bending guide for copper tube.

**ADOPTED: 1980**
**REVISED: 1989, 2003, 2006**

## BENDING GUIDE FOR COPPER TUBE

| Tube Size | | TUBE TYPE | TEMPER | MINIMUM BEND RADIUS | | TYPE OF BENDING EQUIPMENT |
|---|---|---|---|---|---|---|
| In. | (mm) | | | In. | (mm) | |
| ¼ | (6.4) | K, L | Annealed | ¾ | (19.1) | Lever type |
| ⅜ | (9.5) | K, L | Annealed | 1½ | (38) | Lever or gear type |
| | | | | 3 | (76) | None; by hand* |
| | | K, L, M | Drawn | 1¾ | (45) | Gear Type |
| ½ | (12.7) | K, L | Annealed | 2¼ | (57) | Lever or gear type |
| | | | | 4½ | (114) | None; by hand* |
| | | K, L, M | Drawn | 2½ | (64) | Gear type |
| ¾ | (19.1) | K, L | Annealed | 3 | (76) | Lever of gear type |
| | | K | | 4½ | (114) | None; by hand* |
| | | L | | 6 | (152) | None; by hand* |
| | | K | Drawn | 3 | (76) | Gear type |
| | | K, L | | 4 | (102) | Heavy-duty gear type |
| 1 | (25.4) | K, L | Annealed | 4 | (102) | Gear type |
| | | | | 7½ | (191) | None; by hand* |
| 1¼ | (31.8) | K, L | Annealed | 9 | (229) | None; by hand* |

* When bending by hand, without the use of bending equipment, a circular wooden disc is used. The radius of the disc should be about ¼ to ½ inch (6.4 to 12.7 mm) less than the minimum bend radius shown.

# INSTALLATION STANDARD FOR TRENCHLESS INSERTION OF POLYETHYLENE (PE) PIPE FOR SEWER LATERALS

# IAPMO IS 26-2006

**1.0 Scope.**

**1.1** This standard shall govern the Trenchless Installation of Polyethylene (PE) pipe for use in sanitary and storm sewers. The installed pipe shall comply with the requirements of the Uniform Plumbing Code (UPC)™ published by the International Association of Plumbing and Mechanical Officials (IAPMO) as to grade and connections to existing pipe and shall also comply with this standard.

**Note:** The following sections of the Uniform Plumbing Code apply.

| | |
|---|---|
| 103.5.6 | Testing of Systems |
| 103.5.7.2 | Responsibility |
| 103.5.8 | Other Inspections |
| 103.5.8.1 | Defective Systems |
| 103.6.1 | Other Connections |
| 218.0 | Definition of PE |
| 301.1 | Minimum Standards |
| 309.0 | Workmanship |
| 312.0 | Protection of Piping, Materials, and Structures |
| 314.0 | Trenching, Excavation, and Backfill |
| Chapter 7 | Sanitary Drainage |
| 701.2 | Drainage Fittings |
| 705.11.3 | Plastic Pipe to Other Materials |

**Abbreviations.**

| | |
|---|---|
| ASTM | American Society for Testing Materials |
| IAPMO | International Association of Plumbing and Mechanical Officials |
| UPC | Uniform Plumbing Code |

**2.0 Product Requirements.**

**2.1 Minimum Standards.**

**2.1.1 Materials.**

Materials shall comply with the following: The polyethylene pipe used is covered by the ASTM standards listed later in this standard. [UPC 301.1]

**Materials.**

HDPE Extra High Molecular Weight 3408 SDR 17 Pipe Socket-Type PE Fittings for Outside Diameter-Controlled Polyethylene Pipe

**Note:** The HDPE 3408 SDR 17 pipe used in this process was selected because of its ability to retain its circular shape even when bent on a 4-foot radius during and after installation.

**2.1.2 Table 1401.1 Standards.**

ASTM D 2239
ASTM D 2447
ASTM D 2657
ASTM D 2683
ASTM D 3261
ASTM F 714
ASTM F 894
IAPMO PS 25

**2.2 Protection of Pipe.**

**2.2.1 Storage and Handling.** Pipe shall be stored in a way to protect it from mechanical damage (slitting, puncturing, etc.). It shall be stored under cover to keep it clean and avoid long term exposure to sunlight. Exposure to sunlight during normal construction periods is not harmful.

**2.3 Types of Joints.** PE joints shall be made as follows:

**2.3.1 Molded Rubber Coupling Joints.** Molded rubber coupling joints shall be installed in accordance with Appendix I of the UPC and with Section 705.0.

**2.3.2 Shielded Coupling Joints.** Shielded coupling joints shall be installed in accordance with Appendix I of the UPC and with Section 705.4.2.

**2.3.4 Hubless Cast Iron Pipe Joints.** Hubless cast iron pipe joints shall be installed in accordance with Appendix I of the UPC and with Section 705.4.2.

**2.3.5 Heat Fusion Joints.** Heat fusion joints shall be made according to the manufacturer's procedure, installation instructions, and either ASTM D 2659 or ASTM D 3261.

2.4 **Trenchless Installation of sewers will be as follows:**

**I. Preliminary Steps.**

Inspect the inside of the sewer line using a television camera and video tape recorder to ascertain the line condition. Mark the details revealed by the video inspection including:

1. The ground surface to show the location of the lateral tie of the city wye.
2. The line location with an arrow in the street pointing back at the lateral.
3. The property denoting the lateral location.
4. The locations of the proposed excavations.

Obtain utility line identification service contact information and all applicable permits.

**II. Excavation.**

In addition to the above markings, the local utility companies will mark utilities. Considerations are soil density; clearance from obstacles, utilities, and structures; location of bends; and water service locations. Excavations and shoring shall be in accordance with jurisdictional safety requirements.

**III. Set Up.**

Fuse the proper length of polyethylene pipe in accordance with ASTM D 2657 and fuse the end to a small length that is attached to the pulling head. A rod pusher cable is pushed through the damaged host pipe and attached to the pulling cable, which is then drawn through the pipe. The clevis end of the cable is attached to the pulling head. The pulling equipment is then set up according to the manufacturers instructions.

**IV. Pulling.**

Pull the pulling head through. Once the pull is done, complete the connection to the existing piping.

2.5 **Cleanouts.** Cleanouts shall be installed in accordance with UPC Section 707.0.

2.6 **Inspections.** The completed piping shall be internally inspected by television camera unless waived by the Administrative Authority. [UPC 103.5]

2.7 **Testing.** Completed piping shall be subjected to testing in accordance with Section 712.0 or 723.0 of the UPC.

**ADOPTED: 1999**
**REVISED: 2002, 2003, 2006**

# INSTALLATION STANDARD
# FOR ODOR CONTROL SYSTEMS FOR WATER CLOSETS

# IAPMO IS 27-2003

**1.0 Scope.**

**1.1** This standard shall govern the installation of Odor Control Systems for Water Closets. Installation, material and inspection shall comply with the requirements of the Uniform Plumbing Code (UPC)™ published by the International Association of Plumbing and Mechanical Officials (IAPMO) and this standard.

**Note:** The Building Official shall be consulted about penetration of fire separations, height and area or other limitations.

**Note:** The following sections of the Uniform Plumbing Code apply to Odor Control Systems for Water Closets.

| | |
|---|---|
| 103.5 | Inspections |
| Chapter 2 | Definitions |
| 301.1 | Minimum Standards |
| 309.0 | Workmanship |
| 310.0 | Prohibited Fittings and Practices |
| 310.5 | Obstruction of Flow |
| 310.8 | Screwed Fittings |
| 312.0 | Protection of Piping, Materials, and Structures |
| 313.0 | Hangers and Supports |
| 316.0 | Increasers and Reducers |
| Chapter 7 | Sanitary Drainage |
| 701.0 | Materials (drainage) |
| 701.2 | Drainage Fittings |
| 705.0 | Joints and Connections |
| 903.0 | Materials (venting) |
| 1101.3 | Material Uses |

Table 1401.1 Referenced Standards

| | |
|---|---|
| ASME B 16.23 | Cast Bronze Solder-Joint Drainage Fittings - DWV |
| ASME B 16.29 | Wrought Copper and Copper Alloy Solder-Joint Drainage Fittings |
| ASTM A 74 | Cast Iron Soil Pipe and Fittings |
| ASTM A 888 | Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications |
| ASTM B 42 | Specification for Seamless Copper Pipe, Standard Sizes |
| ASTM B 302 | Specification for Threadless Copper Pipe, Standard Sizes |
| ASTM B 306 | Specification for Copper Drainage Tube (DWV) |
| ASTM B 828 | Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings |
| ASTM D 2564 | Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems |
| ASTM D 2661 | Acrylonitrile-Butadiene-Styrene (ABS) Sch. 40 Plastic Drain, Waste and Vent Pipe and Fittings |
| ASTM D 2665 | Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings |
| ASTM D 3311 | Drain, Waste, and Vent (DWV) Plastic Fitting Patterns (note: although referenced in this standard, some of the fittings shown in the standard are not acceptable under the Uniform Plumbing Code.) |
| ASTM F 402 | Safe Handling of Solvent Cement, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings |
| ASTM F 628 | Acrylonitrile-Butadiene-Styrene (ABS) Sch. 40 Plastic Drain, Waste and Vent Pipe with a Cellular Core |
| ASTM F 656 | Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings |
| ASTM F 891 | Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core |
| CISPI 301 | Hubless Cast iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications |
| IAPMO IS 3 | Copper Plumbing Tube, Pipe and Fittings |
| IAPMO IS 5 | ABS Building Drain, Waste and Vent Pipe and Fittings |
| IAPMO IS 6 | Hubless Cast Iron Sanitary and Rainwater Systems |
| IAPMO IS 9 | PVC Building Drain, Waste and Vent Pipe and Fittings |
| UL 1004 | Electric Motors |

**2.0 Product Requirements.**

**2.1 Minimum Standards.**

**2.1.1** **Materials.** All materials shall comply with the appropriate standards in Table 1401.1 of the UPC.

**2.1.2** All pipe and fittings shall be made from approved DWV materials and shall be installed in accordance with the requirements of Chapter 7 of the Uniform Plumbing Code entitled, Sanitary Drainage. In addition, all pipe and fittings shall be installed in accordance with the applicable IAPMO Installation Standard. [UPC 701.0]

**2.2 Odor Control System Components.**

**2.2.1** **Inlet Connection** – The inlet for DWV odor control systems shall be connected at the tailpiece of the flushometer operated water closet using a listed tee. The tee shall immediately transition to the odor control riser using approved DWV pipe and fittings.

**2.2.2** **Riser** – The odor control riser shall be made from listed DWV pipe no smaller than 2½ inch diameter. This minimum riser size was selected to adequately handle the required minimum odor control air flow rate. The riser height shall be a minimum of 6 feet as measured from the connection at the sanitary tee to the overhead connection at the odor control manifold. The minimum riser height was selected to adequately handle the maximum possible water rise generated during the flushometer flushing cycle.

**2.2.3** **Manifold** – The odor control manifold, including all horizontal piping within the odor control system, shall be ⅛" per foot horizontally sloped back to the last riser. The manifold shall be made from approved DWV material no smaller than the pipe size as determined by using Table 1 of this Installation Standard. No traps are permitted within the odor control piping system.

**Note:** The attached Figures 1 and 2 illustrate the basic configuration to be used for the design of any Odor Control System installed in accordance with this Installation Standard.

**2.3 System Sizing.**

**2.3.1** **Minimum Inlet Flow Rate** – The odor control system shall provide a minimum average air flow rate of 5 cfm at each inlet connection (tee).

**2.3.2** **Minimum Inlet Draft** – The odor control system shall provide a minimum average draft of ¼ inch WC (water column) as measured inside the inlet connection (tee), or a minimum of 0.10 inch of WC at the small perforations in the top rim of the water closet bowl.

**2.4 Exhaust Fan.**

**2.4.1** The exhaust fan shall be listed for installation in outdoor and wet locations and in conditioned air streams up to 140°F and shall comply with the applicable requirements of UL 1004.

**2.4.2** The odor control system exhaust fan shall be installed in accordance with local building and electrical code requirements and shall comply with drainage venting termination requirements of the Uniform Plumbing Code.

**2.5 System Testing.**

**2.5.1** Measure the suction pressure at any perforation of the water closet rim. The minimum reading should be 0.10 inch of water column.

**Note:** For conditions other than those covered in Table 1 the exhaust manifold and the main exhaust riser to the odor control system exhaust fan shall be sized to maintain an average air velocity of 300 ±50 feet per minute.

**ADOPTED: 2001**
**REVISED: 2003**

**TABLE 1**
**MAXIMUM ALLOWABLE NUMBER OF WATER CLOSETS CONNECTED TO AN EXHAUST MANIFOLD**

| Pipe Diameter (inch) | 2½ | 3 | 4 | 5 | 6 | 8 |
|---|---|---|---|---|---|---|
| Maximum No. of Water Closets | 2 | 3 | 6 | 8 | 10 | 22 |

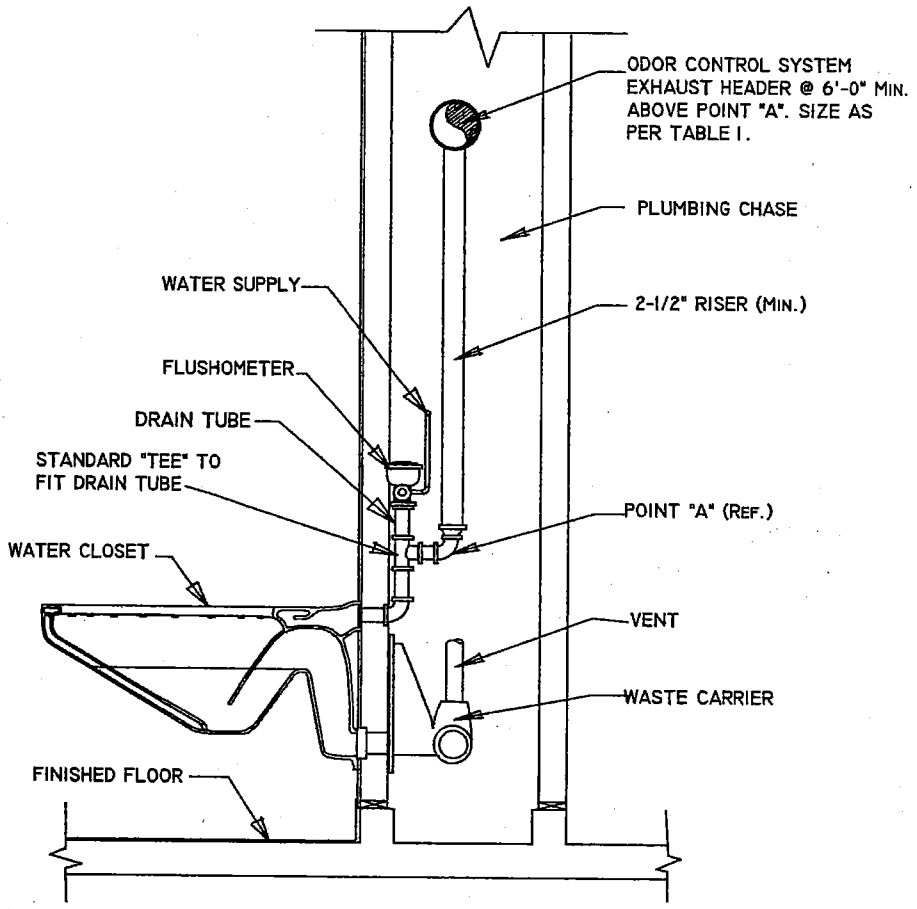



**FIGURE 1**

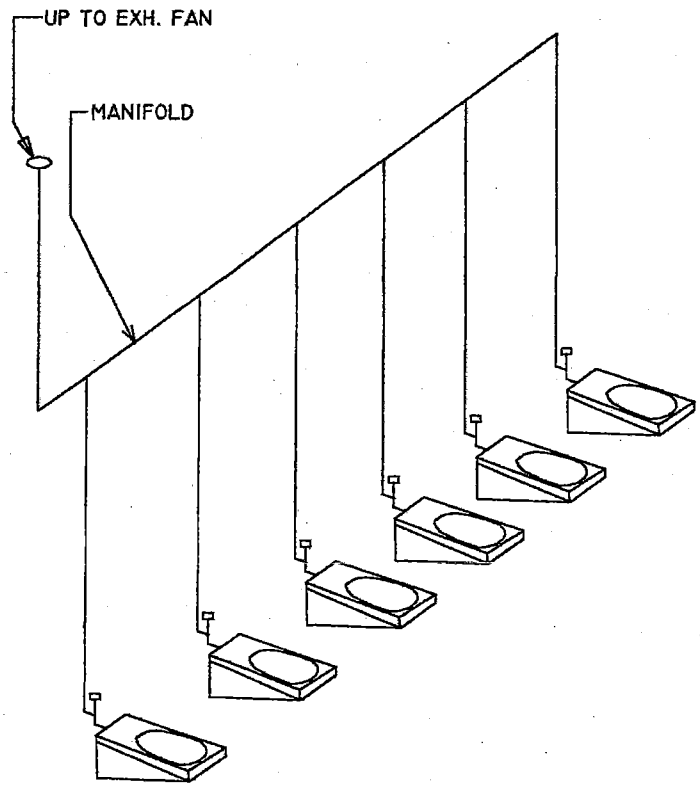



FIGURE 2

# INSTALLATION STANDARD FOR COMPOSITE PEX-AL-PEX HOT AND PE-AL-PE COLD WATER DISTRIBUTION SYSTEMS

# IS 28-2005

**1.0 Scope.**

**1.1** This standard shall govern the installation of composite piping in potable hot and cold water distribution systems within and under buildings and shall apply only to PEX-AL-PEX and PE-AL-PE piping meeting the requirements of ASTM F 1281 and ASTM F 1282 and fittings meeting the requirements of ASTM F 1974. Installation, materials, and inspection should comply with the current edition of the Uniform Plumbing Code published by the International Association of Plumbing and Mechanical Officials, and shall also comply with this standard and manufacturer's installation recommendations.

**Note:** The following sections of the Uniform Plumbing Code shall apply to composite PEX-AL-PEX and PE-AL-PE tubing.

| | |
|---|---|
| 309.0 | Workmanship |
| 312.0 | Protection of Piping, Materials, and Structures |
| Chapter 6 | Water Supply and Distribution |
| 605.0 | Joints and Connections |
| 605.17.2 | Plastic Pipe to Other Materials |
| Chapter 2* | Definitions. |
| ASTM | American Society for Testing and Materials |
| IAPMO | International Association of Plumbing and Mechanical Officials |
| PEX-AL-PEX | Crosslinked Polyethylene-Aluminum-Crosslinked Polyethylene |
| PE-AL-PE | Polyethylene Aluminum–Polyethylene |
| UPC | Uniform Plumbing Code as published by IAPMO |

* The first three numbers refer to the corresponding section of the UPC.

**2.0 Product Requirements.**

**2.1 Materials and Fittings.**

**2.1.1 Materials.** Materials shall comply with the following requirements:

| Materials | ASTM Standard |
|---|---|
| Crosslinked Polyethylene-Aluminum-Crosslinked Polyethylene (PEX-AL-PEX) | F 1281 |
| Polyethylene-Aluminum-Polyethylene (PE-AL-PE) | F 1282 |
| Metal Insert Fittings for PEX-AL-PEX and PE-AL-PE composite pipe | F 1974 |

**2.1.2 Piping.** PEX-AL-PEX composite pipe shall comply with ASTM F 1281. PE-AL PE composite pipe shall comply with ASTM F 1282.

**2.1.3 Fittings.** Fittings shall be metal insert type and shall comply with ASTM F 1974. Fittings are limited to the following types:

(a) Insert fittings or compression type fittings; and

(b) Special listed fittings of other types. Connections to galvanized pipe or fittings shall be specifically designed for that purpose.

**Note 1:** Manufacturers of fittings shall recommend assembly procedures.

**2.2 Markings.**

**2.2.1 Piping.** Composite piping shall be legibly marked at intervals of not more than 5 ft. (1.5 m) with at least the following:

(a) Manufacturer's name or trademark;

(b) ASTM F 1281(PEX-AL-PEX) or ASTM F 1282 (PE-AL-PE);

(c) Piping size;

(d) Material type – PEX-AL-PEX or PE-AL-PE;

(e) Pressure ratings for water and the temperature for which the temperature rating is valid;

(f) Mark of an acceptable certification agency; and

(g) Manufacturer's date and material code. [UPC 301.1.1]

The elevated temperature and pressure ratings for PEX-AL-PEX and PE-AL-PE in accordance with ASTM F 1281 and ASTM F 1282 are:

| | | |
|---|---|---|
| PEX-AL-PEX (orange colored) | 200 psi | 125 psi |
| | at 73° | at 180°F |
| PE-AL-PE (blue colored) | 200 psi | 100 psi |
| | at 73°F | at 180°F |

2.2.2 **Fittings.** Fittings shall be marked with at least the following:

(a) Manufacturer's name or trademark or other acceptable markings; and

(b) The mark of an acceptable certification agency; and

(c) If size permits, ASTM F 1974. [UPC 301.1.1]

2.2.3 **Position of Markings.** When practical, markings shall be visible for inspection. Markings shall be visible prior to installation.

2.3 **Protection of Piping.**

2.3.1 **Abrasion.** Piping passing through metallic studs, joists, or hollow masonry walls shall be protected from abrasion or sharp edges by elastomeric or plastic sleeves, grommets, conical shaped punch holes or other approved means.

2.3.2 **Puncture.** Steel plate protection, minimum 18 gauge, shall be installed when the tubing is within 1 in. (25 mm) of the nailing surface. [UPC 312.9]

2.4 **Exposed Piping.**

2.4.1 **General** – Where exposed tubing may be subjected to mechanical damage it must be protected.

2.4.2 **Freezing.** In areas where the system must be drained to protect the system from freezing, horizontal lines shall be graded to drain.

2.4.3 **Storage.** Piping shall be stored in a way to protect the system from mechanical damage (slitting, puncturing, etc.). Piping should be stored undercover to keep it clean and avoid long term exposure to sunlight. Consult piping manufacturer for recommended limits for outside storage.

2.5 **Thermal Expansion.**

2.5.1 **General.** The linear expansion rate for PEX-AL-PEX and PE-AL-PE is 1.56 in. (39.6 mm) per 100 ft. (30 m) of tube per 100°F (55°C) change in temperature. No accommodation for thermal expansion is required.

2.5.2 **Clearance.** Bored holes and sleeves shall provide adequate clearance between the piping and structure to allow for free longitudinal movement.

2.6 **Hangers and Supports.**

2.6.1 **Vertical Piping.** Vertical piping shall be supported at every floor. Piping shall have a mid-story guide.

2.6.2 **Horizontal Piping.** Horizontal piping shall be supported according to the following Table 1.

**TABLE 1**
**SUPPORT SPACING**

| NOMINAL DIAMETER | SPACING |
|---|---|
| ½", ¾", and 1" | 8' 2" (2489 mm) |

2.6.3 **Hangers and Anchors.** Piping shall not be anchored rigidly to a support, but shall be secured with hangers or straps that provide for a degree of movement and that prevent damage to the tubing. Do not use hangers or straps with sharp or abrasive edges. Do not use hangers that pinch the piping. [UPC 313.0]

2.7 **Inspection and Testing.**

**A. Inspection.** All tubing shall be properly seated on to the fitting per the manufacturer's instructions. For crimp fittings, each crimped joint shall be checked. Buckled, gouged, or obviously damaged pipe shall not be used. Consult manufacturer's recommendations for repair procedures.

**B. Testing.** Upon completion of a section or of the entire hot and cold water supply system it shall be tested and proved tight under a water pressure or air test not less than the working pressure under which it is to be used. The water used for tests shall be obtained from a potable source. The system shall withstand the test without leaking for a period of not less than fifteen (15) minutes.

2.8 **Joints and Connections.**

2.8.1 **Procedure.** Piping should be cut with a pipe cutter designed specifically for composite pipe. Piping shall be cut square, i.e. perpendicular to the length. No other cutting methods shall be used and care must be taken to remove any excess material, flashing, or burrs.

2.8.2 **Tools.** Fitting manufacturer's recommended tool shall be used with the composite insert fitting systems. For specific procedures, follow the manufacturer's recommendations.

2.8.3 **Transition Joints.**

2.8.3.1 **Fittings.** Transitions for composite tubing to metal piping or valves shall be made only with transition fittings intended for that purpose.

2.8.4 **Joints.** Joints shall not be allowed in piping installed in or under a concrete slab resting on grade unless for repair within a building structure. All repair joints must be properly protected with a heat shrink sleeve. All slab penetrations shall be sleeved.

2.9 **Pressure Relief Valves.**

2.9.1 **PEX–AL–PEX Piping.** PEX-AL-PEX piping used for temperature and/or pressure relief valve drain lines shall be graded to the outlet end and shall be supported at a maximum of 8 ft. 2 in. (2,489 mm) interval horizontally. Vertical piping shall be supported at every floor. Vertical piping shall have a mid-story guide.

2.10 **Installation.**

2.10.1 **Bends.** Piping shall be installed by bending the composite pipe by hand to a minimum radius of 5 times the nominal pipe diameter. External bend supports or sleeves are not required as the composite piping is rigid after bending.

2.10.2 **Damage.** Kinked, buckled, gouged, or other obvious damaged pipe shall not be used.

2.10.3 **Finish Nipples.** Finish nipples shall be connected to drop ear fittings to prevent rotation. Finish nipples shall not be PEX.

2.10.4 **Hose Bibs.** The piping directly connected to any hose bib shall be so anchored that the load on the hose bib will not strain the composite piping.

2.10.5 **Heated Joints.** An open flame shall not be applied to PEX-AL-PEX or PE-AL-PE piping when brazing, soldering, or welding joints.

2.10.6 **Working Pressure and Temperature.** Long term working pressures for the PEX-AL-PEX shall not exceed a maximum of 125 psi (860 kPa) and the long term working temperature shall not exceed 180°F (82°C). Long term working pressures for the PE-AL-PE shall not exceed a maximum of 100 psi (690 kPa) and the long term working temperature shall not exceed 180°F (82°C).

2.10.7 **Exposure to Sunlight.** Only UV stabilized composite piping can be subjected to direct sunlight after installation and can be installed on the surface of the building. Composite pipe contains an ultraviolet (UV) inhibitor to withstand limited exposure to UV light. Manufacturer's recommends placing the unused portion of a coil back in the product's box rather than storing in the sunlight while not in use.

2.10.8 **Water Heater Connections.** PEX-AL-PEX or PE-AL-PE piping shall not be installed within the first eighteen inches (18) (457 mm) of piping connected to a water heater. [UPC 604.13]

2.10.9 **Water Hammer Arrestors.** A composite hot water system will withstand repeated pressure surges, well in excess of its rated pressure. The Uniform Plumbing Code requires a means of attenuating water hammer. Consequently, water hammer arrestors shall be required when solenoid valves or other quick closing devices are used in the system. In designing for such situations, it is advisable to consult the pipe or fittings manufacturer for recommended surge pressure limits. Water hammer and surge pressure calculations are reviewed in Chapter 7, AWWA Manual M-11. [UPC 609.10]

2.11 **Sizing.**

2.11.1 **Method.** Piping shall be sized in accordance with UPC Section 610.0.

When UPC Appendix A is applicable, use Table 2. Add equivalent lengths from Table 3 when determining developed length.

Maximum velocities through PEX-AL-PEX and PE-AL-PE copper alloy fittings shall be limited to eight (8) feet per second (fps) (2.4 mps) in cold water and five (5) feet per second (fps) (1.52 mps) in hot water. [UPC 610.0]

**TABLE 2**

| FLOW RATE U.S. GPM | ½" | | ¾" | | 1" | |
|---|---|---|---|---|---|---|
| | HEAD LOSS Psi/c.ft. | VELOCITY Ft./s | HEAD LOSS Psi/c.ft. | VELOCITY Ft./s | HEAD LOSS Psi/c.ft. | VELOCITY Ft./s |
| 0.1 | 0.02 | 0.2 | 0.002 | 0.07 | 0.001 | 0.04 |
| 0.2 | 0.1 | 0.4 | 0.01 | 0.1 | 0.002 | 0.08 |
| 0.3 | 0.2 | 0.6 | 0.02 | 0.2 | 0.005 | 0.1 |
| 0.4 | 0.3 | 0.7 | 0.03 | 0.3 | 0.009 | 0.2 |
| 0.5 | 0.5 | 0.9 | 0.04 | 0.3 | 0.01 | 0.2 |
| 0.6 | 0.6 | 1.1 | 0.05 | 0.4 | 0.02 | 0.3 |
| 0.7 | 0.9 | 1.3 | 0.07 | 0.5 | 0.02 | 0.3 |
| 0.8 | 1.1 | 1.5 | 0.09 | 0.5 | 0.03 | 0.3 |
| 0.9 | 1.4 | 1.7 | 0.1 | 0.6 | 0.04 | 04 |
| 1.0 | 1.6 | 1.8 | 0.1 | 0.7 | 0.05 | 0.4 |
| 2.0 | 5.9 | 3.7 | 0.5 | 1.3 | 0.2 | 0.9 |
| 3.0 | 12.5 | 5.5 | 1.0 | 2.0 | 0.4 | 1.3 |
| 4.0 | 21.3 | 7.3 | 1.8 | 2.6 | 0.6 | 1.7 |
| 5.0 | | | 2.7 | 3.3 | 0.9 | 2.1 |
| 6.0 | | | 3.8 | 4.0 | 1.3 | 2.5 |
| 7.0 | | | 5.0 | 4.6 | 1.7 | 3.0 |
| 8.0 | | | 6.4 | 5.3 | 2.2 | 3.4 |
| 9.0 | | | 8.0 | 5.9 | 2.7 | 3.8 |
| 10.0 | | | 9.7 | 6.6 | 3.3 | 4.2 |
| 11.0 | | | 11.6 | 7.2 | 3.9 | 4.6 |
| 12.0 | | | 13.6 | 7.9 | 4.6 | 5.0 |
| 13.0 | | | | | 5.3 | 5.5 |
| 14.0 | | | | | 6.1 | 5.9 |
| 15.0 | | | | | 6.9 | 6.3 |
| 16.0 | | | | | 7.8 | 6.3 |
| 17.0 | | | | | 8.7 | 6.7 |
| 18.0 | | | | | 9.7 | 7.1 |
| 19.0 | | | | | 10.7 | 7.6 |
| 20.0 | | | | | 11.8 | 8.0 |

**TABLE 3**
**DEVELOPED LENGTH**

| SIZES, inches | TYPE OF FITTINGS | EQUIVALENT LENGTH OF PIPE (feet) |
|---|---|---|
| ½ | Couplings | 2 |
| | Adapters | 2 |
| | Elbows | 7.5 |
| | Tees (Branch Flow) | 8 |
| | Tees (On the Run) | 2.5 |
| ¾ | Couplings | 2 |
| | Adapters | 2 |
| | Elbows | 8.5 |
| | Tees (Branch Flow) | 10.5 |
| | Tees (On the Run) | 2.5 |
| 1 | Couplings | 2 |
| | Adapters | 2 |
| | Elbows | 9 |
| | Tees (Branch Flow) | 11 |
| | Tees (On the Run) | 2.5 |

# INSTALLATION STANDARD
# FOR PE-RT HOT AND COLD WATER DISTRIBUTION SYSTEMS

# IAPMO IS 29-2010

**1.0 Scope.**

**1.1** This Standard shall govern the installation of tubing in potable hot and cold water distribution systems within and under buildings and shall apply only to Polyethylene of Raised Temperature (PE-RT) tubing meeting the requirements of ASTM F 2769 and fittings meeting the requirements of ASTM F 2159, F 2735, F 2769, F 2098, F 1807 or ASSE 1061. Installation, materials, and inspection should comply with the current edition of the Uniform Plumbing Code (UPC) published by the International Association of Plumbing and Mechanical Officials (IAPMO), and shall also comply with this standard and manufacturer's installation recommendations.

**Note:** The following sections of the Uniform Plumbing Code shall apply to composite PE-RT water distribution systems.

| | | |
|---|---|---|
| | 309.0 | Workmanship |
| | 312.0 | Protection of Piping, Materials, and Structures |
| | Chapter 6 | Water Supply and Distribution |
| | 605.9 | PE-RT |
| | 605.17.2 | Plastic Pipe to Other Materials |

| | |
|---|---|
| Chapter 2* | Definitions. |
| ASTM | American Society for Testing and Materials |
| IAPMO | International Association of Plumbing and Mechanical Officials |
| PE-RT | Polyethylene of Raised Temperature |
| UPC | Uniform Plumbing Code as published by IAPMO |

**2.0 Product Requirements.**

**2.1 Materials and Fittings.**

**2.1.1 Materials.** Materials shall comply with the following requirements:

| **Materials** | **ASTM Standard** |
|---|---|
| Polyethylene of Raised Temperature (PE-RT) | F 2769 |
| Insert Fittings for PE-RT | F 2159, F 2735, F1807, F 2769, F 2098 |
| Push-Fit Fittings | ASSE 1061 |

**2.1.2 Tubing.** PE-RT tubing shall comply with ASTM F 2769.

**2.1.3 Fittings.** Fittings shall be metal or plastic insert type complying with ASTM F 2159, F 2735, F 2769, F 2098 or F 1807 or push-fit type complying with ASSE 1061. Fittings are limited to the following types:

(a) Insert fittings or compression type fittings, or push-fit type fittings,

(b) Special listed fittings of other types.

- Connections to galvanized pipe or fittings shall be specifically designed for that purpose.

**Note 1:** Manufacturers of fittings shall recommend assembly procedures.

**2.2 Markings.**

**2.2.1 Tubing.** Tubing shall be legibly marked at intervals of not more than 5 ft. (1.5 m) with at least the following:

(a) Manufacturer's name or trademark;

(b) ASTM F 2769

(c) Nominal tubing size;

(d) Material type – PE-RT;

(e) Pressure ratings for water and the temperature for which the temperature rating is valid;

(f) Mark of an acceptable certification agency;

(g) Manufacturer's date and material code;

(h) Standard dimension ratio, SDR 9;

(i) Standard designation(s) of the fitting system(s) for which the tubing is recommended for use by the tubing manufacturer. [UPC 301.1.1]

The elevated temperature and pressure ratings for PE-RT in accordance with ASTM F 2769 are:

| | | |
|---|---|---|
| PE-RT | 160 psi at 73°F (1103 kPa at 23°C) | 100 psi at 180°F (690 kPa at 82°C) |

2.2.2 **Fittings.** Fittings shall be marked with at least the following:

(a) Manufacturer's name or trademark or other acceptable Markings; and

(b) The mark of an acceptable certification agency.

(c) If size permits, ASTM F 2769, F 2159, F 2735, F 1807, F 2098 or ASSE 1061 whichever is applicable. [UPC 301.1.1]

2.2.3 **Position of Markings.** When practical, markings shall be visible for inspection. Markings shall be visible prior to installation.

2.3 **Protection of Tubing.**

2.3.1 **Abrasion.** Tubing passing through metallic studs, joists, or hollow masonry walls shall be protected from abrasion or sharp edges by elastomeric or plastic sleeves, grommets, conical shaped punch holes or other approved means.

2.3.2 **Puncture.** Steel plate protection, minimum 18 gauge, shall be installed when the tubing is within 1" (25 mm) of the nailing surface. [UPC 312.9]

2.4 **Exposed Tubing.**

2.4.1 **General.** Where exposed tubing may be subjected to mechanical damage it must be protected.

2.4.2 **Freezing.** In areas where the system must be drained to protect the system from freezing, horizontal lines shall be graded to drain.

2.4.3 **Storage.** Tubing shall be stored in a way to protect the system from mechanical damage (slitting, puncturing, etc.). Tubing should be stored undercover to keep it clean and avoid long term exposure to sunlight. Tubing may be stored in coils of number size and length recommended by the manufacturer. Consult tubing manufacturer for recommended limits for outside storage.

2.5 **Thermal Expansion.**

2.5.1 **General.** The linear expansion rate for PE-RT is approximately 1.1 in. (28 mm) per 100 ft. (30 mm) of tube per 10°F (5.6°C) change in temperature. When installing long runs of tubing, allow $\frac{1}{8}$ to $\frac{3}{16}$ in. (10 to 14 mm) of run to accommodate thermal expansion. Tubing should not be anchored rigidly to support but allowed freedom of movement to expand and contract.

2.5.2 **Clearance.** Bored holes and sleeves shall provide adequate clearance between the piping and structure to allow for free longitudinal movement.

2.6 **Hangers and Supports.**

2.6.1 **Vertical Tubing.** Vertical tubing shall be supported at every floor. Tubing shall have a mid-story guide.

2.6.2 **Horizontal Tubing.** The maximum recommended spacing between horizontal supports is 32 in. (800 mm) for all sizes.

2.6.3 **Hangers and Anchors.** Tubing shall not be anchored rigidly to a support; but shall be secured with smooth plastic strap hangers, which permit ease of movement during expansion/contraction cycles. Do not use hangers or straps with sharp or abrasive edges. Do not use hangers that pinch the tubing. [UPC 313.0]

2.7 **Inspection and Testing.**

**A. Inspection.** All tubing shall be properly seated on to the fitting per the manufacturer instructions. For crimp fittings, each crimped joint shall be checked. Buckled, gouged or obviously damaged pipe shall not be used. Consult manufacturer recommendations for repair procedures.

**B. Testing.** Upon completion of a section or of the entire hot and cold water supply system it shall be tested and proved tight under a water pressure or air test not less than the working pressure under which it is to be used. The water used for tests shall be obtained from a potable source. The system shall withstand the test without leaking for a period of not less than fifteen (15) minutes.

2.8 **Joints and Connections.**

2.8.1 **Procedure.** Tubing should be cut with a tube cutter designed specifically for tubing. Tubing shall be cut square, i.e. perpendicular to the length. No other cutting methods shall be used and care must be taken to remove any excess material, flashing, or burrs.

2.8.2 **Tools.** Fitting manufacturer's recommended tool shall be used with the insert fitting systems. For specific procedures, follow the manufacturer's recommendations.

2.8.3 **Transition Joints.**

2.8.3.1 **Fittings.** Transitions for tubing to metal piping or valves shall be made only with transition fittings intended for that purpose.

2.8.4 **Joints.** Joints shall not be allowed in tubing installed in or under a concrete slab resting on grade unless for repair within a building structure. All repair joints must be properly

protected with a heat shrink sleeve. All slab penetrations shall be sleeved.

**2.9 Pressure Relief Valves.**

**2.9.1 PE-RT Tubing.** PE-RT tubing used for temperature and/or pressure relief valve drain lines shall be graded to the outlet end and shall be supported at a maximum of 32 in. (800 mm) interval horizontally. Vertical tubing shall be supported at every floor. Vertical tubing shall have a mid-story guide.

**2.10 Installation.**

**2.10.1 Bends.** Tubing shall be bent at room temperature hand to a minimum radius of 6 times the outside diameter. Outside diameter is equal to nominal diameter plus 1/8 in. (3 mm). Nominal precaution is taken to avoid buckling or flatting. Fix the tubing by supports on both sides of the bend at installation.

**2.10.2 Damage.** Kinked, buckled, gouged, or other obvious damaged pipe shall not be used.

**2.10.3 Finish Nipples.** Finish nipples shall be connected to drop ear fittings to prevent rotation. Finish nipples shall not be PEX.

**2.10.4 Hose Bibs.** The piping directly connected to any hose bib shall be so anchored that the load on the hose bib will not strain the composite piping.

**2.10.5 Heated Joints.** An open flame shall not be applied to PE-RT tubing when brazing, soldering or welding joints.

**2.10.6 Working Pressure and Temperature.** Long term working pressures for the PE-RT shall not exceed a maximum of 100 psi (690 kPa) and the long term working temperature shall not exceed 180°F (82°C).

**2.10.7 Exposure to Sunlight.** Only UV stabilized composite piping can be subjected to direct sunlight after installation and can be installed on the surface of the building. Composite pipe contains an ultraviolet (UV) inhibitor to withstand limited exposure to UV light. Manufacturer recommends placing the unused portion of a coil back in the product's box rather than storing in the sunlight while not in use.

**2.10.8 Water Heater Connections.** Components may not be suitable for use with the instantaneous type (coil or immersion) water heater. Components are suitable for use with storage type water heaters with connections made in an approved manner.

**2.10.9 Water Hammer Arrestors.** A composite hot water system will withstand repeated pressure surges, well in excess of its rated pressure. The Uniform Plumbing Code requires a means of attenuating water hammer. Consequently water hammer arrestors shall be required when solenoid valves or other quick closing devices are used in the system. In designing for such situations, it is advisable to consult the pipe or fittings manufacturer for recommended surge pressure limits. Water hammer and surge pressure calculations are reviewed in Chapter 7, AWWA Manual M-11. [UPC 609.10]

**2.11 Sizing.**

**2.11.1 Method.** Tubing shall be sized in accordance with UPC Section 610.0. Maximum velocities through PE-RT copper alloy fittings shall be limited to eight (8) feet per second (fps) (2.4 mps) in cold water and five (5) feet per second (fps) (1.52 mps) in hot water. [UPC 610.0]

# INSTALLATION STANDARD FOR FLEXIBLE PVC HOSE

# IAPMO SIS 1-2003

This standard shall govern the installation of Flexible PVC Hose (with solvent cemented joints) in Pools, Hot Tubs, Spas and Jetted Bathtubs.

Installation, material and inspection shall comply with the current edition of the Uniform Swimming Pool Code and Uniform Plumbing Code published by the International Association of Plumbing and Mechanical Officials, and shall also comply with this Standard.

**Note:** The following sections of the Uniform Swimming Pool Code and Uniform Plumbing Code apply to Flexible PVC Hose.

**USPC**

| | |
|---|---|
| 201.0 | Definitions |
| 303.0 | Water Supply and Circulating System Pipe and Fitting Materials |
| 304.0 | Water Supply and Circulating System Pipe Joints and Connections |
| 311.0 | Tests and Test Gauges |
| Table 1001.1 | Referenced Standards |

**UPC**

| | |
|---|---|
| 218. 0 | Definition of PVC |
| 309.0 | Workmanship |
| 312.0 | Protection of Piping, Materials, and Structures |
| 314.0 | Trenching, Excavation, and Backfill |
| Table 1401.1 | Referenced Standards |

**Abbreviations.**

| | |
|---|---|
| ASTM | American Society for Testing and Materials |
| IAPMO | International Association of Plumbing and Mechanical Officials |
| UPC | Uniform Plumbing Code |
| USPC | Uniform Swimming Pool, [Spa and Hot Tub] Code |

**1.0 Minimum Standards.**

**1.1 Material.** Materials shall perform to the appropriate standard in Table 1001.1 of the Uniform Swimming Pool Code.

**1.2 Applicable Standards.** For applicable standards, see Table 1001.1 of the Uniform Swimming Pool Code.

**2.0 Markings.**

**2.1** Hoses, fittings, solvent cement and primer used shall be marked with the designated IAPMO certification mark to show compliance with this standard.

**3.0 Protection of Hoses.**

**3.1 Storage.** Unprotected hose shall not be stored in direct sunlight. The hose shall be stored in a way to protect it from mechanical damage (slitting, puncturing, etc.). Exposure to sunlight during normal construction periods is not harmful. PVC solvent cement shall be stored in a cool place, except when actually in use at the job site. The solvent cement manufacturer's specific storage recommendations shall be followed.

**3.2 Thermal Expansion.** Hose shall be "snaked" in the trench bottom with enough slack, at least 6 in. (152.4 mm) per 100 ft. (30.5 m), to compensate for thermal expansion and contraction before stabilizing hose. Stabilize hose by bringing it approximately to operating temperature before testing and backfilling by one of the following methods:

(a) Backfill with a layer of soil for shading.

(b) Fill with water at operating temperature.

(c) Allow to stand overnight.

**3.3 Exposed Hose.** Hose above grade when located on the exterior of the building or structure shall be protected from mechanical damage to the satisfaction of the Administrative Authority. Where exposed to sunlight, the hose shall be wrapped with at least 0.040 in. (1.0 mm) of tape or other approved method acceptable to the Administrative Authority.

**4.0 Trenching, Cover, and Backfill.**

**4.1 Trenching and Cover.** Trench bottoms shall be uniformly graded and shall be of either undisturbed soil or shall consist of a layer or layers of compacted backfill so that minimum settlement will take place.

**4.2 Backfill.** Selected backfill shall be used to provide firm continuous support and proper compaction. Backfill over hose, except that joints shall be left exposed. After inspection and pressure test, complete backfill to a minimum of 12 in. (0.3 m) cover.

**5.0 Installation.**

**5.1 Solvent Cement Joints.**

**5.1.1 Selection.** Solvent cement shall be recommended for flexible PVC hose by the manufacturer. Follow manufacturer's recommendations for types of solvent cement for flexible PVC hose.

**5.1.2 Handling (to maintain effectiveness).** Use solvent cement in containers no larger than 1 quart (1 liter). Keep solvent cement can closed and in the shade when not in use. Keep applicator submerged in solvent cement between application. When solvent cement becomes thicker, THROW IT AWAY. Solvent cement shall NOT be thinned.

**5.1.3 Size of Applicator.** Follow manufacturer's recommendations.

**5.1.4 Application.** Follow manufacturer's recommendations.

**5.1.5 General Principles.**

5.1.5.1 To consistently make good joints, the following should be clearly understood and adhered to:

(a) The joining surfaces must be softened (dissolved) and made semi-fluid.

(b) Sufficient cement must be applied to fill the gap between hose and fitting.

(c) Assembly of hose and fittings must be made while the surfaces are still wet and fluid.

(d) Joint strength develops as the cement dries. In the tight part of the joints the surfaces will tend to fuse together; in the loose part the cement will bond to both surfaces.

(e) When solvent welding flexible PVC hose to other than PVC fittings, follow manufacturer's installation instructions.

5.1.5.2 Penetration and dissolving can be achieved by the cement itself, by a suitable primer, or by the use of both primer and cement. A suitable primer will penetrate and dissolve the plastic more quickly than cement alone. In cold weather more time and additional applications are required (see Fig. 1).

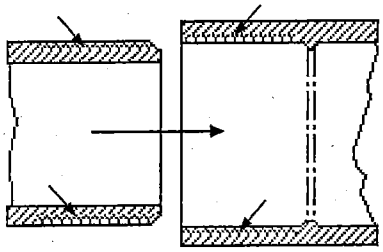


FIGURE 1
AREAS OF HOSE AND FITTINGS TO BE SOFTENED (DISSOLVED) AND PENETRATED

5.1.5.3 More than sufficient cement to fill the loose part of the joint must be applied (see Fig. 2). Besides filling the gap, adequate cement layers will penetrate the surfaces and also remain wet until the joint is assembled.

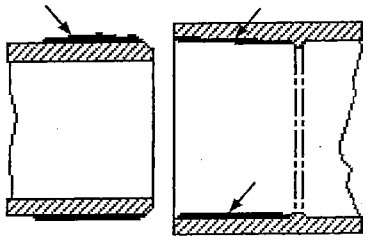


FIGURE 2
CEMENT COATINGS OF SUFFICIENT THICKNESS

5.1.5.4 If the cement coatings on the hose and fittings are wet and fluid when assembly takes place, they will tend to flow together and become one cement layer. Also, if the cement is wet the surfaces beneath them will still be soft, and these dissolved surfaces in the tight part of the joint will tend to fuse together (see Fig. 3).

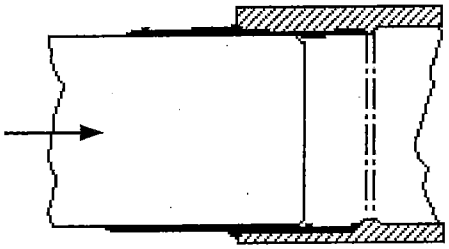


FIGURE 3
ASSEMBLY OF SURFACES WHILE THEY ARE WET AND SOFT

5.1.5.5 As the solvent dissipates, the cement layer and the dissolved surfaces will harden with a corresponding increase in joint strength. A good joint will take the required working pressure long before the joint is fully dry and final strength is obtained. In the tight (fused) part of the joint, strength will develop more quickly than in the looser (bonded) part of the joint. Completed joints should not be disturbed until they have cured sufficiently to withstand handling. Joint strength develops as the cement dries. Information about development of bond strength of solvent cemented joints is available (see Fig. 4).

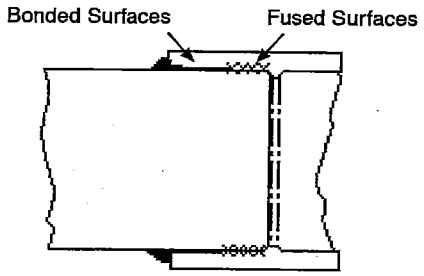



FIGURE 4
BONDED AND FUSED SURFACES OF JOINED HOSES

**5.1.6 Procedure.**

**Note:** Do not take SHORT CUTS. Most failures are caused by short cuts. DON'T TAKE A CHANCE.

Step 1 Cut hose square with hand saw and miter box, mechanical cut-off saw, or tube cutter designed for plastic.

Step 2 Ream and chamfer hose (to eliminate sharp edges, beads and all burrs).

Step 3 Clean all dirt, moisture, and grease from hose and fitting socket. Use a clean, dry rag.

Step 4 Check dry fit of hose in fitting. Hose should enter fitting socket from ⅓ to ¾ depth of socket.

Step 5 Soften inside socket surface by applying an aggressive primer which is a true solvent for PVC and is recommended by the manufacturer.

Step 6 Soften mating outside surface of hose to depth of socket by applying a liberal coat of the (aggressive) primer. Be sure entire surface is softened.

Step 7 Again coat inside socket surface with the (aggressive) primer. Then, without delay, apply solvent cement liberally to outside of hose. Use more than enough to fill any gaps.

Step 8 Apply a light coat of PVC solvent cement to inside of socket using straight outward strokes (to keep excess solvent out of socket). This is also to prevent solvent cement damage to hose. For loose fits, apply a second coat of solvent cement. Time is important at this stage. (See 5.1.4)

Step 9 While both the inside socket surface and the outside surface of the hose are SOFT and WET with solvent cement, forcefully bottom the hose in the socket, giving the hose a one-quarter turn, if possible. The hose must go to the bottom of the socket.

Step 10 Hold the joint together until tight.

Step 11 Wipe excess cement from the hose. A properly made joint will normally show a bead around its entire perimeter. Any gaps may indicate insufficient cement or the use of light bodied cement on larger diameters where heavy bodied cement should have been used.

Step 12 Do not disturb joint for the following periods:

30 minutes minimum at 60°F to 100°F (16°C to 38°C)

1 hour minimum at 40°F to 60°F (4°C to 16°C)

2 hours minimum at 20°F to 40°F (-7°C to 4°C)

4 hours minimum at 0°F to 20°F (-18°C to -7°C)

Handle the newly assembled joints carefully during these periods. If gaps (step 11) or loose fits are encountered in the system, double these periods.

Step 13 The system shall not be pressurized until the joints have cured (set) at least as long as recommended by the manufacturer. If manufacturer's recommendation is not available, the cure times as shown in Table 1 are required.

**5.1.7 Installation and Testing.**

**5.1.7.1 Installation.** The hose shall be properly supported to prevent excessive sagging.

**5.1.7.2 Testing.**

(a) All pool, spa, and hot tub piping shall be inspected and approved before being covered or concealed, except as permitted by sections 3.2 and 4.2. It shall be tested and proved tight to the satisfaction of the Administrative Authority, under a static water or air pressure test of not less than 35 psi (241 kPa) for 15 minutes.

**Exception:** All exposed equipment need not be tested as required in this section.

(b) All swimming pool, spa, or hot tub installations must be completed, filled with water, and in operation before final inspection.

**5.1.8 Safety Requirements and Precautions[1].**

**5.1.8.1 General.** Solvents contained in PVC plastic hose cements are classified as airborne contaminants and flammable and combustible liquids. Precautions listed in this section should be followed to avoid injury to personnel and the hazard of fire.

[1] **CAUTION:** Primers are toxic. Don't allow them to touch skin. Suitable gloves are advised.

**5.1.8.2 Safety Precautions.**

1. Prolonged breathing of solvent vapors should be avoided. When hose and fittings are being joined in partially enclosed areas, a ventilating device should be used in such a manner to minimize the entry of vapors into the breathing areas.
2. Solvent cements should be kept away from all sources of ignition, heat, sparks and open flame.
3. Containers for solvent cements should be kept tightly closed except when the cement is being used.
4. All rags and other materials used for mopping up spills should be kept in a safety waste receptacle which should be emptied daily.
5. Most of the solvents used in PVC hose cements can be considered eye irritants and contact with the eye should be avoided for it may cause eye injury. Proper eye protection and the use of chemical goggles or face shields is advisable where the possibility of splashing exists in handling solvent cements. In case of eye contact, flush with plenty of water for 15 min. and call a physician immediately.
6. Repeated contact with the skin should be avoided. Proper gloves impervious to and unaffected by the solvents should be worn when frequent contact with the skin is likely. Application of the solvents or solvent cements with rags and bare hands is not recommended. Brushes and other suitable applicators can be used effectively for applying the solvent cement, thus avoiding skin contact. In the event of excessive contact, remove contaminated clothing and wash skin with soap and water.

**ADOPTED: 1989**
**REVISED: 2003**

**TABLE 1**
**MINIMUM CURE TIME, IN HOURS[A,B]**
**TEST PRESSURE FOR HOSE**

| | SIZES ½" to 1¼" 12.7 mm TO 31.8 mm | | SIZES 1½" to 3" 38.1 mm TO 76.2 mm | | SIZES 3½" to 8" 88.9 mm TO 203.2 mm | |
|---|---|---|---|---|---|---|
| TEMP. RANGE DURING CURE PERIOD | UP TO 180 psi (1240.2 kPa) | ABOVE 180 TO 370 psi (1240.2 TO 2549.3 kPa) | UP TO 180 psi (1240.2 kPa) | Above 180 TO 315 psi (1240.2 TO 2170.4 kPa) | UP TO 180 psi (1240.2 kPa) | ABOVE 180 TO 315 psi (1240.2 TO 2170.4 kPa) |
| 60°F – 100°F (16°C – 38°C) | 1 hr | 6 hr | 2 hr | 12 hr | 6 hr | 24 hr |
| 40° – 60°F (4°C – 16°C) | 2 hr | 12 hr | 4 hr | 24 hr | 12 hr | 48 hr |
| 10°F – 40°F (-12° + 4°C) | 8 hr | 48 hr | 16 hr | 96 hr | 48 hr | 8 days |

A It is important to note that at temperatures colder than 20°F (-6.7°C) on size that exceed 3 in. (76.2 mm), test results indicate that many variables exist in the actual cure rate of the joint. The data expressed in these categories represent only estimated averages. In some cases, cure will be achieved in less time, but isolated test results indicate that even longer periods of cure may be required.

B These cure schedules are based on laboratory test data obtained on Net Fit Joints (NET FIT = in a dry fit the pipe bottoms snugly in the fitting socket without meeting interference). The relative humidity in these test was 50% or less. Higher relative humidity may require longer cure periods.

# INSTALLATION STANDARD
# FOR ASSEMBLED WHIRLPOOL BATH APPLIANCES

# IAPMO SIS 2-2003

**1. Purpose and Scope.**

To ensure the proper installation of fittings and pumps to maintain no more than the maximum, allowed water retention for each system installed on each different make/model of bathtub. This is a field inspection to be done by the Administrative Authority, and because of this, there will be special, specific points of reference included in the installation instructions to locate jet-suction fitting-pump elevations.

**2. Testing.**

To receive USPC listing, the manufacturer of the kit/or assembler of the whirlpool bath appliance shall provide sample tubs/systems to an approved testing laboratory and said tubs shall be tested to ANSI A112.19.7M. The sample tubs shall represent the parameters described below:

| | TUB VOLUME[1] | NO. OF JETS | PUMP SIZE[2] |
|---|---|---|---|
| Sample #1 | Largest | Greatest | Largest |
| Sample #2 | Largest | Least | Smallest |
| Sample #3 | Smallest | Greatest | Largest |
| Sample #4 | Smallest | Least | Smallest |

[1] As measured in gallon, to the overflow

[2] As rated in gallons per minute (GPM)

**3. Instructions.**

A complete set of installation instructions shall be provided with each appliance or kit and shall include the following:

(a) A side view drawing showing location of jets, suction fittings, pumps, piping and any other parts of the whirlpool system that affect the water retention of the entire system. A point or points of reference shall be chosen by the manufacturer to enable the Administrative Authority to verify these locations after installation of the tub.

(b) Cross reference shall be made as to the kit and the tub (make and model) for which it is listed.

(c) A drawing showing the pump mounting and all hardware to be used.

(d) Recommendations for piping support.

**4. Labeling Requirements.**

Labels shall be permanently affixed to the appliances to be visible from the access door upon final inspection. Labels shall contain the following information:

(a) Title: Assembled Whirlpool Bathtub Appliances

(b) Assembler's Company Name

(c) Date Assembled

(d) Kit Manufacturer Model Number

(e) USPC certification mark with registration ®

**ADOPTED: 1990**

**REVISED: 2003**

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## APPENDIX J - COMBINATION OF INDOOR AND OUTDOOR COMBUSTION AND VENTILATION OPENING DESIGN

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | X | | | | | | | | | | | | | | | X | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |

# APPENDIX J

## COMBINATION OF INDOOR AND OUTDOOR COMBUSTION AND VENTILATION OPENING DESIGN

(The content of this Appendix is based on Annex J of NFPA 54)

**J 1.0 General.**

**J 1.1 Example of Combination Indoor and Outdoor Combustion Air Opening.** Determine the required combination of indoor and outdoor combustion air opening sizes for the following appliance installation example.

Example Installation: A fan-assisted furnace and a draft hood-equipped water heater with the following inputs are located in a 15 foot (4572 mm) by 30 foot (9144 mm) basement with an 8 foot (2438 mm) ceiling. No additional indoor spaces shall be used to help meet the appliance combustion air needs.

Fan-Assisted Furnace Input: 100 000 British thermal units per hour (Btu/h) (29 kW)

Draft Hood-Equipped Water Heater Input: 40 000 Btu/h (11.7 kW)

Solution:

(1) Determine the total available room volume.

Equipment room volume:

15 feet (4572 mm) by 30 feet (9144 mm) with an 8 foot (2438 mm) ceiling = 3600 cubic feet (101.94 $m^3$)

(2) Determine the total required volume.

The standard method to determine combustion air shall be used to calculate the required volume.

The combined input for the appliances located in the basement is calculated as follows:

100 000 Btu/h (29 kW) + 40 000 Btu/h (11.7 kW) = 140 000 Btu/h (41 kW)

The standard method requires that the required volume be determined based on 50 cubic feet per 1000 Btu/h (4.83 $m^3$/kW).

Using Table J 1.1, the required volume for a 140 000 Btu/h (41 kW) water heater is 7000 cubic feet (198.22 $m^3$).

Conclusion:

Indoor volume is insufficient to supply combustion air since the total of 3600 cubic feet (101.94 $m^3$) does not meet the required volume of 7000 cubic feet (198.22 $m^3$). Therefore, additional combustion air shall be provided from the outdoors.

(3) Determine ratio of the available volume to the required volume.

$$\frac{3600 \text{ cubic feet}}{7000 \text{ cubic feet}} = 0.51$$

(4) Determine the reduction factor to be used to reduce the full outdoor air opening size to the minimum required based on ratio of indoor spaces.

1.00 – 0.51 (from Step 3) = 0.49

(5) Determine the single outdoor combustion air opening size as where combustion air is to come from outdoors. In this example, the combustion air opening directly communicates with the outdoors.

$$\frac{140\,000 \text{ Btu/h}}{3000 \text{ British thermal units per square inch (Btu/in}^2\text{)}} = 47 \text{ square inches } (0.03 \text{ m}^2)$$

(6) Determine the minimum outdoor combustion air opening area.

Outdoor opening area = 0.49 (from Step 4) x 47 square inches (0.03 $m^2$) = 23 square inches (0.01 $m^2$)

Section 506.5.3(3) requires the minimum dimension of the air opening shall be not less than 3 inches (76 mm).

**TABLE J 1.1**
**STANDARD METHOD: REQUIRED VOLUME, ALL APPLIANCES***

| APPLIANCE INPUT (Btu/h) | REQUIRED VOLUME (cubic feet) |
|---|---|
| 5000 | 250 |
| 10 000 | 500 |
| 15 000 | 750 |
| 20 000 | 1000 |
| 25 000 | 1250 |
| 30 000 | 1500 |
| 35 000 | 1750 |
| 40 000 | 2000 |
| 45 000 | 2250 |
| 50 000 | 2500 |
| 55 000 | 2750 |
| 60 000 | 3000 |
| 65 000 | 3250 |
| 70 000 | 3500 |
| 75 000 | 3750 |
| 80 000 | 4000 |
| 85 000 | 4250 |
| 90 000 | 4500 |
| 95 000 | 4750 |
| 100 000 | 5000 |
| 105 000 | 5250 |
| 110 000 | 5500 |
| 115 000 | 5750 |
| 120 000 | 6000 |
| 125 000 | 6250 |
| 130 000 | 6500 |
| 135 000 | 6750 |
| 140 000 | 7000 |
| 145 000 | 7250 |
| 150 000 | 7500 |
| 160 000 | 8000 |
| 170 000 | 8500 |
| 180 000 | 9000 |
| 190 000 | 9500 |
| 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 |

For SI units: 1000 British thermal units per hour = 0.293 kW, 1 cubic foot = 0.0283 $m^3$

* See Section 506.4.1, Section 506.4.1(1), Figure 506.4(1), Figure 506.4(2), Section 506.4.1(2), Figure 506.4(3), Section 506.4.2, and Figure 506.4.2.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## APPENDIX K - POTABLE RAINWATER CATCHMENT SYSTEMS

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |

# APPENDIX K

## POTABLE RAINWATER CATCHMENT SYSTEMS

**K 101.0 General.**

**K 101.1 Applicability.** The provisions of this appendix shall apply to the installation, construction, alteration, and repair of potable rainwater catchment systems.

**K 101.2 System Design.** Potable rainwater catchment systems in accordance with this appendix shall be designed by a person registered, licensed, or deemed competent by the Authority Having Jurisdiction to perform potable rainwater catchment system design work.

**K 101.3 Permit.** It shall be unlawful for a person to construct, install, or alter, or cause to be constructed, installed, or altered a potable rainwater catchment systems in a building or on a premise without first obtaining a permit to do such work from the Authority Having Jurisdiction.

**K 101.3.1 Plumbing Plan Submission.** No permit for a rainwater catchment system requiring a permit shall be issued until complete plumbing plans, with data satisfactory to the Authority Having Jurisdiction, have been submitted and approved. No changes or connections shall be made to either the rainfall catchment or the potable water system within a site containing a rainwater catchment water system without approval by the Authority Having Jurisdiction.

**K 101.3.2 System Changes.** No changes or connections shall be made to either the rainwater catchment system or the potable water system within a site containing a rainwater catchment system requiring a permit without approval by the Authority Having Jurisdiction.

**K 101.4 Product and Material Approval.** System components shall be properly identified as to the manufacturer.

**K 101.4.1 Plumbing Materials and Systems.** Pipe, pipe fittings, traps, fixtures, material, and devices used in a potable rainwater system shall be listed or labeled (third-party certified) by a listing agency (accredited conformity assessment body) and shall be in accordance with approved applicable recognized standards referenced within this code, and shall be free from defects. Unless otherwise provided for in this appendix, 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.

**K 101.5 Maintenance and Inspection.** Potable rainwater catchment systems and components shall be inspected and maintained in accordance with Section K 101.5.1 through Section K 101.5.3.

**K 101.5.1 Frequency.** Potable rainwater catchment systems and components shall be inspected and maintained in accordance with Table K 101.5 unless more frequent inspection and maintenance is required by the manufacturer.

**K 101.5.2 Maintenance Log.** A maintenance log for potable rainwater catchment systems shall be maintained by the property owner and be available for inspection. The property owner or designated appointee shall ensure that a record of testing, inspection, and maintenance in accordance with Table K 101.5 is maintained in the log. The log will indicate the frequency of inspection, and maintenance for each system. A record of the required water quality tests shall be retained for not less than 2 years.

**K 101.5.3 Maintenance Responsibility.** The required maintenance and inspection of potable rainwater catchment systems shall be the responsibility of the property owner, unless otherwise required by the Authority Having Jurisdiction.

**K 101.6 Operation and Maintenance Manual.** An operation and maintenance manual for potable rainwater catchment systems shall be supplied to the building owner by the system designer. The operating and maintenance manual shall include the following:

(1) Detailed diagram of the entire system and the location of system components.

(2) Instructions on operating and maintaining the system.

(3) Details on maintaining the required water quality as determined by the Authority Having Jurisdiction.

(4) Details on deactivating the system for maintenance, repair, or other purposes.

(5) Applicable testing, inspection, and maintenance frequencies in accordance with Table K 101.5.

(6) A method of contacting the manufacturer(s).

**K 101.7 Minimum Water Quality Requirements.** The minimum water quality for potable rainwater catchment systems shall comply with the applicable water quality requirements as determined by the public health Authority Having Jurisdiction. In the absence of water quality requirements, the guidelines EPA/625/R-04/108 contain recommended water reuse guidelines to assist regulatory agencies develop, revise, or expand alternate water source water quality standards.

**K 101.8 Material Compatibility.** In addition to the requirements of this appendix, potable rainwater catchment systems shall be constructed of materials that are compatible with the type of pipe and fitting materials and water conditions in the system.

**K 101.9 System Controls.** Controls for pumps, valves, and other devices that contain mercury that come in contact with the water supply shall not be permitted.

TABLE K 101.5
MINIMUM POTABLE RAINWATER CATCHMENT SYSTEM TESTING, INSPECTION, AND MAINTENANCE FREQUENCY

| DESCRIPTION | MINIMUM FREQUENCY |
|---|---|
| Inspect and clean filters and screens, and replace (where necessary). | Every 3 months |
| Inspect and verify that disinfection, filters and water quality treatment devices and systems are operational. Perform water quality tests in accordance with the Authority Having Jurisdiction. | In accordance with the manufacturer's instructions, and the Authority Having Jurisdiction. |
| Perform a water quality test for E. Coli, Total Coliform, and Heterotrophic bacteria. For a system where 25 different people consume water from the system over a 60 day period, a water quality test for cryptosporidium shall be performed. | After initial installation and every 12 months thereafter, or as directed by the Authority Having Jurisdiction. |
| Inspect and clear debris from rainwater gutters, downspouts, and roof washers. | Every 6 months |
| Inspect and clear debris from roof or other aboveground rainwater collection surface. | Every 6 months |
| Remove tree branches and vegetation overhanging roof or other aboveground rainwater collection surface. | As needed |
| Inspect pumps and verify operation. | After initial installation and every 12 months thereafter |
| Inspect valves and verify operation. | After initial installation and every 12 months thereafter |
| Inspect pressure tanks and verify operation. | After initial installation and every 12 months thereafter |
| Clear debris and inspect storage tanks, locking devices, and verify operation. | After initial installation and every 12 months thereafter |
| Inspect caution labels and marking. | After initial installation and every 12 months thereafter |

**K 102.0 Connection.**

**K 102.1 General.** No water piping supplied by a potable rainwater catchment system shall be connected to a source of supply without the approval of the Authority Having Jurisdiction, Health Department, or other department having jurisdiction.

**K 102.2 Connections to Public or Private Potable Water Systems.** Potable rainwater catchment systems shall have no direct connection to a public or private potable water supply or alternate water source system. Potable water from a public or private potable water system is permitted to be used as makeup water to the rainwater storage tank provided the public or private potable water supply connection is protected by an air gap or reduced-pressure principle backflow preventer in accordance with this code.

**K 102.3 Backflow Prevention.** The potable rainwater catchment system shall be protected against backflow in accordance with this code.

**K 103.0 Potable Rainfall Catchment System Materials.**

**K 103.1 Collections Surfaces.** The collection surface for potable applications shall be constructed of a hard, impervious material and shall be approved for potable water use. Roof coatings, paints, and liners shall comply with NSF Protocol P151.

**K 103.1.1 Prohibited.** Roof paints and coatings with lead, chromium, or zinc shall not be permitted. Wood roofing material and lead flashing shall not be permitted.

**K 103.2 Rainwater Catchment System Drainage Materials.** Materials used in rainwater catchment drainage systems, including gutters, downspouts, conductors, and leaders shall be in accordance with the requirements of this code for storm drainage.

**K 103.3 Storage Tanks.** Rainwater storage shall be constructed of solid, durable materials not subject to excessive corrosion or decay and shall be watertight. Storage tanks shall be approved by the Authority Having Jurisdiction for potable water applications, provided such tanks are in accordance with approved applicable standards.

**K 103.4 Water Supply and Distribution Materials.** Potable rainwater supply and distribution materials shall comply with the requirements of this code for potable water supply and distribution systems.

**K 104.0 Design and Installation.**

**K 104.1 Collection Surfaces.** Rainwater shall be collected from roof or other cleanable aboveground surfaces specifically designed for rainwater catchment. A rainwater catchment system shall not collect rainwater from:

(1) Vehicular parking surfaces
(2) Surface water runoff
(3) Bodies of standing water

**K 104.1.1 Prohibited Discharges.** Overflows, condensate, and bleed-off pipes from roof-mounted equipment and appliances shall not discharge onto roof surfaces that are intended to collect rainwater.

**K 104.2 Minimum Water Quality.** The minimum water quality for harvested rainwater shall comply with the appli-

cable water quality requirements for the intended applications as determined by the Authority Having Jurisdiction, Health Department, or other department having jurisdiction.

**K 104.2.1 Filtration Devices.** Potable water filters shall comply with NSF 53 and shall be installed in accordance with the manufacturer's installation instructions.

**K 104.2.2 Disinfection Devices.** Chlorination, ozone, and ultraviolet disinfection methods shall be permitted. The disinfection devices and systems shall be installed in accordance with the manufacturers installation instructions and the conditions of listing. Disinfection devices and systems shall be located downstream of the storage tank.

**K 104.3 Overhanging Tree Branches and Vegetation.** Tree branches and vegetation shall not be located over the roof or other aboveground rainwater collection surface. Where existing tree branch and vegetation growth extends over the rainwater collection surface, it shall be removed in accordance with Section K 101.5.

**K 104.4 Rainwater Storage Tanks.** Rainwater storage tanks shall be installed in accordance with Section K 104.4.1 through Section K 104.4.5.

**K 104.4.1 Location.** Rainwater storage tanks shall be permitted to be installed above or below grade.

**K 104.4.1.1 Above Grade.** Above grade storage tanks shall be of an opaque material, approved for aboveground use in direct sunlight, or shall be shielded from direct sunlight. Tanks shall be installed in an accessible location to allow for inspection and cleaning. The tank shall be installed on a foundation or platform that is constructed to accommodate loads in accordance with the building code.

**K 104.4.1.2 Below Grade.** Rainwater storage tanks installed below grade shall be structurally designed to withstand anticipated earth or other loads. Holding tank covers shall be capable of supporting an earth load of not less than 300 pounds per square foot ($lb/ft^2$) (1465 $kg/m^2$) where the tank is designed for underground installation. Below grade rainwater tanks installed underground shall be provided with manholes. The manhole opening shall be located not less than 4 inches (102 mm) above the surrounding grade. The surrounding grade shall be sloped away from the manhole. Underground tanks shall be ballasted, anchored, or otherwise secured, to prevent the tank from floating out of the ground where empty. The combined weight of the tank and hold down system shall meet or exceed the buoyancy force of the tank.

**K 104.4.2 Drainage and Overflow.** Rainwater storage tanks shall be provided with a means of draining and cleaning. The overflow drain shall not be equipped with a shutoff valve. The overflow outlet shall discharge in accordance with this code for storm drainage systems. Where discharging to the storm drainage system, the overflow drain shall be protected from backflow of the storm drainage system by a backwater valve or other approved method.

**K 104.4.2.1 Overflow Outlet Size.** The overflow outlet shall be sized to accommodate the flow of the rainwater entering the tank and not less than the aggregate cross-sectional area of the inflow pipes.

**K 104.4.3 Opening and Access Protection.**

**K 104.4.3.1 Animals and Insects.** Rainwater tank openings to the atmosphere shall be protected to prevent the entrance of insects, birds, or rodents into the tank.

**K 104.4.3.2 Human Access.** Rainwater tank access openings exceeding 12 inches (305 mm) in diameter shall be secured to prevent tampering and unintended entry by either a lockable device or other approved method.

**K 104.4.3.3 Exposure to Sunlight.** Rainwater tank openings shall not be exposed to direct sunlight.

**K 104.4.4 Inlets.** A device or arrangement of fittings shall be installed at the inlet of the tank to prevent rainwater from disturbing sediment as it enters the tank.

**K 104.4.5 Primary Tank Outlets.** The primary tank outlet shall be located not less than 4 inches (102 mm) above the bottom of the tank, or shall be provided with a floating inlet to draw water from the cistern just below the water surface.

**K 104.5 Pumps.** Pumps serving rainwater catchment systems shall be listed for potable water use. Pumps supplying water to water closets, urinals, and trap primers shall be capable of delivering not less than 15 pounds-force per square inch (psi) (103 kPa) residual pressure at the highest and most remote outlet served. Where the water pressure in the rainwater supply system within the building exceeds 80 psi (552 kPa), a pressure reducing valve reducing the pressure to 80 psi (552 kPa) or less to water outlets in the building shall be installed in accordance with this code.

**K 104.6 Roof Drains.** Primary and secondary roof drains, conductors, leaders, overflows, and gutters shall be designed and installed in accordance with this code.

**K 104.7 Water Quality Devices and Equipment.** Devices and equipment used to treat rainwater to maintain the minimum water quality requirements determined by the Authority Having Jurisdiction shall be listed or labeled (third-party certified) by a listing agency (accredited conformity assessment body) and approved for the intended application.

**K 104.7.1 Filtration and Disinfection Systems.** Filtration and disinfection systems shall be located after the water storage tank. Where a chlorination system is installed, it shall be installed upstream of filtration systems. Where an ultraviolet disinfection system is installed, a filter not more than 5 microns (5 μm) shall be installed upstream of the disinfection system.

**K 104.8 Freeze Protection.** Tanks and piping installed in locations subject to freezing shall be provided with an approved means of freeze protection.

**K 104.9 Roof Washer or Pre-Filtration System.** Collected rainwater shall pass through a roof washer or pre-filtration system before the water enters the rainwater storage tank. Roof washer systems shall comply with Section K 104.9.1 through Section K 104.9.4.

**K 104.9.1 Size.** The roof washer shall be sized to direct rainwater containing debris that has accumulated on the collection surface away from the storage tank. The ARCSA/ASPE rainwater catchment design and installation standard contains additional guidance on acceptable methods of sizing roof washers.

**K 104.9.2 Debris Screen.** The inlet to the roof washer shall be provided with a debris screen or other approved means that protects the roof washer from the intrusion of debris and vermin. Where the debris screen is installed, the debris screen shall be corrosion resistant and shall have openings not larger than ½ of an inch (12.7 mm).

**K 104.9.3 Drain Discharge.** Water drained from the roof washer or pre-filter shall be diverted away from the storage tank and discharged to a disposal area that does not cause property damage or erosion. Roof washer drainage shall not drain over a public way.

**K 104.9.4 Automatic Drain.** Roof washing systems shall be provided with an automatic means of self draining between rain events.

**K 104.10 Filtration and Disinfection Systems.** Filtration and disinfection systems shall be located after the water storage tank. Where a chlorination system is installed, it shall be installed upstream of filtration systems. Where an ultraviolet disinfection system is installed, a filter not more than 5 microns (5 μm) shall be installed upstream of the disinfection system.

**K 104.11 Roof Gutters.** Gutters shall maintain a minimum slope and be sized in accordance with this code.

**K 104.12 Drains, Conductors, and Leaders.** The design and size of rainwater drains, conductors, and leaders shall comply with this code.

**K 104.13 Size of Potable Water Piping.** Potable rainwater system distribution piping shall be sized in accordance with this code for sizing potable water piping.

**K 105.0 Cleaning.**

**K 105.1 General.** The interior surfaces of tanks and equipment shall be clean before they are put into service.

## CALIFORNIA PLUMBING CODE – MATRIX ADOPTION TABLE
## APPENDIX L - SUSTAINABLE PRACTICES

(Matrix Adoption Tables are non-regulatory, intended only as an aid to the user. See Chapter 1 for state agency authority and building application.)

| Adopting Agency | BSC | SFM | HCD | | | DSA | | | OSHPD | | | | BSCC | DPH | AGR | DWR | CA | SL | SLC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | 2 | 1-AC | AC | SS | SS/CC | 1 | 2 | 3 | 4 | | | | | | | |
| Adopt Entire Chapter | | | | | | | | | | | | | | | | | | | |
| Adopt Entire Chapter as amended (amended sections listed below) | | | | | | | | | | | | | | | | | | | |
| Adopt only those sections that are listed below | | | | | | | | | | | | | | | | | | | |
| Chapter/Section | | | | | | | | | | | | | | | | | | | |

# APPENDIX L
## SUSTAINABLE PRACTICES

**L 101.0 General.**

**L 101.1 Applicability.** The purpose of this appendix is to provide a comprehensive set of technically sound provisions that encourage sustainable practices and works towards enhancing the design and construction of plumbing systems that result in a positive long-term environmental impact. This appendix is not intended to circumvent the health, safety, and general welfare requirements of this code.

**L 101.2 Definition of Terms.** For the purposes of this code, the definitions in Section L 201.0 shall apply to this appendix.

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

The definitions of terms are arranged alphabetically according to the first word of the term.

**L 201.0 Definitions.**

**L 201.1 Energy Star.** A joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy. Energy Star is a voluntary program designed to identify and promote energy-efficient products and practices.

**L 201.2 Gang Showers (Non-Residential).** Shower compartments designed and intended for use by multiple persons simultaneously in non-residential occupancies.

**L 201.3 Kitchen and Bar Sink Faucets.** A faucet that discharges into a kitchen or bar sink in domestic or commercial installations. Supply fittings that discharge into other type sinks, including clinic sinks, floor sinks, service sinks and laundry trays are not included.

**L 201.4 Lavatory Faucet.** A faucet that discharges into a lavatory basin in a domestic or commercial installation.

**L 201.5 Maintenance.** The upkeep of property or equipment by the owner of the property in compliance with the requirements of this appendix.

**L 201.6 Metering Faucet.** A self-closing faucet that dispenses a specific volume of water for each actuation cycle. The volume or cycle duration can be fixed or adjustable.

**L 201.7 Multi-Occupant Spaces.** Indoor spaces used for presentations and training, including classrooms and conference rooms.

**L 201.8 Pre-Rinse Spray Valve.** A handheld device for use with commercial dishwashing and ware washing equipment that sprays water on dishes, flatware, and other food service items for the purpose of removing food residue before cleaning and sanitizing the items.

**L 201.9 Run Out.** The developed length of pipe that extends away from the circulating loop system to a fixture(s).

**L 201.10 Self Closing Faucet.** A faucet that closes itself after the actuation or control mechanism is deactivated. The actuation or control mechanism can be mechanical or electronic.

**L 201.11 Single Occupant Spaces.** Private offices, workstations in open offices, reception workstations, and ticket booths.

**L 201.12 Submeter.** A meter installed subordinate to a site meter. Also known as a Dedicated Meter.

**L 201.13 WaterSense.** A voluntary program of the U.S. Environmental Protection Agency designed to identify and promote water-efficient products and practices.

**L 201.14 Water Closet.** A fixture with a water-containing receptor that receives liquid and solid body waste and on actuation conveys the waste through an exposed integral trap into a drainage system. Also referred to as a toilet.

**L 201.15 Water Factor (WF).** A measurement and rating of appliance water efficiency, most often used for residential and light commercial clothes washers, as follows:

**L 201.15.1 Clothes Washer (Residential and Commercial).** The quantity of water in gallons used to complete a full wash and rinse cycle per measured cubic foot capacity of the clothes container.

**L 301.0 General Regulations.**

**L 301.1 Installation.** Plumbing systems covered by this appendix shall be installed in accordance with this code, other applicable codes, and the manufacturer's installation instructions.

**L 301.2 Qualifications.** Where permits are required, the Authority Having Jurisdiction shall have the authority to require contractors, installers, or service technicians to demonstrate competency. Where determined by the Authority Having Jurisdiction, the contractor, installer or service technician shall be licensed to perform such work.

**L 302.0 Disposal of Liquid Waste.**

**L 302.1 Disposal.** It shall be unlawful for a person to cause, suffer, or permit the disposal of sewage, human excrement, or other liquid wastes, in a place or manner, except through and by means of an approved drainage system, installed and maintained in accordance with the provisions of this code.

**L 302.2 Connections to Plumbing System Required.** Equipment and appliances, used to receive or discharge liquid wastes or sewage, shall be connected properly to the drainage system of the building or premises, in accordance with the requirements of this code.

**L 303.0 Abandonment.**

**L 303.1 General.** An abandoned system or part thereof covered under the scope of this appendix shall be disconnected from remaining systems, drained, plugged, and capped in an approved manner.

**L 401.0 Water Conservation and Efficiency.**

**L 401.1 Scope.** The provisions of this section establish the means of conserving potable and nonpotable water used in and around a building.

**L 402.0 Water-Conserving Plumbing Fixtures and Fittings.**

**L 402.1 General.** The installation and water consumption for plumbing fixtures and fixture fittings shall be in accordance with Section L 402.2 through Section L 402.5.2, applicable standards referenced in Table 1401.1, and this code.

**L 402.2 Water Closets.** No water closet shall have a flush volume exceeding 1.6 gallons per flush (gpf) (6.1 Lpf).

**L 402.2.1 Gravity, Pressure Assisted and Electro-Hydraulic Tank Type Water Closets.** Gravity, pressure assisted, and electro-hydraulic tank type water closets shall have a maximum effective flush volume of not more than 1.28 gallons (4.84 L) of water per flush in accordance with ASME A112.19.2/CSA B45.1 or ASME A112.19.14 and shall be listed to the EPA WaterSense Tank-Type High Efficiency Toilet Specification. The effective flush volume for dual flush toilets is defined as the composite, average flush volume of two reduced flushes and one full flush.

**L 402.2.2 Flushometer-Valve Activated Water Closets.** Flushometer-valve activated water closets shall have a maximum flush volume of not more than 1.6 gallons (6.1 L) of water per flush in accordance with ASME A112.19.2/CSA B45.1.

**L 402.3 Urinals.** Urinals shall have a maximum flush volume of not more than 0.5 gallon (1.9 L) of water per flush in accordance with ASME A112.19.2/CSA B45.1 or IAPMO Z124.9. Flushing urinals shall be listed to the EPA WaterSense Flushing Urinal Specification.

**L 402.3.1 Nonwater Urinals.** Nonwater urinals shall comply with ASME A112.19.3/CSA B45.4, ASME A112.19.19, or IAPMO Z124.9. Nonwater urinals shall be cleaned and maintained in accordance with the manufacturer's instructions after installation. Where nonwater urinals are installed they shall have a water distribution line roughed-in to the urinal location at a height not less than 56 inches (1422 mm) to allow for the installation of an approved backflow prevention device in the event of a retrofit. Such water distribution lines shall be installed with shutoff valves located as close as possible to the distributing main to prevent the creation of dead ends. Where nonwater urinals are installed, not less than one water supplied fixture rated at not less than 1 water supply fixture unit (WSFU) shall be installed upstream on the same drain line to facilitate drain line flow and rinsing.

**L 402.4 Lavatory Faucets.** The maximum water flow rate of faucets shall comply with Section L 402.4.1 and Section L 402.4.2.

**L 402.4.1 Lavatory Faucets in Residences, Apartments, and Private Bathrooms in Lodging Facilities, Hospitals, and Patient Care Facilities.** The flow rate for lavatory faucets installed in residences, apartments, and private bathrooms in lodging, hospitals, and patient care facilities (including skilled nursing and long-term care facilities) shall not exceed 1.5 gallons per minute (gpm) (0.09 L/s) at 60 pounds-force per square inch (psi) (414 kPa) in accordance with ASME A112.18.1/CSA B125.1 and shall be listed to the EPA WaterSense High-Efficiency Lavatory Faucet Specification.

**L 402.4.2 Lavatory Faucets in Other Than Residences, Apartments, and Private Bathrooms in Lodging Facilities.** Lavatory faucets installed in bathrooms of buildings or occupancies other than those specified in Section L 402.4.1 shall be in accordance with Section L 402.4.2.1 or Section L 402.4.2.2.

**L 402.4.2.1 Maximum Flow Rate.** The flow rate shall not exceed 0.5 gpm (0.03 L/s) at 60 psi (414 kPa) in accordance with ASME A112.18.1/CSA B125.1.

**L 402.4.2.2 Metering Faucets.** Metering faucets shall deliver not more than 0.25 gallons (0.95 L) of water per cycle.

**L 402.5 Showers.**

**L 402.5.1 Showerheads.** Showerheads shall comply with the requirements of the Energy Policy Act of 1992, except that the flow rate shall not exceed 2.0 gpm (0.13 L/s) at 80 psi (552 kPa), where listed to ASME A112.18.1/CSA B125.1.

**L 402.5.2 Multiple Showerheads Serving One Shower Compartment.** The total allowable flow rate of water from multiple showerheads flowing at a given time, with or without a diverter, including rain systems, waterfalls, bodysprays, and jets, shall not exceed 2.0 gpm (0.13 L/s) per shower compartment, where the floor area of the shower compartment is less than 1800 square inches (1.161 $m^2$). For each increment of 1800 square inches (1.161 $m^2$) of floor area thereafter or part thereof, additional showerheads are allowed, provided the total flow rate of water from flowing devices shall not exceed 2.0 gpm (0.13 L/s) for each such increment.

**Exceptions:**

(1) Gang showers in non-residential occupancies. Singular showerheads or multiple shower outlets serving one showering position in gang showers shall not have more than 2.0 gpm (0.13 L/s) total flow.

(2) Where provided, accessible shower compartments shall not be permitted to have more than 4.0 gpm (0.25 L/s) total flow, where one outlet is the hand shower. The hand shower shall have a control with a nonpositive shutoff feature.

**L 403.0 Fountains and Other Water Features.**

**L 403.1 Use of Alternate Water Source for Special Water Features.** Special water features such as ponds and water fountains shall be provided with reclaimed (recycled) water, rainwater, or on-site treated nonpotable water where the source and capacity is available on the premises and approved by the Authority Having Jurisdiction.

**L 404.0 Meters.**

**L 404.1 Required.** A water meter shall be required for buildings connected to a public water system, including municipally supplied reclaimed (recycled) water. In other than single-family houses, multi-family structures of three stories or fewer above grade, and modular houses, a separate meter or submeter shall be installed in the following locations:

(1) The water supply to an irrigation system for irrigated landscape with an accumulative area exceeding 15 000 square feet (1394 $m^2$).

(2) The water supply to a water-using process where the consumption exceeds 1000 gallons per day (gal/d) (0.0438 L/s), except for manufacturing processes.

(3) The water supply to each building on a property with multiple buildings where the water consumption exceeds 500 gal/d (0.021 L/s).

(4) The water supply to an individual tenant space on a property where one or more of the following applies:

(a) Water consumption exceeds 500 gal/d (0.021 L/s) for that tenant.

(b) Tenant space is occupied by a commercial laundry, cleaning operation, restaurant, food service, medical office, dental office, laboratory, beauty salon, or barbershop.

(c) Total building area exceeds 50 000 square feet (4645 $m^2$).

(5) A makeup water supply to a swimming pool.

**L 404.2 Consumption Data.** A means of communicating water consumption data from submeters to the water consumer shall be provided.

**L 404.3 Access.** Meters and submeters shall be accessible.

**L 405.0 Water-Powered Sump Pumps.**

**L 405.1 General.** Sump pumps powered by potable or reclaimed (recycled) water pressure are not permitted.

**L 501.0 Alternate Water Sources.**

**L 501.1 Scope.** The provisions of this appendix shall apply to the installation, construction, alteration, and repair of potable rainwater catchment systems. Alternate water source systems for nonpotable applications shall comply with this section.

**L 501.2 System Design.** Potable rainwater catchment systems in accordance with this appendix shall be designed by a person registered, licensed, or deemed competent by the Authority Having Jurisdiction to perform potable rainwater catchment system design work.

**L 501.3 Permit.** It shall be unlawful for a person to construct, install, or alter, or cause to be constructed, installed, or altered potable rainwater catchment systems in a building or on a premise without first obtaining a permit to do such work from the Authority Having Jurisdiction.

**L 501.3.1 Plumbing Plan Submission.** No permit for a rainwater catchment system requiring a permit shall be issued until complete plumbing plans, with data satisfactory to the Authority Having Jurisdiction, have been submitted and approved. No changes or connections shall be made to either the rainfall catchment or the potable water system within a site containing a rainwater catchment water system without approval by the Authority Having Jurisdiction.

**L 501.3.2 System Changes.** No changes or connections shall be made to either the rainwater catchment system or the potable water system within a site containing a rainwater catchment system requiring a permit without approval by the Authority Having Jurisdiction.

**L 501.4 Product and Material Approval.** System components shall be properly identified as to the manufacturer.

**L 501.4.1 Plumbing Materials and Systems.** Pipe, pipe fittings, traps, fixtures, material, and devices used in a potable rainwater system shall be listed or labeled (third-party certified) by a listing agency (accredited conformity assessment body) and shall be in accordance with approved applicable recognized standards referenced in this appendix and this code, and shall be free from defects. Unless otherwise provided for in this appendix, 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.

**L 501.5 Maintenance and Inspection.** Potable rainwater catchment systems and components shall be inspected and maintained in accordance with Section L 501.5.1 through Section L 501.5.3.

**L 501.5.1 Frequency.** Potable rainwater catchment systems and components shall be inspected and maintained in accordance with Table L 501.5.1 unless more frequent inspection and maintenance is required by the manufacturer.

**L 501.5.2 Maintenance Log.** A maintenance log for potable rainwater catchment systems shall be maintained by the property owner and be available for inspection. The property owner or designated appointee shall ensure that a record of testing, inspec-

TABLE L 501.5.1
MINIMUM POTABLE RAINWATER CATCHMENT SYSTEM TESTING, INSPECTION, AND MAINTENANCE FREQUENCY

| DESCRIPTION | MINIMUM FREQUENCY |
|---|---|
| Inspect and clean filters and screens, and replace (where necessary). | Every 3 month |
| Inspect and verify that disinfection, filters and water quality treatment devices and systems are operational. Perform water quality tests in accordance with the Authority Having Jurisdiction. | In accordance with the manufacturer's instructions, and the Authority Having Jurisdiction. |
| Perform a water quality test for E. Coli, Total Coliform, and Heterotrophic bacteria. For a system where 25 different people consume water from the system over a 60 day period, a water quality test for cryptosporidium shall also be performed. | After initial installation and every 12 months thereafter, or as directed by the Authority Having Jurisdiction. |
| Inspect and clear debris from rainwater gutters, downspouts, and roof washers. | Every 6 months |
| Inspect and clear debris from roof or other aboveground rainwater collection surface. | Every 6 months |
| Remove tree branches and vegetation overhanging roof or other aboveground rainwater collection surface. | As needed |
| Inspect pumps and verify operation. | After initial installation and every 12 months thereafter |
| Inspect valves and verify operation. | After initial installation and every 12 months thereafter |
| Inspect pressure tanks and verify operation. | After initial installation and every 12 months thereafter |
| Clear debris and inspect storage tanks, locking devices, and verify operation. | After initial installation and every 12 months thereafter |
| Inspect caution labels and marking. | After initial installation and every 12 months thereafter |

tion, and maintenance in accordance with Table L 501.5.1 is maintained in the log. The log will indicate the frequency of inspection, and maintenance for each system. A record of the required water quality tests shall be retained for not less than 2 years.

**L 501.5.3 Maintenance Responsibility.** The required maintenance and inspection of potable rainwater catchment systems shall be the responsibility of the property owner, unless otherwise required by the Authority Having Jurisdiction.

**L 501.6 Operation and Maintenance Manual.** An operation and maintenance manual for potable rainwater catchment systems shall be supplied to the building owner by the system designer. The operating and maintenance manual shall include the following:

(1) Detailed diagram of the entire system and the location of system components.

(2) Instructions on operating and maintaining the system.

(3) Details on maintaining the required water quality as determined by the Authority Having Jurisdiction.

(4) Details on deactivating the system for maintenance, repair, or other purposes.

(5) Applicable testing, inspection, and maintenance frequencies in accordance with Table L 501.5.1.

(6) A method of contacting the manufacturer(s).

**L 501.7 Minimum Water Quality Requirements.** The minimum water quality for potable rainwater catchment systems shall comply with the applicable water quality requirements as determined by the public health Authority Having Jurisdiction. In the absence of water quality requirements, the guidelines EPA/625/R-04/108 contain recommended water reuse guidelines to assist regulatory agencies develop, revise, or expand alternate water source water quality standards.

**L 501.8 Material Compatibility.** In addition to the requirements of this appendix, potable rainwater catchment systems shall be constructed of materials that are compatible with the type of pipe and fitting materials and water conditions in the system.

**L 501.9 System Controls.** Controls for pumps, valves, and other devices that contain mercury that come in contact with the water supply shall not be permitted.

**L 502.0 Connection.**

**L 502.1 General.** No water piping supplied by a potable rainwater catchment system shall be connected to any other source of supply without the approval of the Authority Having Jurisdiction, Health Department, or other department having jurisdiction.

**L 502.2 Connections to Public or Private Potable Water Systems.** Potable rainwater catchment systems shall have no direct connection to a public or private potable water supply or alternate water source system. Potable water from a public or private potable water system is permitted to be used as makeup water to the rainwater storage tank provided the public or private potable water supply connection is protected by an air gap or reduced-pressure principle backflow preventer in accordance with this code.

**L 502.3 Backflow Prevention.** The potable rainwater catchment system shall be protected against backflow in accordance with this code.

**L 503.0 Potable Rainfall Catchment System Materials.**

**L 503.1 Collections Surfaces.** The collection surface for potable applications shall be constructed of a hard, impervious material and shall be approved for potable water use. Roof coatings, paints, and liners shall comply with NSF Protocol P151.

**L 503.1.1 Prohibited.** Roof paints and coatings with lead, chromium, or zinc shall not be permitted. Wood roofing material and lead flashing shall not be permitted.

**L 503.2 Rainwater Catchment System Drainage Materials.** Materials used in rainwater catchment drainage systems, including gutters, downspouts, conductors, and leaders shall be in accordance with the requirements of this code for storm drainage.

**L 503.3 Storage Tanks.** Rainwater storage shall be constructed of solid, durable materials not subject to excessive corrosion or decay and shall be watertight. Storage tanks shall be approved by the Authority Having Jurisdiction for potable water applications, provided such tanks are in accordance with approved applicable standards.

**L 503.4 Water Supply and Distribution Materials.** Potable rainwater supply and distribution materials shall comply with the requirements of this code for potable water supply and distribution systems.

**L 504.0 Design and Installation.**

**L 504.1 Collection Surfaces.** Rainwater shall be collected from roof or other cleanable aboveground surfaces specifically designed for rainwater catchment. A rainwater catchment system shall not collect rainwater from:

(1) Vehicular parking surfaces
(2) Surface water runoff
(3) Bodies of standing water

**L 504.1.1 Prohibited Discharges.** Overflows, condensate, and bleed-off pipes from roof-mounted equipment and appliances shall not discharge onto roof surfaces that are intended to collect rainwater.

**L 504.2 Minimum Water Quality.** The minimum water quality for harvested rainwater shall comply with the applicable water quality requirements for the intended applications as determined by the public health Authority Having Jurisdiction, Health Department, or other department having jurisdiction.

**L 504.2.1 Filtration Devices.** Potable water filters shall comply with NSF 53 and shall be installed in accordance with the manufacturer's installation instructions.

**L 504.2.2 Disinfection Devices.** Chlorination, ozone, and ultraviolet disinfection methods shall be permitted. The disinfection devices and systems shall be installed in accordance with the manufacturers installation instructions and the conditions of listing. Disinfection devices and systems shall be located downstream of the storage tank.

**L 504.3 Overhanging Tree Branches and Vegetation.** Tree branches and vegetation shall not be located over the roof or other aboveground rainwater collection surface. Where existing tree branch and vegetation growth extends over the rainwater collection surface, it shall be removed in accordance with Section L 501.5.

**L 504.4 Rainwater Storage Tanks.** Rainwater storage tanks shall be installed in accordance with Section L 504.4.1 through Section L 504.4.5.

**L 504.4.1 Location.** Rainwater storage tanks shall be permitted to be installed above or below grade.

**L 504.4.1.1 Above Grade.** Above grade storage tanks shall be of an opaque material, approved for aboveground use in direct sunlight, or shall be shielded from direct sunlight. Tanks shall be installed in an accessible location to allow for inspection and cleaning. The tank shall be installed on a foundation or platform that is constructed to accommodate loads in accordance with the building code.

**L 504.4.1.2 Below Grade.** Rainwater storage tanks installed below grade shall be structurally designed to withstand anticipated earth or other loads. Holding tank covers shall be capable of supporting an earth load of not less than 300 pounds per square foot ($lb/ft^2$) (1465 $kg/m^2$) where the tank is designed for underground installation. Below grade rainwater tanks installed underground shall be provided with manholes. The manhole opening shall be located not less than 4 inches (102 mm) above the surrounding grade. The surrounding grade shall be sloped away from the manhole. Underground tanks shall be ballasted, anchored, or otherwise secured, to prevent the tank from floating out of the ground where empty. The combined weight of the tank and hold down system shall meet or exceed the buoyancy force of the tank.

**L 504.4.2 Drainage and Overflow.** Rainwater storage tanks shall be provided with a means of draining and cleaning. The overflow drain shall not be equipped with a shutoff valve. The overflow outlet shall discharge in accordance with this code for storm drainage systems. Where discharging to the storm drainage system, the overflow drain shall be protected from backflow of the storm drainage system by a backwater valve or other approved method.

**L 504.4.2.1 Overflow Outlet Size.** The overflow outlet shall be sized to accommodate the flow of the rainwater entering the tank and not less than the aggregate cross-sectional area of the inflow pipes.

**L 504.4.3 Opening and Access Protection.**

**L 504.4.3.1 Animals and Insects.** Rainwater tank openings to the atmosphere shall be protected to prevent the entrance of insects, birds, or rodents into the tank.

**L 504.4.3.2 Human Access.** Rainwater tank access openings exceeding 12 inches (305 mm) in diameter shall be secured to prevent tampering and unintended entry by either a lockable device or other approved method.

**L 504.4.3.3 Exposure to Sunlight.** Rainwater tank openings shall not be exposed to direct sunlight.

**L 504.4.4 Inlets.** A device or arrangement of fittings shall be installed at the inlet of the tank to prevent rainwater from disturbing sediment as it enters the tank.

**L 504.4.5 Primary Tank Outlets.** The primary tank outlet shall be located not less than 4 inches (102 mm) above the bottom of the tank, or shall be provided with a floating inlet to draw water from the cistern just below the water surface.

**L 504.5 Pumps.** Pumps serving rainwater catchment systems shall be listed for potable water use. Pumps supplying water to water closets, urinals, and trap primers shall be capable of delivering not less than 15 pounds-force per square inch (psi) (103 kPa) residual pressure at the highest and most remote outlet served. Where the water pressure in the rainwater supply system within the building exceeds 80 psi (552 kPa), a pressure reducing valve reducing the pressure to 80 psi (552 kPa) or less to water outlets in the building shall be installed in accordance with this code.

**L 504.6 Roof Drains.** Primary and secondary roof drains, conductors, leaders, overflows, and gutters shall be designed and installed in accordance with this code.

**L 504.7 Water Quality Devices and Equipment.** Devices and equipment used to treat rainwater to maintain the minimum water quality requirements determined by the Authority Having Jurisdiction shall be listed or labeled (third-party certified) by a listing agency (accredited conformity assessment body) and approved for the intended application.

**L 504.7.1 Filtration and Disinfection Systems.** Filtration and disinfection systems shall be located after the water storage tank. Where a chlorination system is installed, it shall be installed upstream of filtration systems. Where an ultraviolet disinfection system is installed, a filter not more than 5 microns (5 μm) shall be installed upstream of the disinfection system.

**L 504.8 Freeze Protection.** Tanks and piping installed in locations subject to freezing shall be provided with an approved means of freeze protection.

**L 504.9 Roof Washer or Pre-Filtration System.** Collected rainwater shall pass through a roof washer or pre-filtration system before the water enters the rainwater storage tank. Roof washer systems shall comply with Section L 504.9.1 through Section L 504.9.4.

**L 504.9.1 Size.** The roof washer shall be sized to direct a sufficient volume of rainwater containing debris that has accumulated on the collection surface away from the storage tank. The ARCSA/ASPE rainwater catchment design and installation standard contains additional guidance on acceptable methods of sizing roof washers.

**L 504.9.2 Debris Screen.** The inlet to the roof washer shall be provided with a debris screen or other approved means that protects the roof washer from the intrusion of debris and vermin. Where the debris screen is installed, the debris screen shall be corrosion resistant and shall have openings not larger than ½ of an inch (12.7 mm).

**L 504.9.3 Drain Discharge.** Water drained from the roof washer or pre-filter shall be diverted away from the storage tank and discharged to a disposal area that does not cause property damage or erosion. Roof washer drainage shall not drain over a public way.

**L 504.9.4 Automatic Drain.** Roof washing systems shall be provided with an automatic means of self draining between rain events.

**L 504.10 Filtration and Disinfection Systems.** Filtration and disinfection systems shall be located after the water storage tank. Where a chlorination system is installed, it shall be installed upstream of filtration systems. Where an ultraviolet disinfection system is installed, a filter not more than 5 microns (5 μm) shall be installed upstream of the disinfection system.

**L 504.11 Roof Gutters.** Gutters shall maintain a minimum slope and be sized in accordance with this code.

**L 504.12 Drains, Conductors, and Leaders.** The design and size of rainwater drains, conductors, and leaders shall comply with this code.

**L 504.13 Size of Potable Water Piping.** Potable rainwater system distribution piping shall be sized in accordance with this code for sizing potable water piping.

**L 505.0 Cleaning.**

**L 505.1 General.** The interior surfaces of tanks and equipment shall be clean before they are put into service.

## L 601.0 Water Heating Design, Equipment and Installation.

**L 601.1 Scope.** The provisions of this section shall establish the means of conserving potable and nonpotable water and energy associated with the generation and use of hot water in a building. This includes provisions for the hot water distribution system, which is the portion of the potable water distribution system between a water heating device and the plumbing fixtures, including dedicated return piping and appurtenances to the water heating device in a recirculation system.

**L 602.0 Service Hot Water – Low-Rise Residential Buildings.**

**L 602.1 General.** The service water heating system for single-family houses, multi-family structures of three stories or fewer above grade, and modular houses shall comply with Section L 602.2 through Section L 602.7. The service water heating system of other buildings shall comply with Section L 603.0.

**L 602.2 Water Heaters and Storage Tanks.** Residential-type water heaters, pool heaters, and unfired water heater storage tanks shall comply with the minimum performance requirements specified by federal law.

Unfired storage water heating equipment shall have a heat loss through the tank surface area of less than 6.5 British thermal units per square foot hour [Btu/(ft$^2$•h)] (20.5 W/m$^2$). [ASHRAE 90.2:7.1]

**L 602.3 Recirculation Systems.**

**L 602.3.1 Pump Operation.** Circulating hot water systems shall be arranged so that the circulating pump(s) are capable of being turned off (automatically or manually) where the hot water system is not in operation. [ASHRAE 90.2:7.2]

**L 602.3.2 Demand Controlled.** The circulation pump shall not operate continuously, be controlled by a timer or have the pump operation initiated by water temperature. The circulation pump shall operate where a signal is received shortly before hot water is desired at the fixture.

**L 602.3.3 System Balancing.** Systems with multiple recirculation zones shall be balanced to uniformly distribute hot water, or they shall be operated with a pump for each zone.

**L 602.3.4 Flow Balancing Valves.** Flow balancing valves shall be a factory preset automatic flow control valve, a flow regulating valve, or a balancing valve with memory stop.

**L 602.3.5 Air Elimination.** Provision shall be made for the elimination of air from the return system.

**L 602.3.6 Gravity or Thermosyphon Systems.** Gravity or thermosyphon systems are prohibited.

**L 602.4 Central Water Heating Equipment.** Service water heating equipment (central systems) that does not fall under the requirements for residential-type service water heating equipment addressed in Section L 602.0 shall comply with the applicable requirements for service water-heating equipment found in Section L 603.0. [ASHRAE 90.2:7.3]

**L 602.5 Insulation.** Hot water supply and return piping shall be thermally insulated. The wall thickness of the insulation shall be equal to the nominal diameter of the pipe up to 2 inches (50 mm). The wall thickness shall be not less than 2 inches (51 mm) for nominal pipe diameters exceeding 2 inches (50 mm). The conductivity of the insulation k-factor in British thermal unit inch per hour square foot degree Fahrenheit [Btu•in/(h•ft$^2$•°F)], measured radially, shall be less than or equal to 0.28 [Btu•in/(h•ft$^2$•°F)] [0.04 W/(m•k)]. Hot water piping to be insulated shall be installed such that insulation is continuous. Pipe insulation shall be installed to within ¼ of an inch (6.4 mm) of appliances, appurtenances, fixtures, structural members, or a wall where the pipe passes through to connect to a fixture within 24 inches (610 mm). Building cavities shall be large enough to accommodate the combined diameter of the pipe plus the insulation, plus other objects in the cavity that the piping shall cross. Pipe supports shall be installed on the outside of the pipe insulation.

**Exceptions:**

(1) Where the hot water pipe is installed in a wall that is not of a width to accommodate the pipe and insulation, the insulation thickness shall be permitted to have the maximum thickness that the wall is capable of accommodating and not less than ½ of an inch (12.7 mm) thick.

(2) Hot water supply piping exposed under sinks, lavatories, and similar fixtures.

(3) Where hot water distribution piping is installed within attic, crawlspace, or wall insulation.

(a) In attics and crawlspaces the insulation shall cover the pipe not less than 5½ inches (140 mm) further away from the conditioned space.

(b) In walls, the insulation shall completely surround the pipe with not less than 1 inch (25.4 mm) of insulation.

(c) Where burial within the insulation will not completely or continuously surround the pipe, then these exceptions do not apply.

**L 602.6 Hard Water.** Where water has hardness equal to or exceeding 9 grains per gallon (gr/gal) (154 mg/L) measured as total calcium carbonate equivalents, the water supply line to water heating equipment in new one- and two family dwellings shall be roughed-in to allow for the installation of water treatment equipment.

**L 602.7 Maximum Volume of Hot Water.** The maximum volume of water contained in hot water distribution lines between the water heater and the fixture stop or connection to showers, kitchen faucets, and lavatories shall be determined in accordance with Section L 602.7.1, Section L 602.7.2, or Section L 602.7.3. The water volume shall be calculated using Table L 602.7.

**L 602.7.1 Central Core/Remote Manifold.** The central core and remote manifold plumbing system hot water distribution line volume to each qualified fixture shall not exceed a volume of 32 ounces (oz) (946 mL).

**L 602.7.2 Central Manifold.** The central manifold plumbing system/hot water system (also referred to as parallel piping or home run), including the supply line from the hot water source to the manifold, the internal volume of the manifold, and the lines to each qualified fixture shall not exceed a volume of 32 oz (946 mL).

TABLE L 602.7
WATER VOLUME FOR DISTRIBUTION PIPING MATERIALS[2]

| OUNCES OF WATER PER FOOT LENGTH OF PIPING | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| NOMINAL SIZE (inch) | COPPER M | COPPER L | COPPER K | CPVC CTS SDR 11 | CPVC SCH 40 | PEX-AL-PEX | PE-AL-PE | PEX CTS SDR 9 |
| 3/8[1] | 1.06 | 0.97 | 0.84 | NA | 1.17 | 0.63 | 0.63 | 0.64 |
| 1/2 | 1.69 | 1.55 | 1.45 | 1.25 | 1.89 | 1.31 | 1.31 | 1.18 |
| 3/4 | 3.43 | 3.22 | 2.90 | 2.67 | 3.38 | 3.39 | 3.39 | 2.35 |
| 1 | 5.81 | 5.49 | 5.17 | 4.43 | 5.53 | 5.56 | 5.56 | 3.91 |
| 1 1/4 | 8.70 | 8.36 | 8.09 | 6.61 | 9.66 | 8.49 | 8.49 | 5.81 |
| 1 1/2 | 12.18 | 11.83 | 11.45 | 9.22 | 13.20 | 13.88 | 13.88 | 8.09 |
| 2 | 21.08 | 20.58 | 20.04 | 15.79 | 21.88 | 21.48 | 21.48 | 13.86 |

For SI units: 1 foot = 304.8 mm, 1 ounce = 29.573 mL

**Notes:**

[1] For the fixture supply tubing only.

[2] NA: Not Applicable.

**L 602.7.3 Recirculation Loop.** Run out lines from a hot water recirculation loop shall not exceed a volume of 16 oz (473 mL). Residential hot water recirculation systems are limited to those that utilize on-demand activation of the circulating pump.

**L 603.0 Service Hot Water – Other Than Low-Rise Residential Buildings.**

**L 603.1 General.** The service hot water, other than single-family houses, multi-family structures of three stories or fewer above grade, and modular houses, shall comply with this section.

**L 603.2 Service Water Heating.**

**L 603.2.1 New Buildings.** Service water heating systems and equipment shall comply with the requirements of this section as described in Section L 603.3. [ASHRAE 90.1:7.1.1.1]

**L 603.2.2 Additions to Existing Buildings.** Service water heating systems and equipment shall comply with the requirements of this section.

**Exception:** Where the service water heating to an addition is provided by existing service water heating systems and equipment, such systems and equipment shall not be required to be in accordance with this appendix. However, new systems or equipment installed shall be in accordance with specific requirements applicable to those systems and equipment. [ASHRAE 90.1:7.1.1.2]

**L 603.2.3 Alterations to Existing Buildings.** Building service water heating equipment installed as a direct replacement for existing building service water heating equipment shall be in accordance with the requirements of Section L 603.0 applicable to the equipment being replaced. New and replacement piping shall comply with Section L 603.4.3.

**Exception:** Compliance shall not be required where there is insufficient space or access to meet these requirements. [ASHRAE 90.1:7.1.1.3]

**L 603.3 Compliance Path(s).** Compliance shall be achieved in accordance with the requirements of Section L 603.1, Section L 603.4, Section L 603.5, and Section L 603.6. [ASHRAE 90.1:7.2.1]

**L 603.3.1 Energy Cost Budget Method.** Projects using the Energy Cost Budget Method (Section 11 of ASHRAE 90.1) for demonstrating compliance with the standard shall be in accordance with the requirements of Section L 603.4, in conjunction with Section 11 of ASHRAE 90.1, Energy Cost Budget Method. [ASHRAE 90.1:7.2.2]

**L 603.4 Mandatory Provisions.**

**L 603.4.1 Load Calculations.** Service water heating system design loads for the purpose of sizing systems and equipment shall be determined in accordance with manufacturer's published sizing guidelines or accepted engineering standards and handbooks acceptable to the adopting authority (e.g., ASHRAE Handbook – HVAC Applications). [ASHRAE 90.1:7.4.1]

**L 603.4.2 Equipment Efficiency.** Water heating equipment, hot-water supply boilers used solely for heating potable water, pool heaters, and hot-water storage tanks shall comply with the criteria listed in Table L 603.4.2. Where multiple criteria are listed, all criteria shall be met. Omission of minimum performance requirements for certain classes of equipment does not preclude use of such equipment where appropriate. Equipment not listed in Table L 603.4.2 has no minimum performance requirements.

**Exceptions:** Water heaters and hot-water supply boilers having more than 140 gallons (530 L) of storage capacity are not required to meet the standby loss (SL) requirements of Table L 603.4.2 where:

(1) The tank surface is thermally insulated to R-12.5.

(2) A standing pilot light is not installed.

(3) Gas- or oil-fired storage water heaters have a flue damper or fan-assisted combustion. [ASHRAE 90.1:7.4.2]

**L 603.4.3 Insulation.** Hot water supply and return piping shall be thermally insulated. The minimum wall thickness of the insulation shall be equal to the nominal diameter of the pipe up to 2 inches (50 mm).

**TABLE L 603.4.2**
**PERFORMANCE REQUIREMENTS FOR WATER HEATING EQUIPMENT**
**[ASHRAE 90.1: TABLE 7.8]**

| EQUIPMENT TYPE | SIZE CATEGORY (INPUT) | SUBCATEGORY OR RATING CONDITION | PERFORMANCE REQUIRED[1] | TEST PROCEDURE[2,3] |
|---|---|---|---|---|
| Electric Table Top Water Heaters | ≤12 kW | Resistance ≥20 gal | 0.93–0.00132V EF | DOE 10 CFR Part 430 |
| Electric water heaters | ≤12 kW | Resistance ≥20 gal | 0.97–0.00132V EF | DOE 10 CFR Part 430 |
| | >12 kW | Resistance ≥20 gal | 20 + 35√V SL, Btu/h | Section G.2 of CSA Z21.10.3 |
| | ≤24 Amps and ≤250 Volts | Heat Pump | 0.93–0.00132V EF | DOE 10 CFR Part 430 |
| Gas storage water heaters | ≤75 000 Btu/h | ≥20 gal | 0.62–0.0019V EF | DOE 10 CFR Part 430 |
| | ≤75 000 Btu/h | <4000 (Btu/h)/gal | 80% Et (Q/800 + 110√V)SL, Btu/h | Sections G.1 and G.2 of CSA Z21.10.3 |
| Gas instantaneous (tankless) water heaters | >50 000 Btu/h and <200 000 Btu/h | ≥4000 (Btu/h)/gal and <2 gal | 0.62–0.0019V EF | DOE 10 CFR Part 430 |
| | ≥200 000 Btu/h[4] | ≥4000 (Btu/h)/gal and <10 gal | 80% Et | CSA Z21.10.3 |
| | ≥200 000 Btu/h | ≥4000 (Btu/h)/gal and ≥10 gal | 80% Et (Q/800 + 110√V) SL, Btu/h | |
| Oil instantaneous water heaters | ≤210 000 Btu/h | ≥4000 (Btu/h)/gal and <2 gal | 0.59–0.0019V EF | DOE 10 CFR Part 430 |
| | ≤210 000 Btu/h | ≥4000 (Btu/h)/gal and <10 gal | 80% Et | Sections G.1 and G.2 of CSA Z21.10.3 |
| | ≤210 000 Btu/h | ≥4000 (Btu/h)/gal and ≥10 gal | 78% Et (Q/800 + 110√V) SL, Btu/h | |
| Hot-water supply boilers, gas and oil | ≥300 000 Btu/h and <12 500 000 Btu/h | <12 500 000 Btu/h | ≥4000 (Btu/h)/gal and <2 gal | Sections G.1 and G.2 of CSA Z21.10.3 |
| Hot-water supply boilers, gas | —— | ≥4000 (Btu/h)/gal and <10 gal | 80% Et (Q/800 + 110√V) SL, Btu/h | |
| Hot-water supply boilers, oil | —— | ≥4000 (Btu/h)/gal and ≥10 gal | 78% Et (Q/800 + 110√V) SL, Btu/h | |
| Pool heaters, oil and gas | All | —— | 78% Et | ASHRAE 146 |
| Heat pump pool heaters | All | 50.0°F db 44.2°F wb Outdoor air 80.0°F Entering Water | 4.0 COP | ARI 1160 |
| Tanks | All | —— | R-12.5 | (none) |

For SI units: 1 gallon = 3.785 L, 1000 British thermal units per hour = 0.293 kW, °C = (°F-32)/1.8

**Notes:**

[1] Energy factor (EF) and thermal efficiency (Et ) are minimum requirements, while standby loss (SL) is maximum Btu/h (kW) based on a 70°F (21°C) temperature difference between stored water and ambient requirements. In the EF equation, V is the rated volume in gallons. In the SL equation, V is the rated volume in gallons and Q is the nameplate input rate in Btu/h (kW).

[2] Section 12 of ASHRAE 90.1 contains a complete specification, including the year version, of the referenced test procedure.

[3] Section G.1 is titled "Test Method for Measuring Thermal Efficiency" and Section G.2 is titled "Test Method for Measuring Standby Loss".

[4] Instantaneous water heaters with input rates below 200 000 Btu/h (58.6 kW) shall be in accordance with these requirements where the water heater is designed to heat water to temperatures of 180°F (82°C) or higher.

The wall thickness shall be not less than 2 inches (51 mm) for nominal pipe diameters exceeding 2 inches (50 mm). The conductivity of the insulation [k-factor (Btu•in/(h•ft$^2$•°F))], measured radially, shall be less than or equal to 0.28 [Btu•in/(h•ft$^2$•°F)] [0.04 W/(m•k)]. Hot water piping to be insulated shall be installed such that insulation is continuous. Pipe insulation shall be installed to within ¼ of an inch (6.4 mm) of appliances, appurtenances, fixtures, structural members, or a wall where the pipe passes through to connect to a fixture within 24 inches (610 mm). Building cavities shall be large enough to accommodate the combined diameter of the pipe, the insulation, and other objects in the cavity that the piping shall cross. Pipe supports shall be installed on the outside of the pipe insulation.

**Exceptions:**

(1) Where the hot water pipe is installed in a wall that is not of a width to accommodate the pipe and insulation, the insulation thickness shall be permitted to have the maximum thickness that the wall is capable of accommodating and not less than ½ of an inch (12.7 mm) thick.

(2) Hot water supply piping exposed under sinks, lavatories, and similar fixtures.

(3) Where hot water distribution piping is installed within attic, crawlspace, or wall insulation:

(a) In attics and crawlspaces the insulation shall cover the pipe not less than 5½ inches (140 mm) further away from the conditioned space.

(b) In walls, the insulation shall completely surround the pipe with not less than 1 inch (25.4 mm) of insulation.

(c) Where burial within the insulation will not completely or continuously surround the pipe, then these exceptions do not apply.

**L 603.4.4 Hot Water System Design.**

**L 603.4.4.1 Recirculation System Balancing.** Systems with multiple recirculation zones shall be balanced to uniformly distribute hot water, or they shall be operated with a pump for each zone.

**Exception:** Systems with multiple recirculation zones that are designed to distribute hot water with differing temperatures.

**L 603.4.4.2 Flow Balancing Valves.** Flow balancing valves shall be factory preset automatic flow control valves, flow regulating valves, or balancing valves with memory stop.

**L 603.4.4.3 Air Elimination.** Provision shall be made for the elimination of air from the return line of a recirculation system.

**L 603.4.4.4 Maximum Volume of Hot Water.** The maximum volume of water contained in hot water distribution lines between the water heater and the fixture stop or connection to showers, kitchen faucets, and lavatories shall be determined in accordance with Section L 602.7.

**L 603.4.5 Service Water Heating System Controls.**

**L 603.4.5.1 Temperature Controls.** Temperature controls shall be provided that allow for storage temperature adjustment from 120°F (49°C) or lower to a maximum temperature compatible with the intended use.

**Exception:** Where the manufacturer's installation instructions specify a higher minimum thermostat setting to minimize condensation and resulting corrosion. [ASHRAE 90.1:7.4.4.1]

**L 603.4.5.2 Temperature Maintenance Controls.** Systems designed to maintain usage temperatures in hot-water pipes, such as recirculating hot-water systems or heat trace, shall be equipped with automatic time switches or other controls that are capable of being set to switch off the usage temperature maintenance system during extended periods where hot water is not required. [ASHRAE 90.1:7.4.4.2]

**L 603.4.5.3 Outlet Temperature Controls.** Temperature controlling means shall be provided to limit the maximum temperature of water delivered from lavatory faucets in public facility restrooms to 110°F (43°C). [ASHRAE 90.1:7.4.4.3]

**L 603.4.5.4 Circulating Pump Controls.** Where used to maintain storage tank water temperature, recirculating pumps shall be equipped with controls limiting operation to a period from the start of the heating cycle to a maximum of 5 minutes after the end of the heating cycle. [ASHRAE 90.1:7.4.4.4]

**L 603.4.6 Pools.**

**L 603.4.6.1 Pool Heaters.** Pool heaters shall be equipped with a readily accessible ON/OFF switch to allow shutting off the heater without adjusting the thermostat setting. Pool heaters fired by natural gas shall not have continuously burning pilot lights. [ASHRAE 90.1:7.4.5.1]

**L 603.4.6.2 Pool Covers.** Heated pools shall be equipped with a vapor retardant pool cover on or at the water surface. Pools heated to more than 90°F (32°C) shall have a pool cover with a minimum insulation value of R-12.

**Exception:** Pools deriving over 60 percent of the energy for heating from site-recovered energy or solar energy source. [ASHRAE 90.1:7.4.5.2]

**L 603.4.6.3 Time Switches.** Time switches shall be installed on swimming pool heaters and pumps.

**Exceptions:**

(1) Where public health standards require 24-hour pump operation.

(2) Where pumps are required to operate solar and waste heat recovery pool heating systems. [ASHRAE 90.1:7.4.5.3]

**L 603.4.7 Heat Traps.** Vertical pipe risers serving storage water heaters and storage tanks not having integral heat traps and serving a nonrecirculating system shall have heat traps on both the inlet and outlet piping as close as practical to the storage tank. A heat trap is a means to counteract the natural convection of heated water in a vertical pipe run. The means is either a device specifically designed for the purpose or an arrangement of tubing that forms a loop of 360 degrees (6.28 rad) or piping that from the point of connection to the water heater (inlet or outlet) includes a length of piping directed downward before connection to the vertical piping of the supply water or hot-water distribution system, as applicable. [ASHRAE 90.1:7.4.6]

**L 603.5 Prescriptive Path.**

**L 603.5.1 Space Heating and Water Heating.** The use of a gas-fired or oil-fired space-heating boiler system, otherwise in accordance with Section L 603.0, to provide the total space heating and water heating for a building is allowed where one of the following conditions is met:

(1) The single space-heating boiler, or the component of a modular or multiple boiler system that is heating the service water, has a standby loss in

Btu/h (kW) not exceeding (13.3 × *pmd* + 400)/*n*, where (*pmd*) is the probable maximum demand in gallons per hour, determined in accordance with the procedures described in generally accepted engineering standards and handbooks, and (*n*) is the fraction of the year where the outdoor daily mean temperature exceeds 64.9°F (18.28°C).

The standby loss is to be determined for a test period of 24 hours duration while maintaining a boiler water temperature of not less then 90°F (32°C) above ambient, with an ambient temperature between 60°F (16°C) and 90°F (32°C). For a boiler with a modulating burner, this test shall be conducted at the lowest input.

(2) It is demonstrated to the satisfaction of the Authority Having Jurisdiction that the use of a single heat source will consume less energy than separate units.

(3) The energy input of the combined boiler and water heater system is less than 150 000 British thermal units per hour (Btu/h) (44 kW). [ASHRAE 90.1:7.5.1]

**L 603.5.2 Service Water Heating Equipment.** Service water heating equipment used to provide the additional function of space heating as part of a combination (integrated) system shall satisfy stated requirements for the service water heating equipment. [ASHRAE 90.1:7.5.2]

**L 603.5.3 Heat Recovery for Service Water Heating.** Condenser heat recovery systems shall be installed for heating or preheating of service hot water provided the following are true:

(1) The facility operates 24 hours a day.

(2) The total installed heat rejection capacity of the water-cooled systems exceed 6 000 000 Btu/h (1758 kW) of heat rejection.

(3) The design service water heating load exceeds 1 000 000 Btu/h (293 kW). [ASHRAE 90.1:6.5.6.2.1]

**L 603.5.3.1 Capacity.** The required heat recovery system shall have the capacity to provide the smaller of:

(1) Sixty percent of the peak heat rejection load at design conditions.

(2) Preheat of the peak service hot water draw to 85°F (29°C).

**Exceptions:**

(1) Facilities that employ condenser heat recovery for space heating with a heat recovery design exceeding 30 percent of the peak water-cooled condenser load at design conditions.

(2) Facilities that provide 60 percent of their service water heating from site-solar or site-recovered energy or from other sources. [ASHRAE 90.1:6.5.6.2.2]

**L 603.6 Submittals.** The Authority Having Jurisdiction shall require submittal of compliance documentation and supplemental information in accordance with Section 103.2.1 of this code.

**L 604.0 Solar Water Heating Systems.**

**L 604.1 General.** The erection, installation, alteration, addition to, use or maintenance of solar water heating systems shall be in accordance with this section and the Uniform Solar Energy Code.

**L 604.2 Annual Inspection and Maintenance.** Solar energy systems that utilize a heat transfer fluid shall be inspected annually, unless inspections are required on a more frequent basis by the solar energy system manufacturer.

**L 605.0 Hard Water.**

**L 605.1 Softening and Treatment.** Where water has a hardness equal to or exceeding 10 gr/gal (171 mg/L) measured as total calcium carbonate equivalents, the water supply line to water heating equipment and the circuit of boilers shall be softened or treated to prevent accumulation of lime scale and consequent reduction in energy efficiency.

**L 701.0 Installer Qualifications.**

**L 701.1 Scope.** The provisions of this section address minimum qualifications of installers of plumbing and mechanical systems covered within the scope of this appendix.

**L 702.0 Qualifications.**

**L 702.1 General.** Where permits are required, the Authority Having Jurisdiction shall have the authority to require contractors, installers, or service technicians to demonstrate competency. Where determined by the Authority Having Jurisdiction, the contractor, installer, or service technician shall be licensed to perform such work.

**L 801.0 Method of Calculating Water Savings.**

**L 801.1 Purpose.** The purpose of this section is to provide a means of estimating the water savings where installing plumbing and fixture fittings that use less water than the maximum required by the Energy Policy Act of 1992 and 2005 and this code.

**L 801.2 Calculation of Water Savings.** Table L 801.2(1) and Table L 801.2(2) shall be permitted to be used to establish a water use baseline in calculating the amount of water saved as a result of using plumbing fixtures and fixture fittings that use less water than the required maximum. Water use is determined by the following equation:

Water use = (flow rate or consumption) x (duration) x (occupants) x (daily uses)

**TABLE L 801.2(1)**
**WATER USE BASELINE[5]**

| FIXTURE TYPE | MAXIMUM FLOW-RATE CONSUMPTION[2] | DURATION | ESTIMATED DAILY USES PER PERSON | OCCUPANTS[3, 4] |
|---|---|---|---|---|
| Showerheads | 2.5 gpm at 80 psi | 8 minutes | 1 | – |
| Private or Private Use Lavatory Faucets | 2.2 gpm at 60 psi | 0.25 minutes | 4 | – |
| Residential Kitchen Faucets | 2.2 gpm at 60 psi | 4 minutes | 1 | – |
| Wash Fountains | 2.2 gpm / 20 [rim space (inches) at 60 psi] | – | – | – |
| Lavatory Faucets in other than Residences, Apartments, and Private Bathrooms in Lodging Facilities | 0.5 gpm | 0.25 minutes | 4 | – |
| Metering Faucets | 0.25 gallons /cycle | 0.25 minutes | 3 | – |
| Metering Faucets for Wash Fountains | 0.25 gpm / 20 [rim space (inches) at 60 psi] | 0.25 minutes | – | – |
| Water Closets | 1.6 gallons per flush | 1 flush | 1 male[1] | – |
| | | | 3 female | – |
| Urinals | 1.0 gallons per flush | 1 flush | 2 male | – |

For SI units: 1 gallon per minute = 0.06 L/s, 1 pound-force per square inch = 6.8947 kPa, 1 gallon = 3.785 L, 1 inch = 25.4 mm

**Notes:**

[1] The daily use number shall be increased to three where urinals are not installed in the room.

[2] The maximum flow rate or consumption is from the Energy Policy Act.

[3] For residential occupancies, the number of occupants shall be based on two persons for the first bedroom and one additional person for each additional bedroom.

[4] For non-residential occupancies, refer to Table 422.1 for occupant load factors.

[5] Where determining calculations, assume one use per person for metering or self closing faucets.

## TABLE L 801.2(2)
## WATER SAVINGS CALCULATOR[1, 2, 3]

| NON-RESIDENTIAL BUILDINGS | | | | | |
|---|---|---|---|---|---|
| BASELINE CASE: CHANGE OCCUPANT VALUES TO REFLECT ANTICIPATED OCCUPANCY | | | | | |
| FIXTURE TYPE | CONSUMPTION (gallons per minute) | DAILY USES | DURATION (minutes) | OCCUPANTS | DAILY WATER USES (gallons) |
| 1.6 gpf (gallons per flush) toilet - male | 1.6 | 1 | 1 | 150 | 240 |
| 1.6 gpf toilet - female | 1.6 | 3 | 1 | 150 | 720 |
| 1.0 gpf urinal - male | 1 | 2 | 1 | 150 | 300 |
| Commercial lavatory faucet - 0.5 gpm | 0.5 | 3 | 0.25 | 300 | 113 |
| Kitchen sink - 2.2 gpm | 2.2 | 1 | 0.25 | 300 | 165 |
| Showerhead - 2.5 gpm | 2.5 | 0.1 | 8 | 300 | 600 |
| | | | | Total Daily Volume | 2138 |
| | | | | Annual Work Days | 260 |
| | | | | Total Annual Usage | 555 750 |

| FIXTURE TYPE | CONSUMPTION (gallons per minute) | DAILY USES | DURATION (minutes) | OCCUPANTS | DAILY WATER USES (gallons) |
|---|---|---|---|---|---|
| 1.6 gpf toilet - male | 1.28 | 1 | 1 | 150 | 192 |
| 1.6 gpf toilet - female | 1.28 | 3 | 1 | 150 | 576 |
| 1.0 gpf urinal - male | 0.5 | 2 | 1 | 150 | 150 |
| Commercial lavatory faucet - 0.5 gpm | 0.5 | 3 | 0.25 | 300 | 113 |
| Kitchen sink - 2.2 gpm | 2.2 | 1 | 0.25 | 300 | 165 |
| Showerhead - 2.5 gpm | 2.5 | 0.1 | 8 | 300 | 600 |
| | | | | Total Daily Volume | 1796 |
| | | | | Annual Work Days | 260 |
| | | | | Total Annual Usage | 466 830 |
| | | | | Annual Savings | 88 920 |
| | | | | % Reduction | -16.0 percent |

For SI units: 1 gallon per minute = 0.06 L/s, 1 gallon = 3.785 L

**Notes:**

[1] Consumption values shown as underlined reflect the maximum consumption values associated with the provisions called out in the IAPMO Green Plumbing & Mechanical Code Supplement.

[2] Where metering faucets are used, insert the flow rate of the faucet in the "Consumption" column and insert the cycle time in the "Duration" column (assume 1 cycle per use).

[3] To determine estimated savings, insert occupant values (same as Baseline) and consumption values based on fixtures and fixture fittings installed.

**TABLE L 801.2(2)**
**WATER SAVINGS CALCULATOR (continued)[1, 2]**

| RESIDENTIAL 3 BEDROOM STRUCTURE | | | | | |
|---|---|---|---|---|---|
| BASELINE CASE: CHANGE OCCUPANT VALUES BASED ON NUMBER OF BEDROOMS (EXAMPLE SHOWN IS FOR 3 BEDROOMS) | | | | | |
| FIXTURE TYPE | CONSUMPTION (gallons per minute) | DAILY USES | DURATION (minutes) | OCCUPANTS | DAILY WATER USES (gallons) |
| 1.6 gpf toilets | 1.6 | 5 | 1 | 4 | 32 |
| Lavatory faucet - 2.2 gpm | 2.2 | 8 | 0.25 | 4 | 18 |
| Kitchen sink - 2.2 gpm | 2.2 | 6 | 0.25 | 4 | 13 |
| Showerhead - 2.5 gpm | 2.5 | 0.75 | 8 | 4 | 60 |
| | | | | Total Daily Volume | 123 |
| | | | | Annual Work Days | 44 822 |

| FIXTURE TYPE | CONSUMPTION (gallons per minute) | DAILY USES | DURATION (minutes) | OCCUPANTS | DAILY WATER USES (gallons) |
|---|---|---|---|---|---|
| 1.6 gpf toilet - male | 1.28 | 5 | 1 | 4 | 26 |
| Lavatory faucet - 1.5 gpm | 1.5 | 8 | 0.25 | 4 | 12 |
| Kitchen sink - 2.2 gpm | 2.2 | 6 | 0.25 | 4 | 13 |
| Showerhead - 2.5 gpm | 2.5 | 0.75 | 8 | 4 | 60 |
| | | | | Total Daily Volume | 111 |
| | | | | Annual Usage | 40 442 |
| | | | | Annual Savings | 4380 |
| | | | | % Reduction | -9.8 percent |

For SI units: 1 gallon per minute = 0.06 L/s, 1 gallon = 3.785 L

**Notes:**

[1] Consumption values shown as underlined reflect the maximum consumption values associated with the provisions called out in the IAPMO Green Plumbing & Mechanical Code Supplement.

[2] To determine estimated savings, insert occupant values (same as Baseline) and consumption values based on fixtures and fixture fittings installed.

**Notes and instructions for Table L 801.2(2):**

Table L 801.2(2) is an example of a calculator that is capable of helping estimate water savings in residential and nonresidential structures. The "Duration" of use and "Daily Uses" values that appear in the table are estimates and based on previous studies. The first example shown below is for a commercial office building with 300 occupants, 150 females, and 150 males. The second example is for a 3 bedroom residential building. To obtain and use a working copy of this calculator, follow the download and use instructions below.

Instructions for download:

1. Go to the IAPMO web site at www.iapmogreen.org in order to download the water-savings calculator. The calculator is a Microsoft Office Excel file (1997 or later), your computer must be capable of running MS Excel.
2. Follow the instructions for downloading and running the file.

Instructions for use:

1. In the Baseline Case section, insert the number of total occupants, male occupants and female occupants that apply for the building in the "Occupants" column. Unless specific gender ratio values are provided, assume a 50/50 gender ratio.
2. Copy and paste these same values in the "Occupants" column of the Calculator section.
3. In the Calculator section, insert the consumption values (flow rates in gpm or gallons per flush or per cycle) in the "Consumption" column.
4. Estimated water savings in terms of percent savings versus baseline values, gallons per day and gallons per year will be automatically calculated.

# USEFUL TABLES

## CONVERSION TABLES

**Note:** The information contained in these tables are not part of this American National Standard (ANS) and have not been processed in accordance with ANSI's requirements for an ANS. As such, these tables may contain material that has not been subjected to public review or a consensus process. In addition, they do not contain requirements necessary for conformance to the standard.

| MULTIPLY | BY | TO OBTAIN |
|---|---|---|
| Acres | 43 560 | Square feet |
| Acre-feet | 43 560 | Cubic feet |
| Acre-feet | 325 851 | Gallons (U.S. liquid) |
| Atmosphere (standard) (atm) | 76.0 | Centimeters of mercury (0°C) |
| Atmosphere (standard) | 33.90 | Feet of water (4°C) |
| Atmosphere (standard) | 29.92 | Inches of mercury |
| Atmosphere (standard) | 101.32501 | KiloPascals (kPa) |
| Atmosphere (standard) | 14.70 | Pounds-force/square inch |
| British thermal units (Btu) | 1055.055 | Joules (J) |
| Btus/hour | 0.000293 | Kilowatts (kW) |
| Btus/hour | 0.293 | Watts (W) |
| Btus/minute | 12.97 | Foot pounds-force/second |
| Btus/minute | 0.02358 | Horsepower (hp) (international) |
| Centimeters (cm) | 0.3937 | Inches |
| Centimeters of mercury (0°C) | 0.01316 | Atmosphere (standard) |
| Centimeters of mercury (0°C) | 0.446 | Feet of water (4°C) |
| Centimeters of mercury (0°C) | 27.84 | Pounds-force/square feet |
| Centimeters of mercury (0°C) | 0.1934 | Pounds-force/square inch |
| Cubic feet ($ft^3$) | 1728 | Cubic inches |
| Cubic feet | 0.0283 | Cubic meters ($m^3$) |
| Cubic feet | 0.03704 | Cubic yards |
| Cubic feet | 7.48052 | Gallons (U.S. liquid) |
| Cubic feet | 29.92 | Quarts (U.S. liquid) |
| Cubic feet/minute ($ft^3$/min) | 0.000472 | Cubic meters/second |
| Cubic feet/minute | 0.1247 | Gallons/second |
| Cubic feet/minute | 0.47194 | Liters/second (L/s) |
| Cubic feet/second ($ft^3$/s) | 646 316.89 | Gallons/day |
| Cubic feet/second | 448.831 | Gallons/minute |
| Cubic yards ($yd^3$) | 27 | Cubic feet |
| Cubic yards | 201.97 | Gallons (U.S. liquid) |
| Degrees | 0.0174 | Rads |
| Feet (ft) | 304.8 | Millimeters |
| Feet of water (4°C) | 0.0295 | Atmosphere (standard) |
| Feet of water (4°C) | 0.8827 | Inches of mercury (0°C) |
| Feet of water (4°C) | 62.43 | Pounds-force/square feet |
| Feet of water (4°C) | 0.4335 | Pounds-force/square inch |
| Feet/minute (ft/min) | 0.01667 | Feet/second |
| Feet/minute | 0.01136 | Miles/hour |
| Feet/second (ft/s) | 0.3048 | Meters/second (m/s) |
| Feet/second | 0.6818 | Miles/hour |
| Feet/second | 0.01136 | Miles/minute |

| MULTIPLY | BY | TO OBTAIN |
|---|---|---|
| Foot pounds-force (ft•lbf) | 1.355 | Joules |
| Gallons (U.S. liquid) | 231 | Cubic inches |
| Gallons (U.S. liquid) (gal) | 0.003785 | Cubic meters |
| Gallons (U.S. liquid) | 0.1337 | Cubic feet |
| Gallons (U.S. liquid) | 3.785 | Liters |
| Gallons (U.S. liquid) | 4 | Quarts (U.S. liquid) |
| Gallons/minute (gpm) | 8.0208 | Cubic feet/hour |
| Gallons/minute | 0.00223 | Cubic feet/second |
| Gallons/minute | 0.06309 | Liters/second |
| Grains (gr) | 0.00006479 | Kilograms (kg) |
| Inches (in) | 2.54 | Centimeters |
| Inches of mercury (0°C) | 0.03342 | Atmosphere (standard) |
| Inches of mercury (0°C) | 1.133 | Feet of water (4°C) |
| Inches mercury (0°C) | 3.3863 | KiloPascals (kPa) |
| Inches of mercury (0°C) | 0.4912 | Pounds-force/square inch |
| Inches of water (4°C) | 0.002458 | Atmosphere (standard) |
| Inches of water (4°C) | 0.07356 | Inches of mercury (0°C) |
| Inches of water (4°C) | 5.202 | Pounds-force/square feet |
| Inches of water (4°C) | 0.03613 | Pounds-force/square inch |
| KiloPascals (kPa) | 0.145038 | Pounds-force/square inch |
| Liters | 61.02 | Cubic inches |
| Liters (L) | 0.001 | Cubic meters |
| Liters | 0.2642 | Gallons (U.S. liquid) |
| Miles | 5280 | Feet |
| Miles/hour (mi/h) | 88 | Feet/minute |
| Miles/hour | 1.467 | Feet/second |
| Millimeters (mm) | 0.1 | Centimeters |
| Millimeters | 0.03937 | Inches |
| Millimeter | 0.001 | Meters |
| Ounces (oz) | 0.02834 | Kilograms |
| Pounds (lb) | 0.45359 | Kilograms |
| Pounds/cubic foot ($lb/ft^3$) | 16.0184 | Kilograms/cubic meter ($kg/m^3$) |
| Pounds/square inch ($lb/in^2$) | 703.1 | Kilograms-force/square meter ($kg/m^2$) |
| Pounds/square foot ($lb/ft^2$) | 4.882427 | Kilograms-force/square meter ($kg/m^2$) |
| Pounds-force (lbf) | 4.4482 | Newtons (N) |
| Pounds-force/square inch (psi) | 0.06805 | Atmosphere (standard) |
| Pounds-force/square inch | 2.307 | Feet of water (4°C) |
| Pounds-force/square inch | 2.036 | Inches of mercury (0°C) |
| Pounds-force/square inch | 6.89476 | KiloPascals |
| Quarts (U.S. dry) (dry qt) | 67.20 | Cubic inches |
| Quarts (U.S. liquid) (liq qt) | 57.75 | Cubic inches |
| Square feet ($ft^2$) | 144 | Square inches |
| Square feet | 0.0929 | Square meters |
| Square inches ($in^2$) | 0.000645 | Square meters |
| Square miles ($mi^2$) | 640 | Acres |
| Square yards ($yd^2$) | 9 | Square feet |
| Temperature (°C) + 17.28 | 1.8 | Temperature (°F) |
| Temperature (°F) – 32 | 5/9 | Temperature (°C) |
| Tons (short) | 2000 | Pounds |
| Water column (1 inch) | 0.24908 | KiloPascals |

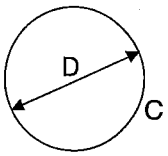
## AREAS AND CIRCUMFERENCES OF CIRCLES

| DIAMETER | | CIRCUMFERENCE | | AREA | |
|---|---|---|---|---|---|
| Inches | mm | Inches | mm | Inches² | mm² |
| ⅛ | 6 | 0.40 | 10 | 0.01227 | 8.0 |
| ¼ | 8 | 0.79 | 20 | 0.04909 | 31.7 |
| ⅜ | 10 | 1.18 | 30 | 0.11045 | 71.3 |
| ½ | 15 | 1.57 | 40 | 0.19635 | 126.7 |
| ¾ | 20 | 2.36 | 60 | 0.44179 | 285.0 |
| 1 | 25 | 3.14 | 80 | 0.7854 | 506.7 |
| 1¼ | 32 | 3.93 | 100 | 1.2272 | 791.7 |
| 1½ | 40 | 4.71 | 120 | 1.7671 | 1140.1 |
| 2 | 50 | 6.28 | 160 | 3.1416 | 2026.8 |
| 2½ | 65 | 7.85 | 200 | 4.9087 | 3166.9 |
| 3 | 80 | 9.43 | 240 | 7.0686 | 4560.4 |
| 4 | 100 | 12.55 | 320 | 12.566 | 8107.1 |
| 5 | 125 | 15.71 | 400 | 19.635 | 12 667.7 |
| 6 | 150 | 18.85 | 480 | 28.274 | 18 241.3 |
| 7 | 175 | 21.99 | 560 | 38.485 | 24 828.9 |
| 8 | 200 | 25.13 | 640 | 50.265 | 32 428.9 |
| 9 | 225 | 28.27 | 720 | 63.617 | 41 043.1 |
| 10 | 250 | 31.42 | 800 | 78.540 | 50 670.9 |

### EQUAL PERIPHERIES

S = 0.7854 D

D = 1.2732 S




S = 0.8862 D

D = 1.1284 S

S = 0.2821 C




### EQUAL AREAS

Area of square (S') =
1.2732 x area of circle

Area of square (S) =
0.6366 x area of circle

$C = \pi D = 2\pi R$

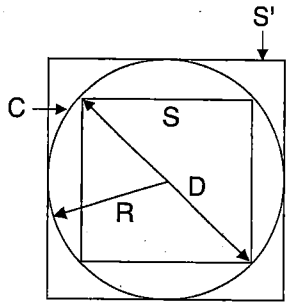
$C = 3.5446 \sqrt{area}$

$D = 0.3183\ C = 2R$

$D = 1.1283 \sqrt{area}$

$Area = \pi R^2 = 0.7854\ D^2$

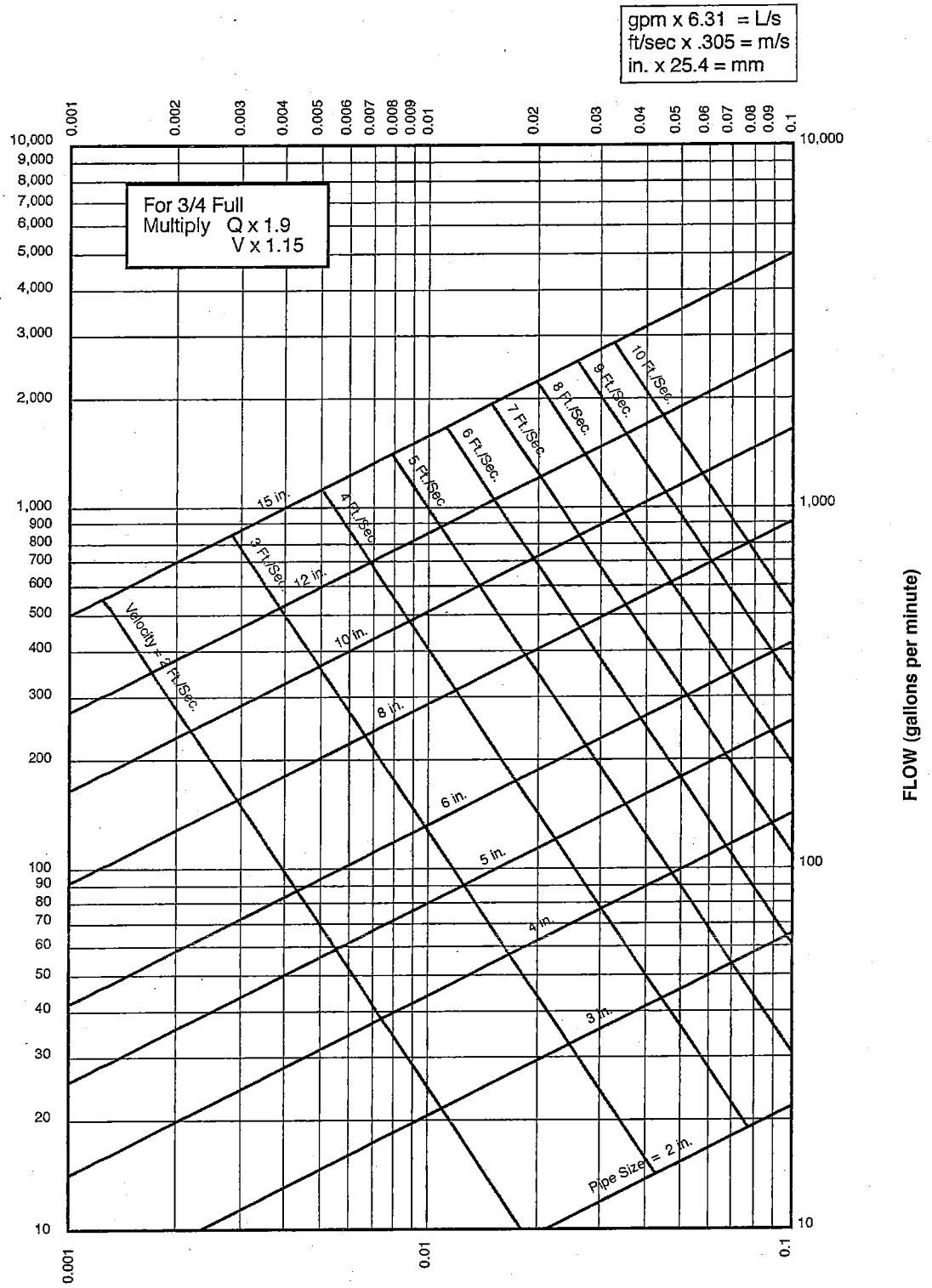
$Area = 0.07958\ C^2 = \frac{\pi D^2}{4}$



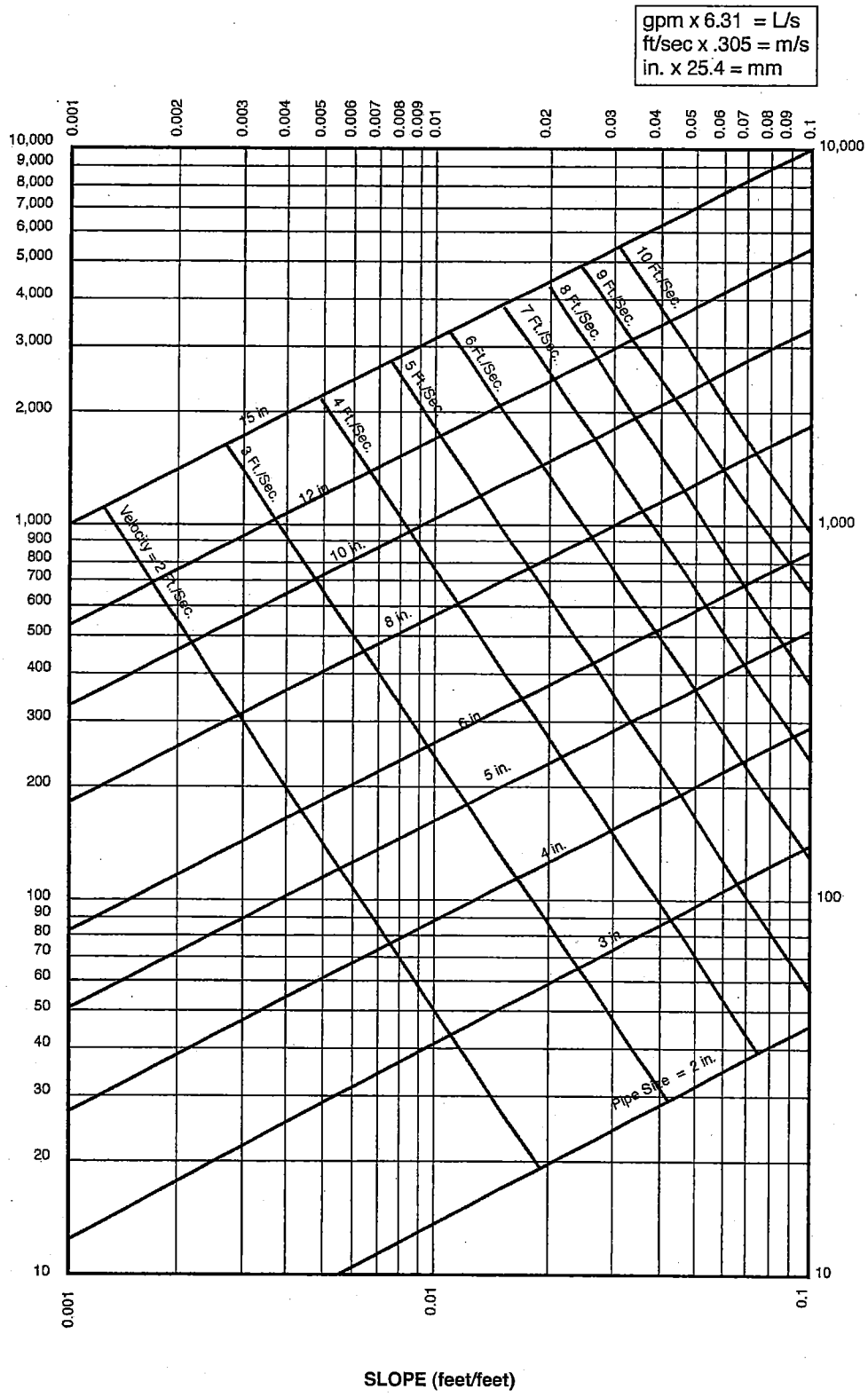

$\pi = 3.1416$

6491

## FLOW IN PARTLY FILLED (ONE-HALF FULL) PIPES (BASED ON MANNING'S FORMULA WITH n = .012)



## FLOW IN PARTLY FILLED (FULL) PIPES
## (BASED ON MANNING'S FORMULA WITH n = .012)



# 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, "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 2 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 ¼ 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 at hand.

The following tables are set up using this approach and using the preferred SI units.

# UNIT CONVERSIONS

| TO CONVERT | INTO | MULTIPLY BY |
|---|---|---|
| Atmosphere | Centimeters of mercury | 76.0 |
| British thermal units (Btu) | Joules | 1055.056 |
| Btus/hour | Kilowatts | 0.000293 |
| Btus/hour | Watts | 0.293 |
| Circumference | Radians | 6.283 |
| Cubic feet | Cubic meters | 0.0283 |
| Cubic feet | Liters | 28.32 |
| Cubic feet/hour | Cubic meters/hour | 0.0283 |
| Cubic feet/minute | Liters/second | 0.4719 |
| Cubic inches | Cubic meters | $1.64 \times 10^{-5}$ |
| Cubic inches | Liters | 0.01639 |
| Cubic meters | Gallons (U.S. liquid) | 264.17 |
| Cubic yards | Cubic meters | 0.76455 |
| Degrees | Radians | 0.0175 |
| Fahrenheit | Celsius | (°F-32)/1.8 |
| Feet | Meters | 0.3048 |
| Feet | Millimeters | 304.8 |
| Feet/second | Meters/second | 0.3048 |
| Foot-pounds | Joules | 1.356 |
| Foot pounds-force/minute | Kilowatts | $2.260 \times 10^{-5}$ |
| Foot pounds-force/second | Kilowatts | $1.356 \times 10^{-3}$ |
| Gallons | Liters | 3.785 |
| Gallons/day | Liters/second | $4.3 \times 10^{-5}$ |
| Gallons/minute | Liters/second | 0.063 |
| Grains | Kilograms | $6.479 \times 10^{-5}$ |
| Horsepower | Kilowatts | 0.7457 |
| Horsepower-hours | Joules | $2.684 \times 10^{+6}$ |
| Horsepower-hours | Kilowatt-hours | 0.7457 |
| Inches | Millimeters | 25.4 |
| Inches/hour | Millimeters/hour | 25.4 |
| Inches of mercury (0°C) | KiloPascals | 3.3863 |
| Joules | Btus | $9.480 \times 10^{-4}$ |
| Joules | Foot-pounds | 0.7376 |
| Joules | Watt-hours | $2.778 \times 10^{-4}$ |
| Kilograms | Pounds | 2.2046 |
| Kilograms | Tons (short) | $1.102 \times 10^{-3}$ |
| Kilometers | Miles (statute) | 0.6214 |
| Kilometers/hour | Miles/hour | 0.6214 |
| Kilowatts | Btus/hour | 3412.14 |
| Kilowatts | Horsepower | 1.341 |
| Kilowatt-hours | Btus | 3413 |
| 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 |

## UNIT CONVERSIONS (continued)

| TO CONVERT | INTO | MULTIPLY BY |
|---|---|---|
| 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) | Kilograms | 0.02834 |
| Pounds | Kilograms | 0.4536 |
| Pounds/foot | Kilograms/meters | 1.4881 |
| Pounds-force/square inch | KiloPascals | 6.8947 |
| Quarts (liquid) | Liters | 0.9463 |
| Radians | Degrees | 57.30 |
| Square feet | Square meters | 0.0929 |
| Square inches | Square meters | $6.45 \times 10^{-4}$ |
| Square inches | Square millimeters | 645.16 |
| Square meters | Square inches | 1550 |
| Square millimeters | Square inches | $1.550 \times 10^{-3}$ |
| Water column (1 inch) | KiloPascals | 0.24908 |
| Watts | Btus/hour | 3.4121 |
| Watts | Horsepower | $1.341 \times 10^{-3}$ |

When the plumbing industry, including plumbers, suppliers, and manufacturers, actually begins the metric conversion program, it will undoubtedly follow the guidelines of committees selected from all phases of the construction industry 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 ten-hour day, a ten-day week, and ten 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 is provided by ANSI, the American National Metric Council, and the Division of Designatronics, Inc.

# INDEX

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**WRAPPING OF PIPE** .....609.3(1), 1210.2, E 32.2
**WROUGHT IRON (GALVANIZED)** .....312.8, 402.6.1, 604.5–604.6, 701.1(1), 707.1, 1101.3, 1208.5.2.2, 1208.5.8.4(2), E 32.1, Table 604.1, Table 707.1
**WYE CONNECTIONS**.....414.3, 419.2, 706.0, 707.5–707.6, 710.4, 719.4, 907.2, 909.1, 1104.3

**– X –**

**X-RAY DARKROOMS** .....811.8

**– Y –**

**YOKE VENTS** .....227.0, 907.0

**– Z –**

**ZINC ALLOY COMPONENTS** .....407.4, 1208.5.8.4(7)

# HISTORY NOTE APPENDIX

## CALIFORNIA PLUMBING CODE
## (TITLE 24, PART 5, CALIFORNIA CODE OF REGULATIONS)

*For prior history, see the History Note Appendix to the California Plumbing Code (CPC), 2010 Triennial Edition effective January 1, 2011.*

1. *(BSC 05/12, DSA-SS 05/12, HCD 05/12, OSHPD 06/12, SFM 06/12) Adoption by reference of the 2012 Uniform Plumbing Code (UPC) with necessary state amendments and repeal of the 2009 edition of the UPC. Effective on January 1, 2014.*