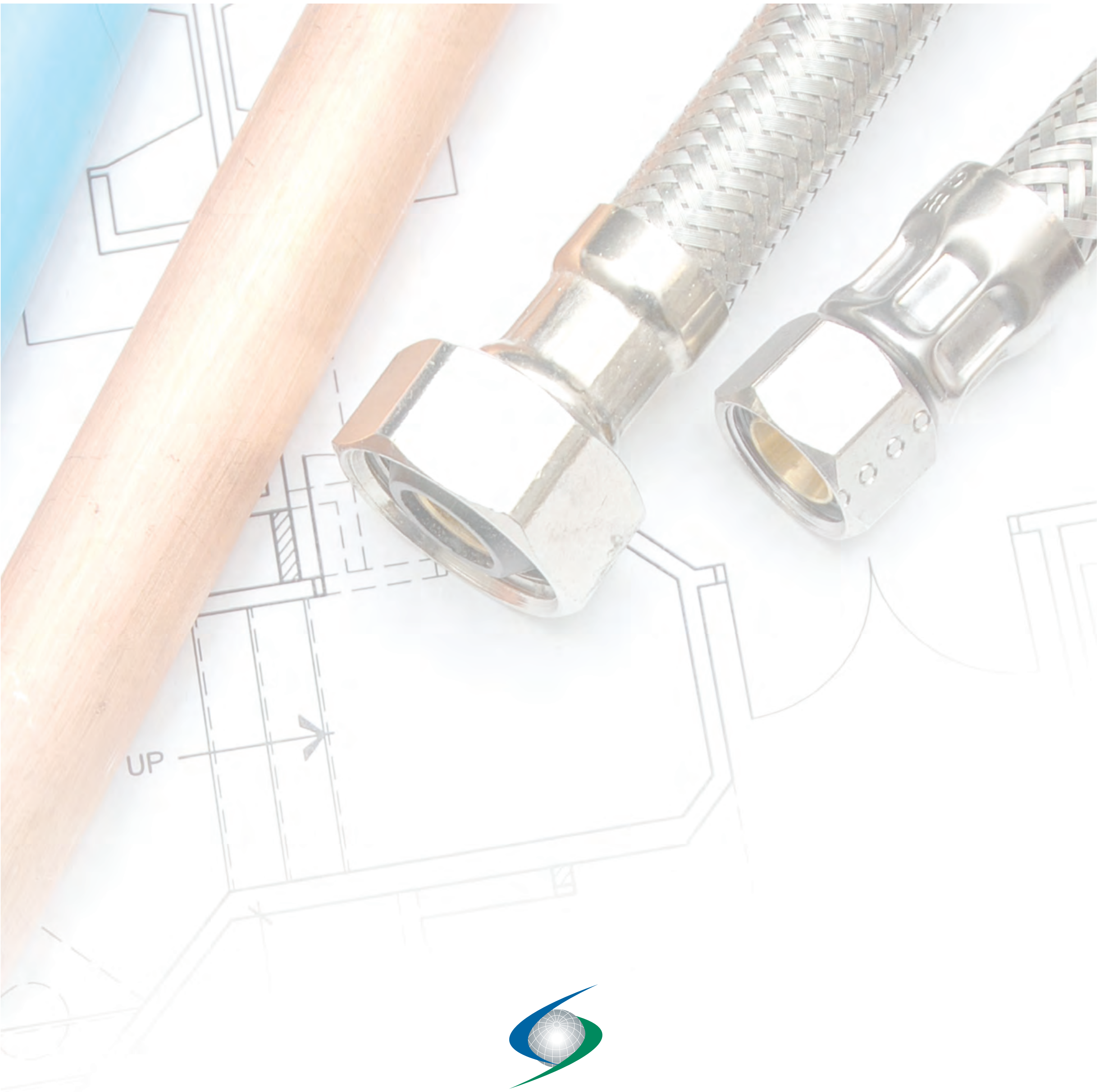

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UNIFORM PLUMBING CODE of Abu Dhabi Emirate

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An Environmental Guide for Water Supply and Sanitation

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Preface

Water has been considered as the most precious commodity on earth since the beginning of human civilizations. It holds a special place in Islamic tradition as it is considered to be the source of life and the medium through which humans cleanse their bodies and souls before prayer.

In arid areas such as the UAE and the rest of the Arabian Peninsula, water has played a central role in the culture, as it determined where human settlements would establish their trading routes and animal grazing grounds.

Today, UAE, as with the rest of the GCC countries is almost totally dependent on the desalination of sea water to produce fresh water which is brought to consumers, often over a network of pipes that extend for hundreds of kilometers. Although the effort and pain of securing fresh water for daily requirements have disappeared, with it has come the complete dependency and reliance of the government to provide desalinated and reconstituted water at a cost that exceeds the cost of any water in the world.

As the population expands and the demand for water rises, the ability to expand to meet the growing need by building additional desalination plants become more difficult not only due to the costs involved but also for the impact such plants will have on the environment. Desalination creates a double impact, both in terms of consuming energy and thus the release of carbon dioxide as well as the release of warm and salty effluents that contain the byproducts of disinfection into the ocean thereby harming our fisheries and the marine environment.

In our analysis for the water supply and demand, we have learned that perhaps as high as 40% of the produced water is unaccounted for. Some of that may be attributed to illegal connections which are being addressed by the installation of more water meters. However, leakage, breakage and failure of materials are also a major cause of the loss of such a high percentage of the produced water. Factors that contribute further to this loss include poor quality of materials, poor designs of internal water supply networks and substandard performance by contractors.

With a view to learn from the experience of other governments worldwide, we were impressed with the efforts made by the Orange County in California to cope with their problem of meeting demands for high quality water and ensuring a secure supply to its constituency. Orange County had sought assistance from the International Association of Pluming and Mechanical Officials (IAMPO), an organization with over 80 years of experience in providing guidance to governments and industries for the protection of public health and safety.

The EAD contracted IAMPO to develop a pluming code for Abu Dhabi built along the lines of the principles from the Orange County Pluming Code that can serve as a guidebook and manual for selection of materials, design of networks, quality of workmanship of water supplies and the waste water collection systems inside buildings.

The code is hoped to enhance the efforts of government officials and contractors in providing our society with a safe, reliable, as well as an efficient water supply and sanitation system for our homes, government, commercial buildings and to the industries.

On a final note, May I emphasize that Codes and manuals alone cannot solve the problem of water loss in our water distribution and waste collection systems. It takes dedication, hard work and perseverance on our part as government agencies and public servants in addition to the commitment we can acquire from our contractors to produce the quality of workmanship worthy of admiration by our people.

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CHAPTER 1

ADMINISTRATION

Preamble.

Chapter 1 of the UPC-AD on Administration contains two parts: one is the general administration and part two is general administration for desalination. Water is no longer considered a natural, self-renewable, low-cost resource in most arid regions. Desalination has received wide acceptance because of the rate at which conventional water resources are depleted. In order to alleviate water scarcity, new water supply resources are in need to supplement available resources. In arid regions, desalination provides water for drinking, domestic, industrial and commercial applications.

Part I

101.0 Title, Scope, and General.

101.1 Title. This document shall be known as the "Uniform Plumbing Code of Abu Dhabi: An Environmental Guide for Water Supply and Sanitation,'' may be cited as such, and will be referred to herein as "this code.''

101.2 Purpose. This code is an ordinance providing minimum requirements and standards for the protection of public health, safety, environment, welfare, and the conservation of water resources and recycling of treated waste waters.

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

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

101.4 Scope.

101.4.1 The provisions of this code shall apply to the desalination of sea water, storage, and distribution of desalinated water, management of brackish ground water and treated wastewater; and also to the erection, installation, alteration, repair, relocation, replacement, addition to, use, or maintenance of plumbing systems within this jurisdiction. This code addresses all aspects of the plumbing system and where there are specific code requirements, regulations or guidelines such references shall be crossed-referenced in the text. In the case of different values between the code and any existing National Regulations, the value of such regulations shall prevail.

Discrepancies shall be resolved during periodic review of this code and applicable regulations in consultation with revelant stakeholders.

101.4.1.1 Repairs and Alterations.

101.4.1.1.1 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.

101.4.1.1.2 Existing building sewers and building drains shall be permitted to be used connection with new buildings or new plumbing and drainage work only when they are found on examination and test to conform in all respects to the requirements governing new work, and the proper Authority Having Jurisdiction shall notify the owner to make any changes necessary to conform to this code. No building, or part thereof, shall be erected or placed over any 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.

101.4.1.1.3 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 required by this code.

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

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

101.4.2 Additions, alterations, repairs, and replacement of plumbing systems shall comply with the provisions for new systems except as otherwise provided in Section 101.5.

101.4.3 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.

101.5 Application to Existing Plumbing System.

101.5.1 Additions, Alterations, or Repairs. Additions, alterations, or repairs shall be permitted to be made to any plumbing system without requiring the existing plumbing system to comply with the requirements of this code, provided the addition, alteration, or repair conforms to that required for a new plumbing system. Additions, alterations, or repairs shall not cause an existing system to become unsafe, insanitary, or overloaded.

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

101.5.3 Existing Installation. Plumbing systems lawfully in existence at the time of the adoption of this code shall have their use, maintenance, or repair continued if the use, maintenance, or repair is in accordance with the original design and location and no hazard to life, health, or property has been created by such plumbing system.

101.5.4 Changes in Building Occupancy. Plumbing systems that are a part of any building or structure undergoing a change in use or occupancy, as defined in the Building Code, shall comply to the requirements of this code that may be applicable to the new use or occupancy.

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

101.5.6 Moved Buildings. Plumbing systems that are part of buildings or structures moved into this jurisdiction shall comply with the provisions of this code for new installations, except as provided for in Section 103.5.5.2.

102.0 Organization and Enforcement.

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

102.2 Duties and Powers of the Authority Having Jurisdiction.

102.2.1 The Authority Having Jurisdiction shall be permitted to appoint such assistants, deputies, inspectors, or other employees as necessary to carry out the functions of the department and this code.

102.2.2 Right of Entry. Whenever it is necessary to make an inspection to enforce the provisions of this code, or whenever the Authority Having Jurisdiction has reasonable cause to believe that there exists in any building or upon any premises any condition or violation of this code that makes the 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 if such building or premises is occupied, the Authority Having Jurisdiction shall present credentials to the occupant and request entry. If 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. If entry is refused, the Authority Having Jurisdiction has recourse to every remedy provided by law to secure entry.

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

102.2.3 Stop Orders. Whenever any 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 any persons engaged in the doing or causing such work to be done, and any such persons shall forthwith stop work until authorized by the Authority Having Jurisdiction to proceed with the work.

102.2.4 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.

102.2.5 Authority to Condemn. Whenever the Authority Having Jurisdiction ascertains that any 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, as appropriate. The order shall fix a reasonable time limit for compliance. No person shall use or maintain defective plumbing after receiving such notice.

When 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.

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

102.3 Violations and Penalties.

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

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

103.0 Permits and Inspections.

103.1 Permits.

103.1.1 Permits Required. It shall be unlawful for any person, firm, or corporation to make any installation, alteration, repair, replacement, or remodel any plumbing system regulated by this code except as permitted in Section 103.1.2, or to cause the same to be done without first obtaining a separate plumbing permit for each separate building or structure.

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

103.1.2.1 The stopping of leaks in drains, soil, waste, or vent pipe, provided, however, that should any trap, drainpipe, 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.

103.1.2.2 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 any work to be done in violation of the provisions of the code or any other laws or ordinances of this jurisdiction.

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

103.2 Application for Permit.

103.2.1 Application. 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. Every such application shall:

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

103.2.1.2 Describe the land upon which the proposed work is to be done by legal description, street address, or similar description that will readily identify and definitely locate the proposed building or work.

103.2.1.3 Indicate the use or occupancy for which the proposed work is intended.

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

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

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

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

Exception: The Authority Having Jurisdiction shall be permitted to waive the submission of plans, calculations, or other data if the Authority Having Jurisdiction finds that the nature of the work applied for is such that reviewing of plans is not necessary to obtain compliance within the code.

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

103.3 Permit Issuance.

103.3.1 Issuance. The application, plans, and specifications and other data filed by an applicant for a permit shall be reviewed by the Authority Having Jurisdiction. Such plans shall be permitted to be reviewed by other departments of this jurisdiction to verify compliance with applicable laws under their jurisdiction. If the Authority Having Jurisdiction finds that the work described in an application for permit and the plans, specifications, and other data filed therewith conform to the requirements of the code and other pertinent laws and ordinances, and that the fees specified in Section 103.4 have been paid, the Authority Having Jurisdiction shall issue a permit therefore to the applicant.

When the Authority Having Jurisdiction issues the permit where plans are required, the Authority Having Jurisdiction shall endorse in writing or stamp the plans and specifications "APPROVED." Such approved plans and specifications shall not be changed, modified, or altered without authorization from the Authority Having Jurisdiction, and 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 complying with pertinent requirements of this code. The holder of such permit may proceed at the holder's risk without assurance that the permit for the entire building, structure, or plumbing system will be granted.

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

103.3.3 Validity of Permit. The issuance of a permit or approval of plans and specifications shall not be construed to be a permit for, or an approval of, any violation of any of the provisions of this code or of any other ordinance of the jurisdiction. No permit presuming to give authority to violate or cancel the provisions of this code shall be valid.

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

103.3.4 Expiration. Every permit issued by the Authority Having Jurisdiction under the provisions of this code shall expire by limitation and become null and void if the work authorized by such permit is not commenced within 180 days from the date of such permit, or if the work authorized by such permit is suspended or abandoned at any time after the work is commenced for a period of 180 days. Before such work can be recommenced, a new permit shall first be obtained to do so, and the fee 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.

Any 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 when the permittee is unable to commence work within the time required by this section for good and satisfactory reasons. 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.

103.3.5 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 whenever 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.

103.4.1 Permit Fees. Fees shall be assessed in accordance with the provisions of this section and as set forth by the Authority Having Jurisdiction. Environmental Impact Assessment fees for desalination plants shall be in accordance with the provisions set forth by the Authority Having Jurisdiction.

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

The plan review fees for 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.

When plans are incomplete or changed so as to require additional review, a fee shall be charged by the Authority Having Jurisdiction.

103.4.3 Expiration of Plan Review. Applications for which no permit is issued within 180 days following the date of application shall expire by limitation, and plans and other data submitted for review may thereafter 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.

103.4.4 Investigation Fees: Work Without a Permit.

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

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

103.4.5 Fee Refunds.

103.4.5.1 The Authority Having Jurisdiction shall be permitted to authorize the refunding of any fee paid hereunder that was erroneously paid or collected.

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

103.4.5.3 The Authority Having Jurisdiction shall not authorize the refunding of any fee paid except upon written application filed by the original permittee not later than 180 days after the date of fee payment.

103.5 Inspections.

103.5.1 General. Plumbing systems for which a permit is required by this code shall be inspected by the Authority Having Jurisdiction.

No portion of any plumbing system shall be concealed until inspected and approved. Neither the Authority Having Jurisdiction nor the jurisdiction shall be liable for expense entailed in the removal or replacement of material required to permit inspection. When the installation of a plumbing system is complete, an additional and final inspection shall be made. Plumbing systems regulated by this code shall not be connected to the water, the energy fuel supply, or the sewer system until authorized by the Authority Having Jurisdiction.

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

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

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

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

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

103.5.3 Testing of Systems. Plumbing systems shall be tested and approved as required by this code or the Authority Having Jurisdiction.

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

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

103.5.3.3 Exceptions. In cases where it would be impractical to provide the required water or air tests, or for minor installations and repairs, the Authority Having Jurisdiction 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.

103.5.3.4 Tightness. Joints and connections in the plumbing system shall be gas tight and water tight for the pressures required by test.

103.5.4 Inspection Requests. It shall be the duty of the person doing the work authorized by a permit to notify the Authority Having Jurisdiction that such work is ready for inspection. The Authority Having Jurisdiction shall be permitted to require that every request for inspection be filed not less than one 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 required by this code to provide access to and means for proper inspection of such work.

103.5.4.1 Advance Notice. It shall be the duty of the person doing the work authorized by the permit to notify the Authority Having Jurisdiction, orally or in writing, that said work is ready for inspection. Such notification shall be given not less than 24 hours before the work is to be inspected.

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

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

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

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 shall be used. The water used for tests shall be obtained from a potable source of supply. Except for plastic piping, air pressure equal to 3bars (45 psi) 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. (See Section 609.4)

The water test shall be applied to the drainage and vent systems either in its entirety or in sections. If 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. If 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 3m (10 ft.) head of water. In testing successive sections, not less than the upper 3m (10 ft.) of the next preceding section shall be tested, so that no joint or pipe in the building (except the uppermost 3m (10 ft.) of the system) shall have been submitted to a test of less than a 3m (10 ft.) 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.

The air test shall be made by attaching an air compressor testing apparatus to any 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 30kPa (4.4 psi) or sufficient to balance a column of mercury 25cm (10 in.) in height. The pressure shall be held without introduction of additional air for a period of not less than 15 minutes.

The piping of the drainage, waste and venting systems (DWV) shall be tested with water or air, except that plastic pipe shall not be tested with air. (See Section 712.0)

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. (see Section 712.3)

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

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

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

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

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

To obtain reinspection, the applicant shall file an application therefore in writing upon a form furnished for that purpose and pay the reinspection fee as stipulated by the Authority Having Jurisdiction.

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

103.5.6.1 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 any 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.

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

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

103.6 Connection Approval.

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

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

103.6.3 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.

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

103.8 Validity.

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

103.8.2 Wherever in this code reference is made to an appendix, the provisions in the appendix shall not apply unless specifically adopted.

Part II

104.0 Desalination Plants.

104.1 General. The purpose of this section is to provide provisions for desalination to enable sources of salt or brackish water, otherwise unacceptable for human consumption used for potable drinking water. The use of desalination process to provide potable drinking water is increasing because of the water scarcity driven by lack of resources.

104.2 Plans Required. The installation and operation of a desalination plant have potential adverse impacts on air, water, sea and groundwater. Plans shall be submitted and approved by the Authority Having Jurisdiction that addresses the following environment and costal impacts as follows:

(1) Construction. Construction shall not result in the environmental impacts such as coastal areas, sea and wildlife.

(2) Energy Usage. Desalination plants require a significant amount of energy for their operation, therefore, such plants shall provide for the use of renewable energy by selecting technology that reduces energy consumption.

(3) Air Quality. Air emissions shall be minimized from electrical power generation and fuel combustion in accordance with the provisions set forth by the Authority Having Jurisdiction. Alternative energy sources shall be provided to minimize air emissions.

(4) Marine Environment. Marine resources shall be preserved and restored to sustain the coastal waters and maintain healthy population of marine species.

(5) Coastal Impact. Seepage from unlined drying lagoons causing increased salinity and toxic metals deposition shall be prohibited. Pipelines and power sources shall be limited in length and number to minimize impacts of coastal area.

(6) Health Issues. Water quality and health effects for quality of water, treatment and distribution for desalination technology shall be provided. Ions such as calcium, magnesium, sodium, chloride, selenium, potassium, bromide, iodide, chromium and manganese shall be replenished by stabilizing and blending in the desalination process in accordance with the provisions set forth by the Authority Having Jurisdiction.

(7) Waste Management. Applicants shall select technologies and processes that minimize or eliminate the discharges of hazardous waste into the ocean. An evaluation shall be submitted that determines the options for combining brine with cooling water or a sewage treatment plant, measurements of dispersion rates to determine how

readily brine is dispersed in the ocean and evaluate whether landfill disposal has an impact on ocean disposal.

104.3 Drawing and Specifications. Plot plans drawn to scale, dimensioned, showing direction and approximate slope of surface, location of all coastal area, location of present or current site for drainage, intake of seawater or brackish water and all details of construction necessary to ensure compliance with the requirements of this section including equipment, materials, methods of assembly and installation.

104.4 Permits. Permits shall be required before any work is commenced and approved by the Authority Having Jurisdiction.

104.5 Desalination Technologies. System components, environmental impacts of desalination process and brine disposal shall be approved by the Authority Having Jurisdiction and incorporate energy reduction technology that reduces consumption.

Desalination technologies shall include one or a combination of reverse osmosis, distillation, electrodialysis and vacuum freezing.

104.5.1 Materials. Selection of materials shall be based on the type of installation, corrosion resistant properties, pressure, temperature, chemically compatibility, source of water, processing and product water quality.

Piping installed in the desalination process shall be of corrosion resistant, chemically compatible, and able to withstand varying temperature and pressures. Such material shall include type 316 L stainless steel, high alloy steel, titanium, high-density polyethylene (HDPE), fiberglass; glass reinforced plastic or other approved material; listed or labeled by a listing agency in accordance with its intended use and shall conform to approved standards referenced in this code. Distribution piping supplying potable water shall meet the requirements of Section 301.1.1 and Table 6-4.

Pumps, valves and tanks installed in the desalination process shall be of corrosion resistant materials, chemically compatible, able to withstand varying temperature and pressures and compatible with component parts. Such materials shall include high-density polyethylene, stainless steel or copper/nickel alloys or other approved material; listed or labeled by a listing agency in accordance with its intended use and shall conform to approved standards referenced in this code.

104.6 Feedwater. Intake of seawater or brackish water shall be either surface (open intake) or nonsurface (wells and infiltration) type and pumped to the desalination plant. Where available, existing power plants shall be used to collect water for use as the intake source for the desalination process.

104.7 Location. The location and construction shall be designed to minimize adverse impacts on environmental and aquatic ecology. Intake piping for distillation plants shall be located not less than 500m (1,640 ft.) away from sewage treatment plants, industrial areas, freshwater discharge, or other locations to prevent intake of discharged effluent.

104.8 Pretreatment. Intake sea or brackish water may pass through pretreatment to remove suspended solids and other solid matter. This may include coagulation, sedimentation followed by filtration or by using microfiltration or ultrafiltration membranes.

104.9 Post-Treatment. Water for domestic use shall be treated to stabilize, disinfect, provide corrosion inhibition, adjustment of a ph level of 8 and restored with nutrients such as magnesium, calcium, fluoride, ions, zinc, copper, chromium, sodium, and in accordance with the provisions set forth by the Authority Having Jurisdiction and the Guide to Water Supply Regulations. Post disinfection shall be required to control micro-organisms during storage and off-site distribution. Treatment and chemicals used shall be approved by the Authority Having Jurisdiction.

104.10 Waste Treatment. The location of wastewater discharge from desalination plants shall be approved by the Authority Having Jurisdiction and shall discharge into areas with high levels of mixing or by the use of diffusers. Wastewater discharge shall be evaluated based on water quality standards and the total discharge concentration. Chlorine and other biocides shall not discharge directly into the ocean and shall be neutralized before discharging into the ocean.

104.11 Maintenance. Periodic cleaning shall be required to remove scale and salt deposits from pipes, tubing and membranes. Alkaline and acid cleaners shall be used to remove scale and salt deposits. Pipes, tubing and membranes shall be flushed after cleaners are used and before system start up.

CHAPTER 2

DEFINITIONS

201.0 General.

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.

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

202.0 Definition of Terms.

203.0 – A –

ABS – Acrylonitrile-butadiene-styrene is a thermoplastic compound from which pipe and fittings are made.

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

Air Admittance Valve – One-way valves designed to allow air to enter the plumbing drainage system when negative pressures develop in the piping system. The device closes by gravity and seals the vent terminal at zero differential pressure (no flow conditions) and under positive internal pressures. The purpose of an air admittance valve is to provide a method of allowing air to enter the plumbing drainage system to prevent siphonage of plumbing fixture traps.

Airbreak – A physical separation which may be a low inlet into the indirect waste receptor from the fixture, appliance, or device indirectly connected.

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

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

Anchors – See Supports.

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.

Approved Testing Agency – An organization primarily established for purposes of testing to approved standards and approved by the Authority Having Jurisdiction.

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, emirate, 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.

204.0 – B –

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

Backflow Connection – Any arrangement whereby backflow can occur.

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

Backflow Preventer – A device or means to prevent backflow into the potable water system.

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

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, bidet, and emergency floor drain.

Bathroom, Half – A room equipped with only a water closet and lavatory.

Battery of Fixtures – Any group of two or more similar, adjacent fixtures that discharge into a common horizontal waste or soil branch.

Biocide – A chemical used to kill biological organisms.

Black Water – Black water is untreated waste water from toilet waste, kitchen waste, dishwasher waste, or similarly contaminated sources and contains higher concentrations of nitrogen, organic matter and human pathogens.

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 – Any part of the piping system other than a main, riser, or stack.

Branch, Fixture – See Fixture Branch.

Branch, Horizontal – See Horizontal Branch.

Branch Interval – A length of soil or waste stack, corresponding in general to a story height, but in no case less than 2.4m (8 ft.), within which horizontal branches from one floor or story of the building are connected to the stack. The number of branch intervals shall be determined, starting with the highest horizontal branch connection and counting down to the stack to the lowest horizontal branch connection. Where no horizontal branches from one floor or story o the building are connected to the stack, this measurement shall not be used in determining the total branch intervals for the stack.

Branch Vent – A vent connecting one or more individual vents with a vent stack or stack vent.

Brine – Water that contains a high concentration of salt. Brine discharges from desalination plants may include constituents used in pretreatment processes, in addition to the high salt concentration seawater.

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.

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 60cm (2 ft.) 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. Building supply shall also mean water service.

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.

Clarifier – See Interceptor.

Clear Water Waste – Cooling water and condensate drainage from refrigeration and air-conditioning equipment; cooled condensate from steam heating systems; 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.

Coagulation – A pretreatment process used in some desalination plants. A substance is added to a solution to cause certain elements to thicken into a coherent mass, so that they may be removed.

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.

Cogeneration – A power plant that is designed to conserve energy by using "waste heat" from generating electricity for another purpose.

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 and/or pressures 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).

Common – That part of a plumbing system that is so designed and installed as to serve more than one appliance, fixture, building, or system.

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 $1.4m^3/300W{*}h$ ($50ft^3/1{,}000$ Btu/h) 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.

CPVC – Chlorinated Poly (Vinyl Chloride) is a polyvinyl chloride that has been chlorinated to improve the material characteristics.

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. When a backflow prevention device does not bear a critical level marking, the bottom of the vacuum breaker, combination valve, or the bottom of any such approved device shall constitute the critical level.

Cross-Connection – Any connection or arrangement, physical or otherwise, between a potable water supply system and any plumbing fixture or any tank, receptor, equipment, or device, through which it may be possible for nonpotable, used, unclean, polluted, and contaminated water, or other substances to enter into any part of such potable water system under any condition.

206.0 – D –

Deaeration – Removal of oxygen. A pretreatment process in desalination plants to reduce corrosion.

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

Desalination – Specific treatment processes such as reverse osmosis or multi-stage flash distillation, to demineralize seawater or brackish (saline) waters for reuse.

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.

Distillation – A process of desalination where the intake water is heated to produce steam. The steam is then condensed to produce product water with low salt concentration.

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 – Any 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.

Dual Plumbed Gray Water Systems – Sanitary drainage systems designed to separate gray water from black water.

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 Opening – The minimum cross-sectional area at the point of water supply discharge measured or expressed in terms of one diameter of a circle or two if the opening is not circular, the diameter of a circle of equivalent cross-sectional area (this is applicable also to airgap).

Electrodialysis – Most of the impurities in water are present in an ionized state. When an electric current is applied, the impurities migrate towards the positive and negative electrodes. The intermediate area becomes depleted of impurities and discharges a purified stream of product water. This technology is used for brackish waters but is not currently available for desalting seawater on a commercial scale.

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 (EVF) – A valve designed to activate when the fuel gas passing through it exceeds a prescribed flow rate.

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, when tested in accordance with ASTM E814, UL 1479 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

Falaj – Irrigation systems, conduits or channels in the ground, conveying water by gravity from one place to another for irrigation purposes.

Feedwater – Water fed to the desalination equipment. This can be source water with or without pretreatment.

Fill Valve – A water supply valve that opens and closes by means of a float or similar device used to supply water to a tank. An antisiphon fill valve contains a device in the form of an approved air gap or vacuum breaker that is an integral part of the fill valve and is positioned on the discharge side of the water supply control valve.

Fixture Branch – A water supply pipe between the fixture supply pipe and the water distributing 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 Level – See Flooded.

Flood-Level Rim – The top edge of a receptor from which water overflows.

Flooded – A fixture is flooded when the liquid therein rises to the flood-level rim.

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.

Fuel Gas – Natural, manufactured, liquefied petroleum, or a mixture of these.

FOG Disposal System – A grease interceptor that reduces nonpetroleum fats, oils, and grease (FOG) in effluent by separation, and mass and volume reduction.

FOG Irrigation Technologies – A system of collection and distribution of FOG water for agricultural and irrigation purposes.

209.0 – G –

Gang or Group Shower – Two or more showers in a common area.

Gas Piping – Any installation of pipe, valves, or fittings that is used to convey fuel gas, installed on any premises or in any building, but shall not include:

(1) Any portion of the service piping.

(2) Any approved piping connection having one-thousand, 1.8m (6 ft.) or less in length between an existing gas outlet and a gas appliance in the same room with the outlet.

Gas Piping System – Any 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 a mm (in.) or percentage slope per m (ft.) 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), a minimum of two compartments, a total volume of not less than 1,100L (300 gal.), 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.

Gray Water – Gray water is untreated waste water that has not come into contact with toilet waste, kitchen waste, dishwasher waste, or similarly contaminated sources. Gray water includes waste water from bathtubs, showers, and bathroom wash basins, clothes washers, and laundry tubs.

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) – Any hydromechanical grease interceptor that automatically, mechanically removes non-petroleum 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 –

Hangers – See Supports.

High Hazard – See Contamination.

High-Rise Building – A building where the floor of an occupiable story exceeds 23m (75 ft.) above the lowest level of fire department vehicle access. [NFPA 5000:3.3.65.10]

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 – Any pipe or fitting that is installed in a horizontal position or which makes an angle of less than 0.8 of a radian (45 degrees) with the horizontal.

Hot Water – Water at a temperature exceeding or equal to 50ºC (120ºF).

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, and/or barriers in combination or separately, and one of the following:

(1) External flow control, with air intake (vent): directly connected

(2) External flow control, without air intake (vent): directly connected

(3) Without external flow control, directly connected

(4) Without external flow control, indirectly connected

These interceptors comply with the requirements of Table 10-2. 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 – Any and all liquid or waterborne 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) Any trap that does not maintain a proper trap seal.

(2) Any opening in a drainage system, except where lawful, that is not provided with an approved liquid-sealed trap.

(3) Any defective fixture, trap, pipe, or fitting.

(4) Any trap, except where in this code exempted, directly connected to a drainage system, the seal of which is not protected against siphonage and back-pressure by a vent pipe.

(5) Any connection, cross-connection, construction, or condition, temporary or permanent, that would permit or make possible by any means whatsoever for any unapproved foreign matter to enter a water distribution system used for domestic purposes.

(6) 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.

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.

Invert – The lowest portion of the inside of a horizontal pipe.

Ion Exchange – A water treatment process. An electric charge is used to remove charged particles from solution.

Irrigation – the application of brackish or treated wastewater for the purpose of supplying moisture for plant growth.

Brackish Water – Water containing dissolved minerals in amounts that exceed normally acceptable standard municipal, domestic, and irrigation uses.

Treated Wastewater – Liquid waste discharged by domestic residences, commercial properties, and industry that has been subjected to one or more physical, chemical, and biological processes to reduce its pollution of health hazard to meet specific reuse requirements.

212.0 – J –

Joint, Brazed – Any joint obtained by joining of metal parts with alloys that melt at temperatures exceeding 450ºC (840ºF), but less than the melting temperature of the parts to be joined.

Joint, Fusion Welding – A joining method of plastic pipe and fittings by melting using heat alone, the surface of the parts to be joined together to form a union.

Joint, Mechanical – A joint that is not screwed, caulked, threaded, soldered, cemented, brazed or welded. A connection between pipes, fittings, or pipe and fittings using a form of internal gasket to assemble where compression is applied along the centerline of the pieces being 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 450ºC (840ºF).

Joint, Solvent Welding – A joining method by the process of fusing the materials of plastic pipe and fittings together by dissolving the surfaces to be joined with a solvent, cleaner or both and placing the softened surfaces together to cure.

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).

Lavatories in Sets – Two or three lavatories that are served by one trap.

Lead Free Pipe and Fittings – Containing not more than 8 percent lead.

Lead Free Solder and Flux – Containing not more than 0.2 percent lead.

Leader – An exterior vertical drainage pipe for conveying storm water from roof or gutter drains. See Downspout.

Liquefied Petroleum Gas (LPG) Facilities – Liquefied petroleum gas (LPG) facilities means tanks, containers, container valves, regulating equipment, meters, and/or appurtenances for the storage and supply of liquefied petroleum gas for any building, structure, or premises.

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

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 conforms to applicable standards and found safe for use in a specific manner.

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.

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 any 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.

Manifold – A control center with pipe openings or outlets for hot and cold water that feed each fixture supply pipe.

Manifold (Medical Gas) – 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]

May – A permissive term.

Medical Air – For purposes of this standard, 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 25ppm gaseous hydrocarbons.

(5) Have equal to or less than 5mg/m^3 of permanent particulates sized 1micron or larger in the air at normal atmospheric pressure. [NFPA 99:5.1.3.5.1(1)-(5)]

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 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 – A large trailer fitted with parts for connection to utilities, which is used for dwelling or sleeping purposes and is installed on a permanent site that is used as a residence.

Mobile Home Park Sewer – That part of the horizontal piping of a drainage system that begins 60cm (2 ft.) 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.

Mosques Wastewater Management – The reuse of water from abolition washrooms such as waste water from washbasins, showers, and hose attachments as gray water for landscape irrigation.

Multiple Effect Distillation (MED) – A form of distillation. Evaporators are in series, and vapor from one effect is used to evaporate water in the next lower pressure effect. This technology is in several forms, one of the most common of which is the Vertical Tube Evaporator (VTE).

Multistage Flash (MSF) – A form of distillation. Intake water is heated then discharged into a chamber maintained slightly below the saturation vapor pressure of the incoming water, so that a fraction of the water content flashes into steam. The steam condenses on the exterior surface of heat transfer tubing and becomes product water. The unflashed brine enters another chamber at a lower pressure, where a portion flashes to steam. Each evaporation and condensation chamber is called a stage.

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]

Nuisance – Includes, but is not limited to:

(1) Any public nuisance known at common law or in equity jurisprudence.

(2) Whenever any work regulated by this code is dangerous to human life or is detrimental to health and property.

(3) Inadequate or unsafe water supply or sewage disposal system.

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.

218.0 – P –

Patient Care Area – Any portion of a health care facility wherein patients are intended to be examined or treated. [NFPA 99:3.3.138]

PE – Polyethylene is classified as an inert polyolefin material (thermoplastic) made from ethylene, which is derived from fossil fuels (oil, gas and coal).

PE-AL-PE – Polyethylene-aluminum-polyethylene is a coextruded polyethylene composite pipe with aluminum tube reinforced between the inner and outer layers.

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, when installed properly on penetrating piping materials, is capable of maintaining the fire-resistance rating of assemblies penetrated.

PEX – Cross-linked polyethylene is a thermoplastic material made by cross-linking polyethylene.

PEX-AL-PEX – Cross-linked polyethylene - aluminum-cross-linked polyethylene is a composite pipe made of an aluminum tube laminated to the interior and exterior layers of cross-linked polyethylene.

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.

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 – Any one of a special class of devices or equipment that is intended to perform a special plumbing function. Its operation and/or control 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 shall be permitted to 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 shall be permitted to 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 any 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 when 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.

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 is a polyolefin that is joined by thermoplastic fusion process.

PP-R – Polyproplene random co-polymer is a type of polypropylene with a modification to the polymer that results in a material that is chemically, corrosion, and temperature resistant.

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

Static Pressure – The pressure existing without any flow.

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.

Pressure-Balancing Valve – A mixing valve that senses incoming hot and cold water pressures and compensates for fluctuations in either to stabilize outlet temperature.

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.

Product Water – The desalted water delivered to the water distribution system.

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 and their use is unrestricted.

Public Sewer – A common sewer directly controlled by public authority.

Purge, Flow – The removal of oxygen from a system by oil-free dry nitrogen during brazing.

Purge, System – The removal of nitrogen from a system with the medical gas required for that system.

PVC – Poly(vinyl chloride) is a thermoplastic material derived from common salt and fossil fuels (oil, gas and coal).

PVDF – Polyvinylidene Fluoride is a fluorocarbon material.

219.0 – Q –

Quick-acting Valve – A valve that closes quickly or abruptly where manually released or electrically actuated.

Quick-Disconnect Device – A hand-operated device that provides a means for connecting and disconnecting an appliance or an appliance connector to a gas supply and that is equipped with an automatic means to shut off the gas supply when the device is disconnected.

220.0 – R –

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.

Regulating Equipment – Includes all 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 – When 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.

Reverse Osmosis (RO) – A process of desalination where pressure is applied continuously to the feedwater, forcing water molecules through a semipermeable membrane. Water that passes through the membrane leaves the unit as product water; most of the dissolved impurities remain behind and are discharged in a waste stream.

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.

Root Hydration – A system where the distribution of water provides wetting along the root for uniform soil moisture.

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.

Scaling – Salt deposits on the interior surfaces of a desalination plant.

SCFM – Standard cubic feet per minute. [NFPA 99:3.3.163]

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.

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.

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. For the purposes of this appendix, where this term is used without any qualifier, it indicates only 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. [NFPA 1981:3.3.40]

Septic Tank – A water-tight 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 – Any 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.

Single-Family Dwelling – A building designed to be used as a home by the owner of such building, which shall be the only dwelling located on a parcel of ground with the usual accessory buildings.

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 – Any 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 – 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]

Storage Tank (Water) – A tank for the storage of potable water before it is distributed.

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.

Subsurface Irrigation – A method of providing water to plants by rasing the water table to the root zone or by carrying moisture to the root zone through a network of perforated underground pipe, valves, tubing and emitters.

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.

222.0 – T –

T Rating – The time period that the penetration firestop system, including the penetrating item, limits the maximum temperature rise of 163°C (325°F) above its initial temperature through the penetration on the nonfire side, when tested in accordance with ASTM E814, UL 1479 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

Tailpiece – The pipe or tubing that connects the outlet of a plumbing fixture to a trap.

Temporary Camping Areas (Wastewater Management) – Temporary living and sleeping quarters where tents or other temporary shelters are set up as housing which includes environmental health requirements to protect the health and sanitation for persons residing in the camps.

Thermostatic (Temperature Control) Valve – A mixing valve that senses outlet temperature and compensates for fluctuations in incoming hot or cold water temperatures.

Total Dissolved Solids (tds) – Total salt and calcium carbonate concentration in a sample of water, usually expressed in mg/L or parts per million (ppm). The recommended Maximum Contaminant Level (MCL) drinking water standard for total dissolved solids is 500mg/L, the upper MCL is 1,000mg/L, and the short-term permitted level is 1,500mg/L.

Transition Gas Riser – Any listed or approved section or sections of pipe and fittings used to convey fuel gas and installed in a gas piping system for the purpose of providing a transition from below ground to above ground.

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

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.

223.0 – U –

Unconfined Space – A room or space having a volume equal to not less than 1.4 m^3/293W*h (50 $ft.^3$/1,000 Btu/h) 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.

Unplasticized Poly Vinyl Chloride Pipe (PVC-U) – Unplasticized (Rigid) Poly Vinyl Chloride is a thermoplastic compound of which pipe and pipe fittings is made of.

Unsanitary – See Insanitary.

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. [NFPA 99:3.3.180]

User Outlet – See Station Outlet.

224.0 – V –

Vacuum – Any pressure less than that exerted by the atmosphere.

Vacuum Breaker – See Backflow Preventer.

Vacuum Freezing (VF) – A process of desalination where the temperature and pressure of the seawater is lowered so that the pure water forms ice crystals. The ice is then washed and melted to produce the product water. This technology is still being developed, and is not yet commercially competitive.

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]

Vacuum Waste Drainage System – An alternative to gravity drainage using the combined forces of atmospheric and vacuum pressures to move wastewater from its point of origin, which is at atmospheric pressure through a vacuumized waste piping network to a central collection point, which is under vacuum pressure. Waste is held at this collection point before being discharged to the facility's sanitary waste line or containment vessel.

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.

Vapor Compression (VC) – A form of distillation. A portion of feedwater is evaporated, and the vapor is sent to a compressor. Mechanical or thermal energy is used to compress the vapor, which increases its temperature. The vapor is then condensed to form product water and the released heat is used to evaporate the feedwater.

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

Vent Pipe – See 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 – A pipe or pipes installed to provide a flow of air to or from a drainage system or to provide a circulation of air within such system to protect trap seals from siphonage and back-pressure.

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 – Any pipe or fitting that is installed in a vertical position or that makes an angle of not more than 0.8 of a radian (45 degrees) 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-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-Distributing 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 excessive surge pressure (hydraulic shock) in the building water supply system where water is abruptly stopped.

Water Heater – An appliance for supplying hot water for domestic or commercial purposes.

Water Main (Street Main) – A water supply pipe for public or community use.

Water Supply Fixture Units – A numerical factor on an arbitrarily chosen scale assigned to intermittently used fixtures in order to calculate their load producing effects on the water supply system.

Water Supply System – The building supply pipe, the water-distributing 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.

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

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 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

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.

CHAPTER 3

GENERAL REGULATIONS

301.0 Materials – Standards and Alternates.

301.1 Minimum Standards.

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

301.1.2 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. When 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.

301.1.3 Standards. Standards listed or referred to in this chapter or other chapters cover materials that will conform to the requirements of this code, when used in accordance with the limitations imposed in this or other chapters thereof and their listing. Where a standard covers materials of various grades, weights, quality, or configurations, there may be only a portion of the listed standard that is applicable. Design and materials for special conditions or materials not provided for herein 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 are included in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. UPC-AD Installation Standards are included 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.

301.1.4 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 a proposal to deviate is first submitted for proper determination in order that health and safety requirements, as they pertain to plumbing, shall be observed.

301.2 Alternate Materials and Methods of Construction Equivalency. Nothing in this code is intended to prevent the use of alternate materials, 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 approve the system, method or device when determined by the Authority Having Jurisdiction to be equivalent or superior.

However, the exercise of this discretionary approval by the Authority Having Jurisdiction shall have no effect beyond the jurisdictional boundaries of said Authority Having Jurisdiction. Any alternate material or method of construction so approved shall not be considered as conforming to the requirements and/or intent of this code for any purpose other than that granted by the Authority Having Jurisdiction when the submitted data does not prove equivalency.

301.2.1 Testing. The Authority Having Jurisdiction shall have the authority to require tests, as proof of equivalency.

301.2.1.1 Tests shall be made in accordance with approved standards, by an approved testing agency at the expense of the applicant. In the absence of such standards, the Authority Having Jurisdiction shall have the authority to specify the test procedure.

301.2.1.2 The Authority Having Jurisdiction shall have the authority to require tests to be made or repeated if, at any time, there is reason to believe that any material or device no longer conforms to the requirements on which its approval was based.

301.3 Alternative Engineered Design.

301.3.1 Design Criteria. An alternative engineered design shall conform to the intent of the provisions of this code and shall provide an equivalent level of quality, strength, effectiveness, fire resistance, durability, and safety. Materials, equipment, or components shall be designed and installed in accordance with the manufacturer's installation instructions.

301.3.2 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 is part of the approved installation.

301.3.3 Technical Data. The registered professional engineer shall submit sufficient technical data to substantiate the proposed alternative engineered design and to prove that the performance meets the intent of this code.

301.3.4 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. When appropriate, the design documents shall indicate the direction of flow, pipe sizes, grade of horizontal piping, loading, and location of fixtures and appliances.

301.3.5 Design Approval. When the Authority Having Jurisdiction determines that the alternative engineered design conforms to the intent of this code, the plumbing system shall be approved. If the alternative engineered design is not approved, the Authority Having Jurisdiction shall notify the registered professional engineer in writing, stating the reasons therefore.

301.3.6 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.

302.0 Disposal of Liquid Waste.

It shall be unacceptable for any person to cause, suffer, or permit the disposal of sewage, human excrement, or other liquid wastes, in any place or manner, except through and by means of an approved drainage system, installed and maintained in accordance with the provisions of this code.

303.0 Connections to Plumbing System Required.

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.

304.0 Sewers Required.

304.1 Every building in which plumbing fixtures are installed shall have a connection to a public or private sewer except as provided in Section 304.2.

304.2 When a public sewer is not available for use, drainage piping from buildings and premises shall be connected to an approved private sewage disposal system.

304.3 In cities and/or counties where the installation of building sewers is under the jurisdiction of a department other than the Authority Having Jurisdiction, the provisions of this code relating to building sewers need not apply.

305.0 Damage to Drainage System or Public Sewer.

305.1 It shall be unacceptable for any person to deposit, by any means whatsoever, into any plumbing fixture, floor drain, interceptor, sump, receptor, or device, which is connected to any 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 would, or could, cause damage to the drainage system or public sewer.

305.2 Roofs, inner courts, vent shafts, light wells, or similar areas having a rainwater drain, shall discharge to the outside of the building or to the gutter and shall not be connected to the sanitary drainage system unless first approved by the Authority Having Jurisdiction.

306.0 Industrial Wastes.

306.1 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 Sewage or other waste from a plumbing system that are deleterious to surface or subsurface waters shall not be discharged into the ground or into any waterway unless it has first been rendered safe by some acceptable form of treatment as required by the Authority Having Jurisdiction.

307.0 Location.

307.1 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 any lot other than the lot that is the site of the building, structure, or premises served by such facilities.

307.2 No subdivision, sale, or transfer of ownership of existing property shall be made in such a manner that the area, clearance, and access requirements of this code are decreased.

308.0 Improper Location.

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

309.2 It is unacceptable to conceal cracks, holes, or other imperfections in materials by welding, brazing, or soldering or by using therein or thereon any paint, wax, tar, solvent cement, or other leak-sealing or repairing agent.

309.3 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 conforming to this code, applicable standards, and the manufacturer's installation instructions. In instances where the code, applicable standards, or the manufacturer's instructions conflict, the more stringent provisions shall prevail.

310.0 Prohibited Fittings and Practices.

310.1 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 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 No waste connection shall be made to a closet bend or stub of a water closet or similar fixture.

310.4 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 per Section 301.1 of this code. The enlargement of a 80mm (3 in.) closet bend or stub to 100mm (4 in.) shall not be considered an obstruction.

310.5 Except for necessary valves, where intermembering or mixing of dissimilar metals occurs, the point of connection shall be confined to exposed or accessible locations.

310.6 Valves, pipes, and fittings shall be installed in correct relationship to the direction of flow.

310.7 Screwed fittings shall be ABS, PVC, or other approved materials. Threads shall be tapped out of solid metal or molded in solid ABS or PVC.

311.0 Water Conservation.

311.1 Purpose. Water conservation measures provided for in this code relate to the necessary measures to establish and enforce methods and procedures to ensure that the water resources are available to the public. Measures include that the unreasonable use, or unreasonable method of use is prevented, and that the conservation of water is accomplished in the interest of public health, safety, welfare and conservation of water resource. All water usage shall be metered in accordance with the provisions set forth by the Authority Having Jurisdiction.

311.1.1 Maximum Flow Rate. Existing fixture fittings for private or public use shall be provided with water conserving devices (aerators or flow restrictors) in accordance with Table 3-1.

TABLE 3-1
Fixture Fitting Maximum Flow Rates

Fixture Fitting	Maximum Flow Rates
Lavatory, Faucet (public)	2L/min
Lavatory, Faucet (private)	8L/min
Shower Head or Hand-held Spray	10L/min
Sink, Faucet	8L/min
Bidet, Hand-held Spray	8L/min

SI: 1L/min = 0.26 gpm

311.1.2 Addition, Alterations or Repairs. Alterations, repairs, and replacement of plumbing fixtures and fixture fittings for private or public use shall comply with the maximum water flow rates and flush volumes in accordance with the applicable provisions in Chapter 4 for new systems.

311.1.3 Changes in Building Occupancy. Plumbing fixtures and fixture fittings that are part of any building or structure undergoing a change in use or occupancy shall comply with the maximum water flow rates and flush volumes in accordance with the applicable provisions in Chapter 4 for new use or occupancy.

312.0 Independent Systems.

The drainage system of each new building and of new work installed in any existing building shall be separate and independent from that of any other building, and, when available and permitted by the Authority Having Jurisdiction, 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.

313.0 Protection of Piping, Materials, and Structures.

313.1 Pipes Passing Through or Under Walls. Piping passing under or through walls shall be protected from breakage. Piping passing through concrete, under cinders, walls, or other corrosive materials shall be protected from external corrosion by a protective coating, wrapping, or by other means that withstand the corrosive material. The material shall have a wall thickness of not less than 0.6mm (0.025 in.). Approved provisions shall be made for expansion of hot water pipes. Voids around piping passing through concrete floors on the ground shall be appropriately sealed.

313.2 Stress and Strain. 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 as defined in the Building Code.

313.3 Location of Building Sewer. 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 60cm (2 ft.) of any building or structure, or less than 30cm (1 ft.) below the surface of the ground.

313.4 Protection Against Corrosion or Physical Damage. Piping subject to corrosion, erosion, or mechanical damage shall be protected in an approved manner.

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 corrosion, erosion, and mechanical damage.

313.5 Protectively Coated Pipe. Protectively coated pipe shall be inspected and tested, and any visible void, damage, or imperfection to the pipe coating shall be repaired to comply with Section 313.0.

313.6 Condensation. Piping subject to operation at temperatures that will form condensation on the exterior of the pipe shall be thermally insulated.

313.7 Insulation and Location. All hot water piping, except when serving an internal fixture, shall be installed in an exterior wall and insulated throughout the developed length of pipe. Such insulation shall have not less than an R-4 value and be approved by the Authority Having Jurisdiction. All cold water shall be installed in an interior wall, except when serving a fixture, and shall not be grouped together with the hot water piping at any point within the system. Hot water pipe should be set at a minimum distance of 20cm (8 in.) from the cold water pipe.

313.8 Exposure. Plastic pipe and fittings shall not be exposed to direct sunlight and shall be stored in an approved manner as to prevent sagging or bending. Tubing and fittings exposed to UV light shall be protected by wrapping with an opaque covering.

313.9 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 applicable Building Codes, applicable standards referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction, and Chapter 15, “Firestop Protection.”

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

313.11 Plastic piping penetrating framing members to within 25mm (1 in.) of the exposed framing shall be protected by steel nail plates not less than 1.3mm (0.05 in. [18 gauge]) in thickness. The steel nail plate shall extend along the framing member not less 40mm (1-1/2 in.) beyond the outside diameter of the pipe or tubing.

313.12 Sleeves.

313.12.1 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.

313.12.2 Piping through concrete or masonry walls shall not be subject to any load from building construction.

313.12.3 In exterior walls, annular space between sleeves and pipes shall be sealed and made water-tight, as approved by the Authority Having Jurisdiction. Any penetration through fire-resistive construction shall be in accordance with Section 313.9.

313.12.4 Any pipe sleeve through a firewall shall have the space around the pipe completely sealed with an approved fire-resistive material in accordance with other codes.

313.13 Any structural member that has been 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 applicable Building Codes or as required by the Authority Having Jurisdiction.

313.14 Ratproofing.

313.14.1 Strainer plates on drain inlets shall be designed and installed so that no opening is exceeding 15mm (0.5 in.) in the least dimension.

313.14.2 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.

313.14.3 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.

313.14.4 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 screens securely fastened to the adjoining structure with no opening exceeding 15mm (0.5 in.) in the least dimension.

314.0 Hangers and Supports.

314.1 Suspended piping shall be supported at intervals not to exceed those shown in Table 3-3.

314.2 Piping shall be supported in such a manner as to maintain its alignment and prevent sagging.

314.3 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 per Section 301.0 of this code.

314.4 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.

314.5 Piping, fixtures, appliances, and appurtenances shall be adequately supported in accordance with this code, the manufacturer's installation instructions, and as required by the Authority Having Jurisdiction.

314.6 Hanger rod sizes shall be no smaller than those shown in Table 3-2.

TABLE 3-2
Hanger Rod Sizes

Pipe and Tube Size mm	Rod Size mm
15 - 100	10
125 - 200	15
250 - 300	16

SI: 1mm = 0.04 in.

314.7 Gas piping shall be supported by metal straps or hooks at intervals not to exceed those shown in Table 3-3.

314.8 Piping for manifold systems shall be supported in accordance with the manufacturer's instructions. Hot and cold water distribution piping shall maintain separation at all points within the system.

315.0 Trenching, Excavation, and Backfill.

315.1 Trenches deeper than the footing of any building or structure and paralleling the same shall be not less than 0.8 radian (45 degrees) therefrom, or as approved per Section 301.0 of this code.

315.2 Tunneling and driving shall be permitted to be done in yards, courts, or driveways of any 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 60cm (2 ft.) above the pipe and shall be limited in length to 1/2 the depth of the trench, with a maximum length of 2.4m (8 ft.). When pipes are driven, the drive pipe shall be not less than one size larger than the pipe to be laid.

315.3 Open Trenches. Excavations required to be made for the installation of a building drainage system or any 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.

315.4 Excavations shall be completely backfilled as soon after inspection as practicable. Adequate precaution shall be taken to ensure proper compactness of backfill around piping without damage to such piping. Trenches shall be backfilled in thin layers to 30cm (1 ft.) above the top of the piping with clean earth, which shall not contain stones, boulders, cinderfill, construction debris, other materials that would 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. Suitable precautions shall be taken to ensure permanent stability for pipe laid in filled or made ground.

316.0 Joints and Connections.

316.1 Types of Joints.

316.1.1 Threaded Joints. 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, nonhardening material or tape. Thread tape or thread lubricants and sealants specifically intended for use with plastics shall be used on plastic threads. Conventional pipe thread compounds, putty, linseed-oil-based products, and unknown lubricants and sealants shall not be used on plastic threads.

316.1.2 Mechanical Joints. When pipe is joined by means of flexible compression joints, such joints shall conform to approved standards and shall not be considered as slip joints. Mechanical joints shall be installed in accordance with the manufacturer's instructions.

316.1.3 Solvent Cement Plastic Pipe Joints. Plastic pipe and fittings designed to be joined by solvent cementing shall comply with applicable Standards referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

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

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

Exception: Listed solvent cements that do not require the use of primer shall be permitted for use with CPVC pipe and fittings, manufactured in accordance with ASTM D2846 or equivalent International Standard(s) approved by the Authority Having Jurisdiction, 15mm through 50mm in diameter (0.5 in. - 2 in.).

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

A solvent cement transition joint between ABS and PVC building drain and building sewer shall be made using a listed transition solvent cement.

316.1.4 Pressure-Lock-Type Connection. This is 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.

316.1.5 Push-Fit Fitting. This is a mechanical connection for joining PEX and CPVC tubing. The connection is hand assembled by pushing the tubing into the fitting. The connection seals with an "O" ring.

316.1.6 Heat-Fusion Weld Joints. This type of joining method involves the preparation of surfaces to be fused, heating of the surfaces to proper fusion temperatures, and bringing the surfaces together in a manner to form the fusion bond. Plastic pipe and fittings designed to be joined by heat-fusion shall comply with one of the specific methods as follows:

(1) A butt heat-fusion joint shall be joined by a device that holds the heater element square to the ends of the piping, compresses the heated ends together, and holds the pipe in proper alignment while the plastic hardens.

(2) A socket heat-fusion joint shall be joined by a device that heats the mating surfaces of the joint uniformly and simultaneously to essentially the same temperature. Proper alignment devices shall be used to hold the pipe and socket fitting together during the joining process.

(3) An electro-fusion joint shall be joined, utilizing the equipment and techniques of the fitting manufacturer's equipment. This technique involves the resistance wire that is

embedded in the fitting. This resistance wire supplies the heat source necessary for fusion.

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

316.3 Flanged Fixture Connections.

316.3.1 Fixture connections between drainage pipes and water closets, floor outlet service sinks and urinals shall be made by means of approved ABS, PVC, 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.

316.3.2 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.

316.3.3 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.

316.4 Prohibited Joints and Connections.

316.4.1 Drainage System. Any 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.

316.4.2 No fitting or connection that offers abnormal obstruction to flow shall be used. The enlargement of a 80mm (3 in.) closet bend or stub to 100mm (4 in.) shall not be considered an obstruction.

317.0 Increasers and Reducers.

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.

318.0 Food-Handling Establishments.

Food or drinks 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:

318.1 Openings through floors over such areas shall be sealed water-tight to the floor construction.

318.2 Floor and shower drains installed above such areas shall be equipped with integral seepage pans.

318.3 Soil or drain pipes shall be of an approved material as listed in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction and Section 701.0. Materials shall conform to established standards. Cleanouts shall be extended through the floor construction above.

318.4 Piping subject to operation at temperatures that will form condensation on the exterior of the pipe shall be thermally insulated.

318.5 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.

319.0 Test Gauges.

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

319.1 Required pressure tests of 70kPa (10 psi) or less shall be performed with gauges of 0.5kPa (0.10 psi) incrementation or less.

319.2 Required pressure tests exceeding 70kPa (10 psi) but less than or equal to 700kPa (100 psi) shall be performed with gauges of 5kPa (1 psi) incrementation or less.

319.3 Required pressure tests exceeding 700kPa (100 psi) shall be performed with gauges incremented for 2 percent or less of the required test pressure.

319.4 Test gauges shall have a pressure range not exceeding twice the test pressure applied.

320.0 Medical Gas and Vacuum Systems.

Such piping shall be installed, tested, and verified in compliance with the applicable standards referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction and the requirements of Chapter 13. The Authority Having Jurisdiction shall require evidence of the competency of the installers and verifiers.

TABLE 3-3
Pipe Material Spacing and Supports

Nominal Pipe Size mm	PVDF		Polyolefin		PVC/ABS	
	Horizontal[1,2,3,4] m	Vertical[5,6] m	Horizontal[1,2,3,4] m	Vertical[5,6] m	Horizontal[1,2,3,4] m	Vertical[5,6] m
15	0.6	2.4	0.6	2.4	0.6	2.4
20	0.6	3.0	0.6	3.0	0.6	3.0
25	0.6	3.0	0.6	3.0	0.6	3.0
32	1.2	3.0	1.2	3.0	1.2	3.0
40	1.2	3.0	1.2	3.0	1.2	3.0
50	1.2	3.0	1.2	3.0	1.2	3.0
65	1.2	3.0	1.2	3.0	1.2	3.0
80	1.2	3.0	1.2	3.0	1.2	3.0
100	1.2	3.0	1.2	3.0	1.2	3.0
150	1.4	3.0	1.4	3.0	1.4	3.0

Nominal Pipe Size mm	CPVC		PEX		PEX-AL-HDPE	
	Horizontal[1,2,3,4] m	Vertical[5,6] m	Horizontal[1,2,3,4] m	Vertical[5,6] m	Horizontal[1,2,3,4] m	Vertical[5,6] m
15	0.5	1.0	0.5	1.0	0.5	1.0
20	0.5	1.0	0.5	1.0	0.5	1.0
25	0.5	1.0	0.5	1.0	0.5	1.0
32	0.8	1.4	0.8	1.4	0.8	1.4
40	0.8	2.0	0.8	2.0	0.8	2.0
50	1.2	2.2	1.2	2.2	1.2	2.2
65	1.5	2.2	1.5	2.2	1.5	2.2
80	1.5	2.4	1.5	2.4	1.5	2.4
100	1.8	2.4	1.8	2.4	1.8	2.4
150	1.8	2.4	1.8	2.4	1.8	2.4

Nominal Pipe Size mm	PEX-AL-PEX		PEX-AL-PE		POLYPROPYLENE	
	Horizontal[1,2,3,4] m	Vertical[5,6] m	Horizontal[1,2,3,4] m	Vertical[5,6] m	Horizontal[1,2,3,4] m	Vertical[5,6] m
15	0.5	1.0	0.5	1.0	0.5	1.0
20	0.5	1.0	0.5	1.0	0.5	1.0
25	0.5	1.0	0.5	1.0	0.5	1.0
32	0.8	1.4	0.8	1.4	0.8	1.4
40	0.8	2.0	0.8	2.0	0.8	2.0
50	1.2	2.2	1.2	2.2	1.2	2.2
65	1.5	2.2	1.5	2.2	1.5	2.2
80	1.5	2.4	1.5	2.4	1.5	2.4
100	1.8	2.4	1.8	2.4	1.8	2.4
150	1.8	2.4	1.8	2.4	1.8	2.4

Nominal Pipe Size mm	Stainless Steel	
	Horizontal[1,2,3,4] m	Vertical[5,6] m
15	1.8	2.4)
20	2.4	2.4
25	2.4	2.7
32	2.7	3.0
40	3.0	3.0
50	3.0	3.0
65	3.0	3.0
80	3.0	3.0
100	3.0	3.0
150	3.0	3.0

Notes:

1 Support adjacent to joint, not to exceed 46cm (18 in.).

2 Brace at intervals of not more than 12m (40 ft.) 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, when first approved by the Authority Having Jurisdiction.

6 See the appropriate UPC-AD, Installation Standard for expansion and other special requirements.

SI: 1m = 3.3 ft., 1mm = 0.04 in.

CHAPTER 4

PLUMBING FIXTURES AND FIXTURE FITTINGS

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 conform in quality and design to nationally recognized applicable standards included in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

401.2 Plumbing fixture fittings covered under the scope of NSF 61 shall comply with the requirements of DIN/NSF 61 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

402.0 Water-Conserving Fixtures and Fittings.

402.1 Maximum flow rates and flush volumes shall be in accordance with applicable standards referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction, and Table 4-1.

402.2 Water Closets. Water closets, either flush tank, flushometer tank, or flushometer valve operated, shall have an average consumption of not more than 6L (1.6 gal) of water per flush. Dual flush water closets shall have an average water consumption in accordance with Table 4-1.

TABLE 4-1
Maximum Flow Rates and Flush Volumes

Plumbing Fixtures/ Fixture Fittings	Maximum Flow Rate
Water Closets (Dual Flush)	4/6L/flush
Water Closet (Single Flush)	5L/flush
Urinals	2L/flush
Lavatory, Faucet (public)	2L/min
Lavatory, Faucet (private)	6L/min
Sink, Faucet	8L/min
Bidet, Hand-held Spray	8L/min
Shower Head or Hand-held Spray	10L/min

SI: 1L = 0.26 gallon, 1L/min. = 0.26 gpm

402.3 Urinals. Urinals shall have an average water consumption of not more than 2L (0.5 gal.) of water per flush.

402.3.1 Nonwater Urinals. Where nonwater urinals are installed, they shall be listed and comply with the applicable standards referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. 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.

402.4 Faucets. Maximum flow rates for faucets shall be in accordance with Table 4-1. Flow rates shall be restricted by the use of air entrained faucets, aerators, or flow restricting devices.

402.5 Emergency Safety Showers. Emergency safety showers shall not be limited in their water supply flow rates.

402.6 Installation. Water-conserving fixtures shall be installed in strict accordance with the manufacturer's instructions to maintain their rated performance.

403.0 Overflows.

When any fixture is provided with an overflow, the waste shall be so arranged that the standing water in the fixture cannot rise in the overflow when the stopper is closed or remains in the overflow when 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 unacceptable to connect such overflows with any other part of the drainage system.

404.0 Strainers and Connections.

404.1 Strainers/Gratings. 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.

404.2 Connections. Fixtures having concealed slip joint connections shall be provided with an access panel or utility space not less than 30cm (1 ft.) in its least dimension and so arranged without obstructions as to make such connections accessible for inspection and repair.

404.3 Continuous wastes and fixture tailpieces shall be constructed from the materials specified in Section 701.0 for drainage piping, provided, however, that such connections where exposed or accessible shall be permitted to be of seamless drawn brass not less than 0.8mm (0.032 in. [No. 20 B&S Gauge]). Each such tailpiece, continuous waste, or waste and overflow shall be not less than 40mm (1.5 in.) O.D. for sinks, dishwashers, laundry tubs, bathtubs, urinals, and similar fixtures, and not less than 32mm (1.25 in.) for lavatories, drinking fountains, and similar small fixtures.

404.4 Approved wye or other directional-type branch fittings shall be installed in continuous wastes connecting or receiving the discharge from food waste disposal units, dishwashers, clothes washers, or other force discharge fixtures or appliances. No dishwasher drain shall be connected to a sink tailpiece, continuous waste, or trap on the discharge side of a food waste disposal unit.

405.0 Prohibited Fixtures.

405.1 Water closets having an invisible seal or an unventilated space or having walls which are not thoroughly washed at each discharge shall be prohibited. Any water closet that might permit siphonage of the contents of the bowl back into the tank shall be prohibited. Drinking fountains shall not be installed in public toilet rooms.

405.2 Prohibited Urinals. Trough urinals and urinals with an invisible seal shall be prohibited.

Exception: Non-water urinals.

405.3 Fixed wooden, or tile wash trays or sinks for domestic use shall not be installed in any 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 any building used for human habitation, unless first approved by the Health Officer.

406.0 Special Fixtures and Specialties.

406.1 Water and Waste Connections. Baptisteries, ornamental and lily ponds, aquaria, ornamental fountain basins, and similar fixtures and specialties requiring water and/or waste connections shall be submitted for approval to the Authority Having Jurisdiction prior to installation.

406.2 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 1.6mm (0.0625 in. [No. 16 U.S. Gauge]). Sheet-metal plumbing fixtures shall be adequately designed, constructed, and braced in an approved manner to satisfactorily accomplish their intended purpose.

406.3 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.

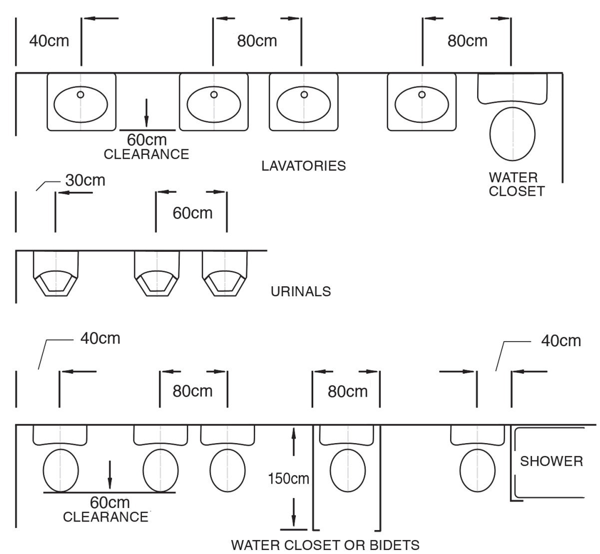
406.4 Zinc Alloy Components. Zinc alloy components shall meet the applicable nationally recognized standards and shall be used in accordance with their listing.

407.0 Installation.

407.1 Cleaning. Plumbing fixtures shall be installed in a manner to afford easy access for repairs and cleaning. Where practical, pipes from fixtures shall be run to the nearest wall.

407.1.1 Interior Finish. Plumbing fixtures installed in bathrooms shall be finished with a nonabsorbent floor and wall surface. Such wall surfaces shall extend to a height of not less than 2m (7 ft.).

407.2 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 water-tight.



SI: 1cm = 0.39 in.

Figure 4-1
Clearances for Fixtures

407.3 Securing Fixtures. Floor-outlet or floor-mounted fixtures shall be rigidly secured to the drainage connection and to the floor, when so designed, by screws or bolts of copper, brass, or other equally corrosion-resistant material.

407.4 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.

407.5 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 40cm (15 in.) from its center to any side wall or obstruction, nor closer than 80cm (30 in.) center to center to any similar fixture. The clear space in front of any water closet or bidet shall be not less than 60cm (2 ft.). No urinal shall be set closer than 30cm (1 ft.) from its center to any side wall or partition, nor closer than 60cm (2ft.) center to center.

The installation of paper dispensers or accessibility grab bars shall not be considered obstructions.

Plumbing fixtures for use and their installation shall conform to the requirements of this section and approved by the Authority Having Jurisdiction. Alternate designs for use and installation shall be approved by the Authority Having Jurisdiction in accordance with Section 301.2.

407.6 Installations for Persons with Disabilities. Where facilities for persons with disabilities are required in applicable building regulations, the facilities shall be installed in accordance with those regulations.

407.7 Supply Fittings. The supply lines and fittings for every plumbing fixture shall be so installed as to prevent backflow as required in Chapter 6.

408.0 Water Closets.

408.1 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 as required below.

408.2 Water Closet Seats.

408.2.1 Water closet seats shall be of smooth, non-absorbent material. Seats for public use shall conform to the applicable standard referenced in Table l4-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

408.2.2 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.

408.2.3 Water closet seats shall be properly sized for the water closet bowl type.

408.3 Securing Floor-Mounted, Back-Outlet Water Closet Bowls. Floor-mounted, back-outlet water closet bowls shall be set level with an angle equal to 1.6 of a radian (90 degrees) 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 15cm (5 in.) 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 80mm (3 in.) in diameter. Offset, eccentric, or reducing floor flanges shall not be used.

408.4 Closet Rings (Closet Flanges).

408.4.1 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 20cm (7 in.) in diameter and, when installed, shall, together with the soil pipe, present a 40mm (1.5 in.) wide flange or face to receive the fixture gasket or closet seal.

408.4.2 Caulked-on closet rings (closet flanges) shall be not less than 6mm (0.25 in.) thick and not less than 50mm (2 in.) in overall depth.

408.4.3 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.

408.4.4 Closet rings (closet flanges) shall be adequately designed and secured to support fixtures connected thereto.

408.4.5 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 adequate size and number to properly support the fixture installed.

409.0 Urinals.

Every water supply to a urinal shall be protected by an approved-type vacuum breaker or other approved backflow prevention device as described in Section 603.4.

410.0 Flushing Devices for Water Closets and Urinals.

410.1 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 anti-siphon requirements required in Section 603.4.

410.2 Automatic Flushing Tanks. Automatic flushing tanks for urinals shall not be used to prevent excessive usage of water. However, manually/automatically controlled flushing devices shall be installed with each urinal.

410.3 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. When 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.

410.4 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 when 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.

410.5 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 when installed per manufacturer's instructions.

411.0 Floor Drains and Shower Stalls.

411.1 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, floor receptors, and shower drains shall be of an approved type, suitably flanged to provide a water-tight joint in the floor.

411.2 Location of Floor Drains. Floor drains shall be installed in the following areas:

411.2.1 Toilet rooms or ablution rooms containing water closets, urinals, hand-held sprays, or any combination thereof, containing two or more water closets or a combination of one water closet and one urinal.

411.2.2 Commercial kitchens and in accordance with Section 704.3.

411.2.3 Laundry rooms in commercial buildings and common laundry facilities in multi-family dwelling buildings.

411.3 Food Storage Areas. If 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 where required under Section 803.0 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, when supplied, are 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.

411.4 Floor Slope. Floors shall be sloped to floor drains where drainage occurs on a regular or frequent basis, or as otherwise required by the Authority Having Jurisdiction.

411.5 Shower receptors are plumbing fixtures and shall conform to the general requirements contained in Section 401.0. Each such shower receptor shall be constructed of vitrified china or earthenware, ceramic tile, porcelain-enameled metal, or of such other material acceptable to the Authority Having Jurisdiction. No shower receptor shall be installed unless it conforms to acceptable standards as referenced in Table 14-1, equivalent International Standard(s) approved by the Authority of Having Jurisdiction or until a specification or a prototype or both of such receptor has first been submitted to and approval obtained from the Authority Having Jurisdiction.

411.6 Each shower receptor shall be an approved type and be so constructed as to have a finished dam, curb, or threshold that is not less than 25mm (1 in.) lower than the sides and back of such receptor. In no case shall any dam or threshold be less than 50mm (2 in.) or exceeding 25cm (9 in.) in depth when 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 water-tight and extend vertically not less than 25mm (1 in.) above the top of the sides of the receptor. The finished floor of the receptor shall slope uniformly from the sides toward the drain not less than 20mm/m (0.25 in./ft.), nor more than 40mm/m (0.5 in./ft.). Thresholds shall be of sufficient width to accommodate not less than a 60cm (22 in.) door. Shower doors shall open so as to maintain not less than a 60cm (22 in.) unobstructed opening for egress.

Exception: Showers that are designed to comply with the accessibility standards listed in Table 14-1 or equivalent International Standard(s) approved by the Authority of Having Jurisdiction.

411.7 Shower compartments, regardless of shape, shall have a finished interior of not less than $0.7m^2$ ($1,024 in.^2$) and shall also be capable of encompassing a 80cm (30 in.) 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 1.8m (70 in.) 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 80cm (30 in.) circle.

Exception No. 1: Showers that are designed to comply with ICC A117.1.

Exception No. 2: The minimum required area and dimension shall not apply for a shower receptor having overall dimensions of not less than 80cm (30 in.) in width and 1.5m (60 in.) in length.

411.8 When the construction of on-site built-up shower receptors is permitted by the Authority Having Jurisdiction, receptors built directly on the ground shall be water-tight 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 water-tight 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 80mm (3 in.) above the top of the finished dam or threshold and shall be first lined with sheet plastic,* lead,* or copper,* or lined with other durable and water-tight 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 water-tight materials that extend not less than 80mm (3 in.) above horizontal surfaces of the seat or the seating area.

Lining materials shall be pitched 20mm/m (0.25 in./ft.) 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 80mm (3 in.) 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, 7kg (15 lbs.) of 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 water-tight 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 100mm (4 in.) in all directions from the corner, and webbing shall be of approved type and mesh, producing a tensile strength of not less than 3.5bar (50 psi) 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 any point that is less than 25mm (1 in.) above the finished dam or threshold. An approved-type subdrain shall be installed with every shower subpan or lining. Each such sub-drain 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 conform to approved standards acceptable to the Authority Having Jurisdiction.

*Note: Lead and Copper subpans or linings shall be insulated from conducting substances other than their connecting drain by 7kg (15 lbs) of asphalt felt or its equivalent, and no lead pan or liner shall be constructed of material weighing less than 20kg/m^2 (4 lbs./$ft.^2$). Copper pans or liners shall be not less than 0.5mm (0.02 in. [No. 24 B & S Gauge]). 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.

411.8.1 Tests for Shower Receptors. Shower receptors shall be tested for water-tightness 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.

411.9 Floors of public shower rooms shall have a nonskid surface and shall be drained in such a manner that wastewater 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 percent toward drains. Drains in gutters shall be spaced not more than 2.4m (8 ft.) from sidewalls, nor more than 4.8m (16 ft.) apart.

411.10 Location of Valves and Heads. Control valves and showerheads shall be located on the sidewall of shower compartments or be otherwise arranged so that the showerhead does not discharge directly at the entrance to the compartment and the bather can adjust the valves prior to stepping into the shower spray.

411.11 Water Supply Riser. Every water supply riser from the shower valve to the showerhead outlet, whether exposed or not, shall be securely attached to the structure.

412.0 Minimum Number of Required Fixtures.

412.1 Fixture Count. Plumbing fixtures shall be provided for the type of building occupancy and in the minimum number shown in Table 4-2.

412.2 Access to Fixtures.

412.2.1 In multi-story buildings, accessibility to the required fixtures shall not exceed one vertical story.

412.2.2 Fixtures accessible only to private offices shall not be counted to determine compliance with this section.

412.3 Separate Facilities. Separate toilet facilities shall be provided for each sex.

Exceptions:

(1) Residential installations.

(2) In occupancies serving not more than ten people, 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 floor area not exceeding 140m^2 (1,500 $ft.^2$), one toilet facility, designed for use by no more than one person at a time, shall satisfy the requirements for serving customers and employees of both sexes.

412.4 Fixture Requirements for Special Occupancies.

412.4.1 Additional fixtures may be required when unusual environmental conditions or referenced activities are encountered.

412.4.2 In food preparation areas, fixture requirements may be dictated by health codes.

412.4.3 Types of occupancy not shown in Table 4-2 shall be considered individually by the Authority Having Jurisdiction.

412.5 Facilities in Mercantile and Business Occupancies Serving Customers.

412.5.1 Requirements for customers and employees shall be permitted to be met with a single set of restrooms accessible to both groups.

The required number of fixtures shall be the greater of the required number for employees or the required number for customers.

412.5.2 Fixtures for customer use shall be permitted to be met by providing a centrally located facility accessible to several stores. The maximum distance from entry to any store to this facility shall not exceed 150m (500 ft.).

412.5.3 In stores with a floor area of 14m^2 (150 $ft.^2$) or less, the requirement to provide facilities for employees shall be permitted to be met by providing a centrally located facility accessible to several stores. The maximum distance from entry to any store to this facility shall not exceed 90m (300 ft).

412.6 Toilet Facilities for Workers. Suitable toilet facilities shall be provided and maintained in a sanitary condition for the use of workers during construction.

413.0 Fixtures and Fixture Fittings for Persons with Disabilities.

Plumbing fixtures and fixture fittings for persons with disabilities shall conform to the appropriate standards referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

413.1 Limitation of Hot Water Temperature for Public Lavatories. Hot water delivered from public-use lavatories shall be limited to a maximum temperature of 50ºC (120ºF) by a device that conforms to ASSE 1070, CSA B125.3 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. The water heater thermostat shall not be considered a control for meeting this provision.

414.0 Bathtubs and Whirlpool Bathtubs.

Unless otherwise listed, bathtubs and whirlpool bathtubs shall comply with the following requirements:

414.1 A removable panel shall be provided to access and remove the pump. Whirlpool pump access located in the crawl space shall be located no more than 6m (20 ft.) from an access door, trap door, or crawl hole.

414.2 The circulation pump shall be located above the crown weir of the trap.

414.3 The pump and the circulation piping shall be self-draining to minimize water retention in accordance with standards referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

414.4 Suction fittings on whirlpool bathtubs shall comply with the listed standards or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

414.5 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 50ºC (120ºF) by a device that conforms to ASSE 1070, CSA B125.3 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. The water heater thermostat shall not be considered a control for meeting this provision.

415.0 Installation of Fixture Fittings.

Where two separate handles control the hot and cold water, the left-hand control of the faucet when facing the fixture fitting outlet shall provide the means to alter the hot water temperature from the fixture fitting.

Single-handle mixing valves shall have the flow of hot water correspond to the markings on the fitting.

416.0 Bidets.

416.1 Materials. Bidets shall conform to the standards listed in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

416.2 Backflow Protection. The water supply to the bidet shall be protected according to Chapter 6, which allows for an airgap or vacuum breaker.

416.3 Limitation of Water Temperature in Bidets. The maximum hot water temperature discharging from a bidet shall be limited to 40ºC (110ºF) by a device that conforms to ASSE 1070, CSA B125.3 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. The water heater thermostat shall not be considered a control for meeting this provision.

417.0 Future Fixtures.

When 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 conform with the plumbing requirements of this code.

418.0 Shower and Tub-Shower Combination Control Valves.

Showers and tub-shower combinations in buildings 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. These valves shall conform to ASSE 1016, ASME A112.18.1/CSA B125.1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Gang showers, when supplied with a single temperature-controlled water supply pipe, shall be controlled by a mixing valve that conforms to ASSE 1069 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Handle position stops shall be provided on such valves and shall be per the manufacturer's instructions to deliver a maximum mixed water setting of 50ºC (120ºF). The water heater thermostat shall not be considered a suitable control for meeting this provision.

TABLE 4-2
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. Table 4-2 applies to new buildings, additions to a building, and changes of occupancy or type in an existing building resulting in increased occupant load. Exception: New cafeterias used only by employees.

The total occupant load shall be determined in accordance with the Building Code. The type of building or occupancy shall be determined based on the actual use of the various spaces within the building. Building categories not shown in Table 4-2 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.

Once the occupant load and uses are determined, the requirements of Section 412.0 and Table 4-2 shall be applied to determine the minimum number of plumbing fixtures required.

Type of Building or Occupancy[2]	Water Closets[14, 18] (Fixtures per Person)	Urinals[5, 10] (Fixtures per Person)	Lavatories (Fixtures per Person)	Bathtubs or Showers (Fixtures per Person)	Abolition Stand, Pedestal or Sink (Fixtures per Person)	Drinking Fountains[3, 13, 17] (Fixtures per Person)
Assembly places – theaters, auditoriums, convention halls, etc. – for permanent employee use	Male Female 1: 1-15 1: 1-15 2: 16-35 3: 16-35 3: 36-55 4: 36-55 Over 55, add 1 fixture for each additional 40 persons.	Male 0: 1-9 1: 10-50 Add 1 fixture for each additional 50 males.	Male Female 1 per 40 1 per 40		1: 1-10 2: 11-40 Over 40, add 1 fixture for each additional 50 persons.	
Assembly places – theaters, auditoriums, convention halls, etc. – for public use	Male Female 1: 1-100 3: 1-50 2: 101-200 4: 51-100 3: 201-400 8: 101-200 11: 201-400 Over 400, add 1 fixture for each additional 500 males and 1 for each additional 125 females.	Male 1: 1-100 2: 101-200 3: 201-400 4: 401-600 Over 600, add 1 fixture for each additional 300 males.	Male Female 1: 1-200 1: 1-200 2: 201-400 2: 201-400 3: 401-750 3: 401-750 Over 750, add 1 fixture for each additional 500 persons.		1: 1-10 2: 11-100 Over 100, add 1 fixture for each additional 100 persons.	1: 1-150 2: 151-400 3: 401-750 Over 750, add 1 fixture for each additional 500 persons.
Dormitories[9] – School or labor[16]	Male Female 1 per 10 1 per 8 Add 1 fixture for each additional 25 males (over 10) and 1 for each additional 20 females (over 8).	Male 1 per 25 Over 150, add 1 fixture for each additional 50 males.	Males Female 1 per 12 1 per 12 Over 12, add 1 fixture for each additional 20 males and 1 for each additional 15 females.	1 per 8 For females, add 1 bathtub per 30. Over 150, add 1 bathtub per 20.	1: 1-10 2: 11-20 3: 21-40 Over 40, add 1 fixture for each additional 20 persons.	1 per 150[12]
Dormitories – for staff use[16]	Male Female 1: 1-15 1: 1-15 2: 16-35 3: 16-35 3: 36-55 4: 36-55 Over 55, add 1 fixture for each additional 40 persons.	Male 1 per 50	Male Female 1 per 40 1 per 40	1 per 8	1: 1-10 2: 11-40 3: 41-80 Over 80, add 1 fixture for each additional 50 persons.	
Dwellings[4] Single dwelling Multiple dwelling or apartment house[16]	1 per dwelling 1 per dwelling or apartment unit		1 per dwelling 1 per dwelling or apartment unit	1 per dwelling 1 per dwelling or apartment unit		
Hospital waiting rooms	1 per room		1 per room		2 per room	1 per 150[12]
Hospitals – for employee use	Male Female 1: 1-15 1: 1-15 2: 16-35 3: 16-35 3: 36-55 4: 36-55 Over 55, add 1 fixture for each additional 40 persons.	Male 0: 1-9 1: 10-50 Add 1 fixture for each additional 50 males.	Male Female 1 per 40 1 per 40		1: 1-10 2: 11-40 Over 40, add 1 fixture for each additional 50 persons.	
Hospitals Individual room Ward room	1 per room 1 per 8 patients		1 per room 1 per 10 patients	1 per room 1 per 20 patients	1 per 10	1 per 150[12]
Industrial[6] warehouses, workshops, foundries, and similar establishments – for employee use	Male Female 1: 1-10 1: 1-10 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 1 fixture for each additional 30 persons.		Up to 100, 1 per 10 persons. Over 100, 1 per 15 persons[7, 8]	1 shower for each 15 persons exposed to excessive heat or to skin contamination with poisonous, infectious, or irritating material	1: 1-10 2: 11-40 3: 41-80 Over 80, add 1 fixture for each additional 50 persons.	1 per 150[12]
Institutional – other than hospitals or penal institutions (on each occupied floor)	Male Female 1 per 25 1 per 20	Male 0: 1-9 1: 10-50 Add 1 fixture for each additional 50 males.	Male Female 1 per 10 1 per 10	1 per 8	1 per 10	1 per 150[12]
Institutional – other than hospitals or penal institutions (on each occupied floor) – for employee use	Male Female 1: 1-15 1: 1-15 2: 16-35 3: 16-35 3: 36-55 4: 36-55 Over 55, add 1 fixture for each additional 40 persons.	Male 0: 1-9 1: 10-50 Add 1 fixture for each additional 50 males.	Male Female 1 per 40 1 per 40	1 per 8	1 per 20	1 per 150[12]

Type of Building or Occupancy[2]	Water Closets[14, 18] (Fixtures per Person)	Urinals[5, 10] (Fixtures per Person)	Lavatories (Fixtures per Person)	Bathtubs or Showers (Fixtures per Person)	Abolition Stand, Pedestal or Sink (Fixtures per Person)	Drinking Fountains[3, 13, 17] (Fixtures per Person)
Office or public buildings	Male Female 1: 1-100 3: 1-50 2: 101-200 4: 51-100 3: 201-400 8: 101-200 11: 201-400 Over 400, add 1 fixture for each additional 500 males and 1 for each additional 150 females.	Male 1: 1-100 2: 101-200 3: 201-400 4: 401-600 Over 600, add 1 fixture for each additional 300 males.	Male Female 1: 1-200 1: 1-200 2: 201-400 2: 201-400 3: 401-750 3: 401-750 Over 750, add 1 fixture for each additional 500 persons.		1: 1-10 2: 11-40 3: 41-80 Over 80, add 1 fixture for each additional 50 persons.	1 per 150[12]
Office or public buildings – for employee use	Male Female 1: 1-15 1: 1-15 2: 16-35 3: 16-35 3: 36-55 4: 36-55 Over 55, add 1 fixture for each additional 40 persons.	Male 0: 1-9 1: 10-50 Add 1 fixture for each additional 50 males.	Male Female 1 per 40 1 per 40		1: 1-10 2: 11-40 Over 40, add 1 fixture for each additional 50 persons.	
Penal institutions – for employee use	Male Female 1: 1-15 1: 1-15 2: 16-35 3: 16-35 3: 36-55 4: 36-55 Over 55, add 1 fixture for each additional 40 persons.	Male 0: 1-9 1: 10-50 Add 1 fixture for each additional 50 males.	Male Female 1 per 40 1 per 40		1: 1-10 2: 11-40 Over 40, add 1 fixture for each additional 50 persons.	1 per 150[12]
Penal institutions – for prison use Cell Exercise room	 1 per cell 1 per exercise room	 Male 1 per exercise room	 1 per cell 1 per exercise room		 1 per cell 2 per exercise room	 1 per cell block floor 1 per exercise room
Public or professional offices[15]	Same as Office or Public Buildings for employee use[15]	Same as Office or Public Buildings for employee use[15]	Same as Office or Public Buildings for employee use[15]		Same as Office or Public Buildings for employee use[15]	Same as Office or Public Buildings for employee use[15]
Restaurants, pubs, and lounges[11, 15]	Male Female 1: 1-50 1: 1-50 2: 51-150 2: 51-150 3: 151-300 4: 151-300 Over 300, add 1 fixture for each additional 200 persons.	Male 1: 1-150 Over 150, add 1 fixture for each additional 150 males.	Male Female 1: 1-150 1: 1-150 2: 151-200 2: 151-200 3: 201-400 3: 201-400 Over 400, add 1 fixture for each additional 400 persons.		1 per 40 customers	
Retail or wholesale stores	Male Female 1: 1-100 1: 1-25 2: 101-200 2: 26-100 3: 201-400 4: 101-200 6: 201-300 8: 301-400 Over 400, add 1 fixture for each additional 500 males and 1 for each 150 females.	Male 0: 0-25 1: 26-100 2: 101-200 3: 201-400 4: 401-600 Over 600, add 1 fixture for each additional 300 males.	1 per 2 water closets		1: 1-10 2: 11-40 3: 41-80 Over 80, add 1 fixture for each additional 50 persons.	0: 1-30[17] 1: 31-150 Over 150, add 1 drinking fountain for each additional 150 persons.
Schools – for staff use All schools	Male Female 1: 1-15 1: 1-15 2: 16-35 2: 16-35 3: 36-55 3: 36-55 Over 55, add 1 fixture for each additional 40 persons.	Male 1 per 50	Male Female 1 per 40 1 per 40		1: 1-10 2: 11-40 3: 41-80 Over 80, add 1 fixture for each additional 50 persons.	
Schools – for student use Nursery	Male Female 1: 1-20 1: 1-20 2: 21-50 2: 21-50 Over 50, add 1 fixture for each additional 50 persons.		Male Female 1: 1-25 1: 1-25 2: 26-50 2: 26-50 Over 50, add 1 fixture for each additional 50 persons.		1 per 20 students	1 per 150[12]
Elementary	Male Female 1 per 30 1 per 25	Male 1 per 75	Male Female 1 per 35 1 per 35		1 per 20 students	1 per 150[12]
Secondary	Male Female 1 per 40 1 per 30	Male 1 per 35	Male Female 1 per 40 1 per 40		1 per 20 students	1 per 150[12]
Others (colleges, universities, adult centers, etc.)	Male Female 1 per 40 1 per 30	Male 1 per 35	Male Female 1 per 40 1 per 40		1 per 20 students	1 per 150[12]
Mosques	Male Female 1 per 15 1 per 10		Male Female 1 per 20 1 per 10		1 per 10 worshippers	1 per 150[12]
Worship places educational and activities unit	Male Female 1 per 150 1 per 75	Male 1 per 150	1 per 2 water closets			1 per 150[12]
Worship places principal assembly place	Male Female 1 per 150 1 per 75	Male 1 per 150	1 per 2 water closets			1 per 150[12]

Notes:

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

[2] Building categories not shown on this table shall be considered separately by the Authority Having Jurisdiction.

[3] Drinking fountains shall not be installed in toilet rooms.

[4] Laundry trays. 1 laundry tray or 1 automatic washer standpipe for each dwelling unit or 1 laundry tray or 1 automatic washer standpipe, or combination thereof, for each 12 apartments. Kitchen sinks, 1 for each dwelling or apartment unit.

[5] For each urinal added in excess of the minimum required, one water closet may be deducted. The number of water closets shall not be reduced to less than 2/3 of the minimum requirement.

[6] As required by PSAI Z4.1, *Sanitation in Places of Employment* or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

[7] Where there is exposure to skin contamination with poisonous, infectious, or irritating materials, provide 1 lavatory for each 5 persons.

[8] 60cm (2 ft.) of wash sink or 45cm (18 in.) of a circular basin, when provided with water outlets for such space, shall be considered equivalent to 1 lavatory.

[9] Laundry trays, 1 for each 50 persons. Service sinks, 1 for each 100 persons.

[10] General. In applying this schedule of facilities, consideration shall be given to the accessibility of the fixtures. Conformity purely on a numerical basis may not result in an installation suited to the needs of the individual establishment. For example, schools should be provided with toilet facilities on each floor having classrooms.

a. Surrounding materials, wall, and floor space to a point 60cm (2 ft.) in front of urinal lip and 1.2m (4 ft.) above the floor, and not less than 60cm (2 ft.) to each side of the urinal shall be lined with non-absorbent materials.
b. Trough urinals shall be prohibited.

[11] 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.

[12] Where food is consumed indoors, water stations may be substituted for drinking fountains. Offices, or public buildings for use by more than 6 persons shall have 1 drinking fountain for the first 150 persons and 1 additional fountain for each 300 persons thereafter.

[13] There shall be not less than 1 drinking fountain per occupied floor in schools, theatres, auditoriums, dormitories, offices, or public buildings.

[14] The total number of water closets for females shall be at least equal to the total number of water closets and urinals required for males. This requirement shall not apply to Retail or Wholesale Stores.

[15] For smaller-type Public and Professional Offices such as banks, dental offices, law offices, real estate offices, architectural offices, engineering offices, and similar uses. A public area in these offices shall use the requirements for Retail or Wholesale Stores.

[16] Recreation or community room in multiple dwellings or apartment buildings, regardless or their occupant load, shall be permitted to have separate single-accommodation facilities in common-use areas within tracts or multi-family residential occupancies where the use of these areas is limited exclusively to owners, residents, and their guests. Examples are community recreation or multi-purpose areas in apartments, condos, townhouses, or tracts.

[17] A drinking fountain shall not be required in occupancies of 30 or less. When a drinking fountain is not required, then footnotes 3, 12, and 13 are not applicable.

[18] European water closets shall be permitted.

SI: 1cm = 0.39 in., 1m = 3.3 ft.

CHAPTER 5

WATER HEATERS, SOLAR THERMAL ENERGY AND CHILLERS

Part I

501.0 General.

The regulations of this chapter shall govern the construction, location, and installation of water heaters heating potable water, use of solar thermal energy for solar space heaters, solar water heating and chillers. The minimum capacity for water heaters shall be in accordance with the first hour rating listed in Table 5-1. Design, construction, and workmanship shall be in conformity with accepted engineering practices, the manufacturer's installation instructions and applicable standards, and shall be of such character as to secure the results sought to be obtained by this code. No water heater shall be hereinafter installed that does not comply in all respects with the type and model of each size thereof approved by the Authority Having Jurisdiction. A list of accepted appliance standards are included in Table 14-1 or equivalent International Standard(s) acceptable to the Authority Having Jurisdiction.

502.0 Water Heaters.

502.1 Construction and Installation. Water heaters deriving heat from fuels or types of energy other than gas shall be constructed and installed in accordance with approved standards. For gas connections to water heaters shall be in accordance with ADNOC Standards. Vents for such appliances shall be approved types. An adequate supply of air for combustion and 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.

502.1.1 Location. Water heaters shall be installed so as to provide for access, maintenance, and replacement.

502.1.2 Base. A water heater supported from the ground shall rest on level concrete or other approved base extending not less than 80mm (3 in.) above the adjoining ground level.

502.1.3 Pan. When 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 water-tight pan of corrosion-resistant materials shall be installed beneath the water heater with not less than 20mm (3/4 in.) diameter drain to an approved location. Discharge from a relief valve into a water heater pan shall be prohibited.

502.1.4 Valves. A fullway valve shall be installed on the cold water supply pipe to each water heater at or near the water heater.

502.1.5 Joints. Where two dissimilar metal materials are joined together at the water heater, an approved dielectric insulator shall be installed on the water piping connection to the water heater and related water heating equipment.

502.2 Electric Water Heaters. Electric water heaters shall comply with UL 174, UL 1453, or the equivalent International Standard(s) acceptable to the Authority Having Jurisdiction. Such water heaters shall be listed and labeled (third-party certified), in compliance with ASHRAE 90.1 or equivalent International Standards approved by the Authority Having Jurisdiction. The minimum capacity for water heaters shall be in accordance with the first hour rating listed in Table 5-1. A drain valve shall be provided for emptying the water heater and installed at the bottom of each tank type heater and storage tank.

502.3 Oil-Fired Water Heaters. Oil-fired water heaters shall be installed in accordance with NFPA 31, *Standard for the Installation of Oil-Burning Equipment* or the equivalent International Standard(s) acceptable to the Authority Having Jurisdiction

502.4 Indirect Fired Water Heaters.

502.4.1 Applicable Standards. Indirect-fired water heaters shall conform to applicable sections of the ASME *Boiler and Pressure Vessel Code*, one of the other applicable standards referenced in Table 14-1 or the equivalent International Standard(s) acceptable to the Authority Having Jurisdiction. Each water heater shall bear a label in accordance with ASME requirements, or an

TABLE 5-1[1] FIRST HOUR RATING

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] L	159	204	204	204	254	254	303	254	303	303	303

Note:

[1] The first hour rating is found on the "Energy Guide" label.

[2] Non-storage and solar water heaters shall be sized to meet the appropriate first hour rating as shown in the table.

SI: 1L=0.26 gallons

approved testing agency, certifying and attesting that such an appliance has been tested, inspected and meets the requirements of the applicable standards or code.

502.4.2 Single-Wall Heat Exchanger. Indirect-fired water heaters that incorporate a single-wall heat exchanger shall meet all of the following requirements:

(1) Connected to a low-pressure hot water boiler limited to a maximum of 2bar (30 psi) 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 must 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 2bars (30 psi) by an approved safety or relief valve.

 Note: The word: "Caution" and the statements in letters shall have an uppercase height of not less than 3mm (0.12 in.) The vertical spacing between lines of type shall be not less than 1mm (0.046 in.). Lower-case letters shall be compatible with the uppercase letter size specification.

502.5 Permits. It shall be unacceptable for any person to install, remove, replace or cause to be installed, removed, or replace any water heater, without first obtaining a permit from the Authority Having Jurisdiction to do so.

502.6 Inspections.

502.6.1 Final Water Heater Inspection. This inspection shall be made after all work authorized by the permit has been installed. The Authority Having Jurisdiction will make such inspection as 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.

503.0 Water Heater Connections.

503.1 Water Heater Connectors. Plastic tubing shall not be installed within the first 50cm (18 in.) of piping connected to a water heater. Stainless steel or copper tubing/pipe that is approved materials for water distribution piping shall be permitted.

503.2 Flexible Corrugated Connectors. Flexible corrugated connectors of copper or stainless steel shall be limited to 60cm (2 ft.). Flexible corrugated water heater connectors shall be stainless steel or copper conforming to ASME A112.18.6 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

504.0 Safety Devices.

504.1 Pressure-Limiting Valve. 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 instructions. Any 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 complying with CSA Z21.22 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Each pressure relief valve shall be an approved automatic type with drain, and each such relief valve shall be set at a pressure not exceeding 10bar (150 psi). No shutoff valve shall be installed between the relief valve and the system or in the drain line.

504.2 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 instructions.

504.3 Combination Temperature and Pressure Relief Valve. Any 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 non-storage instantaneous heaters having an inside diameter not exceeding 80mm (3 in.) and energy cutoff device. Each combination temperature and pressure relief valve shall comply with CSA Z21.22 or equivalent International Standard(s) approved by the Authority Having Jurisdiction and be installed on the water-heating device in an approved location based on its listing requirements and the manufacturer's instructions. The combination temperature and pressure relief valve shall discharge in accordance with Section 504.5. Relief valve shall be set at a pressure of not more than 10bar (150 psi) and shall have a temperature setting of not more than 99ºC (210ºF). No shutoff or check valve shall be installed between the relief valve and the system or in the drain line. The hourly discharge capacity in watts or the rated steam relief capacity of the device shall not be less than the input rating of the water heater.

504.4 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 or bottom fed, a vacuum relief valve complying with CSA Z21.22 or equivalent International Standard(s) approved by the Authority Having Jurisdiction shall be installed on the storage tank or heater.

504.5 Discharge for Relief Valve. Relief valves serving a pressure-limiting, temperature-limiting, or combination temperature and pressure relief valves shall comply with the following:

(1) Relief valves located inside a building shall be provided with a drain, not less than the relief valve outlet.

(2) Discharge pipe shall be approved for water distribution systems and rated for temperatures not less than 121ºC (250ºF) at 7bar (100 psi).

(3) Discharge piping shall not be smaller than the diameter of the outlet of the valve served and shall extend from the valve to the outside of the building.

(4) The end of the discharge pipe shall be not more than 60cm (2 ft.) nor less than 15cm (6 in.) above the ground or the flood level of the area receiving the discharge and pointing downward.

(5) Discharge pipe shall be permitted to terminate at other approved locations and shall not cause structural damage.

(6) No part of such discharge pipe shall be trapped and installed to drain by gravity.

(7) The terminal end of the discharge pipe shall not be threaded.

(8) The discharge pipe shall discharge through an airgap and shall not be directly connected to the drainage system.

505.0 Appliances on Roofs.

505.1 General.

(1) Appliances on roofs shall be designed or enclosed so as to withstand climactic 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 80cm (30 in.) clearance between the entire service access panel(s) of the appliance and the wall of the enclosure. [NFPA 54:9.4.1.1]

(2) 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]

(3) All access locks, screws, and bolts shall be of corrosion-resistant material. [NFPA 54:9.4.1.3]

505.2 Installation of Appliances on Roofs.

(1) Appliances shall be installed in accordance with its listing and the manufacturer's installation instructions. [NFPA 54:9.4.2.1]

(2) Appliances shall be installed on a well-drained surface of the roof. Not less than 1.8m (6 ft.) of clearance shall be available between any 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 1.1m (42 in.) in height shall be provided on the exposed side. [NFPA 54:9.4.2.2]

(3) Appliances requiring an external source of electrical power for its operation shall be provided with one a readily accessible electrical disconnecting means within sight of the appliance that will completely de-energize the appliance, and two a 120-V AC 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]

(4) 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, a suitable 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 can be safely serviced where water stands on the roof. [NFPA 54:9.4.2.4]

505.3 Access to Appliances on Roofs.

505.3.1 General. Appliances located on roofs or other elevated locations shall be accessible. [NFPA 54:9.4.3.1]

505.3.2 Minimum Height. Buildings exceeding 4.5m (15 ft.) 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]

505.3.3 Dimension and Clearance. 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 56cm x 60cm (22 in. x 24 in.) in size, shall open easily and safely under all conditions; and shall be constructed so as to permit access from the roof side unless deliberately locked on the inside.

Not less than 1.8m (6 ft.) of clearance shall be available between the access opening and the edge of the roof or similar hazard, or rigidly fixed rails or guards not less than 1.1m (42 in.) 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 1.1m (42 in.) in height. [NFPA 54:9.4.3.3]

505.3.4 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]

505.4 Appliances in Attics.

505.4.1 Attic Access. An attic 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 56cm x 76cm (22 in. x 30 in.). [NFPA 54:9.5.1]

505.4.2 Passageway Clearance. Where the height of the passageway is less than 1.8m (6 ft.), the distance from the passageway access to the appliance shall not exceed 6m (20 ft.) measured along the centerline of the passageway. [NFPA 54:9.5.1.1]

505.4.3 Passageway Dimension. The passageway shall be unobstructed and shall have solid flooring not less than 60cm (24 in.) wide from the entrance opening to the appliance. [NFPA 54:9.5.1.2]

505.4.4 Work Platform. A level working platform not less 76cm x 76cm (30 in. x 30 in.) shall be provided in front of the service side of the appliance. [NFPA 54:9.5.2]

505.4.5 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]

PART II
Solar Thermal Energy for Solar Space Heaters and Solar Water Heating.

506.0 Thermal Storage or Heat Exchanger Tank Construction.

506.1 General. Plans for tanks shall be submitted to the Authority Having Jurisdiction for approval, unless listed by an approved listing agency. Such plans shall show dimensions, reinforcing, structural calculations, and such other pertinent data as required.

506.1.1 Tanks shall be constructed of materials in accordance with nationally recognized standards, not subject to corrosion or decay and shall be water-tight. Such tank and tank covers shall be structurally designed to withstand all anticipated loads and pressures, and shall be installed level and on a solid base.

506.1.2 Prefabricated tanks shall be listed as required by the Authority Having Jurisdiction.

506.1.3 Tanks shall be permitted to be buried underground when listed and constructed for such burial.

506.1.4 Devices attached to or within the tank shall be accessible for repair and replacement.

506.1.5 Each gravity tank shall be equipped with an overflow opening Internal Pipe Size (IPS) of not less than 50mm (2 in.). The openings shall be above ground and equipped with a screened return bend.

506.1.6 Solar energy systems used for heating potable water shall comply with Part II of this chapter for cross-connection or protection of the potable water supply system required in this code.

506.2 Concrete. The walls and floor of each poured-in-place, concrete tank shall be monolithic. The exterior walls shall be double-formed so as to provide exposure of the exterior walls during the required water test. The minimum compressive strength of any concrete tank wall, top and covers, or floor shall be 172bar (2,500 psi). The concrete shall be sulfate resistant (Type V Portland Cement).

507.0 Expansion Tanks.

507.1 General. Hot water heating systems shall be provided with an air expansion tank securely fastened to the structure. Supports shall be adequate to carry twice the weight of the tank filled with water without placing any strain on connecting piping.

507.2 Systems with Open Expansion Tanks. Systems equipped with an open expansion tank for thermal water expansion shall be provided with an indoor overflow from the upper portion of the expansion tank in addition to an open vent. The indoor overflow shall discharge within the building to an approved location to prevent structural damage.

507.3 Closed-Type Systems. Systems of the closed type shall have an air-tight tank or other suitable air cushion that will be consistent with the volume and capacity of the system, and shall be suitably designed for a hydrostatic test pressure of 2-1/2 times the allowable working pressure of the system. Expansion tanks for systems designed to operate at or above 2bar (30 psi) shall be constructed in accordance with nationally recognized standards approved by the Authority Having Jurisdiction. Provisions shall be made for draining the tank without emptying the system, except for pressurized tanks.

507.4 Minimum Capacity of Closed-Type Tank. The minimum capacity of the closed-type expansion tank shall be determined from Table 5-2 and Table 5-3 or from the following formula:

$$Vt = \frac{(0.00041t - 0.0466)\,Vs}{\frac{(Pa}{(Pf} - \frac{Pa)}{Po)}}$$

Where:

Vt = minimum volume of expansion tank, L.

Vs = volume of system, not including expansion tank, L.

t = average operating temperature, °C.

Pa = atmospheric pressure, m H_2O absolute.

Pf = fill pressure, m H_2O absolute.

Po = maximum operating pressure, m H_2O absolute.

507.5 Test Pressure for Tanks Used in Solar Systems. The test pressure for tanks that are subject to water pressure from utility mains (with or without a pressure reducing valve) shall be two times the working pressure but not less than 21bar (300 psi).

508.0 Collectors.

508.1 Construction. Frames and braces exposed to the weather shall be constructed of materials for exterior locations, and protected from corrosion or deterioration, as approved by the Authority Having Jurisdiction.

508.1.1 Support. Panels shall be anchored to roof structures or other surfaces in a manner to resist wind or seismic loadings in compliance with the Building Code. Anchors secured to and through a roofing material shall be made to maintain the water integrity of the roof covering. Roof drainage shall not be impaired by the installation of collectors. Panels that are not an integral part of the roofing system shall be installed to preserve the integrity of the roof surface.

508.1.2 Minimum Height. Panels installed at ground level shall be not less than 15cm above the ground level.

508.1.3 Glass. Glass used in collector construction shall be tempered.

508.1.4 Plastic. Plastic used in collector construction shall be installed in accordance with its listing and the manufacturer's instructions.

508.1.5 Listed. Collectors that are manufactured as a complete component shall be listed or labeled by an approved listing agency.

508.2 Location. Collectors shall be located and oriented in accordance with the manufacturer's installation instructions to optimize the sun's energy, consistent with the intended purpose of the system.

508.3 Air Collectors.

508.3.1 Materials Exposed Within Collectors. Materials exposed within collectors shall be noncombustible or shall have a flame spread index not exceeding 25 and a smoke developed index not exceeding 50, when tested as a composite product in accordance with one of the following test methods: NFPA 255, *Method of Test of Surface Burning Characteristics of Building Materials*, ASTM E84, *Surface Burning Characteristics of Building Materials*, or UL 723, T*est for Surface Burning Characteristics of Building* or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

508.3.2 Materials Used Within Air Collectors. Materials used within an air collector shall not smoke, smolder, glow, or flame when tested in accordance with ASTM C411 *Test for Hot Surface Performance of High Temperature Thermal Insulation* or equivalent International Standard(s) approved by the Authority Having Jurisdiction, at temperatures exposed to in service. In no case shall the test temperature be less than 121°C (250°F).

508.4 Fire Safety Requirements.

508.4.1 Building Components. Collectors that function as building components shall comply with the Building Code.

508.4.2 Location Within Building Components. Collectors located above or on roofs and functioning as building components shall not reduce the required fire-resistance nor fire-retardance classification of the roof covering materials.

Exceptions:

(1) One- and two-family dwellings.

(2) Collectors located on buildings not exceeding 3 stories in height and/or 836m² (9,000 ft.²) total floor area, providing:

 (a) The collectors are noncombustible.

 (b) Collectors with plastic covers have noncombustible sides and bottoms, and the total area covered and the collector shall not exceed the following:

  (i) Plastic CC1 – 33-1/3 percent of the roof area, or

  (ii) Plastic CC2 – 25 percent of the roof area.

(3) Collectors with plastic film covers having a thickness of 0.25mm (0.010 in.) or less shall have noncombustible sides and bottoms, and the total area covered by the collector shall not exceed 33-1/3 percent of the roof area.

TABLE 5-2
Expansion Tank Capacities for Gravity Hot Water Systems

Based on a two-pipe system with an average operating water temperature of 77ºC, using cast-iron column radiation with a heat emission rate of 473W/m^2 equivalent direct radiation.

m^2 of Installed Expansion Direct Radiation[1]	Tank Capacity, L
Up to 33	68
Up to 42	80
Up to 60	91
Up to 84	114
Up to 102	133
Up to 130	151
Up to 149	8 to 134
Up to 167	8 to 134
Up to 186	8 to 133
Up to 223	8 to 151

Note:

[1] For systems with more than 223m^2 of installed equivalent direct water radiation, the required capacity of the cushion tank shall be increased on the basis of 3.8L tank capacity per 3m^2 of additional equivalent direct radiation.

SI: 1m^2 = 10.8 ft.^{2}; 1L= 0.23 gal.; 1.8ºC + 32 = ºF

1W/m^2 = 150 Btu/ft.^{2}; 1m^2 = 10.76 ft.^{2}

TABLE 5-3
Expansion Tank Capacities for Forced Hot Water Systems

Based on an average operating water temperature of 91ºC, a fill pressure of 0.8bar, and a maximum operating pressure of 2bar.

System Volume,[1] L	Tank Capacity, L
379	57
757	114
1,136	170
1,514	227
1,893	284
3,785	568
7,570	1,136

Note:

[1] Includes volume of water in boiler, radiation, and piping, not including expansion tank.

SI: 1L = 0.22 gal.; 1bar = 14.5 psi; 1.8ºC + 32 = ºF

509.0 Thermal Insulation.

509.1 General. Piping and storage tanks shall be insulated according to this chapter to minimize heat loss. Piping need not be insulated when exposed in conditioned spaces, and the heat loss from such piping does not otherwise contribute to the heating or cooling load within such space. Minimum pipe insulation shall be provided in accordance with Table 5-4.

509.2 Finish. Insulation shall be finished with a jacket or facing with the laps sealed with adhesives or staples so as to secure the insulation on the pipe. Insulation exposed to the weather shall be weatherproofed in accordance with standard practices acceptable to the Authority Having Jurisdiction. In lieu of jackets, molded insulation shall be permitted to be secured with 16 gauge galvanized wire ties not exceeding 23cm (9 in.) on center.

509.3 Tanks. Tanks shall have a minimum thickness of insulation not less than values shown in Table 5-5 or equivalent.

509.4 Temperature Difference. Temperature difference shall be calculated as the difference between the design operating temperature of the tank and the design temperature of the surrounding air or soil during the operating season. When engineering data is not available, assume 38°C (100°F) indoors and 66°C (150°F) outdoors for water and space heating and 66°C (150°F) for air-conditioning.

509.5 Insulation. Coverings and insulation used for hot water pipes shall be of material suitable for the operating temperature of the system. The insulation, jackets, and lap-seal adhesives, including pipe coverings and linings, shall have a flame spread index not exceeding 25 and a smoke-developed index not exceeding 50 when tested in accordance with NFPA 255, *Method of Test of Burning Characteristics of Building Materials*; ASTM E 84, *Surface Burning Characteristics of Building Materials*; UL 723, *Test for Surface Burning Characteristics of Building Materials* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. The specimen preparation and mounting procedures of ASTM E 2231, *Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics* or equivalent International Standard(s) approved by the Authority Having Jurisdiction shall be used. Alternately, materials used for pipe coverings and insulation (including the insulation, jacket, and lap-seal adhesives) shall have a maximum peak heat release rate of 300kW (47,390 Btu), a maximum total heat release of 14kWh (1,024,000 Btu), a maximum total smoke release of 500m^2 (5,382 ft.^{2}) and shall not generate flames that extend 30cm (1 ft.) or more above the top of the vertical portion of the apparatus at any time during the test when tested in accordance with NFPA 274, *Standard Test Method to Evaluate Fire Performance Characteristics of Pipe*

TABLE 5-4
Minimum Pipe Insulation

Fluid Temperature Range in °C	Pipe Diameter in mm: 25 and Less	32 – 50	65 – 100	130 – 150	200 and Larger
	Insulation Thickness[1] in mm				
152 – 238	65	65	80	100	100
122 – 152	50	65	65	80	80
94 – 121	40	40	50	50	50
41 – 93	25	25	40	40	40

SI: 1.8ºC + 32 = ºF; 1mm = 0.04 in.

[1] Insulation thickness in Table 5-4 is based on materials having thermal resistance in the range of R = 4.0 to 4.6 per 2.5cm. For materials with thermal resistance less than R = 4.0 per 2.5cm, the minimum insulation thickness shall be determined as follows:

$$\frac{4.0 \text{ x Table 5-5 thickness}}{\text{actual R}} = \text{new minimum thickness}$$

For materials with thermal resistance more than R = 4.6 per 2.5cm, the minimum insulation thickness shall be permitted to be reduced as follows:

$$\frac{4.6 \text{ x Table 5-5 thickness}}{\text{actual R}} = \text{new minimum thickness}$$

TABLE 5-5
Minimum Tank Insulation

Temperature Difference °C	Minimum Thickness mm
10	38
38	76
66	114
93	152
121	190.5

SI: 1.8ºC + 32 = ºF; 1mm = 0.04 in.

Insulation or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Insulation coverings and linings shall not flame, glow, smolder, or smoke when tested in accordance with ASTM C 411, *Hot-Surface Performance of High Temperature Thermal Insulation* or equivalent International Standard(s) approved by the Authority Having Jurisdiction, at the temperature to which they are exposed in service. In no case shall the test temperature be below 121ºC (250°F).

PART III
Chillers.

510.0 General.

This section shall govern the installation, design, and construction of industrial chillers, including location, refrigerants, evaporators, condensers, and efficiency rating.

510.1 Disconnects. Motor starters and electrical disconnects shall be provided for the chiller's factory wiring, and shall be located inside of the control enclosure.

510.2 Testing. The testing and rating of the chiller shall comply with ARI Standard 590, *Standard for Reciprocating Water-Chilling Packages* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. The chiller shall be pressure tested, and the pressure for the refrigerant side shall be not less than 16bar (225 psi) and the water side shall be not less than 10bar (150 psi).

510.3 Construction. The construction of reciprocating air-cooled liquid chillers shall be in accordance with the *ASME Boiler and Pressure Vessel Code*, Section 8 and ASHRAE Standard 15, *Safety Code for Mechanical Refrigeration* or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

510.4 Installation. Chillers shall be installed in accordance with the manufacturer's installation instructions. The Energy Efficiency Ratio (EER) for reciprocating chillers stated on the stamp shall be not less than the value shown in specification or drawing schedule.

510.5 Clearances. The installation of chillers shall comply with the following requirements:

(A) Listed chillers installed in rooms that are large in comparison with the size of the equipment shall be installed with clearances per the terms of their listing and the manufacturer's instructions.

(B) Unlisted chillers shall be installed with clearances from combustible material not less than 46cm (18 in.) above the equipment and at the sides, front, and rear; and 23cm (9 in.) from the draft hood.

Unlisted chillers installed in rooms that are large in comparison with the size of equipment shall be provided with clearances to combustible material in accordance with the following requirements:

(1) A clearance of not less than 46cm (18 in.) shall be provided above and along the sides of the furnace plenum.

(2) A clearance of not less than 46cm (18 in.) shall be provided along the top of the boiler.

(3) A clearance of not less than 46cm (18 in.) shall be provided along the sides and rear of the jacket.

(4) The front of the chiller shall be provided with a clearance of not less than 46cm (18 in).

(5) The draft hood and barometric draft regulator shall be provided with a clearance of not less than 46cm (18 in.).

(6) The single-wall vent connector shall be provided with a clearance of not less than 46cm (18 in).

(C) Chillers (listed and unlisted) installed in rooms that are large in comparison with the size of the equipment shall be permitted to be installed with reduced clearances to combustible material provided the combustible material or equipment is protected.

(D) Listed chillers shall have the clearance from supply ducts within 90cm (3 ft.) of the furnace plenum be not less than that specified from the furnace plenum. No clearance is necessary beyond this distance. [NFPA 54:9.2.3]

510.6 Electrical. Electric motors shall comply with NEMA Standards. High-efficiency motors shall comply with NEMA Standards, Numbers MG 1, 2, 3, 10, and 11 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

510.6.1 Wiring. Electrical wirings that are provided during the manufacture and installation stages shall comply with the requirements of NFPA 70, *National Electrical Code* or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

510.6.2 Control Panels. The following controls shall be provided for individual chillers:

(1) Power controls for starter.

(2) Compressor starter relay.

(3) Reset relay.

(4) Control wiring terminal strip, including accessory and interlocks for automatic temperature control.

(5) Control power transformer for 115V control voltage.

(6) Pump-down control relay.

(7) Non-recycling compressor overload relay.

(8) High and low pressure cutouts.

(9) Low temperature cutout.

(10) Oil pressure cutout, low oil pressure compressor systems are exempt from this requirement.

(11) Chilled water temperature controller.

(12) Chilled water reset interface.

510.6.3 Accessories. The following accessories shall be provided:

(1) Suction and discharge gauges.

(2) Load limit thermostat.

(3) Vapor proof chilled water flow switch.

(4) Oil pressure gauges, hermetic compressors are exempt from this requirement.

510.6.4 Enclosure. The control board and electrical wirings shall be protected by a weather-tight metal enclosure. Metal enclosures shall have an outdoor rating and shall comply with NEMA Standard 250 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

510.6.5 Inspections. Wiring diagrams shall be provided to the Authority Having Jurisdiction for inspections. The wiring diagram shall include power, accessory, interlock, and control wiring and shall clearly indicate a factory or field installation. The chiller shall not be started without the issuance of a permit by the Authority Having Jurisdiction.

510.7 Transfer. The chiller shall be delivered to the project site as a complete factory assembled protective structure, with a covering and proper fasteners. Hangers, such as eyebolts, shall be provided by the manufacturer for the ease of movement.

510.8 Locations. An adequate structure shall be provided to support the chiller and its accessories where the chiller is located above grade. Where the chiller is located on a building structure, additional supportive structural loads shall be considered in the building's design and approved by the Authority Having Jurisdictions.

510.8.1 Base. Concrete pads having a thickness of not less than 10cm (4 in.) shall be provided as a base for each chiller. Concrete pads shall have steel reinforcements and shall be in accordance with the Building Code.

510.8.2 Support. When a floor-mounted chiller is placed on a concrete pad, cast-anchor-bolting shall be inserted into the pad.

510.9 Access and Service. Removable panels and/or access doors shall be provided for the inspection and service of its internal parts and components.

510.10 Refrigerants. Full operating charge of refrigerant and oil shall be provided prior to start-up. The type and amount of refrigerant shall be limited per Table 5-6.

510.10.1 Refrigerant Circuit. Each chiller refrigerant circuit shall be provided with the following:

(1) Thermal expansion valve.

(2) Liquid line solenoid valve.

(3) Insulated suction line.

(4) Filter dryer.

(5) Liquid line sight glass.

(6) Suction and discharge valves.

510.11 Evaporator. Shell and tube design having seamless roller copper tubes expanded into the tube sheets shall be provided. The evaporator shall be designed, tested, and marked at a working pressure of 16bar (225 psi) in the refrigerant side and 10bar (150 psi) in the water side. One water pass shall be provided with a series of internal baffles. When the evaporator is provided with multiple compressor units, independent multiple refrigerant circuits having gasketed evaporator heads shall be provided.

510.11.1 Insulation. The evaporator shall be insulated with flexible unicellular insulation not less than 13mm (0.5 in.), and shall have a maximum K-value of 0.28.

510.12 Temperature Control. The evaporator shall be provided with a water drain connection and bulb wells for sufficient temperature control and low-temperature limitations.

510.13 Condenser. Condensers shall be provided with the following items:

(1) Configurated copper fins mechanically bonded to seamless copper tubing.

(2) Permanently lubricated ball-bearing motors with overload protection.

(3) Protective grille over air discharge.

(4) Baked phenoy/coating on fins.

(5) Direct or belt driven, statically and dynamically balanced propeller fans.

(6) Protective grilles over exposed coil faces.

510.13.1 Testing. During leak test, cooling condenser coils shall withstand a pressure of 10bars (150 psi) without leaking for a period of not less than 30 minutes. During pressure test, the coils shall withstand a pressure of 31bar (450 psi) without leaking for a period of not less than 15 minutes.

510.13.2 Multiple Compressor. When multiple-compressor units are used, multiple circuited condenser coils shall be provided.

510.13.3 Miscellaneous. Condenser integral subcooling circuit shall be provided with liquid accumulators.

510.14 Compressors. The following items shall be provided for compressors:

(1) Direct drive producing not less than 1,750rpm.

(2) For multi-cylinder reciprocating compressors, crankcase heaters (semihermetic or hermetic) shall be provided.

(3) Minimum steps of capacity control provided by cylinder unloading and/or compressor staging, based on return water temperature.

(4) Vibration isolators inside chiller.

(5) Oil pump, oil filter, oil level sight glass, and oil charging valve.

510.15 Chilled Water Piping. Chilled water piping shall be made and installed in accordance with Chapter 6 of this code.

510.16 Efficiency. The chiller efficiency rating (IPLV) shall comply with the minimum efficiency requirements as stated in ARI standard 550/590 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

TABLE 5-6
Allowable Refrigerant Table[1, 9, 12]

Refrig-erant	Chemical Formula	Chemical Name[4] (Composition for Blends)	Safety Group[1]	OEL[5] (ppm)	IDLH[6] (ppm)	Kg/280m³ of Space[7]
R-11	CCl_3F	Trichlorofluoromethane	A1	C1000[8]	2,000	11.0
R-12	CCl_2F_2	Dichlorodifluoromethane	A1	1,000	15,000	15.8
R-13	$CClF_3$	Chlorotrifluoromethane	A1	1,000[10]	67,000	
R-13B1	$CBrF_3$	Bromotrifluoromethane	A1	1,000	40,000	
R-14	CF_4	Tetrafluoromethane (carbon tetrafluoride)	A1	1,000[10]	67,000	707.0
R-21	$CHCl_2F$	Dichlorofluoromethane	B1	10[14]	5,000	
R-22	$CHClF_2$	Chlorodifluoromethane	A1	1,000[14]	42,000[11]	367.9
R-23	CHF_3	Trifluoromethane	A1	1,000[10]		206.6
R-30	CH_2Cl_2	Dichloromethane (methylene chloride)	B2	C1000[8]	2,300	
R-32	CH_2F_2	Difluoromethane (methylene fluoride)	A2	1,000[13]		135.8
R-40	CH_3Cl	Chloromethane (methyl chloride)	B2	100	2,000	
R-50	CH_4	Methane	A3	1,000[10]		
R-113	CCl_2FCClF_2	1,1,2-trichloro-1, 2, 2 -trifluoroethane	A1	1,000	2,000	134.0
R-114	$CClF_2CClF_2$	1,2-dichloro-1,1,2,2 -tetraflouroethane	A1	1,000	15,000	246.2
R-115	$CClF_2CF_3$	Chloropentafluoroethane	A1	1,000[14]		1,330.1
R-116	CF_3CF_3	Hexafluoroethane	A1	1,000[10]		962.2
R-123	$CHCl_2CF_3$	2,2-dichloro-1,1,1, -trifluoroethane	B1	50[13]	4,000[11]	99.1
R-124	$CHClFCF_3$	2-chloro-1,1,1,2 –tetrafluoroethane	A1	1,000[13]		99.1
R-125	CHF_2CF_3	Pentafluoroethane	A1	1,000[13]		650.9
R-134a	CH_2FCF_3	1,1,1,2-tetrafluoroethane	A1	1,000[13]	50,000[11]	367.9
R-141b	CH_3CCl_2F	1,1-dichloro-1-fluoroethane	A1	500[13]		22.1
R-142b	CH_3CClF_2	1-chloro-1,1-difluoroethane	A2	1,000[13]		144.3
R-143a	CH_3CF_3	1,1,1-trifluoroethane	A2	1000[13]		127.4
R-152a	CH_3CHF_2	1,1-difluoroethane	A2	1,000[13]		56.6
R-170	CH_3CH_3	Ethane	A3	1,000	6,400	15.3
R-E170	CH_3OCH_3	Dimethyl ether	A3	1,000[10]		28.3
R-218	$CF_3CF_2CF_3$	Octafluoropropane	A1	1,000		1,216.9
R-227ea	CF_3CHFCF_3	1,1,1,2,3,3,3-heptafluoropropane	A1	1,000		1,018.8
R-236fa	$CF_3CH_2CF_3$	1,1,1,3,3,3-hexafluoropropane	A1	1,000[13]		594.3
R-245fa	$CHF_2CH_2CF_3$	1,1,1,3,3-pentafluoropropane	B1	300[13]		339.6
R-290	$CH_3CH_2CH_3$	Propane	A3	1,000	2,100	15.8
R-C318	$-(CF_2)_4-$	Octafluorocyclobutane	A1	1,000[10]		1,160.3
R-400	zeotrope	R-12/114 (50/50)	A1	1,000[10]		283
R-400	zeotrope	R-12/114 (60/40)	A1	1,000		311.3
R-401A	zeotrope	R-22/152a/124 (53.0/13.0/34.0)	A1	1,000[10]		186.78
R-401B	zeotrope	R-22/152a/124 (61.0/11.0/28.0)	A1	1,000[10]		204.5

TABLE 5-6 (continued)
Allowable Refrigerant Table[1, 9, 12]

Refrig-erant	Chemical Formula	Chemical Name[4] (Composition for Blends)	Safety Group[1]	OEL[5] (ppm)	IDLH[6] (ppm)	Kg/280m^3 of Space[7]
R-401C	zeotrope	R-22/152a/124 (33.0/15.0/52.0)	A1	1,000[10]		147.1
R-402A	zeotrope	R-125/290/22 (60.0/2.0/38.0)	A1	1,000[10]		240.1
R-402B	zeotrope	R-125/290/22 (38.0/2.0/60.0)	A1	1,000[10]		424.5
R-403A	zeotrope	R-290/22/218 (5.0/75.0/20.0)	A1	1,000[10]		215.1
R-403B	zeotrope	R-290/22/218 (5.0/56.0/39.0)	A1	1,000[10]		509.4
R-404A	zeotrope	R-125/143a/134a (44.0/52.0/4.0)	A1	1,000[10]		877.3
R-405A	zeotrope	R-22/152a/142b/C318 (45.0/7.0/5.5/42.5)		1,000[10]		452.8
R-406A	zeotrope	R-22/600a/142b (55.0/4.0/41.0)	A2	1,000[10]		133.0
R-407A	zeotrope	R-32/125/134a (20.0/40.0/40.0)	A1	1,000[10]		509.4
R-407B	zeotrope	R-32/125/134a (10.0/70.0/20.0)	A1	1,000[10]		566.0
R-407C	zeotrope	R-32/125/134a (23.0/25.0/52.0)	A1	1,000[10]		481.1
R-407D	zeotrope	R-32/125/134a (15.0/15.0/70.0)	A1	1,000[10]		424.5
R-407E	zeotrope	R-32/125/134a (25.0/15.0/60.0)	A1	1,000[10]		452.8
R-408A	zeotrope	R-125/143a/22 (7.0/46.0/47.0)	A1	1,000[10]		594.3
R-409A	zeotrope	R-22/124/142b (60.0/25.0/15.0)	A1	1,000[10]		200.9
R-409B	zeotrope	R-22/124/142b (65.0/25.0/10.0)	A1	1,000[10]		206.6
R-410A	zeotrope	R-32/125 (50.0/50.0)	A1	1,000[10]		707.5
R-410B	zoetrope	R-32.125 (45.0/55.0)	A1	1,000[10]		679.2
R-411A	zeotrope	R-1270/22/152a (1.5/87.5/11.0)	A2	990[10]		82.1
R-411B	zeotrope	R-1270/22/152a (3.0/94.0/3.0)	A2	980[10]		79.2
R-412A	zeotrope	R-22/218/143b (70.0/5.0/25.0)	A2	1,000[10]		144.3
R-413A	zeotrope	R-218/134a/600a (9.0/88.0/3.0)	A2	1,000		164.1
R-414A	zeotrope	R-22/124/600a/142b (51.0/28.5/4.0/16.5)	A1	1,000[10]		181.1
R-414B	zeotrope	R-22/124/600a/142b (50.0/39.0/1.5/9.5)	A1	1,000		169.8
R-415A	zeotrope	R-22/152a (82.0/18.0)	A2	1,000		339.6
R-415B	zeotrope	R-22/152a (25.0/75.0)	A2	1,000		263.2
R-416A	zeotrope	R-134a/124/600 (59.0/39.5/1.5)	A1	1,000		110.4
R-417A	zeotrope	R-125/134a/600 (46.6/50.0/3.4)	A1	1,000		99.1
R-418A	zeotrope	R-290/22/152a (1.5/96.0/2.5)	A2	1,000		367.9
R-419A	zeotrope	R-125/134a/E170 (77.0/19.0/4.0)	A2	1,000		537.7
R-420A	zeotrope	R-134a/142b (88.0/12.0)	A1	1,000		339.6
R-421A	zeotrope	R-125/134a (58.0/42.0)	A1	1,000		486.1
R-421B	zeotrope	R-125/134a (85.0/15.0)	A1	1,000		594.3
R-422A	zeotrope	R-125/134a/600a (85.1/11.5/3.4)	A1	1,000		509.4
R-422B	zeotrope	R-125/134a/600a (55.0/42.0/3.0)	A1	1,000		452.8
R-422C	zeotrope	R-125/134a/600a (82.0/15.0/3.0)	A1	1,000		509.4
R-422D	zoetrope	R-125/134a/600a (65.1/31.5/3.4)	A1	1,000		452.8
R-423A	zeotrope	R-134a/227ea (52.5/47.5)	A1	1,000		537.7

TABLE 5-6 (continued)
Allowable Refrigerant Table[1, 9, 12]

Refrig- erant	Chemical Formula	Chemical Name[4] (Composition for Blends)	Safety Group[1]	OEL[5] (ppm)	IDLH[6] (ppm)	Kg/280m³ of Space[7]
R-424A	zeotrope	R-125/134a/600a/600/601a (50.5/47.0/0.9/1/0/0.6)	A1	970		175.5
R425A	zeotrope	R-32/134a/227ea (18.5/69.5/12.0)	A1	1,000		452.8
R426A	zoetrope	R-125/134a/600/601a (5.1/93.0/1.3/0.6)	A1	990		147.2
R427A	zoetrope	R-32/125/143a/134a (15.0/25.0/10.0/50.0)	A1	1,000		509.4
R428A	zoetrope	R-125/143a/290/600a (77.5/20.0/0.6/1.9)	A1	1,000		650.9
R-429A	zeotrope	R-E170/152a/600a (60.0/10.0/30.0)	A3	1,000		22.9
R-430A	zeotrope	R-152a/600a (76.0/24.0)	A3	1,000		36.8
R-431A	zeotrope	R-290/152a (71.0/29.0)	A3	1,000		19.5
R-432A	zeotrope	R-1270/E170 (80.0/20.0)	A3	710		3.7
R-433A	zeotrope	R-1270/290 (30.0/70.0)	A3	880		9.6
R-434A	zeotrope	R-125/143a/134a/600a (63.2/18.0/16.0/2.8)	A1	1,000		566.0
R-435A	zeotrope	R-E170/152a (80.0/20.0)	A3	1,000		31.1
R-436A	zeotrope	R-290/600a (56.0/44.0)	A3	1,000		14.2
R-436B	zeotrope	R-290/600a (52.0/48.0)	A3	1,000		14.2
R-437A	zeotrope	R-125/134a/600/601 (19.5/78.5/1.4/0.6)	A1	990		141.5
R-500	azeotrope	R-12/152a (73.8/26.2)	A1	1,000[10]	47,000[11]	215.1
R-501	azeotrope	R-22/12 (75.0/25.0)	A1	1,000		367.9
R-502	azeotrope	R-22/115(48.8/51.2)	A1	1,000[10]	65,000[11]	594.3
R-503	azeotrope	R-23/13 (40.1/59.9)		1,000	67,000	
R-504	azeotrope	R-32/115 (48.2/51.8)		1,000		820.7
R-507A	azeotrope	R-125/143a (50.0/50.0)	A1	1,000[10]		905.6
R-508A	azeotrope	R-23/116 (39.0/61.0)	A1	1,000[10]		396.2
R-508B	azeotrope	R-23/116 (46.0/54.0)	A1	1,000[10]		367.9
R509A	azeotrope	R-22/218 (44.0/56.0)	A1	1,000[10]		679.2
R-510A	azeotrope	R-E170/600a (88.0/12.0)	A3	1,000		24.6
R-600	$CH_3CH_2CH_2CH_3$	butane	A3	1,000	3,400	2.8
R-600a	$CH(CH_3)_2CH_3$	isobutane (2-methyl propane)	A3	1,000	3,400	16.9
R-601	$CH_3CH_2CH_2CH_2CH_3$	pentane	A3	600		5.7
R-601a	$(CH_3)_2CHCH_2CH_3$	2-methylbutane (isopentane)	A3	600		5.7
R-611	$HCOOCH_3$	methyl formate	B2	100		
R-702	H_2	hydrogen	A3			
R-704	He	helium	A1			
R-717	NH_3	ammonia	B2	50[12]	300	0.4
R-718	H_2O	water	A1			footnote 14
R-720	Ne	neon	A1			
R-728	N_2	nitrogen	A1			

TABLE 5-6 (continued)
Allowable Refrigerant Table[1, 9, 12]

Refrig-erant	Chemical Formula	Chemical Name[4] (Composition for Blends)	Safety Group[1]	OEL[5] (ppm)	IDLH[6] (ppm)	Kg/280m³ of Space[7]
R-740	Ar	argon	A1			
R-744	CO_2	carbon dioxide	A1	5,000	40,000	127.4
R-764	SO_2	sulfur dioxide	B1	5	100	
R-1150	$CH_2{=}CH_2$	ethene (ethylene)	A3	200	5,200	10.8
R-1270	$CH_3CH{=}CH_2$	propene (propylene)	A3	500	3,400	2.8

Notes:

1 Refrigerant safety group designation.

2 Refrigerant properties are those needed for this chapter.

3 Allowable quantities are for high-probability systems.

4 Chemical name shown is the preferred name. The popular name is shown in parenthesis.

5 OEL is the Occupational Exposure Limit.

6 IDLH is that designated by NIOSH unless otherwise designated. If no value is shown, use the value listed under Kg/280m³ of Space. Use the following formula to convert from pounds per 1000cf of Space to ppm. ppm = pounds per 1000cf of space/(0.000002557 x M), where M equals the molar mass of the refrigerant in g/mole.

7 28.3Kg/m³ of refrigerant in a high-probability system of occupied space (lbs/1,000 ft.³). See Section 1104.0. This column does not apply to refrigerant machinery rooms or areas covered by Section 1106.0. If no value is listed use zero unless sufficient data can be provided to determine the value as described in Section 7 of ASHRAE Standard 34-2007.

8 The OEL value shown is the TLV-C recommended by ACGIH.

9 The IDLH value shown is reduced from that designated by NIOSH in light of cardiac sensitization potential.

10 A PEL has not yet been established; the value given was determined in a consistent manner.

11 An IDLH has not yet been established; the value given was determined in a consistent manner.

12 OSHA PEL is 50 ppm; ACGIH TLV-TWA is 25 ppm.

13 The OEL value shown is the WEEL recommended by AIHA

14 The OEL value show is the ACGIH TLV-TWA

SI: 1Kg = 2.2 lb; $1m^3 = 35.5 ft^3$; 1mg/L = ppm

CHAPTER 6

WATER SUPPLY AND DISTRIBUTION

Preamble.

Chapter 6 of the UPC-AD on Water Supply and Distribution presumes that adequate infrastructure exists for the supply of water at suitable pressure for all requirements. The purpose of this preamble is to outline the criteria for determining capacities of storage tanks.

(A) Preliminary Information.

A.1 Estimate the quantum of water required per day for the installation. This will be based on the population in the proposed project and proposed use of the building.

A.2 Identify possible sources that may be (but not limited to) the following to augment the shortfall in public utility water supply:

A.2.1 Rainwater harvesting.

A.2.2 Underground source (open well/bore/tube well).

A.2.3 Recycled/reclaimed water from sewage treatment works.

A.2.4 Desalinated sea water, or;

A.2.5 A combination of the above.

(B) Water Treatment.

B.1 An analysis of the available water is essential to decide the treatment process to render the water adequate for consumption. The treatment process would depend on the quality of water and the purpose for which it is being treated. Appropriate standards referenced in Chapter 14 or equivalent International Standard(s) approved by the Authority Having Jurisdiction shall be adhered to, for treating the water to a desired quality. Additional treatment may be required in specific cases such as laboratories, pharmaceutical, industrial, and health care.

(C) Water Storage Tanks.

C.1 Since continuous availability of water at adequate pressure cannot be ensured, it is essential to have storage facilities. Where the distribution system proposed is by gravity from an elevated tank, the combined capacity of the low level and high level tanks shall be adequate for the duration of anticipated disruption in supply. The tank partitions shall be based on structural considerations, different qualities of water to be stored, and water requirements for fire fighting. Storage tank compartments containing potable and non-potable water shall have adequate sanitary separation. Water storage tanks shall be constructed of impervious materials, protected against contamination and provided with locked, watertight covers. Any overflow or ventilation openings shall be down-facing and provided with a corrosion resistant screening of not less than No. 24 mesh to prevent the entry of insects and vermin. Water storage tanks shall not have direct connections to sewers.

C.2 Unless permitted by the Authority Having Jurisdiction, low level tanks shall not be located below ground to avoid contamination by surface water or any other foreign materials. Where tanks are located below ground, the following minimum precautions shall be taken:

C.2.1 All inspection covers shall be adequately raised above the surrounding ground level.

C.2.2 Submersible pump(s) shall be installed in suitable sump(s) at the floor of the tank for draining the contents of the tank for cleaning.

C.2.3 Adequate number of ventilating pipes with insect screens shall be provided and terminated at a suitable location.

Part I
Water Supply and Distribution Systems.

601.0 Hot and Cold Water Required.

601.1 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.

Exception: Listed fixtures that do not require water for their operation and are not connected to the water supply.

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, bathtubs, whirlpool bathtubs, bidets and shower control valves.

601.2 Identification of Nonpotable Water Systems. In buildings where nonpotable water systems are installed, each nonpotable system shall be clearly identified in accordance with Sections 601.2.1 through 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 Sections 1615.0 and 1622.0, 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 conform to Table 6-1.

The background color and required information shall be indicated every 6m (20 ft.), but not less than once per room, and shall be visible from the floor level.

TABLE 6-1
Minimum Length of Color Field and Size of Letters

Outside Diameter of Pipe or Covering mm	Minimum Length of Color Field cm	Minimum Size of Letters mm
15 to 32	20	15
40 to 50	20	20
65 to 150	30	32
200 to 250	60	65
Over 250	80	90

SI: 1mm = 0.04 in.; 1cm = 0.39 in.

601.2.3 Fixtures. Where vacuum breakers or backflow preventers are installed with fixtures listed in Table 14-1, or equivalent International Standard(s) approved by the Authority Having Jurisdiction, 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 Faucets and diverters shall be connected to the water distribution system so that hot water corresponds to the left side of the fittings.

602.0 Unlawful Connections.

602.1 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 any portion of such piping from any tank, receptor, equipment, or plumbing fixture by reason of backsiphonage, suction, or any other cause, either during normal use and operation thereof, or when any 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 No person shall make a connection or allow one to exist between pipes or conduits carrying domestic water supplied by any public or private water service system; and any pipes, conduits, or fixtures containing or carrying water from any other source or containing or carrying water that has been used for any purpose whatsoever; or any piping carrying chemicals, liquids, gases, or any 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 when potential cross contamination of individual units exists.

602.3 No plumbing fixture, device, or construction shall be installed or maintained or shall be connected to any domestic water supply when 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 No water piping supplied by any 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.

Cross-connection control shall be provided in accordance with the provisions of this chapter.

No person shall install any water-operated equipment or mechanism, or use any water-treating chemical or substance if 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 only when equipped with an approved backflow prevention device or assembly.

TABLE 6-2
Backflow Prevention Devices, Assemblies and Methods

Device, Assembly, or Method[1]	Applicable Standards[6]	Degree of Hazard: Pollution (Low Hazard)		Degree of Hazard: Contamination (High Hazard)		Installation[2,3]
		Back-Siphonage	Back-Pressure	Back-Siphonage	Back-Pressure	
Airgap	ASME A112.1.2	X		X		See Table 6-3 in this chapter.
Airgap fittings for use with plumbing fixtures, appliances and appurtenances	ASME A112.1.3	X		X		Airgap fitting is a device with an internal airgap and typical installation includes plumbing fixtures, appliances and appurtenances. The critical level shall not be installed below the flood level rim.
Atmospheric-type vacuum breaker (consists of a body, checking member and atmospheric port)	ASSE 1001 or CSA B 64.1.1	X		X		Upright position. No valve downstream. Minimum of 15cm or listed distance above all down-stream 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 B 125.3	X		X		Installation on gravity water closet flush tank and urinal tanks with the fill valve installed with the critical level not less than 25mm above the opening of the overflow pipe.[4,5]
Vacuum breaker wall hydrants, hose bibbs, automatic draining type	ASSE 1019 or CSA B 64.2.1.1	X		X		Installation includes wall hydrants and hose bibbs. Such devices are not for use under continuous pressure conditions (means of shut-off 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.

TABLE 6-2 (continued)

Device, Assembly, or Method[1]	Applicable standards[6]	Degree of Hazard: Pollution (Low Hazard)		Degree of Hazard: Contamination (High Hazard)		Installation[2,3]
		Back-Siphonage	Back-Pressure	Back-Siphonage	Back-Pressure	
Spill-Resistant Pressure-Type Backflow Prevention Assembly (single check valve with air inlet vent and means of field testing)	ASSE 1056	X		X		Upright position. Minimum of 15cm or listed distance above all down-stream 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 B 64.5 or CSA B 64.5.1	X	X			Horizontal unless otherwise listed. Requires 30cm clearance at bottom for maintenance. May need platform/ ladder for test and repair. Does not discharge water.
	ASSE 1048	X	X			Horizontal unless otherwise listed. Requires 30cm 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.
Pressure Vacuum Breaker Backflow Prevention Assembly (loaded air inlet valve, internally loaded check valve and means of field testing)	ASSE 1020 or CSA B 64.1.2	X		X		Upright position. May have valves downstream. Minimum of 30cm above all down-stream piping and flood-level rim of receptor. May discharge water.
Reduced Pressure Principle Backflow Prevention Assembly (two independently acting loaded check valves, a pressure relief valve and means of field testing)	ASSE 1047	X	X	X	X	Horizontal unless otherwise listed. Requires 30cm minimum 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.
	ASSE 1013; AWWA C511; CSA B64.4 or CSA B64.4.1	X	X	X	X	Horizontal unless otherwise listed. Requires 30cm minimum clearance at bottom for maintenance. May need platform/ ladder for test and repair. May discharge water.

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 any 24 hour period.
5 For deck-mounted and equipment-mounted vacuum breaker, see Section 603.4.15.
6 Standards listed in Table 6-2 or equivalent International Standard(s) approved by the Authority Having Jurisdiction shall be permited.

SI: 1cm = 0.39 in.

603.1 Approval of Devices or Assemblies. Before any device or 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 for conformity with recognized standards or other standards acceptable to the Authority Having Jurisdiction. Backflow prevention devices and assemblies shall comply with Table 6–2, except for specific applications and provisions as stated in Sections 603.4 through 603.4.22.

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 when required by the Authority Having Jurisdiction. If 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.

603.2 Backflow Prevention Devices, Assemblies, and Methods.

603.2.1 Airgap. The minimum airgap to afford backflow protection shall be in accordance with Table 6-3.

603.2.2 Atmospheric Vacuum Breaker (AVB). An atmospheric vacuum breaker consists of a body, a checking member, and an atmospheric port.

603.2.3 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.

603.2.4 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.

603.2.5 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 installed indoors only if provisions for spillage are provided.

603.2.6 Pressure Vacuum Breaker Spill Resistant-Type Backflow Prevention Assembly (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.

TABLE 6-3[4]
Minimum Airgaps for Water Distribution[4]

Fixtures	When not affected by sidewalls[1] mm	When affected by sidewall[2] mm
Effective openings[3] not greater than 15mm in diameter	25	40
Effective openings[3] not greater than 20mm in diameter	40	65
Effective openings[3] not greater than 25mm in diameter	50	80
Effective openings[3] greater than 25mm in diameter	2 times diameter of effective opening	3 times diameter of effective opening

[1] Sidewalls, ribs, or similar obstructions do not affect airgaps when spaced from the inside edge of the spout opening a distance exceeding 3 times the diameter of the effective opening for a single wall, or a distance exceeding 4 times the effective opening for 2 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 Note 1 above. The effect of 3 or more such vertical walls or ribs has not been determined. In such cases, the airgap 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, the supply pipe or tubing that feeds the device or outlet. If 2 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] Airgaps less than 25mm (1 in.) shall be approved only as a permanent part of a listed assembly that has been tested under actual backflow conditions with vacuums of 0 to 64cm (0 - 25 in.) of mercury.

SI: 1mm = 0.04 in

603.2.7 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 General Requirements.

603.3.1 Assemblies shall conform to listed standards and be acceptable to the Authority Having Jurisdiction, with jurisdiction over the selection and installation of backflow prevention assemblies.

603.3.2 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.

603.3.3 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 when required by the Authority Having Jurisdiction. The periodic testing shall be performed in accordance with the procedures referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction by a tester qualified in accordance with those standards.

603.3.4 Access and clearance shall be provided for the required testing, maintenance, and repair. Access and clearance shall require not less than 30cm (1 ft.) between the lowest portion of the assembly and grade, floor, or platform. Elevated installations exceeding 1.5m (5 ft.) above the floor or grade shall be provided with a permanent platform capable of supporting a tester or maintenance person.

603.3.5 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 airgap of two pipe diameters of the supply inlet, but in no case shall the gap be less than 25mm (1 in.). Connections shall be permitted to be made to the inlet side of a trap fixture, provided that an approved vacuum breaker is installed not less than 15cm (6 in.), or the distance according to the device's listing above the flood-level rim of such trapped fixture, so that at no time will any such device be subjected to any back pressure.

603.3.6 Backflow preventers for hot water exceeding 40ºC (110ºF) shall be a type designed to operate at temperatures exceeding 40ºC (110ºF) without rendering any portion of the assembly inoperative.

603.3.7 Fixtures, appliances, or appurtenances with integral backflow preventers or integral airgaps manufactured as a unit shall be installed in accordance with their listing requirements and the manufacturer's instructions.

603.3.8 Backflow assemblies and devices shall be protected from mechanical damage, with an outdoor enclosure or by a method acceptable to the Authority Having Jurisdiction.

603.3.9 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.

603.3.10 Design and Installation of Plumbing Fixtures. Plumbing fixtures shall be installed such that fixture fittings, complying with the backflow prevention requirements of ASME A112.18.1/CSA B125.1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction, do not have these requirements compromised by the designated fixture fitting mounting surface.

603.4 Specific Requirements.

603.4.1 Water closet and urinal flushometer valves shall be 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 15cm (6 in.), or the distance according to its listing, above the overflow rim of a water closet bowl or the highest part of a urinal.

603.4.2 Water closet and urinal tanks shall be equipped with a fill valve. The fill valve shall be installed with the critical level not less than 25mm (1 in.) above the full opening of the overflow pipe. In cases where the fill valve has no hush tube, the bottom of the water supply inlet shall be installed 25mm (1 in.) above the full opening of the overflow pipe.

603.4.3 Water closet flushometer tanks shall be protected against backflow by an approved backflow prevention assembly, device, or method.

603.4.4 Heat Exchangers.

603.4.4.1 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 502.4.2. 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.

603.4.5 Water supply inlets to tanks, vats, sumps, and other receptors shall be protected by one of the following means:

(1) An approved airgap.

(2) A listed vacuum breaker installed on the discharge side of the last valve with the critical level not less than 15cm (6 in.) or in accordance with its listing.

(3) A backflow preventer suitable for contamination or pollution, installed in accordance with the requirements for that type of device or assembly as set forth in this chapter.

603.4.6 Protection from Lawn Sprinklers and Irrigation Systems.

603.4.6.1 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.

(2) Pressure vacuum breaker.

(3) Spill resistant pressure vacuum breaker.

(4) Reduced-pressure backflow preventer.

603.4.6.2 Where sprinkler and irrigation systems have pumps, connections for pumping equipment, auxiliary air tanks, or are otherwise capable of creating back-pressure, the potable water supply shall be protected by the following type of device if the backflow device is located upstream from the source of back-pressure:

(1) Reduced-pressure backflow preventer.

603.4.6.3 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.

(2) Pressure vacuum breaker.

(3) Spill resistant pressure vacuum breaker.

(4) Reduced-pressure backflow preventer.

603.4.6.4 Where systems include a chemical injector or any provisions for chemical injection, the potable water supply shall be protected by the following:

(1) Reduced-pressure backflow preventer.

603.4.7 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 15cm (6 in.) above the highest point of usage located on the discharge side of the last valve.

603.4.8 Watercooled compressors, degreasers, or any other watercooled equipment shall be protected by a backflow preventer installed in accordance with the requirements of this chapter.

Note: Watercooled equipment that produces back-pressure shall be equipped with the appropriate protection.

603.4.9 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 airgap. When the tail-piece of a fixture to receive the discharge of an aspirator is used, the airgap shall be located above the flood-level rim of the fixture.

603.4.10 Potable water makeup connections to steam or hot water boilers shall be provided with a listed backflow protection assembly.

603.4.11 Nonpotable Water Piping. In cases where it is impractical to correct individual cross-connections on the domestic water line, the line supplying such outlets shall be considered a nonpotable water line. No drinking or domestic water outlets shall be connected to the nonpotable water line. Whenever possible, portions of the nonpotable water line shall be exposed, and exposed portions shall be properly identified in a manner satisfactory to the Authority Having Jurisdiction. Each outlet on the nonpotable water line that is permitted to be used for drinking or domestic purposes shall be posted:

“CAUTION: NONPOTABLE WATER,
DO NOT DRINK.”

603.4.12 Potable water supply to carbonators shall be protected by either an airgap or a vented backflow preventer for carbonated beverage dispensers installed within the carbonated beverage dispenser. The carbonated beverage dispenser shall bear the label of an approved testing agency, certifying and attesting that such equipment has been tested, inspected and meets the requirements of the approved applicable standard. Carbonated beverage dispensers without an approved internal airgap or vented backflow preventer for carbonated beverage dispensers and carbonated beverage dispensing systems shall have the water supply protected with a vented backflow preventer for carbonated beverage dispensers.

603.4.13 Water Treatment Units. Reverse osmosis drinking water treatment units shall meet the requirements of the applicable standards referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Waste or discharge from reverse osmosis or other types of water treatment units shall enter the drainage system through an airgap.

603.4.14 Backflow preventers shall not be located in any area containing fumes that are toxic, poisonous, or corrosive.

603.4.15 Deck-mounted or equipment-mounted vacuum breakers shall be installed in accordance with their listing and the manufacturer's instructions, with the critical level not less than 25mm (1 in.) above the flood-level rim.

603.4.16 Protection from Fire Systems.

603.4.16.1 Except as provided under Sections 603.4.16.2 and 603.4.16.3, potable water supplies to fire protection systems that are normally under pressure, including but not limited to standpipes and automatic sprinkler systems, except in one- or two-family residential sprinkler systems, piped in materials approved for potable water distribution systems shall be protected from back-pressure and back-siphonage by one of the following testable devices:

(1) Double check valve assembly.

(2) Double check detector assembly.

(3) Reduced pressure backflow preventer.

(4) Reduced pressure detector assembly.

Potable water supplies to fire protection systems that are not normally under pressure shall be protected from backflow and shall meet the requirements of the appropriate standards referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

603.4.16.2 Where fire protection systems supplied from a potable water system include a fire department (siamese) connection that is located less than 520m (1,700 ft.) from a nonpotable water source that is used by the fire department as a secondary water supply, the potable water supply shall be protected by one of the following:

(1) Reduced pressure backflow preventor.

(2) Reduced pressure detector assembly.

Note: Nonpotable water sources include fire department vehicles carrying water of questionable quality or water that is treated with antifreeze, corrosion inhibitors, or extinguishing agents.

603.4.16.3 Where antifreeze, corrosion inhibitors, or other chemicals are added to a fire protection system supplied from a potable water supply, the potable water system shall be protected by one of the following:

(1) Reduced pressure backflow preventer.

(2) Reduced pressure detector assembly.

603.4.16.4 Whenever a backflow device is installed in the potable water supply to a fire protection system, the hydraulic design of the system shall account for the pressure drop through the backflow device. If such devices are retrofitted for an existing fire protection system, the hydraulics of the sprinkler system design shall be checked to verify that there will be sufficient water pressure available for satisfactory operation of the fire sprinklers.

603.4.16.5 Residential Sprinkler Systems. When residential sprinkler systems are installed using the potable water system, they shall be installed in accordance with the standards listed in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

603.4.17 Special Equipment, Water Supply Protection. Vacuum breakers for washer-hose bedpans shall be located not less than 1.5m (5 ft.) above the floor. Hose connections in health care or laboratory areas shall be not less than 1.8m (6 ft.) above the floor.

603.4.18 Portable cleaning equipment, dental vacuum pumps, and chemical dispensers shall be protected from backflow by an airgap, an atmospheric vacuum breaker, a spill proof vacuum breaker, or a reduced pressure principle backflow preventer.

603.4.19 Combination stop-and-waste valves or cocks shall not be installed underground.

603.4.20 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 back-pressure and back-siphonage by a reduced-pressure principle backflow preventer.

TABLE 6-4
Materials for Building Supply and Water Distribution Pipe and Fittings

Material	Building Supply Pipe and Fittings	Water Distribution Pipe and Fittings	Referenced Standard(s) Pipe[2]	Referenced Standard(s) Fittings[2]
CPVC	X	X	ASTM D2846, ASTM F441, ASTM F442	ASTM D2846, ASTM F1970, ASTM F437, ASTM F438, ASTM F439
PE	X[1]		ASTM D2239, ASTM D2737, ASTM D3035, AWWA C901, CSA B137.1	ASTM D2609, ASTM D2683, ASTM D3261, ASTM F1055, CSA B137.1
PE-AL-PE	X	X	ASTM F1282, CSA B137.9	ASTM F 1282, ASTM F1974, CSA B137.9
PEX	X	X	ASTM F876 , ASTM F877, CSA B137.5	ASTM F877, ASTM F1807, ASTM F1960, ASTM F1961, ASTM F2080, ASTM F2159, CSA B137.5
PEX-AL-HDPE	X	X	ASTM F1986	ASTM F1986
PEX-AL-PEX	X	X	ASTM F1281, CSA B137.10, ASTM F2262	ASTM F1281, ASTM F1974, ASTM F2434, CSA B137.10
Polypropylene (PP), (PP-R)	X	X	ASTM F2389, CSA B137.11	ASTM F2389, CSA B137.11
PP-AL-PP	X	X	IAPMO IGC 223	IAPMO IGC 223
PVC	X[1]		ASTM D1785, ASTM D2241, AWWA C900	ASTM D2464, ASTM D2466, ASTM D2467, ASTM F1970

[1] For Building Supply or cold-water applications.

[2] Standards listed in Table 6-4 or equivalent International Standard(s) approved by the Authority Having Jurisdiction shall be permitted.

603.4.20.1 Dialysis Water Systems. The individual connections of the dialysis related equipment to the dialysis pure water system shall not require additional backflow protection.

603.4.21 Plumbing Fixture Fittings. Plumbing fixture fittings with integral backflow protection shall comply with ASME A112.18.1/CSA B125.1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

603.4.22 Potable water supply to swimming pools, spas and hot tubs shall be protected by an airgap or a reduced pressure principle backflow preventer in accordance with the following:

(1) The unit is equipped with a submerged fill line; or

(2) The potable water supply is directly connected to the unit circulation system.

604.0 Materials.

604.1 Pipe, tube, and fittings carrying water used in potable water systems intended to supply drinking water shall meet the requirements of DIN/NSF 61 or applicable referenced standard for drinking water system components and health effects as found in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. 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 be in accordance with the applicable standards referenced in Table 6-4 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

604.2 Listed flexible water connectors shall be installed in readily accessible locations, unless otherwise listed.

604.3 Piping and tubing that has previously been used for any purpose other than for potable water systems shall not be used.

604.4 Approved plastic materials shall be permitted to be used in water service piping, provided that where metal water service 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 water service 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 above ground 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.

604.5 Water pipe and fittings with a lead content which exceeds 8 percent shall be prohibited in piping systems used to convey potable water.

604.6 Plastic Fittings. Female PVC screwed fittings for water piping shall be used with plastic male fittings and plastic male threads.

604.7 Flexible Corrugated Connectors. Flexible corrugated connectors of copper or stainless steel shall be limited to the following connector lengths:

(1) Fixture Connectors – 80cm (30 in.).

(2) Washing Machine Connectors – 1.8m (72 in.).

(3) Dishwasher and Icemaker Connectors – 3m (120 in.).

604.8 Slip Joints. In water piping, slip joints shall be permitted to be used on the exposed fixture supply.

605.0 Joining Methods.

605.1 PVC Plastic Pipe and Joints. PVC plastic pipe and fittings joining methods shall comply with the following:

(1) 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 conforming to ASTM F656 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Primer shall be applied until pipe and fitting is softened. Solvent cements complying with ASTM D2564 or equivalent International Standard(s) approved by the Authority Having Jurisdiction 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. Universal or multi-purpose solvent cement shall be prohibited. Solvent cement joints shall be installed in accordance with the manufacturer's instructions.

(2) Mechanical joints shall be installed in accordance with the manufacturer's instructions. Such 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 gasket shall be of such size and shape as to provide a compressive force against the spigot and socket after assembly to provide a positive seal.

(3) Threaded joints shall be installed in accordance with the manufacturer's installation instructions. 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 does not result in a 50 percent reduction in the pressure rating of the pipe because the molded fittings are fabricated so that the wall thickness of the material is maintained at the threads. Caution shall be used during assembly to prevent over-tightening of the PVC components once the thread sealant has been applied.

605.2 CPVC Plastic Pipe and Joints. CPVC plastic pipe and fittings joining methods shall comply with the following:

(1) Solvent cement joints for CPVC pipe and fittings shall be clean from dirt and moisture. Solvent cements complying with ASTM F493 or equivalent International Standard(s) approved by the Authority Having Jurisdiction, requiring the use of a primer shall be orange in color. The primer shall be colored and conform to ASTM F656 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Listed solvent cement complying with ASTM F493 or equivalent International Standard(s) approved by the Authority Having Jurisdiction that does not require the use of primers, yellow in color, shall be permitted for pipe and fittings manufactured in accordance with ASTM D2846 or equivalent International Standard(s) approved by the Authority Having Jurisdiction, 15mm through 65mm (0.5 - 2.5 in.) in external pipe diameter. Apply primer where required inside the fitting and to the depth of the fitting on the 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. Solvent cement joints shall be installed in accordance with the manufacturer's instructions.

(2) Removable and non-removable push-fit fittings that employ a quick assembly push-fit connector shall comply with ASSE 1061 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

Mechanical joints shall be installed in accordance with the manufacturer's instructions.

605.3 PE Plastic Pipe/Tubing and Joints. PE plastic pipe/tubing and fittings joining methods shall comply with the following:

(1) Heat-fusion joints between PE pipe/tubing and fittings shall comply with ASTM D2657 or equivalent International Standard(s) approved by the Authority Having Jurisdiction and shall be assembled using butt, socket, and electro-fusion heat methods.

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. Butt-fusion joints shall be installed in accordance with the manufacturer's instructions.

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. Socket-fusion joints shall be installed in accordance with the manufacturer's instructions.

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. Electro-fusion joints shall be installed in accordance with the manufacturer's instructions.

(2) Mechanical joints between PE pipe/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 3.1 of a radian (180 degrees) 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 any fitting or valve.

Mechanical joints shall be designed for their intended use and shall be installed in accordance with the manufacturer's instructions.

605.4 PE-AL-PE Plastic Pipe/Tubing and Joints. PE-AL-PE plastic pipe/tubing and fittings joining methods shall comply with the following:

Mechanical joints for PE-AL-PE pipe/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. Such joints shall comply with ASTM F1974, CSA B137.9 or equivalent International Standard(s) approved by the Authority Having Jurisdiction and in accordance with the manufacturer's instructions.

Crimp insert fittings shall be joined to the pipe by the 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 3mm to 6mm (0.125 - 0.25 in.) 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.

Compression joints for PE-AL-PE pipe/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.

605.5 PEX Plastic Tubing and Joints. PEX plastic tubing and fittings joining methods shall comply with the following:

Mechanical joints between PEX tubing and fittings shall include mechanical and compression-type fittings and insert fittings.

Mechanical cold expansion fittings shall be joined to PEX tubing in accordance with ASTM F1960, ASTM F2080, CSA B137.5 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Such joints shall be made by first expanding the end of the pipe with the expander tool, inserting the cold-expansion fitting into the expanded pipe, then pulling the compression-sleeve or reinforcing ring over the PEX pipe and fitting, compressing the pipe between the compression-sleeve and the fitting.

Mechanical cold flare compression fittings shall be joined to PEX tubing in accordance with ASTM F1961, CSA B137.5 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. The proper cone assembly (female fitting) shall be placed onto the assembly tool. PEX tubing shall be placed into the tool, so that the cut end abuts the cone union. Close the locking handle of the tool until the tool locks. The compression lever shall press the grip ring of the cone union assembly onto the PEX tubing which flares the end of the PEX tubing. Open the compression lever and tighten the cone union nut onto the male end of the desired fitting and apply torque.

Crimp insert fittings shall be joined to PEX tubing in accordance with ASTM F1807, ASTM F2098, ASTM F2159, ASTM F2434, CSA B 137.5 or equivalent International Standard(s) approved by the Authority Having Jurisdiction 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 3mm to 6mm (0.125 - 0.25 in.) 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.

Removable and non-removable push-fit fittings that employ a quick assembly push-fit connector shall comply with ASSE 1061 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

Mechanical joints shall be installed in accordance with the manufacturer's instructions.

605.6 PEX-AL-HDPE Plastic Tubing and Joints. PEX-AL-HDPE plastic pipe/tubing and fittings joining methods shall comply with the following:

Compression joints between PEX-AL-HDPE tubing and fittings shall comply with ASTM F1986 or equivalent International Standard(s) approved by the Authority Having Jurisdiction and shall include threaded or solder adapters that are utilized to connect the compression fittings and joints. Compression fittings shall be made from cast bronze, brass or plastic. Such fittings shall be approved for the intended application and be free from defects. The snap-ring, a part of threaded or solder adapters utilized in the assembly between fittings and threaded or solder adapters shall be made from injection molded PVDF. Such joints shall be installed in accordance with the manufacturer's instructions.

605.7 PEX-AL-PEX Plastic Tubing and Joints. PEX-AL-PEX plastic pipe/tubing and fittings joining methods shall comply with the following:

Mechanical joints between PEX-AL-PEX tubing and fittings shall include mechanical and compression-type fittings and insert fittings with a copper crimping ring. Such joining methods shall comply with ASTM F1974, ASTM F2434, CSA B137.10 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Crimp joints for crimp insert fittings shall be joined to PEX-AL-PEX pipe by the compression of a copper crimp ring around the outer circumference of the pipe, forcing the pipe material into annular spaces formed by ribs on the fitting.

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.

Mechanical joints shall be installed in accordance with the manufacturer's instructions.

605.8 Polypropylene Plastic Pipe and Joints. Polypropylene plastic pipe and fittings joining methods shall comply with the following:

(1) Heat-fusion joints between polypropylene pipe and fittings shall comply with ASTM D2389, CSA B137.11 or equivalent International Standard(s) approved by the Authority Having Jurisdiction and shall be assembled using butt-, socket- and electro-fusion heat methods.

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. Butt-fusion joints shall be installed in accordance with the manufacturer's instructions.

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. Socket-fusion joints shall be installed in accordance with the manufacturer's instructions.

Electro-fusion joints shall be made by embedding the resistance wire in the fitting and supplying with an electric 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. Electro-fusion joints shall be installed in accordance with the manufacturer's instructions.

(2) Mechanical and compression sleeve joints shall be installed in accordance with the manufacturer's instructions.

605.9 PP-AL-PP Plastic Pipe and Joints. PP-AL-PP plastic pipe and fittings joining methods shall comply with the following:

(1) Heat-fusion joints between polypropylene pipe and fittings shall comply with ASTM D2389, CSA B137.11 or equivalent International Standard(s) approved by the Authority Having Jurisdiction and shall be assembled using butt-, socket- and electro-fusion heat methods.

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. Butt-fusion joints shall be installed in accordance with the manufacturer's instructions.

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. Socket-fusion joints shall be installed in accordance with the manufacturer's instructions.

Electro-fusion joints shall be made by embedding the resistance wire in the fitting and supplying with an electric 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. Electro-fusion joints shall be installed in accordance with the manufacturer's instructions.

(2) Mechanical and compression sleeve joints shall be installed in accordance with the manufacturer's instructions.

606.0 Valves.

606.1 Valves up to and including 50mm (2 in.) in size shall be brass or other approved material. Sizes exceeding 50mm (2 in.) 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 meet the requirements of NSF 61 as referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

606.2 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 any 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 any 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 at all times. 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 In multidwelling units, one or more shutoff valves shall be provided in each dwelling unit so that the water supply to any plumbing fixture or group of fixtures in that dwelling unit can be shut off without stopping the water supply to fixtures in other dwelling units. These valves shall be accessible in the dwelling unit that they control.

606.4 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 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 Required shutoff or control valves shall be accessible.

606.7 A single control valve shall be installed on a water supply line ahead of any automatic metering valve that supplies a battery of fixtures.

607.0 Potable Water Storage Tanks.

607.1 General. The regulations set forth shall govern the installation, location and construction of potable water storage tanks. For the purposes of this section, potable water storage tanks shall be defined as any storage vessel that holds potable water for consumption and is connected to a public water supply known as the water storage tank (see Guide to Water Supply Regulations for Roof Tanks).

607.1.1 Water Tanks Required. Every building provided with water shall have one or a combination of the following arrangements:

(1) Low level and high level tanks with transfer pump(s).

(2) Low level tanks with a hydropneumatic pumping system.

607.1.2 Location and Covering. The elevated water tanks shall be positioned so that its contents are protected from direct sunlight. An assembly or shade system shall be provided to prevent the adverse impact from UV radiation and vaporization of water from the storage tank. Such assembly or system shall be designed to cover the top and sides of the water storage tank to resist temperatures of not less than 50°C (122°F). Reflective shade panels or coverings shall be permitted; and technical data, such as the shade factor or transmission level of material having puncture resistant, tear strength, burst strength and UV resistance shall be submitted and approved by the Authority Having Jurisdiction.

607.1.3 Sizing. The minimum storage capacity for a water storage tank not providing fire protection shall be based on the requirements in Section 607.1.1. Where fire protection is provided, fire storage capacity shall be in accordance with the provisions set forth by the Authority Having Jurisdiction. Hydropneumatic tanks shall not be used for fire protection.

Excessive storage capacity (exceeding 60 hours) shall be prohibited to minimize detention times and water quality deterioration.

607.1.4 Materials and Construction. Water storage tanks and appurtenant materials including, but not limited to: paints, linings, coatings, adhesives, bladders, gaskets and sealants in direct contact with potable water, shall be certified to NSF 61 (health effects testing criteria for products used in a drinking water system) or equivalent International Standard(s) approved by the Authority Having Jurisdiction and the following:

(1) Water storage tanks shall be listed and labeled by a listing agency and shall conform to applicable standards referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

(2) Water storage tanks shall be resistant to temperatures not less than 50°C (122°F).

(3) Water tank shall be tight against leakage; dust and insect proof.

(4) Water storage tanks shall be UV stabilized for outdoor applications.

(5) Water storage tanks shall be designed and accessible for visual inspection.

(6) Water storage tank materials that are in contact with stored water shall be compatible with the stored water quality and shall comply with referenced standards listed in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Stainless steel, concrete, fiberglass, reinforced plastics (polypropylene, PVDF, HDPE and CPVC) are considered approved materials.

(7) Interior coatings shall meet the requirements of NSF 61 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Interior coatings shall be properly applied and cured. After curing, the coating shall not transfer any substance to the water that causes toxic or taste odors. Wax coatings for the tank interior shall be prohibited.

    Exterior coatings shall comply with referenced standards listed in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

(8) Material of the tank shall not be adversely affected by condensate that forms inside the tank and shall not cause pollution of the stored water.

(9) Metallic materials shall be protected against internal or external corrosion.

(10) Tanks constructed of erosive materials shall be lined with thick safe, non-corrosive, and non-leaking material.

(11) Concrete tanks shall be seamless and reinforced.

(12) Water storage tank materials shall be capable of withstanding internal and external forces to which they are subjected.

(13) The design of the structural systems supporting water storage tanks shall include the necessary interfaces between the tank and the supporting structure or base. Engineered structural calculations shall be submitted and approved by the Authority Having Jurisdiction. The design of elevated water storage tanks shall include consideration of lateral loads due to seismic provisions. Individual foundations shall be designed

with a minimum safety factor of 1.2 against uplift, overturning, and sliding. Earth coverings shall not be included in the calculations for the foundation structure design.

(14) Water storage tanks located on the roof shall be installed in well drained locations, and its contents shall be protected from direct sunlight in accordance with Section 607.1.2.

(15) Transparent tanks shall be coated on the outside with paint to become opaque.

(16) Underground storage tanks shall be installed in areas that are graded to drain surface water runoff and prevent ponding on top of the storage tank.

(17) Underground tanks shall be installed on a foundation that is stable and protected from settlement. Such tanks shall be constructed to prevent the infiltration of external water or other contaminants.

(18) The water supply inlet to the tank shall have an airgap of not less than 15cm (6 in.). The supply outlet shall be not less than 100mm (4 in.) above the bottom of the tank. Inlet and outlet pipes shall be installed such that provision is made for expansion and contraction.

(19) Fullway valves shall be installed on the water supply inlet to the tank and on the supply outlet for service to enable maintenance or repair.

607.1.5 Vents. Water storage tanks shall be provided with a vent(s). The vent shall have a return bend and screened with mesh having 1mm (0.04 in.) openings, stainless steel, plastic or bronze screen. Vents on above ground tanks shall terminate not less than three pipe diameters above the tank roof. Vents for below ground tanks shall terminate not less than 60cm (24 in.) above grade or tank roof.

607.1.6 Overflows. Water storage tanks shall be provided with an overflow pipe one size larger than that of the supply pipe. Such overflows shall be indirectly connected to the drainage system with an airgap, not less than 15cm (6 in.) and screened with 1.6mm (1/16 in.) mesh stainless steel or bronze screen.

607.1.7 Drains. Water storage tanks shall be provided with a valved drain pipe located at the lowest point and shall discharge through an indirect waste opening with an airgap of twice the diameter of the drain pipe.

607.1.8 Water Supply Inlet. The water supply inlet to a water storage tank shall be controlled by a float valve or switches as a means to monitor the water level and overflow. The float valve or switch shall be made of noncorrosive material and shall be approved for a temperature rating not less than 50°C (122°F). Such inlet shall be provided with an airgap not less than 15cm (6 in.) above the overflow. Alarms to indicate high and low water levels are indicated.

607.1.9 Covers and Access. Water storage tanks shall be provided with a fitted, solid, water-tight, gasketed cover. Access for cleaning, painting, inspection and maintenance shall be provided. The cover shall be of material that will not transform into a brittle substance and that disintegrates in small fragments where broken. The cover shall prevent the light from entering the tank.

607.1.10 Auxiliary Connection. A pipe connection shall be provided to supply the low level tank from a water tank and the connection from the city mains.

607.1.11 More Than One Tank. Where installing more than one tank, each tank shall be provided with separate inlet, outlet, overflow, and drain pipes.

607.1.12 Disinfection. Water storage tanks shall be disinfected prior to use, after cleaning, repair, or painting in accordance with the following:

(1) Drain or empty tank.

(2) Clean interior surfaces to remove dirt and debris.

(3) Interior surfaces shall be thoroughly disinfected by means of chlorine solutions.

(4) Dispersion of a chlorine solution of not less than 30mm/L (30ppm).

(5) Chlorine solution shall remain in contact with interior surfaces for not less than 1 hour.

(6) Water supply tank shall be flushed with potable water from an approved source until chlorine solution is dispelled.

(7) Bacteriological test samples shall be collected and analyzed. Where samples are approved by the Authority Having Jurisdiction, the system shall be permitted to be placed in service.

(8) Where sufficient water is not available, an alternative method for disinfection shall be submitted in writing, describing the proposed disinfection procedure and the need for an alternative procedure to the Authority Having Jurisdiction for approval.

608.0 Water Pressure, Pressure Regulators, Pressure Relief Valves, and Vacuum Relief Valves.

608.1 Inadequate Water Pressure. A minimum water pressure equal to 1.25bar (18.0 psi) shall be ensured in the distribution system. In situations where this is unavailable, a suitable booster pump shall be installed (see Section 608.1.1). Booster pumps shall be installed on the discharge side of the elevated tank that supplies the water to the building in accordance with the manufacturer's instructions and engineering design. Pressure to be generated by the booster pump shall depend on the type of fixtures installed.

608.1.1 Booster Pumps. Booster pumps shall operate on the following principles:

(1) Cut-in and cut-off at preset low/high pressure limits.

(2) Variable Frequency Drive (VFD), wherein the frequency of the motor shall be determined by the system demand.

Booster pumps shall preferably be provided with a flooded suction from a storage tank. Where this is not feasible, either submersible pumps or pumps with adequate priming arrangements shall be provided. All booster pumps shall have dry run protection.

Water pressure tanks in a hydro-pneumatic booster system shall be provided with a pressure relief valve and be set at a maximum pressure equal to the rating of the tank. Such valves shall be sized and installed in accordance with the manufacturer's instruction.

608.2 Excessive Water Pressure. Where static water pressure in the water supply piping exceeds 6bar (80 psi), an approved-type pressure regulator preceded by an adequate strainer shall be installed and the static pressure reduced to 6.5bar (80 psi) or less. Pressure regulator(s) equal to or exceeding 40mm (1.5 in.) shall not require a strainer. Such regulator(s) shall control the pressure to all water outlets in the building unless otherwise approved by the Authority Having Jurisdiction. Each such regulator and strainer shall be accessibly located above ground or in a vault equipped with a properly sized and sloped, bore-sighted drain to daylight, shall be protected from mechanical damage, 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. 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. The expansion tank shall be properly sized and installed in accordance with the manufacturer's 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 7bar (100 psi) or less.

608.3 Thermal Expansion. Any water system provided with a check valve, backflow preventer, pressure regulating valve, or any other normally closed device that prevents the 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 recommendation.

609.0 Installation, Testing, Unions, and Location.

609.1 Installation. Water piping shall be adequately supported in accordance with Section 314.0. 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 may be made with bends, provided that such bends are made with bending equipment that does not deform or create a loss in the cross-sectional area of the tubing. Changes in direction are allowed with flexible pipe and tubing without fittings in accordance with the manufacturer's installation instructions. Provisions shall be made for expansion in hot-water piping. Piping, equipment, appurtenances, and devices shall be installed in a manner conforming with the provisions and intent of this code. The cover for water service piping shall be not less than 30cm (12 in.) below finish grade.

609.2 Water pipes shall not be run or laid in the same trench as building sewer or drainage piping constructed of materials that are not approved for use within a building unless both of the following conditions are met:

609.2.1 The bottom of the water pipe, at all points, shall be not less than 30cm (12 in.) above the top of the sewer or drain line.

609.2.2 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 30cm (12 in.) from the sewer or drain line.

Water pipes crossing sewer or drainage piping materials that are not approved for use within a building shall be laid not less than 30cm (12 in.) above the sewer or drain pipe.

609.3 Water piping installed within a building and in or under a concrete floor slab resting on the ground shall be installed in accordance with Section 315.0.

609.4 Testing. Upon completion of a section or the entire hot and cold water supply system shall be tested and proved tight under a water pressure of not less than the working pressure under which it shall be used. The water used for tests shall be obtained from a potable source of supply. Except for plastic piping, air pressure equal to 3.5bar (50psi) 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 30cm (12 in.) of regulating equipment, 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 any lot other than the lot that is the site of the building or structure served by such building supply.

609.7 Nothing contained in this code shall be construed to prohibit the use of all or part of an abutting lot to:

609.7.1 Provide access to connect a building supply to an available public water service when proper cause and legal easement not in violation of other requirements have been first established to the satisfaction of the Authority Having Jurisdiction.

609.7.2 Provide additional space for a building supply when 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 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 Disinfection of Potable Water System. New or repaired potable water systems shall be disinfected prior to use whenever required by the Authority Having Jurisdiction. The method to be followed shall be that prescribed by the Health Authority or, in case no method is prescribed by it, the following:

609.8.1 The pipe system shall be flushed with clean, potable water until only potable water appears at the points of outlet.

609.8.2 The system or parts thereof shall be filled with a water-chlorine solution, containing not less than 30mm/L (30 parts per million) of chlorine, and the system or part thereof shall be valved-off and allowed to stand for 1 hour.

609.8.3 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.

609.8.4 The procedure shall be repeated if it is shown by bacteriological examination made by an approved agency that contamination persists in the system.

609.9 Water Hammer. 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 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction and shall be installed as close as possible to quick-acting valves.

609.9.1 Mechanical Devices. When listed mechanical devices are used, the manufacturer's specifications as to the location and method of installation shall be followed.

610.0 Size of Potable Water Piping.

610.1 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 peak demand and shall be determined according to the methods and procedures outlined in this section, engineering methods, or appendices A and L. 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 Where a water filter, water softener, backflow prevention device, or similar device is installed in any 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 any such pressure loss.

No water filter, water softener, backflow prevention device, or similar device regulated by this code shall be installed in any potable water supply piping when the installation of such device produces an excessive pressure drop in any such water supply piping. In the absence of specific pressure drop information, the diameter of the inlet or outlet of any 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 The quantity of water required to be supplied to every plumbing fixture shall be represented by water supply fixture unit values, as shown in Table 6-7.

610.4 Listed parallel water distribution systems shall be installed in accordance with their listing, but at no time shall any portion of the system exceed the maximum velocities allowed by this code.

610.5 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) may be expected, all friction-loss data shall be obtained from the charts in Appendix A of this code. Friction or pressure losses in the 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 as required by Section 610.2.

610.6 On any proposed water piping installation sizing, the following conditions shall be determined:

(1) Determine static pressure for highest outlet (elevation difference to highest outlet).

(2) Determine friction head loss (pump to farthest fixture x 1.5 [equals equivalent length]).

(3) Required outlet pressure [fixture with most pressure requirements (i.e. flush valves etc.)].

(4) Head loss through PRV at pump (add total for required initial pressure).

(5) Total number of water supply fixture units as determined from Table 6-7, Separate Cold and Hot Water Supply Fixture Unit Values, for the fixtures to be installed.

(6) Convert to L/min. (gpm) as determined from Table 6-9.

(7) Head on pump (total required initial pressure).

(8) Suction pressure (bar).

(9) Select pump capacity and head (based on L/min. at a head of bar).

(10) Water service must supply total L/min (gpm) (use friction loss tables for appropriate type of material).

(11) Determine pressure loss of pipe (per 100m [100 ft.] of pipe).

(12) Determine sizing for main (designing velocities at or below 2.4m/s [8fps] and manufacturer's recommendations).

(13) Determine sizing for branches (from the most remote riser work towards source of supply).

(a) Use table for converting WSFU to L/min (gpm) (Table 6-9) and the friction loss tables for selecting pipe sizes for the corresponding L/min (gpm) flow (Appendix A tables for friction loss).

610.7 Sizing for Velocity. Water piping systems shall not exceed the maximum velocities listed in this section or Appendix A.

610.7.1 Water Supply Systems. Maximum velocities in pipe, tubing, and fitting systems shall not exceed 2.4m/s (8 fps) in cold water and 1.5m/s (5 fps) in hot water.

610.8 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 all 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 water lines as defined in Section 601.2.

(7) The size and material of irrigation water piping installed outside of any building or structure and separated from the potable water supply by means of an approved airgap 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 Manifold or Gridded Systems.

611.1 General. Manifold and gridded systems shall be installed as a remote manifold design. Hot and cold water distribution piping shall be installed with a smaller remote manifold at such locations where groups of fixtures are located. Such manifold shall be either flow-through or closed end. All manifolds shall be accessible. Individual water distribution piping shall be installed to each fixture.

611.2 Valves. Individual fixture shut off valves shall be installed at the manifold and identify the fixture served. All valves shall be accessible.

611.3 Installation. Tubing for the installation of manifold and gridded systems shall be installed in accordance with the manufacturer's instructions. Tubing shall be not less than 30cm (12 in.) vertically or 15cm (6 in.) horizontally from sources of high heat. Tubing shall be installed to permit expansion and contraction. Water distribution piping shall be bundled together and shall permit movement.

611.4 Sizing. Hot and cold water manifolds shall be sized in accordance with Table 6-5.

Individual water distribution piping for manifold systems shall be sized in accordance with Table 6-6.

612.0 Drinking Water Treatment Units.

612.1 Compliance with Standard. Drinking water treatment units shall meet the requirements of the appropriate standard referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

612.2 Airgap Discharge. Discharge from drinking water treatment units shall enter the drainage system through an airgap or an airgap device that meets the requirements of the appropriate standards referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

612.3 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 the appropriate standards referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

612.4 Sizing of Residential Softeners. Residential-use water softeners shall be sized per Table 6-8.

TABLE 6-5
Manifold Sizing

Nominal Size Internal Diameter	Maximum Demand Litres per Minute (lpm) Velociy at 1.22 Metres per Second	Velocity at 2.44 Metres per Second
mm	**lpm**	**lpm**
15	8	19
20	23	42
25	38	76
32	57	117
40	83	167

SI: 1mm = 0.04in.; 1m/s = 3.3 ft./s

TABLE 6-6
Minimum Sizes of Individual Water Distribution Piping for Manifold Systems

Fixture	Minimum Pipe Size
	mm
Bathtubs and Whirlpool Tubs	15
Tub and Shower Combination	15
Shower (Single Head)	15
Lavatory	10
Water closet (Private) Flush Tank	10
Water closet (Public) Flush Tank	15
Water closet (Public) Flush Valve	20
Urinal (Private) Flush Tank	10
Urinal (Public) Flush tank	15
Urinal (Public) Flush Valve	15
Bidet (Private) Flush Tank	10
Bidet (Public) Flush Valve	15
Kitchen Sink	10
Laundry or Washing Machine	10
Utility Sink	10

SI: 1mm = 0.04 in.

TABLE 6-7
Separate Cold and Hot Water Supply Fixture Unit Values

Appliances, Appurtenances or Fixtures[1]	Minimum Fixture Branch Pipe Size mm[2]	Occupancy	Water Supply Fixture Units (WSFU)		
			Cold	Hot	Total
Bathtub or Bath/shower	15	Private	1.0	1.0	1.4
	15	Public	3.0	3.0	4.0
Bidet	15	Private	1.0		1.0
Clothes washer	15	Private or Public	3.0	3.0	4.0
Dental Unit, cuspidor	15	Public	1.0		1.0
Dishwasher, domestic	15	Private or Public		1.5	1.5
Drinking Fountain	15	Private or Public	0.5		0.5
		Assembly	0.75		0.75
Hose Bibb	15	Private or Public	2.5		2.5
Hose Bibb, each additional when used with total demand	15	Private or Public	1.0		1.0
Lavatory	15	Private, Public, or Assembly	0.75	0.75	1.0
Lawn sprinkler, each head[3]		Private or Public	5.0		5.0
Sinks					
Bar	15	Private	0.75	0.75	1.0
		Public	1.5	1.5	2.0
Clinic, Faucet	15	Public	2.25	2.25	3.0
Clinic Flushometer Valve with or without faucet	25	Public	8.0		8.0
Kitchen, domestic	15	Private or Public	1.125	1.125	1.5
Laundry		Private or Public	1.125	1.125	1.5
Service or Mop Basin	15	Private	1.125	1.125	1.5
		Public	2.25	2.25	3.0
Washup, each set of faucets	15	Public	1.5	1.5	2.0
Shower, per head	15	Private or Public	1.5	1.5	2.0
Urinal, 2L/flush flushometer valve	20	Public	4.0		4.0
		Assembly	5.0		5.0
Urinal, flush tank	15	Private or Public	2.0		2.0
		Assembly	3.0		3.0
Wash fountain, circular spray	20	Public	3.0	3.0	4.0
Water closet, 6L/flush gravity tank	15	Private or Public	2.5		2.5
		Assembly	3.5		3.5
Water closet, 6L/flush flushometer tank	15	Private or Public	2.5		2.5
		Assembly	3.5		3.5
Water closet, 6L/flush flushometer valve	25	Public	5.0		5.0
		Assembly	8.0		8.0

Notes:

1 Appliances, fixtures and appurtenances not included in this table may be sized by reference to fixtures having similar flow rates and frequency of use.

2 The listed minimum supply branch pipe sizes for individual fixtures are the nominal (ID) pipe size.

3 For fixtures or supply connections likely to impose continuous flow demands, determine the required flow in L/min and add separately to the demand in L/min for the distribution system or portions thereof.

SI: 1mm = 0.04in.; 1L = 0.26 gal.

TABLE 6-8
Sizing of Residential Water Softeners

Required Size of Softener Connection mm	Number of Bathroom Groups Served[1]
20	up to 2[2]
25	up to 4[3]

[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 4 bathroom groups, the softener size shall be engineered for the specific installation.

SI: 1mm = 0.04in.

TABLE 6-9
Conversion of Water Supply Fixture Units Equivalent to L/min

Demand (Load) Water Supply Fixture Units	Demand (Load), L/min per System with Flush Tanks	Demand (Load), L/min per System with Flush Valves
1	0	–
2	3.8	–
3	11	–
4	15	–
5	19	–
6	23	–
8	25	–
10	30	102
12	34	110
14	42	114
16	45	121
18	49	125
20	53	132
25	64	144
30	76	155
35	87	167
40	95	178
45	102	185
50	110	197
60	121	208
70	132	223
80	144	235
90	155	246
100	167	257
120	182	276
140	201	295
160	216	314
180	231	329
200	246	348
225	265	367
250	284	382
275	303	401
300	322	416
400	397	477
500	473	537
750	643	674
1,000	787	787
1,250	908	908
1,500	1,011	1,011
1,750	1,113	1,113
2,000	1,215	1,215
2,250	1,317	1,317
2,500	1,419	1,419
2,750	1,522	1,522
3,000	1,635	1,635
4,000	1,987	1,987
5,000	2,245	2,245
6,000	2,434	2,434
7,000	2,593	2,593
8,000	2,718	2,718
9,000	2,820	2,820
10,000	2,911	2,911

SI: 1L/min = 0.26 gpm

Part II
Booster Pump Systems.

Part II is an adjunct to Chapter 6 and shall not be considered as part of this code unless formally adopted as such. The following has been provided for the convenience of the user for reference purposes:

6.1 Where the water pressure is not sufficient to meet the water supply demands of a building, a booster pump system shall be installed. The pump system shall be permitted to be used for the entire building, for the upper floors in one or more zones, or for select equipment connections having high-pressure requirements.

The required capacity of the pump system shall be determined where the building demand is evaluated in terms of peak demand. The peak demand shall be determined as described for the water service. The pressure requirement shall be derived from the Bernoulli equation.

Note: Between any 2 points of an ideal flow stream, $h + p/d + v^2/2g$ shall be a constant. In a more realistic flow, a friction head and pump head shall be as follows:

Equation 6-1

$$h_1 + \frac{p_1}{d} + \frac{v_1^{\,2}}{2g} + h_p = h_2 + \frac{p_2}{d} + \frac{v_1^{\,2}}{2g} + h_f$$

Where:

h = the flow stream's elevation above a datum, m (ft.) p as its static pressure, kPa (lb./ft.^{2})

d = its density, kg/m^3 (lb./ft.^{3})

v = its velocity, m/sec (ft./sec)

h_p= the pump head (total dynamic head)

g = acceleration of gravity, 9.8m/s^2 (32.2ft./sec^2)

h_f = the friction head loss between Points 1 and 2, m (ft.)

Where Point 1 is at a location of a known pressure such as the street main and Point 2 is at a fixture, the equation shall be rearranged to derive the required pump head to adequately supply that fixture. Various fixtures in the building shall be permitted to be selected to derive various pump heads. The maximum pump head is considered the top fixture of the most remote riser. Additionally, after considering that velocities are similar between Points 1 and 2, the two velocity terms shall be permitted to be omitted.

Equation 6-2

$$h_p = h_2 - h_1 + \frac{(p_2 - p_1)}{d} + h_f$$

The friction head includes various losses such as friction from straight pipe, fittings, valves meters, tanks, treatment devices, and backflow preventers. In addition, the head loss through the booster pump system piping and its control valves shall be added. These are typically 1.2m (4 ft.) and up to 5.5m (18 ft.) respectively.

The design of the booster pump system shall consist of one or more electrically driven centrifugal pumps, connecting pipework various controls such as pressure-reducing valves, motor controls, and a hydro-pneumatic tank.

Example 6-1: Determining Total Dynamic Head. Determine the required total dynamic head of a booster pump system for a building with its most remote fixture as a pressure balancing shower valve (assumed 138kPa [20 psi]) located 14.6m (48 ft.) above the pump; street pressure as 172kPa (25 psi) as read from a gauge near the pump; the total equivalent length of pipe as 122m (400 ft.); the uniform pressure loss of this length as 35kPa per 35m (5 psi/100 ft.); and pressure loss through the service meter as 41kPa (6 psi) and through a water softener as 62kPa (9 psi).

Solution: From Equation 6-2, $(p_2 - p_1)/d$ becomes (138 – 172)/9.8 = -3.50m.

The building friction head becomes (120 x 35/30 + 41 + 62)/9.8 = 24.8m.

The pump system friction head becomes 1.22 + 5.49 = 6.7m.

The total dynamic head therefore becomes 14.6 – 3.50 + 24.6 + 6.70 = 42.4m.

Solution (U.S.): From Equation 6-2, $(p_2 - p_1)/d$ becomes (20 - 25) x 144/62.4 = -11.5ft.

The building friction head becomes (400 x 0.05 + 6 + 9) x 144/62.4 = 80.8ft.

The pump system friction head becomes 4 + 18 = 22ft.

The total dynamic head therefore becomes 48 - 11.5 + 80.8 + 22 = 139ft.

CHAPTER 7

SANITARY DRAINAGE

Preamble.

Chapter 7 of the UPC-AD on Sanitary Drainage covers the design, materials, construction, and installation of sanitary drainage systems. Every structure having plumbing fixtures installed and intended for human occupancy shall have a dual plumbed gray water system in accordance with the provisions in Chapter 16, Nonpotable Water Reuse, unless approved by the Authority Having Jurisdiction.

Part I
Drainage Systems.

701.0 Materials.

701.1 Materials for drainage piping shall be in accordance with the applicable standards referenced in Table 7–1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction, except that:

701.1.1 ABS and PVC DWV piping installations shall be installed in accordance with the applicable standards referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction and Chapter 15, "Firestop Protection." Except for individual single-family dwelling units, materials exposed within ducts or plenums shall have a flame-spread index of not more than 25 and a smoke-developed index of not more than 50, when tested in accordance with NFPA 255, *Test for Surface Burning Characteristics of the Building Materials* or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

701.2 Materials for drainage fittings shall be in accordance with the applicable standards referenced in Table 7-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction of the same diameter as the piping served, and such fittings shall be compatible with the type of pipe used.

701.2.1 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 The threads (either parallel or tapered type) of drainage fittings shall be of the tapped type so as to allow a grade of 20mm/m (1/4 in./ft.).

701.2.3 Fittings used for drainage shall be of the drainage type, have a smooth interior waterway, and be constructed so as to allow a grade of 20mm/m (1/4 in./ft.).

702.0 Fixture Unit Equivalents.

702.1 The unit equivalent of plumbing fixtures shown in Table 7-3 shall be based on the size of the trap required, and the unit equivalent of fixtures and devices not shown in Table 7-3 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 100mm (4 in.) are as follows:

Size of Trap and Trap Arm	Drainage Fixture Unit Values (dfu)
32mm	1 unit
40mm	3 units
50mm	4 units
75mm	6 units
100mm	8 units

SI: 1mm = 0.04 in.

Exception: On self-service laundries.

702.2 Drainage fixture units for intermittent flow into the drainage system shall be computed on the rated discharge capacity in litres per second, in accordance with Table 7-2.

702.3 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 allowed for each 0.06L/s (1 gpm) of flow.

702.4 Discharge capacity exceeding 3.2L/s (50 gpm) shall be determined by the Authority Having Jurisdiction.

703.0 Drainage System Sizing.

703.1 Drainage Fixture Units. Drainage fixture units shall be sized in accordance with Table 7-3 and Section 702.0.

703.2 Size of Building Drain and Building Sewer. The maximum number of drainage fixture units allowed on the building drain shall be in accordance with Table 7-4 and building sewers shall be in accordance with Table 7-7. The minimum size of any building drain or building sewer serving a water closet shall be 80mm (3 in.).

703.3 Size of Horizontal Branches and Vertical Stacks for Three Branch Intervals or Less. The maximum number of drainage fixture units allowed on any vertical or horizontal drainage pipe of a given size; horizontal branch or vertical stack, three branch

TABLE 7-1
Materials for Drain, Waste and Vent Pipe and Fittings

Material	Underground Drain, Waste and Vent Pipe and Fittings	Above ground Drain, Waste and Vent Pipe and Fittings	Building Sewer Pipe and Fittings	Referenced Standard(s) Pipe	Referenced Standard(s) Fittings
ABS (Schedule 40)	X	X	X	ASTM D1527, ASTM D2661, ASTM D2680[1] ASTM F628	ASTM D2661, ASTM D2680[1]
Co-extruded ABS (Schedule 40)	X	X	X	ASTM F1488	ASTM D2661, ASTM D2680[1]
Polyolefin (Schedule 40)	X	X	X	ASTM F1412, CSA B181.3	ASTM F1412, CSA B181.3
Polyvinylidene Flouride (PVDF Schedule 40)	X	X	X	ASTM F1673	ASTM F1673
PVC (Schedule 40, Type DWV)	X	X	X	ASTM D1785, ASTM D2665, ASTM F794[1],	ASTM D2665, ASTM F794[1], ASTM F1866
Co-extruded PVC (Schedule 40)	X	X	X	ASTM F1488 ASTM F891	ASTM D2665, ASTM F794[1], ASTM F1866

[1] For Building Sewer applications.

intervals or less and the maximum length of any vertical drainage pipe of a given size shall be in accordance with Table 7-4.

703.4 Size of Horizontal Branches and Vertical Stacks for More Than Three Branch Intervals. The maximum number of drainage fixture units allowed on a vertical stack, branch interval and total for stacks exceeding three branch intervals shall be in accordance with Table 7-4. Vertical stacks shall be sized, based on the total accumulated connected load at each story or branch interval.

703.4.1 Horizontal Stack Offsets. Horizontal stack offsets shall be sized in accordance with Table 7-4 as required for building drains.

703.4.2 Vertical Stack Offsets. Vertical stack offsets shall be sized in accordance with Table 7-4 as required for vertical stacks, based on the total accumulated connected load for stacks exceeding three branch intervals.

703.4.3 Horizontal Stack Offsets and Horizontal Branch Connections. Horizontal branch connections shall not connect to a horizontal stack offset or within 60cm (2 ft.) above or below the offset where such horizontal offset is located exceeding 4 branch intervals below the top of the stack.

703.5 For alternate method of sizing drainage piping, see Appendix L.

704.0 Fixture Connections (Drainage).

704.1 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 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 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 as required by this code.

TABLE 7-2
Discharge Capacity in Litres per Second For Intermittent Flow Only

L/sec.	L/sec.
0.5 to 1.0	Equals 2 Fixture Units
1.0 to 2.0	Equals 4 Fixture Units
2.0 to 3.2	Equals 6 Fixture Units

Note: Discharge capacity exceeding 3.2L/s (50 gpm) shall be determined by the Authority Having Jurisdiction.
SI: 1L/s = 15.85 gpm

705.0 Joints and Connections.

705.1 Types of Joints.

705.1.1 ABS Plastic Pipe and Joining Methods. The joining methods for ABS plastic pipe and fittings shall comply with the following:

(1) 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 complying with ASTM D 2235 or equivalent International Standard(s) approved by the Authority Having Jurisdiction 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. Universal or multi-purpose solvent cement shall be prohibited. Solvent cement joints shall be installed in accordance with the manufacturer's instructions.

(2) Mechanical joints shall be installed in accordance with the manufacturer's instructions. Such joints shall be designed to provide a permanent seal and shall be of the mechanical or push-on-joint.

(3) Threaded joints shall be installed in accordance with the manufacturer's installation instructions. Molded threads on adapter fittings for transition to threaded joints shall be permitted. The joint between the pipe and transition fitting shall be of the solvent cement type.

705.1.2 Polyolefin Plastic Pipe and Joints. Polyolefin plastic pipe and fittings joining methods shall comply with the following:

(1) Heat-fusion joints between polyolefin pipe and fittings shall comply with ASTM D2657, ASTM F1290 or equivalent International Standard(s) approved by the Authority Having Jurisdiction and shall be assembled using butt-, socket- and electro-fusion heat methods.

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. Butt-fusion joints shall be installed in accordance with the manufacturer's instructions.

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. Socket-fusion joints shall be installed in accordance with the manufacturer's instructions.

Electro-fusion joints shall be made by embedding the resistance wire in the fitting and supplying with an electric 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. Electro-fusion joints shall be installed in accordance with the manufacturer's instructions.

(2) Mechanical and compression joints shall be installed in accordance with the manufacturer's instructions.

705.1.3 PVC Plastic Pipe and Joining Methods. The joining methods for PVC plastic pipe and fittings shall comply with the following:

(1) 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, conforming to ASTM F 656 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Primer shall be applied until pipe and fitting is softened. Solvent cements complying with ASTM D 2564 or equivalent International Standard(s) approved by the Authority Having Jurisdiction 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. Universal or multi-purpose solvent cement shall be prohibited. Solvent cement joints shall be installed in accordance with the manufacturer's instructions.

(2) Mechanical joints shall be installed in accordance with the manufacturer's instructions. Such 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 when 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 gasket shall be of such size and shape as to provide a compressive force against the spigot and socket after assembly to provide a positive seal.

(3) Threaded joints shall be installed in accordance with the manufacturer's installation instructions. A minimum of Schedule 80 shall be permitted to be threaded.

705.1.4 Polyvinylidene Flouride (PVDF) Plastic Pipe and Joints. PVDF plastic pipe and fittings joining methods shall comply with the following:

(1) Heat-fusion joints between PVDF pipe and fittings shall comply with ASTM D2657 or equivalent International Standard(s) approved by the Authority Having Jurisdiction and shall be assembled using butt-, socket- and electro-fusion heat methods.

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. Butt-fusion joints shall be installed in accordance with the manufacturer's instructions.

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. Socket-fusion joints shall be installed in accordance with the manufacturer's instructions.

Electro-fusion joints shall be made by embedding the resistance wire in the fitting and supplying with an electric 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. Electro-fusion joints shall be installed in accordance with the manufacturer's instructions.

(2) Mechanical and compression joints shall be installed in accordance with the manufacturer's instructions.

705.2 Special Joints.

705.2.1 Slip Joints. In fixture drains and traps, slip joints of approved materials shall be permitted to be used in accordance with their approvals.

705.2.2 Expansion Joints. Expansion joints shall be accessible, except when in vent piping or drainage stacks, and shall be permitted to be used where necessary to provide for expansion and contraction of the pipes.

706.0 Changes in Direction of Drainage Flow.

706.1 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 1/16 bend, 1/8 bend, or 1/6 bend, or other approved fittings of equivalent sweep.

706.2 Horizontal drainage lines, connecting with a vertical stack, shall enter through wye branches equal to 0.8 radian (45 degrees), wye branches equal to 1.1 radian (60 degrees), combination wye and 1/8 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.

TABLE 7-3
Drainage Fixture Unit Values (DFU)

Plumbing Appliance, Appurtenance, or Fixture	Min. Size Trap and Trap Arm[7, 8] mm	Private	Public	Assembly[9]
Bathtub or Combination Bath/Shower	40	2.0	2.0	
Bidet	32	1.0		
Bidet	40	2.0		
Clothes Washer, domestic, standpipe[5]	50	3.0	3.0	3.0
Dental Unit, cuspidor	32		1.0	1.0
Dishwasher, domestic, with independent drain	40[2]	2.0	2.0	2.0
Drinking Fountain or Watercooler	32	0.5	0.5	1.0
Food-Waste-Grinder, commercial	50		3.0	3.0
Floor Drain, emergency	50		0.0	0.0
Floor Drain (for additional sizes see Section 702)	50	2.0	2.0	2.0
Shower, single-head trap	50	2.0	2.0	2.0
Multi-head, each additional	50	1.0	1.0	1.0
Lavatory, single	32	1.0	1.0	1.0
Lavatory, in sets of two or three	40	2.0	2.0	2.0
Wash Fountain	40		2.0	2.0
Wash Fountain	50		3.0	3.0
Mobile Home, trap	80	12.0		
Receptor, indirect waste[1,3]	40		See footnote [1,3]	
Receptor, indirect waste[1,4]	50		See footnote [1,4]	
Receptor, indirect waste[1]	80		See footnote [1]	
Sinks				
Bar	40	1.0		
Bar	40[2]		2.0	2.0
Clinical	80		6.0	6.0
Commercial with food waste	40[2]		3.0	3.0
Special Purpose	40[2]	2.0	3.0	3.0
Special Purpose	50	3.0	4.0	4.0
Special Purpose	80		6.0	6.0
Kitchen, domestic (with or without food-waste grinder and/or dishwasher)	40[2]	2.0	2.0	
Laundry (with or without discharge from a clothes washer)	40[2]	2.0	2.0	2.0
Service or Mop Basin	50		3.0	3.0
Service or Mop Basin	80		3.0	3.0
Service, flushing rim	80		6.0	6.0
Wash, each set of faucets			2.0	2.0
Urinal, integral trap 2L/flush	50[2]	2.0	2.0	5.0
Urinal, integral trap greater than 2L/flush	50	2.0	2.0	6.0
Urinal, exposed trap	40[2]	2.0	2.0	5.0
Urinal, non-water supplied	40[2,7]	0.5	0.5	0.5
Water Closet, 6L/flush Gravity Tank[6]	80	3.0	4.0	6.0
Water Closet, 6L/flush Flushometer Tank[6]	80	3.0	4.0	6.0
Water Closet, 6L/flush Flushometer Valve[6]	80	3.0	4.0	6.0
Water Closet, greater than 6L/flush Gravity Tank[6]	80	4.0	6.0	8.0
Water Closet, greater than 6L/flush Flushometer Valve[6]	80	4.0	6.0	8.0

[1] Indirect waste receptors shall be sized based on the total drainage capacity of the fixtures that drain therein to, in accordance with Table 7-2.
[2] Provide a 50mm (2 in.) 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 six fixture units each for purposes of sizing common horizontal and vertical drainage piping.
[6] Water closets shall be computed as six fixture units when determining septic tank sizes based on Appendix K of this code.
[7] Minimum trap size shall be based on the fixture outlet size.
[8] Trap sizes shall not be increased to the point where the fixture discharge may be inadequate to maintain their self-scouring properties.
[9] Assembly [Public Use (See Table 4-1)].
SI: 1mm = 0.04 in.; 1L = 0.26 gal.

TABLE 7-4
Maximum Unit Loading and Maximum Length of Drainage and Vent Piping

Size of Pipe, mm	**32**	**40**	**50**	**65**	**80**	**100**	**150**	**200**	**250**	**300**
Maximum Units										
Drainage Piping[1]										
Vertical	1	2[2]	16[3]	32[3]	48[4]	256	1,380	3,600	5,600	8,400
Horizontal	1	1	8[3]	14[3]	35[4]	216[5]	720[5]	2,640[5]	4,680[5]	8,200[5]
Vertical Stack **(exceeding three branch intervals)**										
Total for 1 branch interval		2[2]	6[3]	9[3]	20[4]	90	350	600	1,000	1,500
Total for Stack		8[2]	24[3]	42[3]	72[4]	500	1,900	3,600	5,600	8,400
Maximum Length										
Drainage Piping										
Vertical, m	14	20	26	45	65	91	155	229		
Horizontal (unlimited)										
Vent Piping **(see note)**										
Horizontal and Vertical Maximum Units	1	8[3]	24	48	84	256	1,380	3,600		
Maximum Lengths, m	14	18	37	55	65	91	155	229		

[1] Excluding trap arm.
[2] Except sinks, urinals, and dishwashers.
[3] Except six-unit traps or water closets.
[4] Only four water closets or six-unit traps allowed on any vertical pipe or stack; not to exceed three water closets or six-unit traps on any horizontal branch or drain.
[5] Based on 20 mm/m (1/4 in./ft.) slope. For 10mm/m (1/8 in./ft.) slope, multiply horizontal fixture units by a factor of 0.8.

Note: The diameter of an individual vent shall be not less than 32mm (1-1/4 in.) nor less than 1/2 the diameter of the drain to which it is connected. Fixture unit load values for drainage and vent piping shall be computed from Table 7-3 and Section 702.0. Not to exceed 1/3 of the total permitted length of any vent may be installed in a horizontal position. When vents are increased one pipe size for their entire length, the maximum length limitations specified in this table do not apply.

SI: 1mm = 3.281 ft.; 1mm = 0.04 in.

706.3 Horizontal drainage lines connecting with other horizontal drainage lines shall enter through wye branches equal to 0.8 radian (45 degrees), combination wye and 1/8 bend branches, or other approved fittings of equivalent sweep.

706.4 Vertical drainage lines connecting with horizontal drainage lines shall enter through wye branches equal to 0.8 radian (45 degrees), combination wye and 1/8 bend branches, or other approved fittings of equivalent sweep. Branches or offsets equal to 1.1 radian (60 degrees) shall be permitted to be used only when installed in a true vertical position.

707.0 Cleanouts.

707.1 Each cleanout fitting shall consist of an approved plug and shall be not less in size than as specified in Table 7-5. Plugs shall have raised square heads or approved countersunk rectangular slots.

707.2 Cleanouts shall be designed to be gas- and water-tight.

707.3 Each horizontal drainage pipe shall be provided with a cleanout at its upper terminal, and each run of piping exceeding 30m (100 ft.) in total developed length, shall be provided with a cleanout for each 30m (100 ft.), or fraction thereof, in length of such piping. An additional clean-out shall be provided in a drainage line for each aggregate horizontal change of direction exceeding 2.4 radian (135 degrees).

Exceptions:

(1) Cleanouts shall be permitted to be omitted on a horizontal drain line less than 1.5m (5 ft.) in length, unless such line is serving sinks or urinals.

(2) Cleanouts shall be permitted to be omitted on any horizontal drainage pipe installed on a slope, equal to 1.3 radian (72 degrees) or less from the vertical angle (1/5 bend).

(3) Excepting the building drain and its horizontal branches, a cleanout shall not be required on any 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 shall be permitted to be substituted for an upper terminal cleanout.

707.4 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.

707.5 Each cleanout extension shall be considered as drainage piping and each cleanout extension equal to 1.6 radian (90 degrees) shall be extended from a wye-type fitting or other approved fitting of equivalent sweep.

707.6 Each cleanout for an interceptor shall be outside of such interceptor.

707.7 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.

707.8 Each cleanout in piping of 50mm (2 in.) or less in size shall be so installed that there is a clearance of not less than 30cm (12 in.) in front of the cleanout. Cleanouts in piping exceeding 50mm (2 in.) shall have a clearance of not less than 50cm (18 in.) in front of the cleanout. Cleanouts in under-floor piping shall be extended to or above the finished floor or shall be extended outside of the building when there is less than 50cm (18 in.) vertical overall, allowing for obstructions such as ducts, beams, and piping, and 80cm (30 in.) of horizontal clearance from the means of access to such cleanout. No under-floor cleanout shall be located exceeding 6m (20 ft.) from an access door, trap door, or crawl hole.

707.9 Cleanouts shall be provided for pressure drainage systems as classified under Section 710.7.

707.10 Countersunk cleanout plugs shall be installed where raised heads cause a hazard.

707.11 Cleanouts for trap arms shall be installed in accordance with Section 1002.3.

708.0 Grade of Horizontal Drainage Piping.

Horizontal drainage piping shall be run in practical alignment and a uniform slope of not less than 20mm/m (1/4 in./ft.) or 2 percent toward the point of disposal, provided that, where it is impractical due to the depth of the street sewer or to the structural features or to the arrangement of any building or structure to obtain a slope of 20mm/m (1/4

TABLE 7-5
Cleanouts

Size of Pipe mm	Size of Cleanout mm	Threads (per 25mm)
40	40	11
50	40	11
65	65	8
80	65	8
100 & larger	90	8

SI: 1mm = 0.04 in.

in./ft.) or 2 percent, any such pipe or piping equal to 100mm (4 in.) or larger in diameter shall be permitted to have a slope of not less than 10mm/m (1/8 in./ft.) or 1 percent, when first approved by the Authority Having Jurisdiction.

709.0 Gravity Drainage Required.

Whenever practicable, plumbing fixtures shall be drained by gravity flow to the building drain.

710.0 Drainage of Fixtures Located Below the Next Upstream Manhole or Below the Main Sewer Level.

710.1 When a fixture is installed on a floor level that is lower than the next upstream manhole cover of the public or private sewer, serving such drainage piping, the fixture shall be protected from backflow of sewage by installing an approved type of 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 Drainage piping serving fixtures that are located below the crown level of the main sewer shall discharge into an approved water-tight 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 A sewage ejector or sewage pump receiving the discharge of water closets or urinals:

710.3.1 Shall have a discharge capacity of not less than 76L/min (20 gpm).

710.3.2 In single dwelling units, the ejector or pump shall be capable of passing a 40mm (1.5 in.) diameter solid ball, and the discharge piping of each ejector or pump shall have a backwater valve and gate valve not less than 50mm (2 in.) in diameter.

710.3.3 In other than single-dwelling units, the ejector or pump shall be capable of passing a 50mm (2 in.) diameter solid ball, and the discharge piping of each ejector or pump shall have a backwater valve and gate valve not less than 80mm (3 in.) in diameter.

710.4 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. If 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, when installed in drainage piping, shall be fullway type with working parts of corrosion-resistant metal. Sizes of 100mm (4 in.) or more in diameter shall have cast-iron bodies, and sizes less than 100mm (4 in.) shall have cast-iron or brass bodies.

710.5 Building drains or building sewers receiving discharge from any pump or ejector shall be adequately sized to prevent overloading. Two fixture units shall be allowed for each 0.06L/s (1 gpm) of flow.

710.6 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 at all times 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; having noncorrosive bearings, seats, and self-aligning discs; and shall be constructed so as to ensure a positive mechanical seal. Such backwater valves shall remain sufficiently open during periods of low flows to avoid the screening of solids and shall not restrict capacities or cause excessive turbulence during peak loads. Unless otherwise listed, valve access covers shall be a bolted type with gasket, and each valve shall bear the manufacturer's name cast into the body and the cover.

710.7 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 Sumps and receiving tanks shall be water-tight and shall be constructed of concrete, metal, plastic, or other approved materials. If constructed of poured concrete, the walls and bottom shall be adequately reinforced, treated internally and externally to resist corrosion, 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 with acid-resistant materials.

710.9 Such sumps and receiving tanks shall be automatically discharged and, when in any "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 50mm (2 in.) from the high-water or "starting" level of the sump.

710.10 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 7-4 for the number and type of fixtures discharging into the sump, nor less than 4cm (1.5 in.) in diameter. When 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 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 3kg for each metre (2 pounds for each foot) 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 per the manufacturer's instructions and shall be not less than 32mm (1-1/4 in.) 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 when approved by the Authority Having Jurisdiction.

710.13.1 Sumps. The sump shall be water- and gas-tight.

710.13.2 Discharge Piping. The discharge piping shall be sized per manufacturer's instructions and shall be not less than 20mm (3/4 in.) in diameter. The developed length of the discharge piping shall not exceed the manufacturer's recommendations. 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 per this code. The sump shall be vented per manufacturer's instructions and such vent shall be permitted to connect to the fixture venting.

711.0 Suds Relief.

Drainage connections shall not be made into a drainage piping system within 2.4m (8 ft.) of any 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 of 2.4m (8 ft.) 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 drainage, waste, and venting systems (DWV) 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 any 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. If 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. If 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 3m (10 ft.) head of water. In testing successive sections, not less than the upper 3m (10 ft.) of the next preceding section shall be tested, so that no joint or pipe in the building [except the uppermost 3m (10 ft.) of the system] shall have been submitted to a test of less than a 3m (10 ft.) 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 any 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 35kPa (5 psi) or sufficient to balance a column of mercury 25cm (10 in.) 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 Every building in which plumbing fixtures are installed and every premises having drainage piping thereon shall have a connection to a public or private sewer, except as provided in Sections 101.4.1.3, 713.2, and 713.4.

713.2 When no public sewer intended to serve any lot or premises is available in any thoroughfare or right of way abutting such lot or premises, drainage piping from any building or works shall be connected to an approved private sewage disposal system.

713.3 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 any such smaller parcel or parcels shall connect to the public sewer.

713.4 The public sewer shall be permitted to be considered as not being available when such public sewer or any building or any exterior drainage facility connected thereto is located exceeding 60m (200 ft.) from any proposed building or exterior drainage facility on any lot or premises that abuts and is served by such public sewer.

713.5 No permit shall be issued for the installation, alteration, or repair of any private sewage disposal system, or part thereof, on any lot for which a connection with a public sewer is available.

713.6 On every lot or premises hereafter connected to a public sewer, all plumbing and drainage systems or parts thereof on such lot or premises shall be connected with such public sewer.

> **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, when no hazard, nuisance, or insanitary condition is evidenced and written permission has been obtained from the Authority Having Jurisdiction, to remain connected to such properly maintained private sewage disposal system when 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 It shall be unacceptable for any person to deposit, by any means whatsoever, into any plumbing fixture, floor drain, interceptor, sump, receptor, or device which is connected to any drainage system, public sewer, private sewer, septic tank, or cesspool; any ashes, cinders, solids, rags; flammable, poisonous, or explosive liquids or gases; oils, grease, and any other thing whatsoever that would or could cause damage to the public sewer, private sewer, or private sewage disposal system.

714.2 No rain, surface, or subsurface water shall be connected to or discharged into any drainage system, unless first approved by the Authority Having Jurisdiction.

714.3 No cesspool, septic tank, seepage pit, or drainfield shall be connected to any public sewer or to any building sewer leading to such public sewer.

714.4 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 An approved-type water-tight sewage or wastewater holding tank, the contents of which, due to their character, must be periodically removed and disposed of at some approved off-site location, and shall be installed only when 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 The building sewer, beginning 60cm (2 ft.) from any building or structure, shall be of such materials as prescribed in this code.

715.2 Joining methods and materials shall be as prescribed in this code.

715.3 Replacement of existing building sewer and building storm sewers using trenchless methodology and materials shall be installed in accordance with UPC-AD, Installation Standards.

716.0 Markings.

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 conform to the approval requirements of Chapter 3 of this code.

717.0 Size of Building Sewers.

The minimum size of any building sewer shall be determined on the basis of the total number of fixture units drained by such sewer, in accordance with Table 7-7. No building sewer shall be smaller than the building drain.

For alternate methods of sizing building sewers, see Appendix L.

718.0 Grade, Support, and Protection of Building Sewers.

718.1 Building sewers shall be run in practical alignment and at a uniform slope of not less than 20mm/m (1/4 in./ft.) toward the point of disposal.

Exception: When 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 any building or structure, to obtain a slope of 20mm/m (1/4 in./ft.), any such pipe or piping 100mm (4 in.) through 150mm (6 in.) shall be permitted to have a slope of not less than 10mm/m (1/8 in./ft.) and any such piping 200mm (8 in.) and larger shall be permitted to have a slope of not less than 5mm/m (1/16 in./ft.).

718.2 Building sewer piping shall be laid on a firm bed throughout its entire length, and any 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 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 60cm (2 ft.) of any building or structure, or part thereof, nor less than 30 cm (1 ft.) below the surface of the ground. The provisions of this subsection include structures such as porches and steps, whether covered or uncovered; breezeways, roofed patios, carports, covered walks, covered driveways, and similar structures or appurtenances.

719.0 Cleanouts.

719.1 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 30m (100 ft.) straight runs and for each aggregate horizontal change in direction exceeding 2.4 radian (135 degrees).

719.2 When a building sewer or a branch thereof does not exceed 3m (10 ft.) 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 Required building sewer cleanouts shall be extended to grade and shall comply with the appropriate sections of "Cleanouts," Section 707.0, for sizing, construction, and materials. When building sewers are located under buildings, the cleanout requirements of Section 707.0 shall apply.

719.4 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 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 Approved manholes shall be permitted to be installed in lieu of cleanouts, when first approved by the Authority Having Jurisdiction. The maximum distance between manholes shall not exceed 90m (300 ft.).

The inlet and outlet connections shall be made by the use of a flexible compression joint not less than 30cm (1 ft.) and not exceeding 90cm (3 ft.) from the manhole. No flexible compression joints shall be embedded in the manhole base.

720.0 Sewer and Water Pipes.

Building sewers or drainage piping 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 both of the following requirements are met:

(1) The bottom of the water pipe, at points, shall be not less than 30cm (1 ft.) 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 30cm (1 ft.) from the sewer or drain line.

Water pipes crossing sewer or drainage piping constructed of materials that are not approved for use within a building shall be laid not less than 30cm (1 ft.) above the sewer or drain pipe.

Note: For the purpose of this section, "within the building" shall mean within the fixed limits of the building foundation.

721.0 Location.

721.1 Except as provided in Section 721.2, no building sewer shall be located in any lot other than the lot that is the site of the building or structure served by such sewer nor shall any building sewer be located at any point having less than the minimum distances indicated in Table 7-6.

721.2 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 when 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 when 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 Authority Having Jurisdiction as part of the conditions of ownership of said properties, and shall be binding on heirs, successors, and assigns to such properties.

722.0 Abandoned Sewers and Sewage Disposal Facilities.

722.1 Every abandoned building (house) sewer, or part thereof, shall be plugged or capped in an approved manner within 1.5m (5 ft.) of the property line.

722.2 Every 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 connected, shall have the sewage removed therefrom and be completely filled with earth, sand, gravel, concrete, or other approved material.

722.3 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.

722.4 No person owning or controlling any 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 comply with the provisions of this section or upon receipt of notice so to comply from the Authority Having Jurisdiction.

722.5 Where disposal facilities are abandoned, consequent to connecting any premises with the public sewer, the permittee making the connection shall fill abandoned facilities as required by the Authority Having Jurisdiction within 30 days from the time of connecting to the public sewer.

TABLE 7-6
Minimum Horizontal Distance Required From Building Sewer

Buildings or structures[1]	0.6m
Property line adjoining private property[2]	Clear
Water supply wells[3]	15m
Streams	15m
On-site domestic water service line[4]	0.3m
Public water main[5,6]	3m

Notes:

[1] Including porches and steps, whether covered or uncovered; breezeways; roofed patios; carports; covered walks; covered driveways; and similar structures or appurtenances.

[2] See also Section 315.1.

[3] Drainage piping shall clear domestic water supply wells by not less than 15m (50 ft.). This distance shall be permitted to be reduced to not less than 7.6m (25 ft.) when 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 Authority Having Jurisdiction shall be required.

SI: 1m = 3.3 ft.

TABLE 7-7
Minimum/Maximum Fixture Unit Loading on Building Sewer Piping

Size of Pipe	Slope, mm per m		
mm	5	10	20
150	(As specified in Table 7-4/ No minimum loading)		
200	1,500	625	275
250	1,600	675	300
300	1,700	725	325

SI: 1mm = 0.04 in.; 1m = 3.3 ft.

723.0 Building Sewer Test.

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 (see Section 712.3).

Part III
Vacuum Waste Drainage Systems.

724.0 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 conform to standards and specifications listed in Table 14-1 of this code or equivalent International Standard(s) approved by the Authority Having Jurisdiction and other national consensus standards applicable to plumbing systems and materials. Where such standards and specifications are not available, alternate materials and equipment shall be approved in accordance with Section 301.2.

724.1 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.

724.1.1 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 airgap in accordance with Table 6-3. 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.

724.1.2 Waste Collection Center or Storage Tanks. Vacuum collection center or storage tanks shall be of such capacity to provide adequate 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.

724.1.3 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 installation instructions. The water closet outlet fitting shall connect with a piping network having not less than a 40mm (1-1/2 in.) nominal inside diameter.

724.1.4 Vacuum Interface Valve. A normally 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.

724.1.5 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 when sufficient vacuum pressure exists to remove the accumulated waste. Each tank shall incorporate a level indicator switch that automatically controls the discharge pump and warn of malfunction or blockage as follows:

(1) Start discharge;

(2) Stop discharge;

(3) Activate an audible alarm when the level of effluent is usually high and

(4) Warning of system shut-down when tank is full.

724.2 Fixtures. Fixtures utilized in a vacuum waste drainage system shall comply with referenced standards listed in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. All components shall be of corrosion resistant materials. The water closet outlet shall be able to pass a 25mm (1 in.) diameter ball and shall have a smooth, impervious surface. The waste outlet and passages shall be free of obstructions, recesses, or chambers that would permit fouling. The mechanical valve and its seat shall be of such materials and design to provide a leak-free connection when 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 25mm (1 in.) above the floodlevel 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.

724.3 Drainage Fixture Units. Drainage fixture units shall be determined by the manufacturer's installation instructions. The pump discharge load from the collector tanks shall be in accordance with this chapter.

724.4 Water Supply Fixture Units. Water supply fixture units shall be determined by the manufacturer's installation instructions.

724.5 Materials. Materials used for water distribution pipe and fittings shall be in accordance with Table 6-4. Materials used for above ground drainage shall be in accordance with Table 7-1 and shall have a smooth bore, and be constructed of non-porous material.

724.6 Traps and Cleanouts. Traps and cleanouts shall be installed in accordance with Chapters 7 and 10.

724.7 Testing. The entire vacuum waste system shall be subjected to a vacuum test of 74cm (29 in.) of mercury or not less than the working pressure of the system for 30 minutes. The system shall be gas- and water-tight at all points. Verification of test results shall be submitted to the Authority Having Jurisdiction.

724.8 Manufacturer's Installation Instructions. Manufacturer's installation 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.

CHAPTER 8

INDIRECT WASTES

801.0 Indirect Wastes.

801.1 Airgap or Airbreak Required. Indirect waste piping shall discharge into the building drainage system through an airgap or airbreak as set forth in this code. Where a drainage airgap 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 25mm (1 in.).

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 Except for refrigeration coils and ice-making machines, the size of the indirect waste pipe shall be not less than the drain on the unit, but shall be not less than 25mm (1 in.), and the maximum developed length shall not exceed 4.5m (15 ft.). Indirect waste pipe for ice-making machines shall be not less than the drain on the unit, but shall be not less than 20mm (0.75 in.).

801.2.2 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 15cm (6 in.) lower than the lowest floor drain. Such floor drains shall be trapped and individually vented. Cleanouts shall be provided at every turn equal to 1.6 of a radian (90 degrees) and shall be accessibly located. Such waste shall discharge through an airgap or airbreak into a trapped and vented receptor, except that a full-size airgap is required where the indirect waste pipe is under vacuum.

801.2.3 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 airgap. 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 airgap. 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 it shall be not less than 15mm (1/2 in.).

801.3 Sink Traps. Where the sink in a coffee shop or counter is so located that the trap serving the sink cannot be vented, the sink drain shall discharge through an airgap or airbreak (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 1.5m (5 ft.).

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 airgap, constructed in accordance with Table 6-3.

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 airgap. Each such indirect waste pipe shall be separately piped to the receptor and shall not exceed 4.5m (15 ft.). 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 airgap or airbreak (see Section 801.2.1).

802.0 Approvals.

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.

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 any sewer-connected vent, but shall extend separately to the outside air. Indirect waste pipes exceeding 1.5m (5ft.), but less than 4.5m (15 ft.) in length shall be directly trapped, but such traps need not be vented.

Indirect waste pipes less than 4.5m (15 ft.) 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 15mm (1/2 in.) in size. 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 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 any clothes washer shall extend more than 80cm (30 in.), nor less than 50cm (18 in.) above its trap. No trap for any clothes washer standpipe receptor shall be installed below the floor, but shall be roughed in not less than 15cm (6 in.) and not more than 50cm (18 in.) above the floor. No indirect waste receptor shall be installed in any toilet room, closet, cupboard, or storeroom, nor in any other 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 when the clothes washer is installed in the same room.

804.2 Where water service connections are installed for a clothes washer, an approved method of waste disposal shall be provided.

805.0 Pressure Drainage Connections.

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 any part of the drainage system.

The foregoing shall not apply to any approved sump pump or to any approved pressure-wasting plumbing fixture or device when the Authority Having Jurisdiction has been satisfied that the drainage system is adequately sized to accommodate the anticipated discharge thereof.

806.0 Sterile Equipment.

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 airgap.

807.0 Appliances.

807.1 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 When 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 When undiluted condensate waste from a fuel-burning condensing appliance is discharged into the drainage system, the material in the drainage system shall be of materials approved for this use.

Exceptions:

(1) When the above condensate is discharged to an exposed fixture tailpiece and trap, such tailpiece and trap shall be permitted to be brass.

(2) Any materials approved in Section 701.0 shall be permitted to be used when data is provided that the condensate waste is adequately diluted.

807.4 No domestic dishwashing machine shall be directly connected to a drainage system or food waste disposer without the use of an approved dishwasher airgap fitting on the discharge side of the dishwashing machine. Listed airgaps 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.

When 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 15cm (6 in.) above the overflow rim of the fixture.

809.0 Drinking Fountains.

Drinking fountains shall be permitted to be installed with indirect wastes.

810.0 Steam and Hot Water Drainage Condensers and Sumps.

810.1 No steam pipe shall be directly connected to any part of a plumbing or drainage system, nor shall any water having a temperature exceeding 60˚C (140ºF) be discharged under pressure directly into any part of 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 15cm (6 in.) of the bottom of the tank. The top of the deep seal trap shall have an opening equal to 20mm (3/4 in.) 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 water line to be maintained that will permanently occupy not less than 1/2 the capacity of the condenser or sump. Inlets shall enter above the water line. 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 8-1. The contents of condensers receiving steam or hot water under pressure must pass through an open sump before entering the drainage system.

810.2 Sumps, condensers, or intercepting tanks that are constructed of concrete shall have walls and bottom not less than 100mm (4 in.) in thickness, and the inside shall be cement plastered not less than 15mm (1/2 in.) in thickness. Condensers constructed of metal shall be not less than No. 12 U.S. standard gauge 2.77mm (0.109 in.), and such metal condensers shall be protected from external corrosion by an approved bituminous coating.

TABLE 8-1

Pipe Connections in Blowoff Condensers and Sumps

Boiler Blowoff	Water Outlet	Vent
20mm*	20mm*	50mm
25mm	25mm	65mm
32mm	32mm	80mm
40mm	40mm	100mm
50mm	50mm	125mm
65mm	65mm	150mm

*To be used only with boilers of 9m^2 of heating surface or less.
SI: 1mm = 0.04 in.

810.3 Sumps and condensers shall be provided with a 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 when the normal water level of such boiler or boilers is reduced not less than 100mm (4 in.).

810.4 Strainers. Every 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 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, and 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 conform to standard drainage installation procedures.

Copper tube and galvanized steel pipe shall not be used for chemical or industrial wastes as defined in this section.

811.2 Each waste pipe receiving or intended to receive the discharge of any fixture into which acid or corrosive chemical is placed, and each vent pipe connected thereto, shall be constructed of Chlorinated Polyvinyl-chloride (CPVC), Polypropylene (PP), Polyvinylidene Flouride (PVDF), chemical-resistant glass, high-silicon iron pipe, or lead pipe with a wall thickness of not less than 3mm (1/8 in.); an approved type of ceramic glazed or unglazed vitrified clay; or other approved corrosion-resistant materials.

811.3 Joining materials shall be of approved type and quality.

811.4 Wherever practicable, piping shall be readily accessible and installed with the maximum of clearance from other services.

811.5 The owner shall make and keep a permanent record of the location of piping and venting carrying chemical waste.

811.6 No chemical vent shall intersect vents for other services.

811.7 Chemical wastes shall be discharged in a manner approved by the Authority Having Jurisdiction.

811.8 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.

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.

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. If 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 10mm/m (1/8 in./ft.) or 1 percent slope and shall be of approved corrosion-resistant material not smaller than the outlet size as required in Table 8-2 for air-cooling coils or condensing fuel-burning appliances, respectively. Condensate or wastewater shall not drain over a public way.

814.2 Size. Air-conditioning condensate waste pipes shall be independent of any drainage and waste system and shall not be smaller than shown in Table 8-2.

TABLE 8-2
Minimum Condensate Pipe Size

Equipment Capacity in Tons of Refrigeration (kW)	Minimum Condensate Pipe Diameter (mm)
Up to 70	20
71 - 140	25
141 - 320	32
321 - 440	40
441 - 800	50

SI: 1kW = 0.28 tons; 1mm = 0.04 in.

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 10mm/m (1/8 in./ft.) or 1 percent slope, with the following pipe conditions:

Outside Air – 20%		Room Air – 80%	
DB	WB	DB	WB
32˚C	23˚C	24˚C	17˚C

SI: 1.8º C + 32 = F

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 airgap or airbreak to a properly trapped and vented receptors dry wells, leach pits, or the tailpiece of plumbing fixtures.

Condensate waste shall not drain over a public way.

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 back-pressure, 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 25mm (1 in.) of water column on the outlet side of the trap.

902.0 Vents Not Required.

902.1 Vent piping shall be permitted to be omitted on an interceptor when 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 Traps serving sinks that are part of the equipment for coffee shops or counters need not be vented when the location and construction is impossible to do so. When 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 Vent pipe and fittings shall be in accordance with the applicable standards referenced in Table 7-1, except that:

> **903.1.1** ABS and PVC DWV piping installations shall be in accordance with the applicable standards referenced in Table 14-1, or equivalent International Standard(s) approved by the Authority Having Jurisdiction and Chapter 15, "Firestop Protection." Except for individual single-family dwelling units, materials exposed within ducts or plenums shall have a flame-spread index of not more than 25 and a smoke-developed index of not more than 50 when tested in accordance with NFPA 255, *Standard Method of Test for Surface Burning Characteristics of the Building Materials* or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

903.2 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 The size of vent piping shall be determined from its length and the total number of fixture units connected thereto, as set forth in Table 7-4. The diameter of an individual vent shall be not less than 32mm (1-1/4 in.), nor less than 1/2 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 7-4. Vent pipes from fixtures located upstream from pumps, ejectors, backwater valves, or other devices that in any way 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:** When 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 7-4, provided the aggregate cross-sectional area of vents is not less than that of the largest required common building sewer.

904.2 No more than 1/3 of the total permitted length, per Table 7-4, of any minimum-sized vent shall be installed in a horizontal position.

> **Exception:** When a minimum-sized vent is increased one pipe size for its entire length, the maximum length limitation does not apply.

904.3 Where vents exceed 12m (40 ft.) in developed length, such vent(s) shall be increased by one pipe size for the entire developed length of the vent pipe.

905.0 Vent Pipe Grades and Connections.

905.1 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 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 Unless prohibited by structural conditions, each vent shall rise vertically to a point not less than 15cm (6 in.) above the flood-level rim of the fixture served before offsetting horizontally, and whenever two or more vent pipes converge, each such vent pipe shall rise to a point not less than 15cm (6 in.) in height above the flood-level rim of the plumbing fixture it serves before being connected to any other vent. Vents less than 15cm (6 in.) above the flood-level rim of the fixture shall be installed with approved drainage fittings, material, and grade to the drain.

905.4 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 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 Two fixtures shall be permitted to be served by a common vertical pipe when each such fixture wastes separately into an approved double fitting, having inlet openings at the same level.

906.0 Vent Termination.

906.1 Each vent pipe or stack shall extend through its flashing and shall terminate vertically not less than 15cm (6 in.) above the roof, nor less than 30cm (1 ft.) from any vertical surface.

906.2 Each vent shall terminate not less than 3m (10 ft.) from, or not less than 90cm (3 ft.) above any openable window, door, opening, air intake, or vent shaft, nor less than 90cm (3 ft.) in every direction from any lot line, alley and street excepted.

906.3 Vent pipes shall be extended separately or combined, of full required size, not less than 15cm (6 in.) 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 3m (10 ft.) of any part of the roof that is used for such other purposes shall extend not less than 2m (7 ft.) above such roof and shall be securely stayed.

906.4 Vent pipes for outdoor installations shall extend not less than 3m (10 ft.) above the surrounding ground and shall be securely supported.

906.5 Joints at the roof around vent pipes shall be made water-tight by the use of approved flashings or flashing material.

906.6 Lead. See Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Sheet lead shall be not less than the following:

For safe pans – not less than 20kg/m^2 (4lbs./ft.^{2}) or 2mm (1/16 in.) thick .

For flashings or vent terminals – not less than 20kg/m^2 (4lbs./ft.^{2}).

Lead bends and lead traps shall be not less than 3mm (1/8 in.) wall thickness.

907.0 Vent Stacks and Relief Vents.

907.1 Each drainage stack that extends ten or more branch intervals above the building drain or other horizontal drain, shall be served by a parallel (relief) 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 The yoke vent connection to the vent stack shall be placed not less than 1m (42 in.) 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.

907.3 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 Sections 907.3.1 and 907.3.2.

907.3.1 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 the vent stack connects to the building drain, the connection shall be located downstream of the drainage stack and within a distance of ten times the diameter of the drainage stack.

907.3.2 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 not be less in diameter than the required size for the vent serving the drainage stack. The yoke vent connection shall be permitted to be a vertical extension of the drainage stack.

908.0 Wet Venting.

908.1 Vertical Wet Venting.

908.1.1 Wet venting is limited to vertical drainage piping receiving the discharge from the trap arm of one and two 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 1.8m (6 ft.) in developed length.

908.1.2 Size. The vertical piping between any 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 50mm (2 in.).

908.1.3 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 any fixture served, or by Section 904.0.

908.2 Horizontal Wet Venting for Bathroom (Groups).

908.2.1 Where Permitted. Water closets, bathtubs, 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 10-1. 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 any fixture drain or trap arm connections. Any additional fixtures shall discharge downstream of the wet vent system and be conventionally vented.

908.2.2 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.

908.2.3 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 50mm (2 in.) in diameter for 4 dfu or less, and not less than 80mm (3 in.) in diameter for 5 dfu or more. The dry vent shall be sized in accordance with Tables 7-3 and 7-4, based on the total fixture units discharging into the wet vent.

909.0 Special Venting for Island Fixtures.

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 15cm (6 in.) above the flood-level rim of the fixtures served. Drainage fittings shall be used on all parts of the vent below the floor level, and a slope of not less than 20mm/m (1/4 in./ft.) back to the drain shall be maintained. The return bend used under the drainboard shall be a one piece fitting or an assembly of elbows in the following order:

(1) 0.8 of a radian (45 degrees)

(2) 1.6 of a radian (90 degrees), and

(3) 0.8 of a radian (45 degrees)

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 Combination waste and vent systems shall be permitted only where structural conditions preclude the installation of conventional systems as otherwise prescribed by this code.

910.2 Plans and specifications for each combination waste and vent system shall first be approved by the Authority Having Jurisdiction before any portion of any such system is installed.

910.3 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. Any branch exceeding 4.5m (15 ft.) in length shall be separately vented in an approved manner. The area of any vent installed in a combination waste and vent system shall be not less than 1/2 the inside cross-sectional area of the drain pipe served. The vent connection shall be downstream of the uppermost fixture.

910.4 Each waste pipe and each trap in any such 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 any fixture tailpiece or connection.

910.5 No vertical waste pipe shall be used in any such 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 60cm (2 ft.).

> **Exception:** Branch lines shall be permitted to have vertical offsets equal to 0.8 radian (45 degrees.

910.6 An accessible cleanout shall be installed in each vent for the combination waste and vent system. Cleanouts shall not be required on any wet-vented branch serving a single trap when the fixture tailpiece or connection is not less than 50mm (2 in.) in diameter and provides ready access for cleaning through the trap.

910.7 No water closet or urinal shall be installed on any such 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.

> **Note:** 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 practice. The system shall be designed by a registered design professional and approved in accordance with Section 301.3.

911.2 Minimum Requirements. An engineered vent system shall provide protection of the trap seal in accordance with Section 901.2.

CHAPTER 10

TRAPS AND INTERCEPTORS

1001.0 Traps Required.

1001.1 Each plumbing fixture, excepting those having integral traps or as permitted in Section 1001.2, shall be separately trapped by an approved type of liquid seal trap. Not more than one trap shall be permitted on a trap arm.

1001.2 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 if the waste outlets are not more than 80cm (30 in.) apart and the trap is centrally located when three compartments are installed.

1001.3 No food waste disposal unit shall be installed with any set of restaurant, commercial, or industrial sinks served by a single trap; each such food waste disposal unit 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 receive the waste from a clothes washer set adjacent thereto. No clothes washer or laundry tub shall be connected to any trap for a kitchen sink.

1001.4 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 any fixture exceed 60cm (2 ft.) in length.

1002.0 Traps Protected by Vent Pipes.

1002.1 Each plumbing fixture trap, except as otherwise provided in this code, shall be protected against siphonage and back-pressure, and air circulation shall be assured throughout all parts of the drainage system by means of a vent pipe installed in accordance with the requirements of this code.

1002.2 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 10-1, but in no case less than two times the diameter of the trap arm.

1002.3 A trap arm shall be permitted to change direction without the use of a cleanout when such change of direction does not exceed 1.6 radian (90 degrees). All horizontal changes in direction of trap arms shall comply with Section 706.3.

> **Exception:** For trap arms 80mm (3 in.) in diameter and larger, the change of direction shall not exceed 2.4 radian (135 degrees) without the use of a cleanout.

1002.4 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 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 and weight and shall be of ABS, cast brass, cast-iron, PP, PVC, or other approved material. An exposed and readily accessible drawn-brass tubing trap, not less than 1mm (0.045 in.) (No. 17 B&S Gauge), shall be permitted to be used on fixtures discharging domestic sewage. Drum and bottle traps shall be permitted for special conditions and approved by the Authority Having Jurisdiction.

TABLE 10-1
Horizontal Lengths of Trap Arms
(Except for water closets and similar fixtures)*

Trap Arm Pipe Diameter mm	Distance Trap to Vent Minimum mm	Length Maximum m
32	65	0.8
40	80	1.0
50	100	1.5
80	150	1.8
100	200	3.0
Exceeding 100	2 x Diameter	3.0

Maintain 20mm/m (1/4 in./ft.) slope.

* The developed length between the trap of a water closet of similar fixture (measured from the top of the closet, flange to the inner edge of the vent) and its vent shall not exceed 1.8m (6 ft.).

SI: 1mm= 0.04 in.; 1m= 3.3 ft.

Exception: 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. Every trap shall have a smooth and uniform interior waterway.

1003.2 No more than 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.

1003.3 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 7-3. The trap shall be the same size as the trap arm to which it is connected.

1004.0 Traps — 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 and crown-vented traps shall be prohibited. No fixture shall be double trapped. No trap shall be installed without a vent, except as otherwise provided in this code.

1004.1 Bladders, check valves or any other type of devices with moveable parts shall not be considered as traps.

1005.0 Trap Seals.

Each fixture trap shall have a liquid seal of not less than 50mm (2 in.) and not more than 100mm (4 in.), except where a deeper seal is found necessary by the Authority Having Jurisdiction. Traps shall be set true with respect to their liquid seals.

1006.0 Floor Drain Traps.

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 at all times in full view. When subject to reverse flow of sewage or liquid waste, such drains shall be equipped with an approved backwater valve.

1007.0 Trap Seal Protection.

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.

Building traps shall not be installed except where required by the Authority Having Jurisdiction. Each building trap, when 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 exceed 1/2 the diameter of the drain to which it connects. Such relieving vent or fresh-air intake shall be carried above grade, turned downward and terminate in a screened outlet located outside of the building.

1009.0 Industrial Interceptors (Clarifiers) and Separators.

1009.1 When Required. Interceptors (clarifiers) (including grease, oil, sand interceptors [clarifiers], etc.) shall be required by the Authority Having Jurisdiction when 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 any 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 15cm (6 in.).

1009.4 Relief Vent. Interceptors (clarifiers) shall be so designed that they will not become air-bound if 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 and approved by the Authority Having Jurisdiction. In order to minimize evaporation for interceptors and separators installed outside, a burial depth of not less than 90cm (3 ft.) and not more than 1.8m (6 ft.). Interceptors and separators shall be designed to withstand vehicle loading, wheel loading, dead load, horizontal pressures, and live surcharge. Verification shall be provided and approved by the Authority Having Jurisdiction.

1009.6 Maintenance of Interceptors. Interceptors shall be maintained in efficient operating condition by the 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.

Every fish, fowl, and animal slaughterhouse or establishment; every fish, fowl, and meat packing or curing establishment; every soap factory, tallow-rendering, fat-rendering, and hide-curing establishment shall be connected to and shall drain or discharge into an approved grease interceptor (clarifier) of an approved design for this use.

1011.0 Minimum Requirements for Auto Wash Racks.

Every private or public wash rack and 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) of an approved design for this use.

On-site wash water recycling system shall be installed in accordance with Sections 1620.0 through 1626.0.

1012.0 Commercial and Industrial Laundries.

Laundry equipment in commercial and industrial buildings that do 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 15mm (1/2 in.) or larger in maximum dimension, such as string, rags, buttons, or other solid materials detrimental to the public sewerage system. Laundry waste water pre-treatment shall be required to neutralize detergents before discharging into the drainage system.

On-site laundry water recycling system shall be permitted and recommended for water reuse in accordance with Sections 1620.0 through 1626.0.

1013.0 Bottling Establishments.

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 it is determined by the Authority Having Jurisdiction that waste pretreatment is required, an approved type of grease interceptor(s) complying 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 and floor sinks and other fixtures or equipment in serving establishments such as restaurants, cafes, lunch counters, cafeterias, 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 interior (hydromechanical) and exterior (gravity) grease interceptors shall be permitted in order to meet grease separation needs 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 any private living quarters. Water closets, urinals, and other plumbing fixtures conveying human waste shall not drain into or through the grease interceptor.

1014.1.1 Each fixture discharging into a grease interceptor shall be individually trapped and vented in an approved manner.

1014.1.2 Grease interceptors shall be maintained in efficient operating condition by the periodic removal of accumulated grease and latent material. No such collected grease shall be introduced into any drainage piping or public or private sewer. If 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 any grease interceptor. Commercial food waste disposers shall be permitted to discharge directly into the building's drainage system.

1014.2 Hydromechanical Grease Interceptors.

1014.2.1 Plumbing fixtures or equipment connected to a 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 instructions.

1014.2.2 The total capacity in litres of fixtures discharging into any hydromechanical grease interceptor shall not exceed 2-1/2 times the certified litres per second flow rate of the interceptor as per Table 10-2.

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 any provision of this section.

1014.2.3 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 Sections 1014.3.1 through 1014.3.6.

1014.3.1 General. The provisions of this section shall apply to the design, construction, installation, and testing of commercial kitchen gravity grease interceptors.

TABLE 10-2
Hydromechanical Interceptor Sizing Using Gravity Flow Rates[1]

		Size of Grease Interceptor	
Diameter of Grease Waste Pipe mm	Maximum Full Pipe Flow[2] L/s	One-Minute Drainage Period L/s	Two-Minute Drainage Period L/s
50	1.3	1.3	0.6
75	3.8	4.7	2.2
100	7.9	9.5	4.7
125	14.5	15.8	7.9
150	23.7	31.5	15.8

[1] For interceptor sizing by fixture capacity see the example below.
[2] 6.4mm/m slope per metre based on Manning's formula with friction factor N = 0.012
SI: 1L/s = 15.85 gpm; 1mm = 0.04 in.

Example For Sizing
Hydromechanical Interceptor(s) Using Fixture Capacity

Step 1: Determine the flow rate from each fixture.

[Length] X [Width] X [Depth] / [231] =L X [0.75 fill factor] / [Drain Period (1 min or 2 min)]

Step 2: Calculate the total load from all fixtures that discharge into the interceptor.

Fixtures	Compartments	Load	Size of Grease Interceptor	
			One-Minute Drainage Period	Two-Minute Drainage Period
		litres	L/s	L/s
Compartment Size 305mm x 610mm x 305mm	2	170	–	–
Hydrant	–	11.36	–	–
Rated Appliance	–	7.57	–	–
		188.9	3.15	1.58

SI: 1L = 0.26 gal.; 1L/s = 15.85 gpm

1014.3.2 Waste Discharge Requirements.

1014.3.2.1 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 drained into the sanitary waste through the interceptor when approved by the Authority Having Jurisdiction.

1014.3.2.2 Water closets, urinals, and other similar fixtures shall not drain through the interceptor.

1014.3.2.3 Waste shall enter the interceptor through the inlet pipe only.

1014.3.3 Design.

1014.3.3.1 Gravity Interceptors shall be constructed in accordance with the applicable standard in Table 14-1, IAPMO Z 1001 or equivalent International Standard(s) approved by the Authority Having Jurisdiction and or the design approved by the Authority Having Jurisdiction.

1014.3.4 Location.

1014.3.4.1 Each grease interceptor shall be so installed and connected that it shall be, at all times, easily accessible for inspection, cleaning, and removal of the intercepted grease. A gravity grease interceptor shall not be installed in any part of a building where food is handled. Location of the grease interceptor shall meet the approval of the Authority Having Jurisdiction.

1014.3.4.2 Interceptors shall be placed as close as practical to the fixtures they serve.

1014.3.4.3 Each business establishment for which a gravity grease interceptor is required shall have an interceptor which

TABLE 10-3
Gravity Interceptor Sizing[1]

Pipe Diameter mm	Full Pipe Flow (Nominal)[2] L/s	Interceptor Size Based on Thirty (30) Minute retention time.[3] Rounded up to the next nominal size Litres
50	1.22	3,000
75	3.70	8,000
100	7.93	16,000
125	14.49	30,000
150	23.68	60,000

[1] For interceptor sizing by fixture capacity see the example below.

[2] 6.4mm/m slope per metre based on Mannings formula with friction factor N=0.012.

[3] Based on 30 minute retention time (ref.) Metcalf & Eddy, Inc. 3rd Ed. *Small and Decentralized Wastewater Management Systems*, 1998 and rounded up to nominal interceptor volume.

SI: 1L/s = 15.85 gpm; 1L = 0.26 Gal.

Example For Sizing
Gravity Interceptor Sizing Using Fixture Capacity

Step 1: Determine fixture capacity:
[Length] X [Width] X [Depth] / [231] = L X [0.75 fill factor]

Step 2: Calculate the total load from all fixtures discharging into the interceptor.
Add hydrant capacity in litres (gpm supply); Add rated appliances such as dishwasher, water wash hood at manufactures ratings.
Interceptor Sizing = fixture capacity x 30

Step 3:

Fixture Compartment Size	Compartments	Load	Recommended Interceptor Size *(Based on 30 minute retention time. Round up to the next nominal size.)
mm		Litres	Litres
610 x 610 x 305	2	170	5,678

shall serve only that establishment unless otherwise approved by the Authority Having Jurisdiction.

1014.3.4.4 Each gravity grease interceptor shall be located so as to be readily accessible to the equipment required for maintenance.

1014.3.5 Construction Requirements.

1014.3.5.1 Purpose. 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 all gravity grease interceptors so that the Authority Having Jurisdiction can periodically sample effluent quality.

1014.3.6 Sizing Criteria.

1014.3.6.1 Sizing. The volume of the interceptor shall be determined by using Table 10-3.

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.

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 comply with the requirements of Section 301.2 of this code.

1015.3 Components, Materials, and Equipment. FOG disposal systems, including all components, materials, and equipment necessary for the proper function of the system, shall comply with Sections 301.1.3 or 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 specifications.

1015.5 Performance. FOG disposal systems shall be tested and certified as referenced in Table 14-1 of this code, or equivalent International Standard(s) approved by the Authority Having Jurisdiction applicable to FOG disposal systems as discharging no more than 100 mg/L FOG.

1016.0 Sand Interceptors.

1016.1 Where Required.

1016.1.1 Whenever the discharge of a fixture or drain contains 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.

1016.1.2 Sand interceptors are required whenever the Authority Having Jurisdiction deems it advisable to have a sand interceptor to protect the drainage system.

1016.2 Construction and Size. Sand interceptors shall be built of brick or concrete, prefabricated coated steel, or other water-tight 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 80mm (3 in.), 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 any 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 dimension of not less than 0.2m^2 (2 $ft.^2$) for the net free opening of the inlet section and a depth under the invert of the outlet pipe of not less than 60cm (2 ft.).

For each 20L/min (5 gpm) of flow or fraction thereof exceeding 76L/min (20 gpm), the area of the sand interceptor inlet section shall be increased by 0.09m^2 (1 $ft.^2$). The outlet section shall at all times have an area of not less than 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.

1016.3 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 15cm (6 in.), 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 floor drains. The separation or vapor compartment shall be independently vented to the outer air. If 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 not less than 15cm (6 in.) above the spill line of the lowest floor drain and vented independently to the outer air. The size of a flammable vapor vent shall be not less than 50mm (2 in.), and, when vented through a sidewall, the vent shall be not less than 3m (10 ft.) 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 gas-tight cleanout covers that shall be readily accessible. The waste line shall be not less than 80mm (3 in.) in diameter with a full-size cleanout to grade. When an interceptor is provided with an overflow, it shall be provided with an overflow line (not less than 50mm (2 in.) in diameter) to an approved waste oil tank having a capacity of not less than 2,000L (550 gal.) 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 not less than a 50mm (2 in.) pump-out connection at grade and not less than a 40mm (1-1/2 in.) vent to atmosphere at an approved location not less than 3m (10 ft.) 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 litres per second. The full discharge rate to such an interceptor shall be determined at full flow. Each interceptor shall be rated equal to or exceeding the incoming flow and shall be provided with an overflow line to an under-ground tank.

Interceptors not rated by the manufacturer shall have a depth of not less than 60cm (2 ft.) below the invert of the discharge drain. The outlet opening shall have not less than a 46cm (18 in.) water seal. Where not more than three motor vehicles are serviced and/or stored, interceptors shall have a capacity of not less than $0.2m^3$ (6 $ft.^3$), and $0.03m^3$ (1 $ft.^3$) of capacity shall be added for each vehicle up to ten vehicles. Above ten vehicles, the Authority Having Jurisdiction shall determine the size of the interceptor required. Where vehicles are serviced only and not stored, interceptor capacity shall be based on a net capacity of $0.03m^3$ (1 $ft.^3$) for each $9.3m^3$ (100 $ft.^3$) of surface to be drained into the interceptor, with not less than $0.2m^3$ (6 $ft.^3$).

CHAPTER 11

STORM DRAINAGE

1101.0 General.

1101.1 Where Required. Roofs, paved areas, yards, courts, and courtyards 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 only.

1101.3 Material Uses. Rainwater piping placed within the interior of a building or run within a vent or shaft shall be in accordance with the applicable standards referenced in Table 7-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction for above ground drain, waste and vent piping, and changes in direction shall conform to the requirements of Section 706.0. ABS and PVC DWV piping installations shall be installed in accordance with applicable standards referenced in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction, and Chapter 15 "Firestop Protection." Except for individual single-family dwelling units, materials exposed within ducts or plenums shall have a flame-spread index of not more than 25 and a smoke developed index of not more than 50, when tested in accordance with NFPA 255, *Test for Surface-Burning Characteristics of Building Materials* or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

1101.4 Expansion Joints Required. Expansion joints or sleeves shall be provided where warranted by temperature variations or physical conditions.

1101.5 Subsoil Drains.

1101.5.1 Subsoil drains shall be provided around the perimeter of buildings having basements, cellars, or 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 80mm (3 in.) in diameter, and shall be laid in gravel, slag, crushed rock, approved 20mm (3/4 in.) crushed, recycled glass aggregate, or other approved porous material with not less than 100mm (4 in.) surrounding the pipe on all sides. Filter media shall be provided for exterior subsoil piping.

1101.5.2 Subsoil drains shall be piped to a storm drain, to an approved water course, to the front street curb or gutter, or to an alley, or the discharge from the subsoil drains shall be conveyed to the alley by a gutter. Where a continuously flowing spring or groundwater is encountered, subsoil drains shall be piped to a storm drain or an approved water course.

1101.5.3 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 375mm (15 in.) in diameter, 46cm (18 in.) in depth, and provided with a fitted cover. The sump pump shall have an adequate capacity to discharge all water coming into the sump as it accumulates to the required discharge point, and the capacity of the pump shall be not less than 1L/s (15 gpm). The discharge piping from the sump pump shall be not less than 40mm (1-1/2 in.) in diameter and have a union or other approved quick-disconnect assembly to make the pump accessible for servicing.

1101.5.4 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 not less than a length of 60cm (24 in.). This pipe shall be within 100mm (4 in.) of the splash block and positioned to direct the flow parallel to the recessed line of the splash block.

1101.5.5 Subsoil drains subject to backflow when 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.

1101.5.6 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 3m (10 ft.) from any property line; and

(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 50mm (2 in.) in diameter for areaways not exceeding 9.3m^2 (100 ft.^{2}) in area, and shall be discharged in the manner provided for subsoil drains not serving continuously flowing springs or groundwater (see Section 1101.5.2). Areaway drains for areaways exceeding 9.3m^2 (100 ft.^{2}) shall be sized according to Table 11-2 and drain in accordance with Section 1102.3.

1101.8 Window Areaway Drains. Window areaways not exceeding 0.9m^2 (10 ft.^{2}) in area shall be permitted to discharge to the subsoil drains through a 50mm (2 in.) pipe. However, window areaways exceeding 0.9m^2 (10 ft.^{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 15cm (6 in.) 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. The 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 duration of 60 minutes and a 100 year return period.

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 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 100mm (4 in.) high and have a width equal to the circumference of the roof drain required for the area served, sized by Table 11-1.

1101.11.2.2 Secondary Roof Drain. Secondary roof drains shall be provided. The secondary roof drains shall be located not less than 50mm (2 in.) 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 conforming to Section 1101.11.2.2.1 or 1101.11.2.2.2.

1101.11.2.2.1 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.

1101.11.2.2.2 Combined System. The secondary roof drains shall connect to the vertical piping of the primary storm drainage conductor downstream of any 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.

1101.11.3 Siphonic Roof Drainage System. Siphonic roof drainage systems shall be designed in accordance with ASPE 45 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

1101.12 Cleanouts.

1101.12.1 Cleanouts for building storm drains shall comply with the requirements of Section 719.0 of this code.

1101.12.2 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 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.

1102.1.1 Conductors installed above ground in buildings shall be in accordance with the applicable standards referenced in Table 7-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction for above ground drain, waste and vent pipe.

1102.2 Leaders.

1102.2.1 Leaders installed outside shall be in accordance with the applicable standards referenced in Table 7-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction for above ground 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 be in accordance with the applicable standards referenced in Table 7-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction for underground drain, waste and vent pipe.

1102.4 Building Storm Sewers. Building storm sewers shall be in accordance with the applicable standards referenced in Table 7-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction for building sewer pipe.

1102.5 Subsoil Drains.

1102.5.1 Subsoil drains shall be constructed of materials specified in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

1102.5.2 Subsoil drains shall be open-jointed or of perforated pipe, vitrified clay, plastic, cast-iron, or porous concrete.

1103.0 Traps on Storm Drains and Leaders.

1103.1 Where Required. Leaders and storm drains, when 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, when 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 single wye fittings to the combined building sewer not less than 3m (10 ft.) downstream from any soil stack.

1105.0 Roof Drains.

1105.1 Material.

1105.1.1 Roof drains shall be constructed of materials specified in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

1105.1.2 Roof drains shall be of cast-iron, copper or copper alloy, lead, plastic, or other approved acceptable materials.

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 100mm (4 in.) 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 1-1/2 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 water-tight by the use of proper flashing material.

1105.4.1 Where lead flashing material is used, it shall be not less than 20kg/mm^2 (4 lbs./ft.^{2}).

1105.4.2 Where copper flashing material is used, it shall be not less than 4kg/mm^2 (12 lbs./ft.^{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 11-1.

1106.2 Size of Horizontal Storm Drains and Sewers. The size of building storm drains or building storm sewers or any of their horizontal branches shall be based upon the maximum projected roof or paved area to be handled and Table 11-2.

1106.3 Size of Roof Gutters. The size of semi-circular gutters shall be based on the maximum projected roof area and Table 11-3.

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 11-1 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, per (3) and (5) above.

(7) Walls on four sides having no allowance for wall areas below the top of the lowest wall – add for areas above the top of the lowest wall per (1), (3), (5), and (6) above.

1106.5 Size of Combined Storm and Sanitary Drainage. The size of a combined sanitary and storm drain or sewer shall be in accordance with Section 1106.2 and as follows:

(1) Where the total drainage fixture unit load is 256 drainage fixture units or less, use 93m^2 (1,000 ft.^{2}) as a minimum for the equivalent drainage area in horizontal projection.

(2) Where the total drainage fixture unit load exceeds 256 drainage fixture units, multiply such units by 0.36m^2 (3.9 ft.^{2}) to convert to the equivalent drained area.

These values are based on a rainfall rate of 100mm/h. Multiply by the correct factor for other rainfall rates.

1107.0 Values for Continuous Flow.

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, 4L/min (1 gpm) of such discharge shall be computed as being equivalent to 2.2m^2 (24 ft.^{2}) of roof area, based upon a rate of rainfall of 100mm/h (4 in.).

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 11-4.

(3) Not less than two drains shall be installed in roof areas of 929m^2 (10,000 ft.^{2}) or less, and no less than one additional drain shall be installed for each 929m^2 (10,000 ft.^{2}) of roof area exceeding 929m^2 (10,000 ft.^{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.

(5) Pipe sizing shall be based on the pre-calibrated rate of flow (L/min) of the pre-calibrated weir for the maximum allowable water depth, and Tables 11-1 and 11-2.

(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 147kg/m^2 (30 lbs./ft.^{2}) to provide a safety factor exceeding 73kg/m^2 (15 lbs./ft.^{2}), represented by the depth of water stored on the roof as indicated in Table 11-4.

(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 11-5.

(9) Scupper openings shall be not less than 100mm (4 in.) high and have a width equal to the circumference of the roof drain required for the area served, sized by Table 11-1.

(10) Flashings shall extend above the top of the scuppers.

(11) At any wall or parapet, 0.8 radian (45 degrees) 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;

(2) The square footage of the setback drainage area is converted as outlined in Section 1108.0 to L/min, and the storm-water pipe sizes in the controlled-flow system are based on the sum of the loads; and

(3) The branch from each of the roof drains that are not provided with controlled flow shall be sized in accordance with Table 11-1.

TABLE 11-4
Controlled-Flow Maximum Roof Water Depth

Roof Rise* mm	Max Water Depth at Drain mm
Flat	75
50	100
100	125
150	150

*Vertical measurement from the roof surface at the drain to the highest point of the roof surface served by the drain, ignoring any local depression immediately adjacent to the drain.
SI: 1mm = 0.04 in.

TABLE 11-5
Distance of Scupper Bottoms Above Roof

Roof Rise* mm	Maximum Distance of Scupper Bottom Above Roof Level at Drains mm
Flat	75
50	100
100	125
150	150

*Vertical measurement from the roof surface at the drain to the highest point of the roof surface served by the drain, ignoring any local depression immediately adjacent to the drain.

SI: 1mm = 0.04 in.

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 as described in Section 1109.2 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 plastic pipe shall not be tested with air), and proved tight. The Authority Having Jurisdiction shall be permitted to require the removal of any cleanout plugs to ascertain whether the pressure has reached all parts of the system. One of the following test methods shall be used:

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. If 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. If 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 3m (10 ft.) head of water. In testing successive sections, not less than the upper 3m (10 ft.) of the next preceding section shall be tested so that no joint of pipe in the building (except the uppermost 3m (10 ft.) 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 a 3m (10 ft.) 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 all points.

1109.2.2 Air Test. The air test shall be made by attaching an air compressor testing apparatus to any suitable opening after closing all other inlets and outlets to the system, forcing air into the system until there is a uniform gauge pressure of 35kPa (5 psi) or of sufficient pressure to balance a column of mercury, 25cm (10 in.) 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. When circumstances exist that make water and air tests described in Sections 1109.2.1 and 1109.2.2 above impractical, see Section 103.5.3.3.

TABLE 11-1
Sizing Roof Drains, Leaders, and Vertical Rainwater Piping [2, 3]

Size of Drain, Leader or Pipe, Flow,		Maximum Allowable Horizontal Projected Roof Areas Square Metres at Various Rainfall Rates											
mm	L/s[1]	25mm/h	50mm/h	75mm/h	100mm/h	125mm/h	150mm/h	175mm/h	200mm/h	230mm/h	250mm/h	280mm/h	300mm/h
50	1.9	215	135	90	70	55	45	40	35	30	25	25	25
75	5.8	820	410	275	205	165	140	120	100	90	80	75	70
100	12.1	1,710	855	570	430	340	285	245	215	190	170	155	140
125	22.7	3,215	1,610	1,070	805	645	535	460	400	360	320	290	270
150	35.5	5,015	2,510	1,670	1,255	1,000	835	715	630	560	500	455	420
200	76.2	10,775	5,390	3,590	2,695	2,155	1,795	1,540	1,350	1,200	1,080	980	900

Notes:

1 Maximum discharge capacity, L/s with approximately 45mm (1-3/4 in.) 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 25mm/hour (1 in./hour) column by the desired rainfall rate.

3 Vertical piping may be round, square, or rectangular. Square pipe shall be sized to enclose its equivalent roundpipe. Rectangular pipe shall have at least the same cross-sectional area as its equivalent round pipe, except that the ratio of its side dimensions shall not exceed 3 to 1.

SI: 1mm = 0.04 in.; 1 L/s = 15.85 gpm

TABLE 11-2
Sizing of Horizontal Rainwater Piping[1, 2]

Size of Pipe, mm	Flow at 10mm/m Slope, L/s	Maximum Allowable Horizontal Projected Roof Areas Square Metres at Various Rainfall Rates					
		25mm/h	50mm/h	75mm/h	100mm/h	125mm/h	150mm/h
75	2.1	305	153	102	76	61	51
100	4.9	700	350	233	175	140	116
125	8.8	1,241	621	414	310	248	207
150	14.0	1,988	994	663	497	398	331
200	30.2	4,273	2,137	1,424	1,068	855	713
250	54.3	7,692	3,846	2,564	1,923	1,540	1,282
300	87.3	12,375	6,187	4,125	3,094	2,476	2,062
375	156.0	22,110	11,055	7,370	5,528	4,422	3,683

Size of Pipe, mm	Flow at 20mm/m Slope, L/s	Maximum Allowable Horizontal Projected Roof Areas Square Metres at Various Rainfall Rates					
		25mm/h	50mm/h	75mm/h	100mm/h	125mm/h	150mm/h
75	3.0	431	216	144	108	86	72
100	6.9	985	492	328	246	197	164
125	12.4	1,754	877	585	438	351	292
150	19.8	2,806	1,403	935	701	561	468
200	42.7	6,057	3,029	2,019	1,514	1,211	1009
250	76.6	10,851	5,425	3,618	2,713	2,169	1807
300	123.2	17,465	8,733	5,816	4,366	3,493	2912
375	220.2	31,214	15,607	10,405	7,804	6,248	5202

Size of Pipe, mm	Flow at 40mm/m Slope, L/s	Maximum Allowable Horizontal Projected Roof Areas Square Metres at Various Rainfall Rates					
		25mm/h	50mm/h	75mm/h	100mm/h	125mm/h	150mm/h
75	4.3	611	305	204	153	122	102
100	9.8	1,400	700	465	350	280	232
125	17.5	2,482	1,241	827	621	494	413
150	28.1	3,976	1,988	1,325	994	797	663
200	60.3	8,547	4,273	2,847	2,137	1,709	1,423
250	108.6	15,390	7,695	5,128	3,846	3,080	2,564
300	174.6	24,749	12,374	8,250	6,187	4,942	4,125
375	312.0	44,220	22,110	14,753	11,055	8,853	7,367

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 25mm/hour (1 in./hour) column by the desired rainfall rate.

SI: 1mm = 0.04 in.; 1L/s = 15.85 gpm

TABLE 11-3

Size of Gutters

Diameter of Gutter in mm	Maximum Rainfall in Millimeters per Hour				
5mm/m Slope	**50**	**75**	**100**	**125**	**150**
75	32	21	16	13	11
100	67	45	33	27	22
125	116	78	58	47	39
150	178	119	89	71	60
175	256	171	128	102	85
200	370	247	185	148	123
250	669	446	334	268	223

Diameter of Gutter in mm	Maximum Rainfall in Millimeters per Hour				
10mm/m Slope	**50**	**75**	**100**	**125**	**150**
75	45	30	22	18	15
100	95	63	47	38	32
125	164	109	82	65	55
150	253	169	126	101	84
175	362	242	181	145	121
200	520	348	260	208	174
250	948	632	474	379	316

Diameter of Gutter in mm	Maximum Rainfall in Millimeters per Hour				
20mm/m Slope	**50**	**75**	**100**	**125**	**150**
75	63	42	32	25	21
100	134	89	67	53	45
125	232	155	116	93	78
150	357	238	178	142	119
175	513	342	256	205	171
200	740	493	370	295	247
250	134	892	669	534	446

Diameter of Gutter in mm	Maximum Rainfall in Millimeters per Hour				
40mm/m Slope	**50**	**75**	**100**	**125**	**150**
75	89	60	45	36	30
100	190	126	95	76	63
125	329	219	164	132	110
150	514	343	258	206	172
175	725	483	362	290	241
200	1,041	693	520	416	347
250	1,858	1,238	929	743	619

SI: 1mm = 0.04 in.

CHAPTER 12

FUEL PIPING

1201.0 Scope of Gas Piping.

(A) Coverage of piping systems shall extend from the point of delivery to the connections with each gas utilization device. For other than undiluted liquefied petroleum gas systems, the point of delivery shall be considered 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 in the system. [NFPA 54:1.1.1.1(A)]

(B) Piping systems requirements shall include design, materials, components, fabrications, assembly, installation, testing inspection, operation, and maintenance. [NFPA 54:1.1.1.1(C)]

(C) This code shall not apply to the following [NFPA 54:1.1.1.2]:

(1) Portable LP-Gas appliances of all types that are not connected to a fixed fuel piping system.

(2) Installation of farm equipment such as brooders, dehydrators, dryers, and irrigation equipment.

(3) Raw material (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.

1202.0 General.

The regulations of this chapter shall govern the installation of fuel gas piping in or in connection with any building or structure or within the property lines of any premises up to 35kPa (5 psi), other than service pipe. Fuel oil piping systems shall be installed in accordance with NFPA 31 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

1203.0 Inspection.

1203.1 Upon completion of the installation, alteration, or repair of any 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 All excavations required for the installation of underground piping shall be kept open until such time as the piping has been inspected and approved. If any such piping is covered or concealed before such approval, it shall be exposed upon the direction of the Authority Having Jurisdiction.

1203.3 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 comply with this code.

1203.3.1 Rough Piping Inspection. This inspection shall be made after all gas piping authorized by the permit has been installed and before any such piping has been covered or concealed or any 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 all piping authorized by the permit has been installed and after all portions thereof that are to be covered or concealed are so concealed and before any fixture, appliance, or shutoff valve has been attached thereto. This inspection shall be in accordance with Section 1213.1. Test gauges used in conducting tests shall comply with Section 319.0, Test Gauges.

1203.4 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 If, upon final piping inspection, the installation is found to comply with the provisions of this code, a certificate of inspection shall be permitted to be issued by the Authority Having Jurisdiction.

1204.2 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 It shall be unacceptable for any serving gas supplier, or person furnishing gas, to turn on or cause to be turned on, any fuel gas or any gas meter or meters, until such certificate of final inspection, as herein provided, has been issued.

1205.0 Authority to Render Gas Service.

1205.1 It shall be unacceptable for any person, firm, or corporation, excepting an authorized agent or employee of a person, firm, or corporation engaged in the business of furnishing or supplying gas and whose service pipes supply or connect with the particular premises, to turn on or reconnect gas service in or on any premises where and when gas service is, at the time, not being rendered.

1205.2 It shall be unacceptable to turn on or connect gas in or on any premises unless all outlets are properly and securely connected to gas appliances or capped or plugged with screw joint fittings.

1206.0 Authority to Disconnect.

1206.1 The Authority Having Jurisdiction or the serving gas supplier is hereby authorized to disconnect any gas piping or appliance or both that shall be found not to conform to the requirements of this code or that are found defective and in such condition as to endanger life or property.

1206.2 Where such disconnection has been made, a notice shall be attached to such gas piping or appliance or both that shall state the same has been disconnected together with the reasons thereof.

1206.3 It shall be unacceptable to remove or disconnect any gas piping or gas appliance without capping or plugging with a screw joint fitting, the outlet from which said pipe or appliance was removed. Outlets to which gas appliances are not connected shall be left capped gas-tight on any piping system that has been installed, altered, or repaired.

Exception: When an approved listed quick-disconnect device is used.

1207.0 Temporary Use of Gas.

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 conforms to the requirements of this code regarding material, sizing, and safety.

1208.0 Gas-Piping System Design, Materials, and Components.

1208.1 Piping Plan.

1208.1.1 Installation of Piping System. Where required by the Authority Having Jurisdiction, a piping sketch or plan shall be prepared before proceeding with the installation. This plan shall show the proposed location of piping, the size of different branches, the various load demands, and the location of the point of delivery. [NFPA 54:5.1.1]

1208.1.2 Addition to Existing System. When an additional gas utilization appliance is being connected to a gas-piping system, the existing piping shall be checked to determine whether it has adequate capacity (see Section 1208.4.3). If inadequate, the existing system shall be enlarged as required, or separate gas piping of adequate 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. [NFPA 54:5.3]

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. [NFPA 54:5.4]

1208.4.1 General Considerations. Gas-piping systems shall be of such size and so installed as to provide a supply of gas sufficient to meet the maximum demand and supply gas to each appliance inlet at not less than the minimum supply pressure required by the appliance. [NFPA 54:5.4.1]

1208.4.2 Maximum Gas Demand. The volume of gas to be provided (cubic metre per hour) shall be determined directly from the manufacturer's input ratings of the gas utilization appliance served. Where the input rating is not indicated, the gas supplier, appliance manufacturer, or a qualified agency shall be contacted or the rating from Table 12-1 shall be used for estimating the volume of gas to be supplied. The total connected hourly load shall be used as the basis for piping sizing, assuming the appliance is operating at full capacity, simultaneously.

Exception: Sizing shall be permitted to be based upon established load diversity factors. [NFPA 54:5.4.2]

1208.4.3 Sizing Methods. Gas piping shall be sized in accordance with one of the following [NFPA 54:5.4.3]:

(1) Pipe sizing tables or sizing equations in this chapter.

(2) Other approved engineering methods acceptable to the Authority Having Jurisdiction.

(3) Sizing tables included in a listed piping system manufacturer's installation instructions.

1208.4.4 Allowable Pressure Drop. The design pressure loss in any piping system under maximum probable flow conditions, from the point of delivery to the inlet connection of the appliance, shall be such that the supply pressure at the appliance exceeds or is equal to the minimum pressure required by the appliance. [NFPA 54:5.4.4]

1208.5 Acceptable Piping Materials and Joining Methods.

1208.5.1 General.

1208.5.1.1 Acceptable Materials. Materials used for piping systems shall comply with the requirements of this chapter or shall be acceptable to the Authority Having Jurisdiction. [NFPA 54:5.6.1.1]

1208.5.1.2 Used Materials. Pipe, fittings, valves, or other materials shall not be used again, unless they are free of foreign materials and have been ascertained to be adequate for the service intended. [NFPA 54:5.6.1.2]

1208.5.1.3 Other Materials. Material not covered by the standards specifications listed herein shall be investigated and tested to determine that it is safe and suitable for the proposed service and, in addition, shall be recommended for that service by the manufacturer and shall be acceptable to the Authority Having Jurisdiction. [NFPA 54:5.6.1.3]

1208.5.2 Metallic Pipe.

1208.5.2.1 Cast-iron pipe shall not be used. [NFPA 54:5.6.2.1]

1208.5.2.2 Steel and wrought-iron pipe shall be not less than standard weight (Schedule 40) and shall comply with one of the following standards [NFPA 54:5.6.2.2]:

(1) ASME B36.10, *Welded and Seamless Wrought-Steel Pipe* or equivalent International Standard(s) approved by the Authority Having Jurisdiction

(2) ASTM A 53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless* or equivalent International Standard(s) approved by the Authority Having Jurisdiction

(3) ASTM A 106, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service* or equivalent International Standard(s) approved by the Authority Having Jurisdiction

1208.5.2.3 Copper and brass pipe shall not be used if the gas contains more than an average of 0.7mg/100L (0.3 grains per 100 ft.^{3}) of hydrogen sulfide. [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 pipe shall comply with ASTM B241, *Specification for Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube* or equivalent International

Standard(s) approved by the Authority Having Jurisdiction (except that the use of alloy 5456 is prohibited) and shall be marked at each end of each length indicating compliance. Aluminum alloy pipe shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation or is subject to repeated wettings by such liquids as water, detergents, or sewage. [NFPA 54:5.6.2.5] 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 tubing shall comply with ASTM A254, *Standard Specification for Copper Brazed Steel Tubing* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 54:5.6.3.1]

1208.5.3.2 Copper and brass tubing shall not be used if the gas contains more than an average of 0.7mg/100L (0.3 grains per 100ft.^{3}) of hydrogen sulfide. Copper tubing shall comply with standard Type K or L of ASTM B88, *Specification for Seamless Copper Water Tube*, ASTM B280, *Specification for Seamless Copper Tube for Air-Conditioning and Refrigeration Field Service* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 54:5.6.3.2]

1208.5.3.3 Aluminum alloy tubing shall comply with ASTM B210, *Specification for Aluminum-Alloy Drawn Seamless Tubes*, ASTM B241, *Specification for Aluminum Alloy Seamless Pipe and Seamless Extruded Tube* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Aluminum alloy tubing shall be coated to protect against external corrosion where it is in contact with masonry, plaster, or insulation or is subject to repeated wettings by liquids such as water, detergent, or sewage. Aluminum alloy tubing shall not be used in exterior locations or underground. [NFPA 54:5.6.3.3]

1208.5.3.4 Corrugated stainless steel tubing shall be tested and listed in compliance with the construction, installation, and performance requirements of CSA LC-1, *Standard for Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing* or equivalent

TABLE 12-1
Approximate Gas Input for Typical Appliances
[NFPA 54: Table 5.4.2.1]

Appliance	Input (Approximate) kW/h
Space Heating Units	
Warm air furnace	
Single family	29.3
Multifamily, per unit	17.6
Hydronic boiler	
Single Family	29.3
Multifamily, per unit	17.6
Space- and Water-Heating Units	
Hydronic boiler	
Single family	35.2
Multifamily, per unit	22
Water-Heating Appliances	
Water heater, automatic storage 113.6 to 151.4L tank	10.3
Water heater, automatic storage 189.3L tank	14.7
Water heater, automatic instantaneous	
Capacity at 7.5L/minute	41.9
Capacity at 15L/minute	83.5
Capacity at 22.7L/minute	125.6
Water heater, domestic, circulating or side-arm	10.3
Cooking Appliances	
Range, freestanding, domestic	19
Built-in oven or broiler unit, domestic	7.3
Built-in top unit, domestic	11.7
Other Appliances	
Refrigerator	0.9
Clothes dryer, Type 1 (domestic)	10.3
Gas fireplace direct vent	11.7
Gas log	23.4
Barbecue	11.7
Gaslight	0.7

SI: 1kW = 3.4 Btu; 1L = 0.26 gal.

International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 54:5.6.3.4]

1208.5.4 Plastic Pipe, Tubing, and Fittings. Plastic pipe, tubing, and fittings used to supply fuel gas shall conform with ASTM D2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Pipe to be used shall be marked: "gas" and "ASTM D2513." [NFPA 54:5.6.4.1]

Anodeless risers shall comply with the following [NFPA 54:5.6.4.3]:

1208.5.4.1 Regulator Vent Piping. Plastic pipe, tubing, and fittings used to connect regulator vents to remote vent terminations shall be PVC conforming to UL 651, *Schedule 40 and 80 Rigid PVC Conduit and Fittings* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. PVC vent piping shall not be installed indoors. [NFPA 54:5.6.4.2]

1208.5.4.2 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)]

1208.5.4.3 Service head adapters and field-assembled anodeless risers incorporating service head adapters shall be recommended by the manufacturer for the gas used by the manufacturer and shall be design certified to meet the requirements of Category I of ASTM F1973, *Factory Assembled Anodeless Riser and Transition Fitting on Polyethylene (PE) Fuel Gas Distribution Systems* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 54:5.6.4.3(2)]

1208.5.4.4 The use of plastic pipe, tubing, and fittings in undiluted liquefied petroleum gas-piping systems shall be in accordance with NFPA 58, *Liquefied Petroleum Gas Code* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 54:5.6.4.3(3)]

1208.5.5 Workmanship and Defects. Gas pipe or tubing and fittings shall be clear and free from cutting burrs and defects in structure or threading, and shall be thoroughly brushed and chip and scale blown. Defects in pipe, 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.

(A) Specifications for Pipe Threads. Metallic pipe and fitting threads shall be taper pipe threads and shall comply with ASME B1.20.1, *Standard for Pipe Threads, General Purpose (mm)* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 54:5.6.7.1]

(B) 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]

(C) Number of Threads. Field threading of metallic pipe shall be in accordance with Table 12-2. [NFPA 54:5.6.7.3]

(D) Thread Compounds. Thread (joint) compounds (pipe dope) shall be resistant to the action of liquefied petroleum gas or to any other chemical constituents of the gases to be conducted through the piping. [NFPA 54:5.6.7.4]

TABLE 12-2
Specifications for Threading Metallic Pipe
[NFPA 54:5.6.7.3]

Iron Pipe size mm	Approximate Length of Threaded Portion mm	Approximate No. of Threads to Be Cut
15	20	10
20	26	10
25	22	10
32	25	11
40	25	11
50	25	11
65	40	12
80	40	12
100	42	13

SI: 1mm = 0.04 in.

1208.5.8 Metallic Piping Joints and Fittings. The type of piping joint used shall be suitable for the pressure-temperature conditions and shall be selected giving consideration to joint tightness and mechanical strength under the service conditions. The joint shall be able to sustain the maximum end force due to the internal pressure and any additional forces due to temperature expansion or contraction, vibration, fatigue, or to the weight of the pipe and its contents. [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 538°C (1,000°F). 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 538°C (1,000°F), or made by press-connect fittings complying with CSA LC-4 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. 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 only in systems constructed from nonferrous pipe and tubing where experience or tests have demonstrated that the joint is suitable for the conditions and where provisions are made in the design to prevent separation of the joints. [NFPA 54:5.6.8.3]

1208.5.8.4 Metallic Fittings (Including Valves, Strainers, Filters). [NFPA 54: 5.6.8.4]

(1) Threaded fittings in sizes exceeding 100mm (4 in.) 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 100mm (4 in.) and larger shall not be used indoors unless approved by the Authority Having Jurisdiction.

  (e) Fittings in sizes 150mm (6 in.) and larger shall not be used unless approved by the Authority Having Jurisdiction.

(6) Aluminum Alloy Fittings. Threads shall not form the joint seal.

(7) Zinc-Aluminum Alloy Fittings. Fittings shall not be used in systems containing flammable gas-air mixtures.

(8) Special Fittings. Fittings such as couplings; proprietary-type joints; saddle tees; gland-type compression fittings; and flared, flareless, or compression-type tubing fittings shall be: (1) used within the fitting manufacturer's pressure-temperature recommendations; (2) used within the service conditions anticipated with respect to vibration, fatigue, thermal expansion, or contraction; (3) installed or braced to prevent separation of the joint by gas pressure or external physical damage; and (4) acceptable to the Authority Having Jurisdiction.

1208.5.9 Plastic Piping, Joints, and Fittings. Plastic pipe, tubing, and fittings shall be joined in accordance with the manufacturer's instructions. The following shall be observed when making such joints [NFPA 54:5.6.9]:

(A) 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)]

(B) Heat-fusion joints shall be made in accordance with AWS B2.4, *Specification for Welding Procedure and Performance Qualification for Thermoplastics* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Joints shall be made with the joining method recommended by the pipe manufacturer. Heat-fusion fittings shall be marked "ASTM D2513" or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 54:5.6.9(2)]

(C) 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 to the outside end of the pipe or tubing and shall extend not less than to the outside end of the compression fitting when installed. The stiffener shall be free of rough or sharp edges and shall not be a forced fit in the plastic. Split tubular stiffeners shall not be used. [NFPA 54:5.6.9(3)]

(D) Plastic piping joints and fittings for use in liquefied petroleum gas-piping systems shall be in accordance with NFPA 58, *Liquefied Petroleum Gas Code* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 54:5.6.9(4)]

1208.5.10 Flanges. Flanges shall comply with ASME B16.1, *Standard for Cast-Iron Pipe Flanges and Flanged Fittings*; ASME B16.20, *Standard for Ring-Joint Gaskets and Grooves for Steel Pipe Flanges*; or MSS SP-6, *Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. The pressure-temperature ratings shall equal or exceed that required by the application. [NFPA 54:5.6.10]

(A) Flange Facings. Standard facings shall be permitted for use under this code. Where steel flanges equal to 10bar (150 psi) are bolted to Class 125 cast-iron flanges, the raised face on the steel flange shall be removed. [NFPA 54:5.6.10.1]

(B) Lapped Flanges. Lapped flanges shall be used only above ground 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]

(1) Acceptable materials include the following [NFPA 54:5.6.11.1]:

  (a) Metal or metal-jacketed asbestos (plain or corrugated).

  (b) Asbestos.

  (c) Aluminum "O" rings and spiral-wound metal gaskets.

(2) When a flanged joint is opened, the gasket shall be replaced. [NFPA 54:5.6.11.2]

(3) Full-face gaskets shall be used with all bronze and cast-iron flanges. [NFPA 54:5.6.11.3]

1208.6 Gas Meters.

1208.6.1 Capacity. Gas meters shall be selected for the maximum expected pressure and permissible pressure drop. [NFPA 54:5.7.1]

1208.6.2 Location.

(A) Gas meters shall be located in ventilated spaces readily accessible for examination, reading, replacement, or necessary maintenance. [NFPA 54:5.7.2.1]

(B) Gas meters shall not be placed where they will be subjected to damage, such as adjacent to a driveway; under a fire escape; in public passages, halls, coal bins; where they will be subject to excessive corrosion or vibration. [NFPA 54:5.7.2.2]

(C) 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 54:5.7.2.4]

1208.6.3 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 the 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]

1209.6.4 Meter Protection. Meters shall be protected against overpressure, back-pressure, and vacuum where such conditions are anticipated. [NFPA 54:5.7.4]

1208.6.5 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.

1208.7.1 Where Required. A line gas pressure regulator or gas appliance pressure regulator, as applicable, shall be installed where the gas supply pressure exceeds that at which the branch supply line or gas utilization appliance is designed to operate or varies beyond design pressure limits. [NFPA 54:5.8.1]

1208.7.2 Listing. The line gas pressure regulator shall be listed in accordance with CSA Z21.80 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [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.

(A) Line Gas Pressure Regulators. [NFPA 54:5.8.5.1]

(1) An independent vent to the outside of the building, sized in accordance with the regulator manufacturer's instructions, shall be provided where the location of a regulator is such that a ruptured diaphragm will cause a hazard. Where there is more than one regulator at a location, each regulator shall have a separate vent to the outside or, if approved by the Authority Having Jurisdiction, the vent lines shall be permitted to be manifolded in accordance with accepted engineering practices to minimize back-pressure in the event of diaphragm failure. Materials for vent piping shall be in accordance with Section 1208.5.

Exception: A regulator and vent limiting means combination listed as complying with CSA Z21.80, *Standard for Line Pressure Regulators* or equivalent International Standard(s) approved by the Authority Having Jurisdiction, shall be permitted to be used without a vent to the outdoors.

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

(3) At locations where regulators might be submerged during floods, a special anti-flood-type breather vent fitting shall be installed, or the vent line shall be extended above the height of the expected flood waters.

(4) A regulator shall not be vented to the gas appliance flue or exhaust system.

(B) Gas Appliance Pressure Regulators. Venting of gas appliance pressure regulators shall comply with the following requirements [NFPA 54:9.1.19]:

(1) Gas appliance pressure regulators requiring access to the atmosphere for successful operation shall be equipped with vent piping leading outdoors or, if the regulator vent is an integral part of the 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 only.

(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 gas utilization 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 termination 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.

(C) Discharge of Vents. [NFPA 54:5.9.7]

(1) The discharge stacks, vents, or outlet parts of all pressure-relieving and pressure-limiting devices shall be located so that gas is safely discharged into the outside atmosphere.

(2) Discharge stacks or vents shall be designed to prevent the entry of water, insects, or any 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.

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 Back-Pressure Protection.

1208.8.1 Where to Install. Protective devices shall be installed as close to the utilization appliance as practical, where the design of utilization appliances connected are such that air, oxygen, or standby gases could be forced into the gas supply system. [NFPA 54:5.10.1.1] 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 35kPa (5 psi) or more. [NFPA 54:5.10.1.2]

1208.8.2 Protective Devices. Protective devices shall include but not be limited to the following [NFPA 54:5.10.2]:

(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; and

(4) Normally closed air-actuated positive shutoff pressure regulators.

1208.9 Low-Pressure Protection. A protective device shall be installed between the meter and the gas utilization appliance if the operation of the appliance (i.e., gas compressors) is such that it could produce a vacuum or a dangerous reduction in gas pressure at the meter. Such devices include, but are not limited to, mechanical, diaphragm-operated, or electrically operated low-pressure shutoff valves. [NFPA 54:5.11]

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 25mm (1 in.) and smaller shall be listed.

1208.11 Expansion and Flexibility.

1208.11.1 Design. Piping systems shall be designed to have sufficient flexibility to prevent thermal expansion or contraction from causing excessive stresses in the piping material, excessive bending or loads at joints, or undesirable forces or moments at points of connections to equipment and at anchorage or guide points. Formal calculations or model tests shall be required only where reasonable doubt exists as to the adequate flexibility of the system. [NFPA 54:5.13.1]

Flexibility shall be provided by the use of bends, loops, offsets, or couplings of the slip type. Provision shall be made to absorb thermal changes by the use of expansion joints of the bellows type, or by the use of "ball" or "swivel" joints. Expansion joints of the slip type shall not be used inside buildings or for thermal expansion. Where expansion joints are used, anchors or ties of sufficient strength and rigidity shall be installed to provide for end forces due to fluid pressure and other causes. [NFPA 54:5.13.1.1]

Pipe alignment guides shall be used with expansion joints according to the recommended practice of the joint manufacturer. [NFPA 54:5.13.1.2]

1208.11.2 Special Local Conditions. Where local conditions include earthquake, tornado, unstable ground, or flood hazards; special consideration shall be given to increased strength and flexibility of piping supports and connections. [NFPA 54:5.13.2]

1209.0 Excess Flow Valve.

Where automatic excess flow gas valves are installed, they shall be listed, sized, and installed in accordance with the manufacturer's instructions.

1210.0 Gas Piping Installation.

1210.1 Piping Underground.

1210.1.1 Clearances. Underground gas piping shall be installed with sufficient clearance from any other underground structure to avoid contact therewith, to allow maintenance, and to protect against damage from proximity to other structures. In addition, underground plastic piping shall be installed with sufficient clearance or shall be insulated from any source of heat so as to prevent the heat from impairing the serviceability of the pipe. [NFPA 54:7.1.1]

1210.1.2 Protection Against Damage.

(A) Cover Requirements. Underground piping systems shall be installed with not less than 46cm (18 in.) of cover. Where external damage to the pipe is not likely to result, the cover shall be not less than 30cm (12 in.). When not less than 30cm (12 in.) of cover cannot be provided, the pipe shall be installed in conduit or bridged (shielded). [NFPA 54:7.1.2.1]

(B) 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]

(C) Backfilling. Where flooding of the trench is done to consolidate the backfill, care shall be exercised to see that the pipe is not floated from its firm bearing on the trench bottom. [NFPA 54:7.1.2.3]

1210.1.3 Protection Against Corrosion. Gas piping in contact with earth or other material that could corrode the piping shall be protected against corrosion in an approved manner. When dissimilar metals are joined underground, an insulating coupling or fitting shall be used. Piping shall not be laid in contact with cinders. Uncoated threaded or socket-welded joints shall not be used in piping in contact with soil or where internal or external crevice corrosion is known to occur. [NFPA 54:7.1.3]

1210.1.4 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 building or sleeve shall be sealed to prevent entry of gas and water. [NFPA 54:7.1.5]

1210.1.5 Piping Underground Beneath Buildings. Where the installation of gas piping underground beneath buildings is unavoidable, the piping shall be encased in an approved conduit designed to withstand the superimposed loads. [NFPA 54:7.1.6] The conduit shall extend into a normally usable and accessible portion of the building and, at the point where the conduit terminates in the building, the space between the conduit and the gas piping shall be sealed to prevent the possible entrance of any gas leakage. Where the end sealing is of a type that will retain the full pressure of the pipe, the conduit shall be designed for the same pressure as the pipe. The conduit shall extend not less than 100mm (4 in.) outside the building, be vented above grade to the outside, and be installed so as to prevent the entrance of water and insects. [NFPA 54:7.1.6.1]

1210.1.6 Plastic Pipe.

(A) Connection of Plastic Piping. Plastic pipe shall be installed outside, underground only. [NFPA 54:7.1.7.1]

Exception No. 1: Plastic pipe shall be permitted to terminate above ground where an anodeless riser is used.

Exception No. 2: Plastic pipe shall be permitted to terminate with a wall head adapter above ground in buildings, including basements, where the plastic pipe is inserted in a piping material permitted for use in buildings.

(B) Connections Between Metallic and Plastic Piping. Connections made between metallic and plastic piping shall be made only with fittings conforming to one of the following:

(1) ASTM D2513, *Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings, Category I Transition Fittings* or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

(2) ASTM F1973, *Standard Specification for Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide 11 (PA11) Fuel Gas Distribution Systems* or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

(3) ASTM F2509, *Standard Specification for Field-Assembled Anodeless Riser Kits for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 54:7.1.7.2]

(C) An electrically continuous corrosion-resistant tracer wire (minimum AWG 14) or tape shall be buried with the plastic pipe to facilitate locating. One end shall be brought above ground at a building wall or riser. [NFPA 54:7.1.7.3]

1210.2 Installation of Piping.

1210.2.1 Piping installed above ground shall be securely supported and located where it will be protected from physical damage (also see 1210.2.5). Where passing through an outside wall, the piping shall also be protected against corrosion by coating or wrapping with an inert material approved for such applications. Where piping is encased in a protective pipe sleeve, the annular space between the gas piping and the sleeve shall be sealed at the wall to prevent the entry of water, insects, or rodents. [NFPA 54:7.2.1]

1210.2.2 Building Structure.

(1) The installation of gas piping shall not cause structural stresses within building components to exceed allowable design limits. [NFPA 54:7.2.2.1]

(2) Approval shall be obtained before any beams or joists are cut or notched. [NFPA

TABLE 12-3
Support of Piping
[NFPA 54: Table 7.2.6.2]

Steel Pipe, Nominal Size of Pipe	Spacing of Supports	Nominal Size of Tubing Smooth Wall	Spacing of Supports
mm	**m**	**mm**	**m**
15	1.8	15	1.2
20 or 25	2.4	16 or 20	1.8
32 or larger – Horizontal	3.0	22 or 25	2.4
32 or larger – Vertical	Every Floor Level	25 or larger – Vertical	Every Floor Level

SI: 1mm = 0.04 in.; 1m = 3.3 ft.

54:7.2.2.2] Permission shall be obtained from the Authority Having Jurisdiction.

1210.2.3 Other than Dry Gas. Drips, sloping, protection from mechanical damage, and branch pipe connections, as provided for in Sections 1210.8.1 and 1210.10 shall be provided when other than dry gas is distributed and climactic conditions make such provisions necessary. [NFPA 54:7.2.3]

1210.2.4 Gas Piping to be Sloped. Piping for other than dry gas conditions shall be sloped not less than 6mm/4.6m (1/4 in./15 ft.) to prevent traps. [NFPA 54:7.2.4]

1210.2.4.1 Ceiling Locations. Gas piping shall be permitted to be installed in accessible spaces between a fixed ceiling and a dropped ceiling, whether or not such spaces are used as a plenum. Valves shall not be located in such spaces.

Exception: Appliance shutoff valves required by this code shall be permitted to be installed in accessible spaces containing vented gas utilization appliances.

1210.2.5 Prohibited Locations. Gas piping inside any building shall not be installed in or through a circulating air duct, clothes chute, gas vent, ventilating duct, dumbwaiter, or elevator shaft. [NFPA 54:7.2.5]

1210.2.6 Hangers, Supports, and Anchors.

(A) Piping shall be supported with metal pipe hooks, metal pipe straps, metal bands, metal brackets, metal hangers, or building structural components, suitable for the size of piping, of adequate strength and quality; and located at intervals so as to prevent or damp out excessive vibration. Piping shall be anchored to prevent undue strains on connected equipment and shall not be supported by other piping. Pipe hangers and supports shall conform to the requirements of MSS SP-58, *Pipe Hangers and Supports Materials, Design and Manufacture* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 54:7.2.6.1]

(B) Spacings of supports in gas-piping installations shall not exceed as shown in Table 12-3. Spacing of supports for CSST shall be in accordance with the CSST manufacturer's instruction. [NFPA 54:7.2.6.2]

(C) Supports, hangers, and anchors shall be installed so as not to interfere with the free expansion and contraction of the piping between anchors. All parts of the supporting equipment shall be designed and installed so they will not be disengaged by movement of the supported piping. [NFPA 54:7.2.6.3]

1210.2.7 Removal of Pipe. 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 any cutting or welding is done (see Section 1213.6.). [NFPA 54:7.2.7]

1210.3 Concealed Piping in Buildings.

1210.3.1 General. Gas piping in concealed locations shall be installed in accordance with this section. [NFPA 54:7.3.1]

1210.3.2 Connections. Where gas piping is to be concealed; unions, tubing fittings, right and left couplings, bushings, swing joints, and compression couplings made by combinations of fittings shall not be used. Connections shall be of the following type [NFPA 54:7.3.2]:

(1) Joining tubing by brazing, welding or flanges.

(2) Fittings listed for use in concealed spaces that have been demonstrated to sustain, without leakage, any forces due to temperature expansion or contraction, vibration, or fatigue based on their geographic location, application, or operation.

1210.3.3 Piping in Partitions. Concealed gas piping shall not be located in solid partitions. [NFPA 54:7.3.3]

1210.3.4 Tubing in Partitions. This provision shall not apply to tubing that pierces walls, floors, partitions, to tubing installed vertically and horizontally inside hollow walls or partitions without protection along its entire concealed length where both of the following requirements are met [NFPA 54:7.3.4]:

(1) A steel striker barrier not less than 1mm (0.0508 in.) thick, or equivalent, is installed between the tubing and the finished wall and extends not less than 100mm (4 in.) beyond concealed penetrations of plates, fire stops and, wall studs.

(2) The tubing is installed in single runs and is not rigidly secured.

1210.3.5 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 could be 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 40mm (1-1/2 in.) 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. (See Section 1202.0.) Where gas piping exceeding 35kPa (5 psi) is located within vertical chases in accordance with Section 1210.5, the requirements of Sections 1210.5.1 through 1210.5.4 shall apply. [NFPA 54:7.4]

1210.5 Maximum Design Operating Pressure. The maximum design operating pressure for piping systems located inside buildings shall not exceed 35kPa (5 psi) unless one or more of the following conditions are met [NFPA 54-09:5.5.1]:

(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.

1210.5.1 Pressure Reduction. (See Section 1202.0.) Where pressure reduction is required in branch connections for compliance 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 1208.7.4. The regulator shall be accessible for service and repair and vented in accordance with one of the following [NFPA 54:7.4.1]:

(1) Where the fuel gas is lighter than air, regulators equipped with a vent-limiting means shall be permitted to be vented into the chase. Regulators not equipped with a vent-limiting means shall be permitted to be vented either directly to the outdoors or to a point within the top 30cm (1 ft.) of the chase.

(2) Where the fuel gas is heavier than air, the regulator vent shall be vented only directly to the outdoors.

1210.5.2 Liquefied Petroleum Gas Systems. The maximum operating pressure of LP-Gas piping systems shall be:

(1) In accordance with Section 1210.5.1;

(2) In accordance with NFPA 58, where the pressure exceeds 1.4bar (20 psi) and;

(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 -21ºC (-5ºF) or with butane or a propane-butane mix.

1210.5.3 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]

1210.5.4 Ventilation. A chase shall be ventilated to the outdoors and only at the top. The openings shall have a minimum free area (in mm^2 [in.])

equal to the product of 1/2 of the maximum pressure in the piping (in kPa [psi]) times the largest nominal diameter of that piping (in mm [in.]), 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]

1210.6 Appliance Over Pressure Protection. The maximum operating pressure for piping systems serving appliances designed to operate at 36cm (14 in.) w.c. inlet pressure or less shall be 14kPa (2.0 psi) unless an over pressure protection device designed to limit pressure at the appliance to 14kPa (2.0 psi) 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 or factory bends. [NFPA 54:7.5]

1210.7.1 Metallic Pipe. Metallic pipe bends shall comply with the following [NFPA 54:7.5.1]:

(1) Bends shall be made only with bending equipment and procedures intended for that purpose.

(2) Bends shall be smooth and free from 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 1.6 radian (90 degrees).

(5) The inside radius of a bend shall be not less than six times the outside diameter of the pipe.

1210.7.2 Plastic Pipe. Plastic pipe bends shall comply with the following [NFPA 54:7.5.2]:

(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 twenty-five 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.

1210.7.3 Elbows. Factory made welding elbows or transverse segments cut therefrom shall have an arc length measured along the junction of not less than 25mm (1 in.) for pipe sizes 50mm (2 in.) 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 any point in the line of pipe where condensate collects. Where required by the Authority Having Jurisdiction or the serving gas supplier, a drip shall be provided at the outlet of the meter. This drip shall be installed 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 only in such locations that they will be readily accessible to permit cleaning or emptying.

1210.8.3 Sediment Traps. (See Section 1211.7).

1210.9 Outlets.

1210.9.1 Location and Installation.

(1) The outlet fittings or piping shall be securely fastened in place. [NFPA 54:7.7.1.1]

(2) Outlets shall not be located behind doors. [NFPA 54:7.7.1.2]

(3) Outlets shall be located far enough from floors, walls, patios, slabs, and ceilings to permit the use of wrenches without straining, bending, or damaging the piping. [NFPA 54:7.7.1.3]

(4) The unthreaded portion of gas piping outlets shall extend not less than 25mm (1 in.) through finished ceilings, indoor or outdoor walls. [NFPA 54:7.7.1.4]

(5) The unthreaded portion of gas-piping outlets shall extend not less than 50mm (2 in.) above the surface of floors, outdoor patios or slabs. [NFPA 54:7.7.1.5]

(6) The provisions of Sections 1210.9.1(4) and (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 54:7.7.1.6]

1210.9.2 Cap Outlets.

(A) Each outlet, including a valve, shall be closed gas-tight with a threaded plug or cap immediately after installation and shall be left closed until the gas utilization appliance is connected thereto. When an appliance is disconnected from an outlet and the outlet is not to be used again immediately, it shall be closed gas-tight. [NFPA 54:7.7.2.1]

Exception No. 1: Laboratory equipment installed in accordance with 1211.3(A) shall be permitted.

Exception No. 2: The use of a listed quick-disconnect device with an integral shutoff or listed gas convenience outlet shall be permitted.

(B) Appliance shutoff valves installed in fireplaces shall be removed and the piping capped gas-tight where the fireplace is used for solid-fuel burning. [NFPA 54:7.7.2.2]

1210.10 Branch Pipe Connection. When a branch outlet is placed on a main supply line before it is known what size pipe will be connected to it, the outlet shall be of the same size as the line that supplies it. [NFPA 54:7.8]

1210.11 Manual Gas Shutoff Valves. (Also see Section 1211.5)

1210.11.1 Valves at Regulators. An accessible gas shutoff valve shall be provided upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve shall not be required at the second regulator. [NFPA 54:7.9.1]

1210.11.2 Valves Controlling Multiple Systems.

(A) Accessibility of Gas Valves. Main gas shutoff valves controlling several gas piping systems shall be readily accessible for operation and installed so as to be protected from physical damage. They shall be marked with a metal tag or other permanent means attached by the installing agency so that the gas piping systems supplied through them can be readily identified. [NFPA 54:7.9.2.1]

(B) 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]

1210.11.3 Emergency Shutoff Valves. An exterior shutoff valve to permit turning off the gas supply to each building in an emergency shall be provided. The emergency shutoff valves shall be plainly marked as such and their locations posted as required by the Authority Having Jurisdiction. [NFPA 54:7.9.2.3]

1210.11.4 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.

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 proper 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 above ground 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 when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance. [NFPA 54-09:7.13.1]

1210.15.2 CSST gas piping systems shall be bonded to the electrical service grounding electrode system at the point where the gas service enters the building. The bonding jumper shall be not smaller than 6 AWG copper wire. [NFPA 54-09:7.13.2]

1210.15.3 Gas piping shall not be used as a grounding conductor or electrode. This does not preclude the bonding of metallic piping to a grounding system. [NFPA 54-09:7.13.2]

1210.15.4 Where lightning protection is installed, the bonding of the gas piping system shall be in accordance with NFPA 780 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 54-09:7.13.4]

1210.16 Electrical Circuits. Electrical circuits shall not utilize gas piping or components as conductors. [NFPA 54-09:7.14]

Exception: Low-voltage (50 V or less) control circuits, ignition circuits, and electronic flame detection device circuits shall be permitted to make use of piping or components as a part of an electric circuit.

1210.17 Electrical Connections.

(A) Electrical connections between wiring and electrically operated control devices in a piping system shall conform to the requirements of NFPA 70, *National Electrical Code* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 54:7.15.1]

(B) Any essential safety control depending on electric current as the operating medium shall be of a type that will shut off (fail safe) the flow of gas in the event of current failure. [NFPA 54:7.15.2]

1211.0 Appliance Connections to Building Piping.

1211.1 Connecting Gas Appliances. Gas utilization appliances shall be connected to the building piping in compliance with Section 1211.5 by one of the following [NFPA 54:9.6.1]:

(1) Rigid metallic pipe and fittings.

(2) Semirigid metallic tubing and metallic fittings. Aluminum alloy tubing shall not be used in exterior locations.

(3) Listed flexible gas connectors in compliance with CSA Z21.24, *Standard for Connectors for Gas Appliances* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. The connector shall be used in accordance with the terms of their listing that are completely in the same room as the appliance.

(4) CSST where installed in accordance with the manufacturer's instructions.

(5) Listed nonmetallic gas hose connectors in accordance with 1211.3.

(6) Gas-fired food service (commercial cooking) appliances listed for use with casters or otherwise subject to movement for cleaning, and other large and heavy gas utilization appliances that can be moved, shall be connected in accordance with the connector manufacturer's installation instructions using a listed appliance connector complying with CSA Z21.69, *Standard for Connectors for Movable Gas Appliances* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 54:9.6.1.1] The commercial cooking appliance connector installation shall be configured in accordance with the manufacturer’s installation instructions.

(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.

(8) In 1211.1(2), (3), and (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, or insulation or are subject to repeated wettings by such liquids as water (except rain water), detergents, or sewage.

1211.2 Suspended Low-Intensity Infrared Tube Heaters. [NFPA54-09:9.6.1.3] 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/CGA 6.10, Connectors for Gas Appliances or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

(A) The connector shall be installed in accordance with the tube heater installation instructions, and shall be in the same room as the appliance.

(B) Only one connector shall be used per appliance.

1211.3 Use of Nonmetallic Gas Hose Connectors. Listed nonmetallic gas hose connectors shall be used in accordance with the terms of their listing and as follows [NFPA 54:9.6.2]:

(A) Indoor. Indoor gas hose connectors shall be used only to connect laboratory, shop, and ironing equipment requiring mobility during operation. An equipment 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 1.8m (6 ft.). The connector shall not be concealed and shall not extend from one room to another or pass through wall partitions, ceilings, or floors.

(B) Outdoor. Outdoor gas hose connectors are permitted to connect portable outdoor gas-fired appliances. 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. The connector length shall not exceed 4.6m (15 ft.).

1211.4 Connection of Portable and Mobile Industrial Gas Appliance.

(A) Where portable industrial gas utilization appliances, or appliances requiring mobility or subject to vibration, are connected to the building gas piping system by the use of a flexible hose; the hose shall be suitable and safe for the conditions under which it can be used. [NFPA 54:9.6.3.1]

(B) Where industrial gas utilization appliances requiring mobility are connected to the rigid piping by the use of swivel joints or couplings, the swivel joints or couplings shall be suitable for the service required, and only the minimum number required shall be installed. [NFPA 54:9.6.3.2]

(C) Where industrial gas utilization appliances subject to vibration are connected to the building piping system by the use of all metal flexible connectors, the connectors shall be suitable for the service required. [NFPA 54:9.6.3.3]

(D) 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 any walls, partitions, ceilings, or floors. Flexible connections shall not be used in any concealed location. They shall be protected against physical or thermal damage and shall be provided with gas shutoff valves in readily accessible locations in rigid piping upstream from the flexible connections. [NFPA 54:9.6.3.4]

1211.5 Appliance Shutoff Valves and Connections. Gas utilization 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 [NFPA 54:9.6.4], installed within 1.8m (6 ft.) 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 the removal of controls. Shutoff valves serving decorative gas appliances shall be permitted to be installed in fireplaces if listed for such use. [NFPA 54:9.6.4.1]

1211.6 Quick-Disconnect Devices. Quick-disconnect devices used to connect appliances to the building piping shall be listed. [NFPA 54:9.6.5.1] When they are installed indoors, an approved manual shutoff valve with a nondisplaceable valve member shall be installed upstream of the quick-disconnect device. [NFPA 54:9.6.5.2]

1211.7 Sediment Trap. When a sediment trap is not incorporated as a part of the gas utilization 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 12-1, or other device recognized as an effective sediment trap. Illuminating appliances, ranges, clothes dryers, decorative vented appliances for installation in vented fireplaces, gas fireplaces, and outdoor grills shall not be required to be so equipped. [NFPA 54:9.6.7]

1211.8 Installation of Piping. Piping shall be installed in a manner not to interfere with inspection, maintenance, or servicing of the gas utilization equipment. [NFPA 54:9.6.8]

1212.0 Liquefied Petroleum Gas Facilities and Piping.

1212.1 General. Tanks shall be constructed, fabricated, designed, tested, and stamped in accordance with the *ASME Boiler and Pressure Vessel Code*, Section VIII or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

1212.2 Indoor. Tanks having a water capacity exceeding 473L (125 gal.) shall not be installed inside a building or a structure.

1212.3 Outdoor. When tanks are located on roofs or exterior balconies, the buildings shall be constructed with noncombustible materials.

1212.3.1 Grade Level Tank. Liquefied petroleum gas filling connections, liquid level valves, and relief valve tanks having a water capacity equal to or less than 7,600L (2,000 gal.) shall be provided with a distance of not less than 7.6m (25 ft.) from the property line, structure, building exterior wall, building projections, central air-conditioning condenser, ventilation air intake, appliance combustion intake/outlet, clothes dryer outlet, or window air conditioner. Liquefied petroleum gas filling connections, liquid level valves, and relief valve tanks having a water capacity exceeding 7,600L (2,000 gal.) shall be provided with a distance of not less than 30m (100 ft.) from the property line, structure, building exterior wall, building projections, central air-conditioning condenser, ventilation air intake, appliance combustion intake/outlet, clothes dryer outlet, or window air conditioner.

1212.3.2 Underground Tank. Liquefied petroleum gas filling connections, liquid level valves, and relief valve tanks having a water capacity equal to or less than 7,600L (2,000 gal.) shall be provided with a distance of not less than 3.6m (12 ft.) from the property line, structure, building exterior wall, building projections, central air-conditioning condenser, ventilation air intake, appliance combustion intake/outlet, clothes dryer outlet, or window air conditioner. Liquefied petroleum gas filling connections, liquid level valves, and relief valve tanks having a water capacity exceeding 7,600L (2,000 gal.) shall be provided with a distance of not less than 15m (50 ft.) from the property line, structure, building exterior wall, building projections, central air-conditioning condenser, ventilation air intake, appliance combustion intake/outlet, clothes dryer outlet, or window air conditioner. Tanks shall not be located underneath any building or structure.

1212.4 Group Tanks. The number of tanks in a group shall not exceed six. The distance between tanks having a water capacity equal to or less than 7,600L (2,000 gal.) shall be not less than 90cm (3 ft.). The distance between tanks having a water capacity exceeding 7,600L (2,000 gal.) shall be not less than half the sum of the tanks' diameter. The distance between tank groups shall be not less than 15m (50 ft.).

1212.5 Coating. The liquefied petroleum gas tank shall be provided with an external coating to protect against corrosion. One of the following materials shall be permitted as an external coating:

(1) Epoxy.

(2) Polyurethane.

(3) Silicone.

(4) Enamel.

(5) Latex.

(6) Coal tar mastic.

1212.6 Limitation. Each general purpose liquefied petroleum gas tank shall have a water capacity not exceeding 475,000L (125,000 gal.) and shall be constructed to withstand a gauge pressure of not less than 16bar (240 psi).

1212.7 Prohibition. Heating or cooling coils shall not be permitted to be installed inside tanks.

Liquefied petroleum gas tanks with excessive dents, gouges, and corrosions shall not be used.

1212.8 Marking. Liquefied petroleum gas tanks shall be marked with the following:

(A) Date of manufacture.

(B) Serial and model numbers.

(C) Name, address, and phone number of supplier.

(D) Shell and head thickness.

(E) Dimensions: length, outside diameter, and outside tank surface area.

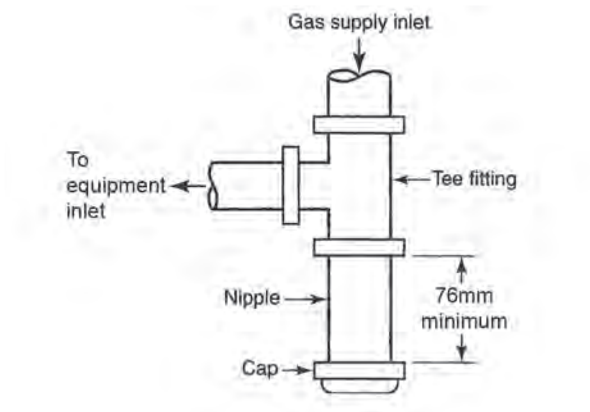
(F) Water capacity in liters (gal.).

(G) Type of installation (underground, above ground or both).

(H) Maximum pressure allowed at 38°C (100°F).

1212.8.1 Regulations. Tanks shall meet the regulations, code, and rules under where they were constructed.

1212.9 LP Gas Piping. Liquefied petroleum gas pipes, joints, and fittings shall be installed in accordance with this code. Plastic piping for LP gas shall be installed outdoors 30cm (12 in.) below grade. When the grade cannot be met, plastic piping shall be shielded or protected with conduit.



SI: 1mm = 0.04 in.

Figure 12-1 Method of Installing a Tee Fitting Sediment Trap.

1212.10 Protection and Security. Tanks located in public areas shall be protected with secured ventilated metal enclosures having an outdoor rating. When the enclosure exceeds 9.3m² (100 ft.²), not less than two egresses shall be provided. Tanks shall be painted to prevent any corrosion.

1212.10.1 Fire Protection. Fire sprinkler systems shall be provided with an inside enclosure where a tank having a 15,000L (2,000 gal.) capacity is installed.

1212.10.2 Lighting. Illumination shall be provided inside the enclosure.

1212.11 Safety Devices. Safety devices shall be installed in a compartment, protected from weather and mud. Safety devices shall be made from noncombustible materials.

1212.11.1 Regulator. Liquefied petroleum gas tanks shall be installed with a regulator.

1212.11.2 Pressure Relief Valve. Liquefied petroleum gas tanks shall be installed with a pressure relief valve.

1212.11.3 Pressure Gauge and Excess Flow Valve. A pressure gauge shall be provided and be installed directly to a valve that is connected directly to the tank opening. When the opening exceeds a No. 45 drill size 1.4 mm (0.055 in.), an excess flow valve shall be provided.

1213.0 Pressure Testing and Inspection.

1213.1 General.

1213.1.1 Prior to acceptance and initial operation, piping installations shall be inspected and pressure-tested to determine that the materials, design, fabrication, and installation practices comply with the requirements of this code. [NFPA 54:8.1.1.1]

1213.1.2 Inspection shall consist of visual examination during or after manufacture, fabrication, assembly, or pressure tests; as appropriate. Supplementary types of non-destructive inspection techniques, such as magnetic particle, radiographic, and ultrasonic; shall not be required unless specifically listed herein or in the engineering design. [NFPA 54:8.1.1.2]

1213.1.3 Where repairs or additions are made following the pressure test, the affected piping shall be tested. Minor repairs and additions are not required to be pressure-tested, provided that the work is inspected and connections are tested with a noncorrosive leak-detecting fluid or other leak-detecting methods approved by the Authority Having Jurisdiction. [NFPA 54:8.1.1.3]

1213.1.4 Where new branches are installed from the point of delivery to new appliances, only the newly installed branches shall be required to be pressure tested. Connections between the new piping and the existing piping shall be tested with a noncorrosive leak-detecting fluid or approved leak-detecting methods. [NFPA 54:8.1.1.4]

1213.1.5 A piping system shall be tested as a complete unit or in sections. Under no circumstances shall a valve in a line be used as a bulkhead between gas in one section of the piping system and test medium in an adjacent section, unless two valves are installed in series with a pressure indicating valve located between these valves. A valve shall not be subjected to the test pressure, unless it can be determined that the valve, including the valve-closing mechanism, is designed to safely withstand the pressure. [NFPA 54:8.1.1.5]

1213.1.6 Regulator and valve assemblies fabricated independently of the piping system in which they are to be installed shall be permitted to be tested with inert gas or air at the time of fabrication. [NFPA 54:8.1.1.6]

1213.1.7 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, including welds, shall be left exposed for examination during the test. [NFPA 54:8.1.3.1]

Exception: Covered or concealed pipe end joints that have been previously tested in accordance with this code.

1213.2.2 Expansion joints shall be provided with temporary restraints, if required for the additional thrust load under test. [NFPA 54:8.1.3.2]

1213.2.3 Appliances and equipment that are not to be included in the test shall be either disconnected from the piping or isolated by blanks, blind flanges, or caps. Flanged joints at which blinds are inserted to blank off other equipment during the test shall not be required to be tested. [NFPA 54:8.1.3.3]

1213.2.4 Where the piping system is connected to appliances, equipment, or equipment components designed for operating pressures of less than the test pressure, such appliances, equipment, or equipment components shall be isolated from the piping system by disconnecting them and capping the outlets. [NFPA 54:8.1.3.4]

1213.2.5 Where the piping system is connected to appliances, equipment, or equipment components designed for operating pressures equal to or exceeding the test pressure, such appliances shall be isolated from the piping system by closing the individual appliance equipment shutoff valves. [NFPA 54:8.1.3.5]

1213.2.6 Testing of piping systems shall be done with due regard for the safety of employees and the public during the test. Bulkheads, anchorage, and bracing suitably designed to resist test pressures shall be installed if necessary. Prior to testing, the interior of the pipe shall be cleared of foreign material. [NFPA 54:8.1.3.6]

1213.3 Test Pressure.

1213.3.1 Test pressure shall be measured with a manometer or with a pressure-measuring device designed and calibrated to read, record, or indicate a pressure loss due to leakage during the pressure test period. The source of pressure shall be isolated before the pressure tests are made. Mechanical gauges used to measure test pressures shall have a range such that the highest end of the scale does not exceed five times the test pressure. [NFPA 54:8.1.4.1]

1213.3.2 The test pressure to be used shall be not less than one and one-half times the proposed maximum working pressure, but not less than 21kPa (3 psi), irrespective of design pressure. [NFPA 54:8.1.4.2]

1213.3.3 Test duration shall be not less than one-half hour for each $14m^3$ (500 $ft.^3$) of pipe volume or fraction thereof. When testing a system having a volume less than $0.3m^3$ (10 $ft.^3$), or a system in a single-family dwelling, the test duration shall be not less than 10 minutes. The duration of the test shall not be required to exceed 24 hours. [NFPA 54:8.1.4.3]

1213.4 Detection of Leaks and Defects.

1213.4.1 The piping system shall withstand the test pressure specified without showing any evidence of leakage or other defects. Any reduction of test pressures as indicated by pressure gauges shall be deemed to indicate the presence of a leak, unless such reduction can be readily attributed to some other cause. [NFPA 54:8.1.5.1]

1213.4.2 The leakage shall be located by means of an approved gas detector, a noncorrosive leak detection fluid, or other approved leak detection methods. Matches, candles, open flames, or other methods that provide a source of ignition shall not be used. [NFPA 54:8.1.5.2]

1213.4.3 Where leakage or other defects are located, the affected portion of the piping system shall be repaired or replaced and retested (see Section 1213.1.3). [NFPA 54:8.1.5.3]

1213.5 Piping System Leak Check.

1214.5.1 Test Gases. 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]

1213.5.2 Before 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]

1213.5.3 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]

1213.5.4 Placing Appliances in Operation. Gas utilization appliances shall not be placed in operation until after the piping system has been tested in accordance with Section 1213.5.3 and purged in accordance with Section 1213.6.2. [NFPA 54:8.2.4]

1213.6 Purging.

1213.6.1 Removal From Service. When gas piping is to be opened for servicing, addition, or modification, the section to be worked on shall be turned off from the gas supply at the nearest convenient point, and the line pressure vented to the outdoors or to ventilated areas of sufficient size to prevent accumulation of flammable mixtures. The remaining gas in this section of pipe shall be displaced with an inert gas as required by Table 12-4. [NFPA 54:8.3.1]

TABLE 12-4
Length of Piping Requiring Purging with Inert Gas for Servicing or Modification
[NFPA 54: Table 8.3.1]

Nominal Pipe Size mm	Length of Piping Requiring Purging m
65	>15.25
80	>9.15
100	>4.57
150	>3.05
200 or larger	Any length

SI: 1mm = 0.04 in.; 1m = 3.3 ft.

1213.6.2 Placing in Operation. When piping full of air is placed in operation, the air in the piping shall be displaced with fuel gas; except where such piping is required by Table 12-5 to be purged with an inert gas prior to introduction of fuel gas. The air can be safely displaced with fuel gas, provided that a moderately rapid and continuous flow of fuel gas is introduced at one end of the line and air is vented out at the other end. The fuel gas flow shall be continued without interruption until the vented gas is free of air. The point of discharge shall not be left unattended during purging. After purging, the vent shall then be closed. Where required by Table 12-5, the air in the piping shall first be displaced with an inert gas, and the inert gas shall then be displaced with fuel gas. [NFPA 54:8.3.2]

TABLE 12-5
Length of Piping Requiring Purging with Inert Gas Before Placing in Operation
[NFPA 54: Table 8.3.2]

Nominal Pipe Size mm	Length of Piping Requiring Purging m
80	>9.15
100	>4.57
150	>3.05
200 or larger	Any length

SI: 1mm = 0.04 in.; 1m = 3.3 ft.

1213.6.3 Discharge of Purged Gases. The open end of piping systems being purged shall not discharge into confined spaces or areas where there are sources of ignition unless precautions are taken to perform this operation in a safe manner by ventilation of the space, control of purging rate, and elimination of hazardous conditions. [NFPA 54:8.3.3]

1213.6.4 Placing Appliances in Operation. After the piping has been placed in operation, appliances shall be purged and then placed in operation, as necessary. [NFPA 54:8.3.4]

1214.0 Interconnections Between Gas Piping Systems. [NFPA 54:5.3]

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. [NFPA 54:5.3.2.1] 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 54:5.3.2.2]

1215.0 Required Gas Supply.

1215.1 The following regulations, as set forth in this section and in Section 1216.0, Required Gas Piping Size, 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 0.6, supplied at 15cm to 20cm (6 in. to 8 in.) water column pressure at the outlet of the meter or regulator. For undiluted liquefied petroleum gas, gas piping shall be permitted to be sized at 28cm (11 in.) water column pressure at the outlet of the meter or regulator and specific gravity of 1.5.

Note: Where gas of a different specific gravity is to be delivered, the serving gas supplier should be contacted for specific gravity conversion factors to use in sizing piping systems from the pipe sizing tables in this chapter.

1215.2 The hourly volume of gas required at each piping outlet shall be taken as not less than the maximum hourly rating as specified by the manufacturer of the appliance or appliances to be connected to each such outlet.

1215.3 Where the gas appliances to be installed have not been definitely specified, Table 12-1 shall be permitted to be used as a reference to estimate requirements of typical appliances.

To obtain the m^3/h ($ft.^3/h$) of gas required, divide input of appliances by the average Watt (Btu) heating value per m^3 ($ft.^3$) of the gas. The average W/m^3 ($Btu/ft.^3$) of the gas in the area of the installation shall be permitted to be obtained from the serving gas supplier.

1215.4 The size of the supply piping outlet for any gas appliance shall be not less than 15mm (0.5 in.).

The size of any piping outlet for a mobile home shall be not less than 20mm (3/4 in.).

1216.0 Required Gas Piping Size.

1216.1 Pipe Sizing Methods. Where the pipe size is to be determined using any of the methods in Sections 1216.1.1 through 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 12-2). [NFPA 54:6.1.1]

1216.1.2 Branch Length Method. Pipe shall be sized as follows [NFPA 54:6.1.2]:

(A) 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.

(B) 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.

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. Tables 12-7 through 12-40 shall be used to size gas piping in conjunction with one of the methods described in Sections 1216.1.1 through 1216.1.3. [NFPA 54:6.3]

1216.3 Sizing Equations. The inside diameter of smooth-wall pipe or tubing shall be determined by the sizing Equations 12-1 or 12-2, using the equivalent pipe length determined by Sections 1216.1.1 through 1216.1.3. [NFPA 54:6.4]

Equation 12-1 Low-Pressure Gas Formula (Less than 10.3kPa [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, mm

Q = input rate appliance(s), m^3/h ($ft.^3/h$) at 16˚C (61˚F) and 76cm (30 in.) mercury column

P_1 = upstream pressure, kPa

P_2 = downstream pressure, kPa

L = equivalent length of pipe, m

ΔH = pressure drop, mm water column (704mm [27.7 in.] H_2O = 6.9kPa [1 psi])

Equation 12-2 High-Pressure Gas Formula (10.3kPa [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, mm

Q = input rate appliance(s), m^3/h ($ft.^3/h$) at 16˚C (61˚F) and 76cm (30 in.) mercury column

P_1 = upstream pressure, kPa

P_2 = downstream pressure, kPa

L = equivalent length of pipe, m.

ΔH = pressure drop, inches water column (704mm [27.7 in.] H_2O = 6.9kPa [1 psi])

TABLE 12-6
Cr and Y for Natural Gas and Undiluted Propane at Standard Conditions
[NFPA 54: Table 6.4.2]

Formula Factors Gas	Cr	Y
Natural Gas	0.6094	0.9992
Undiluted Propane	1.2462	0.9910

SI: $1m^3 = 35.3\ ft.^3$; 1m = 3.3 ft.;

1kPa = 4.0 in. water column;

1kPa = 0.15 psi; 1kW = 3.4 Btu

1216.4 To determine the size of each section of pipe in any system within the range of the table proceed as follows:

(A) Measure the length of the pipe from the gas meter location to the most remote outlet on the system.

(B) Select the length in feet column and row showing that distance, or the next longer distance if the table does not give the exact length.

(C) Starting at the most remote outlet, find in the row just selected the gas demand for that outlet. If the exact figure of demand is not shown, choose the next larger figure in the row.

(D) At the top of this column will be found the correct size of pipe.

(E) 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, only the larger of the two demand loads needs be used in sizing these sections.

(F) 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 B, C, D, and E above.

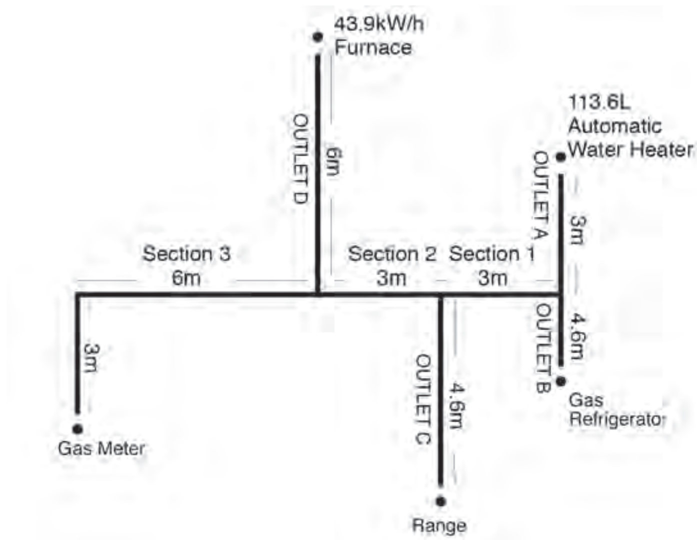
Note: Size branch piping in the order of their distance from the meter location, beginning with the most distant outlet not previously sized.

1216.5 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 any outlet when full demand is being supplied to all outlets, shall comply with the requirements of Section 1208.4.

1216.6 Where the gas pressure exceeds 36cm (14 in.) or less than 15cm (6 in.) of water column, or when diversity demand factors are used, the design, pipe, sizing, materials, location, and use of such systems first shall be approved by the Authority Having Jurisdiction. Piping systems designed for pressures 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 12-2 Example Illustrating Use of Tables 12-1 and 12-7

Problem: Determine the required pipe size of each section and outlet of the piping system shown in Figure 12-2. Gas to be used has a specific gravity of 0.6 and 11.4kW/m^3 , delivered at 20cm water column pressure.



Solution:

(1) Maximum gas demand of outlet A —
10.3kW/h (from Table 12-1).
Maximum gas demand of outlet B —
0.9kW/h (from Table 12-1).
Maximum gas demand of outlet C —
19kW/h (from Table 12-1).
Maximum gas demand of outlet D —
43.9kW/h divided by 11.4kW/m^3 = 3.8m^3/h

(2) The length of pipe from the gas meter to the most remote outlet (outlet A) is 18m.

(3) Using the length in feet column row marked 18m in Table 12-7:
Outlet A, supplying 10.3kW/h, requires 15mm pipe. Section 1, supplying outlets A and B, or 11.2kW/h requires 15mm pipe.
Section 2, supplying outlets A, B, and C, or 30.2kW/h requires 20mm pipe.
Section 3, supplying outlets A, B, C, and D, or 74.1kW/h, requires 25mm pipe.

(4) Using the column marked 20m in Table 12-7:
Outlet B supplying 0.08m^3/h, requires 15mm pipe.
Outlet C, supplying 1.67m^3/h, requires 15mm pipe.

(5) Using the column marked 15m in Table 12-7:
Outlet D, supplying 3.85m^3/h, requires 20mm pipe.

SI: 1cm = 0.4 in.; 1m = 3.3 ft.; 1mm = 0.04 in.; 1m^3 = 33.3 ft.^{3}; 1kW = 3.4 Btu/h ; 1L = 0.26 gal.

TABLE 12-7 Schedule 40 Metallic Pipe [NFPA 54: Table 6.2(b)]

												Gas:	Natural
												Inlet Pressure:	Less than 0.138bar
												Pressure Drop:	12.7mm w.c.
												Specific Gravity:	0.6
	Pipe Size (mm)												
DN:	**15**	**20**	**25**	**32**	**40**	**50**	**65**	**80**	**100**	**125**	**150**	**200**	**250**	**300**
Length (m)	**Capacity in m³/h**													
3	4.9	10.2	19.2	39.4	59.2	113.8	181.2	319.9	654.0	1,183.4	1,913.8	3,935.1	7,134.1	11,295.7
6	3.3	7.0	13.2	27.1	40.5	78.1	124.6	220.3	450.1	812.5	1,316.4	2,703.6	4,897.6	7,785.3
9	2.7	5.6	10.6	21.7	32.6	62.8	99.9	176.9	359.5	651.1	1,056.0	2,171.4	3,935.1	6,228.2
12	2.3	4.8	9.1	18.6	27.9	53.8	85.5	151.5	308.6	557.7	903.1	1,857.1	3,368.9	5,350.6
15	2.0	4.3	8.0	16.5	24.7	47.6	75.9	134.2	273.5	495.4	801.2	1,647.6	3,000.9	4,727.8
18	1.8	3.9	7.3	14.9	22.4	43.0	68.8	121.4	248.0	447.3	724.7	1,491.9	2,709.3	4,303.1
21	1.7	3.6	6.7	13.8	20.6	39.6	63.1	111.8	227.9	413.3	668.1	1,373.0	2,494.1	3,935.1
24	1.6	3.3	6.2	12.8	19.2	36.8	58.9	103.9	203.5	385.0	622.8	1,276.8	2,318.6	3,680.3
27	1.5	3.1	5.9	12.0	18.0	34.5	55.2	97.7	199.0	359.5	583.2	1,197.5	2,177.0	3,453.8
30	1.4	2.9	5.5	11.3	17.0	32.8	52.1	92.3	188.0	339.7	552.0	1,132.4	2,055.3	3,255.7
38	1.2	2.6	4.9	10.1	15.1	28.9	46.1	81.8	166.7	300.1	486.9	1,002.2	1,820.3	2,887.6
45	1.1	2.3	4.4	9.1	13.6	26.3	41.9	73.9	150.9	273.2	441.6	908.8	1,650.5	2,613.0
53	1.0	2.2	4.1	8.4	12.5	24.2	38.5	68.2	139.0	251.4	407.7	835.1	1,517.4	2,403.5
60	1.0	2.0	3.8	7.8	11.7	22.5	36.0	63.4	129.1	233.8	379.4	778.5	1,412.7	2,236.5
75	0.8	1.8	3.4	6.9	10.4	19.9	31.7	56.1	114.7	207.2	336.9	687.9	1,251.3	1,981.7
90	0.8	1.6	3.1	6.3	9.4	18.1	28.9	51.0	103.9	187.7	302.9	625.7	1,135.2	1,794.9
105	0.7	1.5	2.8	5.7	8.6	16.6	26.5	46.7	95.4	172.7	279.7	574.7	1,044.6	1,653.3
120	0.7	1.4	2.6	5.4	8.0	15.5	24.6	43.6	88.9	160.8	260.2	535.1	971.0	1,537.2
135	0.6	1.3	2.4	5.0	7.5	14.5	23.1	40.8	83.2	150.9	244.0	501.1	911.6	1,441.0
150	0.6	1.2	2.3	4.8	7.1	13.7	21.8	38.5	78.7	142.4	230.7	472.8	860.6	1,361.7
165	0.6	1.2	2.2	4.5	6.8	13.0	20.7	36.5	74.7	135.3	219.1	450.1	818.2	1,293.8
180	0.5	1.1	2.1	4.3	6.5	12.4	19.8	35.1	71.3	129.1	208.9	430.3	778.5	1,234.3
195	0.5	1.1	2.0	4.1	6.2	11.9	18.9	33.4	68.2	123.4	200.2	410.5	747.4	1,183.4
210	0.5	1.0	1.9	4.0	5.9	11.4	18.2	32.3	65.7	118.6	192.2	396.3	716.2	1,135.2
225	0.5	1.0	1.9	3.8	5.7	11.0	17.5	30.9	63.1	114.4	185.1	379.4	690.8	1,092.8
240	0.5	1.0	1.8	3.7	5.5	10.6	16.9	30.0	61.1	110.4	178.9	368.0	668.1	1,056.0
255	0.5	0.9	1.7	3.6	5.4	10.3	16.4	28.9	59.2	107.0	173.0	356.7	645.5	1,022.0
270	0.4	0.9	1.7	3.5	5.2	10.0	15.9	28.1	57.2	103.6	167.9	345.4	625.7	990.9
285	0.4	0.9	1.6	3.3	5.0	9.7	15.4	27.3	55.5	100.5	163.1	334.1	608.7	962.5
300	0.4	0.8	1.6	3.3	4.9	9.4	15.0	26.5	54.1	98.0	158.5	325.6	591.7	937.1
330	0.4	0.8	1.5	3.1	4.6	8.9	14.2	25.2	51.2	92.9	0.2	308.6	560.5	888.9
360	0.4	0.8	1.4	2.9	4.4	8.5	13.6	24.0	49.0	88.6	143.5	294.4	535.1	849.3
390	0.3	0.7	1.4	2.8	4.2	8.2	13.0	23.0	47.0	84.9	137.6	282.5	512.4	812.5
420	0.3	0.7	1.3	2.7	4.1	7.8	12.5	22.1	45.0	81.5	132.2	271.5	492.6	781.4
450	0.3	0.7	1.3	2.6	3.9	7.6	12.1	21.3	43.3	78.7	127.4	261.6	475.6	753.0
480	0.3	0.7	1.2	2.5	3.8	7.3	11.6	20.6	41.9	75.9	122.9	252.5	458.6	724.7
510	0.3	0.6	1.2	2.4	3.7	7.1	11.3	19.9	40.5	73.3	118.9	244.3	444.5	702.1
540	0.3	0.6	1.2	2.4	3.6	6.9	10.9	19.3	39.4	71.3	115.2	237.0	430.3	682.3
570	0.3	0.6	1.1	2.3	3.5	6.7	10.6	18.7	38.2	69.1	112.1	230.2	419.0	662.5
600	NA	0.6	1.1	2.2	3.4	6.5	10.3	18.2	37.1	67.4	109.0	223.9	407.7	642.6

NA means a flow of less than 0.3 m^3/h.

Note: All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; 1m^3 = 33.3 ft.^{3}; 1bar = 14.5 psi

Table 12-8 Schedule 40 Metallic Pipe [NFPA 54: Table 6.2(c)]

						Gas:		**Natural**	
						Inlet Pressure:		**Less than 0.138bar**	
						Pressure Drop:		**0.069bar**	
						Specific Gravity:		**0.6**	
	Pipe Size (mm)								
DN:	**15**	**20**	**25**	**32**	**40**	**50**	**65**	**80**	**100**
Length (m)	**Capacity in m^3/h**								
3	42.7	86.1	157.4	322.7	484.1	931.4	1486.3	2627.2	5350.6
6	30.3	60.9	111.3	228.5	342.6	659.6	1050.3	1857.1	3793.5
9	24.6	49.8	90.9	186.6	279.7	537.9	857.8	1517.4	3085.8
12	21.3	43.0	78.7	161.7	242.1	467.1	744.6	1313.6	2681.0
15	19.1	38.5	70.5	144.7	216.6	416.2	665.3	1174.9	2397.9
18	17.4	35.1	64.3	131.9	197.6	382.2	605.8	1072.9	2188.4
21	16.1	32.6	59.5	122.3	183.2	353.9	563.4	993.7	2027.0
24	15.1	30.6	55.8	114.4	171.3	331.2	526.6	928.6	1896.8
27	14.2	28.6	52.4	107.9	161.4	311.4	495.4	874.8	1786.4
30	13.1	26.4	48.4	99.4	148.9	285.9	455.8	806.8	1647.6
38	11.7	23.7	43.3	88.9	133.1	256.5	407.7	721.9	1475.0
45	10.5	21.3	38.8	79.8	119.5	230.2	368.0	648.3	1322.1
53	9.7	19.7	36.0	73.6	110.7	213.2	339.7	600.2	1225.8
60	9.0	18.2	33.1	68.2	102.2	197.0	314.2	554.9	1132.4
75	7.9	16.5	29.4	60.6	90.9	175.0	278.9	492.6	1005.0
90	7.2	14.9	26.8	54.9	82.4	158.5	252.5	447.3	911.6
105	6.6	13.8	24.6	50.7	75.6	145.8	232.4	410.5	838.0
120	6.1	12.8	22.9	47.0	70.5	135.6	216.3	382.2	778.5
135	5.7	12.0	21.5	44.2	66.0	127.4	203.0	359.5	730.4
150	5.4	11.4	20.3	41.6	62.6	120.3	191.7	339.7	690.8
165	5.2	10.8	19.3	39.6	59.2	114.1	182.0	322.7	656.8
180	4.9	10.3	18.4	37.7	56.6	109.0	173.5	305.7	625.7
195	4.7	9.9	17.6	36.2	54.1	104.2	166.2	294.4	600.2
210	4.5	9.5	16.9	34.8	52.1	100.2	159.7	282.3	574.7
225	4.4	9.1	16.3	33.4	50.1	96.5	154.0	272.1	554.9
240	4.2	8.8	15.7	32.3	48.4	93.1	148.6	262.7	535.1
255	4.1	8.5	15.2	31.1	46.7	90.3	143.8	254.2	518.1
270	3.9	8.3	14.8	30.3	45.3	87.5	139.6	246.6	503.9
285	3.8	8.0	14.4	29.4	44.2	84.9	135.3	239.5	486.9
300	3.7	7.8	14.0	28.6	43.0	82.7	131.6	232.7	475.6
330	3.5	7.4	13.2	27.2	40.8	78.4	125.1	221.1	450.1
360	3.4	7.1	12.6	26.0	38.8	74.7	119.5	210.9	430.3
390	3.2	6.8	12.1	24.9	37.4	71.6	114.4	202.1	413.3
420	3.1	6.5	11.6	23.9	35.7	68.8	109.8	194.2	396.3
450	3.0	6.3	11.2	23.0	34.5	66.2	105.9	186.8	382.2
480	2.9	6.1	10.8	22.2	33.4	64.0	102.2	180.6	368.0
510	2.8	5.9	10.5	21.5	32.3	62.0	98.8	174.7	356.7
540	2.7	5.7	10.1	20.8	31.1	60.0	96.0	169.3	345.4
570	2.6	5.5	9.9	20.2	30.3	58.3	93.1	164.5	336.9
600	2.6	5.4	9.6	19.7	29.4	56.9	90.6	160.0	325.6

Note: All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3\ ft.^3$; 1bar = 14.5 psi

Table 12-9 Schedule 40 Metallic Pipe [NFPA 54: Table 6.2(d)]

						Gas:	Natural		
						Inlet Pressure:	Less than 0.207bar		
						Pressure Drop:	0.138bar		
						Specific Gravity:	0.6		
	Pipe Size (mm)								
DN:	15	20	25	32	40	50	65	80	100
Length (m)	Capacity in m^3/h								
3	66.5	139.3	262.4	537.9	806.8	1554.2	2477.1	4388.1	8946.0
6	45.9	95.7	180.3	370.9	554.9	1067.3	1701.4	3000.9	6143.3
9	36.8	77.0	144.7	297.3	444.5	857.8	1367.4	2417.7	4925.9
12	31.4	65.7	124.0	254.5	382.2	733.2	1169.2	2069.5	4218.2
15	27.9	58.3	109.8	225.6	336.9	651.1	1036.1	1834.5	3736.9
18	25.3	52.9	99.7	204.4	305.7	588.8	939.9	1661.8	3397.2
21	23.2	48.7	91.4	188.0	281.7	543.6	863.5	1528.7	3114.1
24	21.6	45.3	85.2	175.0	262.2	503.9	804.0	1421.2	2887.6
27	20.3	42.5	79.8	164.2	245.7	472.8	755.9	1333.4	2720.6
30	19.2	40.2	75.6	154.9	232.1	447.3	713.4	1259.8	2570.5
38	17.0	35.4	66.8	137.3	205.8	396.3	631.3	1118.2	2279.0
45	15.4	32.3	60.6	124.6	186.6	359.5	571.9	1010.7	2063.8
53	14.2	29.7	55.8	114.4	171.6	331.2	526.6	931.4	1899.6
60	13.2	27.5	51.8	106.4	159.7	308.6	489.8	866.3	1766.5
75	11.7	24.4	45.9	94.3	141.6	272.3	433.1	767.2	1565.5
90	10.6	22.1	41.6	85.5	128.2	246.9	393.5	696.4	1418.3
105	9.7	20.4	38.2	78.7	118.1	227.0	362.4	639.8	1305.1
120	9.1	18.9	35.7	73.3	109.6	211.2	336.9	594.5	1214.5
135	8.5	17.8	33.4	68.8	103.0	198.2	317.1	557.7	1138.1
150	8.0	16.8	31.7	64.8	97.1	187.1	297.3	526.6	1075.8
165	7.6	15.9	30.0	61.7	92.3	177.8	283.1	501.1	1022.0
180	7.3	15.2	28.6	58.9	88.0	169.6	270.4	478.4	973.9
195	7.0	14.6	27.4	56.3	84.4	162.5	259.0	458.6	934.2
210	6.7	14.0	26.4	54.1	81.0	156.0	248.8	438.8	897.4
225	6.5	13.5	25.4	52.1	78.1	150.3	239.8	424.7	863.5
240	6.2	13.0	24.5	50.4	75.3	145.2	231.6	410.5	835.1
255	6.0	12.6	23.7	48.7	73.0	140.4	223.9	396.3	806.8
270	5.8	12.2	23.0	47.3	70.8	136.2	217.1	385.0	784.2
285	5.7	11.9	22.3	45.9	68.8	132.2	210.9	373.7	761.5
300	5.5	11.5	21.7	44.7	66.8	128.8	205.0	362.4	738.9
330	5.2	11.0	20.6	42.5	63.4	122.3	195.1	345.4	702.1
360	5.0	10.4	19.7	40.5	60.6	116.6	186.0	328.4	670.9
390	4.8	10.0	18.9	38.8	58.0	111.5	178.1	314.2	642.6
420	4.6	9.6	18.1	37.1	55.8	107.3	171.0	302.9	617.2
450	4.4	9.3	17.4	36.0	53.8	103.3	164.8	291.6	594.5
480	4.3	8.9	16.8	34.5	51.8	99.9	159.1	283.1	574.7
510	4.1	8.7	16.3	33.4	50.1	96.5	154.0	272.1	554.9
540	4.0	8.4	15.8	32.6	48.7	93.7	149.2	263.8	537.9
570	3.9	8.2	15.3	31.4	47.3	90.9	144.9	256.2	520.9
600	3.8	7.9	14.9	30.6	45.9	88.3	141.0	249.1	509.6

Note: All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3 ft.^3$; 1bar = 14.5 psi

Table 12-10 Schedule 40 Metallic Pipe [NFPA 54: Table 6.2(e)]

						Gas:	Natural		
						Inlet Pressure:	Less than 0.345bar		
						Pressure Drop:	0.241bar		
						Specific Gravity:	0.6		
	Pipe Size (mm)								
DN:	**15**	**20**	**25**	**32**	**40**	**50**	**65**	**80**	**100**
Length (m)	Capacity in m^3/h								
3	90.3	182.0	334.1	685.1	1,024.8	1,973.2	3,142.4	5,548.8	11,352.3
6	63.7	128.8	235.5	484.1	724.7	1,395.7	2,225.2	3,935.1	8,011.7
9	52.1	105.3	192.2	396.3	591.7	1,140.9	1,817.5	3,199.0	6,539.6
12	45.0	91.2	166.5	342.6	512.4	988.0	1,574.0	2,780.0	5,662.0
15	40.5	81.5	148.9	305.7	458.6	883.3	1,407.0	2,488.4	5,067.5
18	36.8	74.5	135.9	279.1	419.0	806.8	1,285.3	2,270.5	4,642.8
21	34.0	68.8	126.0	258.5	387.8	747.4	1,189.0	2,103.4	4,274.8
24	32.6	66.0	120.6	241.8	362.4	699.3	1,112.6	1,967.5	4,020.0
27	30.0	60.9	111.0	227.9	342.6	656.8	1,047.5	1,854.3	3,793.5
30	27.7	56.1	102.5	210.3	314.2	605.8	968.2	1,709.9	3,482.1
38	24.8	50.1	91.7	188.0	281.7	543.6	866.3	1,528.7	3,114.1
45	22.3	45.0	82.4	168.7	253.1	486.9	775.7	1,373.0	2,799.9
53	20.6	41.6	76.2	156.3	234.1	450.1	719.1	1,271.1	2,593.2
60	19.1	38.5	70.5	144.4	216.6	416.2	665.3	1,174.9	2,397.9
75	15.8	33.1	62.3	127.7	191.4	368.0	588.8	1,039.0	2,120.4
90	14.3	30.0	56.3	115.8	173.5	334.1	532.2	942.7	1,919.4
105	13.2	27.5	51.8	106.4	159.7	308.6	489.8	866.3	1,766.5
120	12.3	25.6	48.4	99.1	148.6	285.9	455.8	806.8	1,644.8
135	11.5	24.0	45.3	93.1	139.3	268.4	427.5	755.9	1,542.9
150	10.9	22.7	42.7	87.8	131.6	253.4	404.8	713.4	1,458.0
165	10.3	21.6	40.8	83.5	125.1	240.6	385.0	679.4	1,384.4
180	9.9	20.6	38.8	79.6	119.2	229.6	365.2	648.3	1,319.2
195	9.4	19.7	37.1	76.2	114.1	220.0	351.0	620.0	1,262.6
210	9.1	18.9	35.7	73.3	109.8	211.2	336.9	594.5	1,214.5
225	8.7	18.2	34.3	70.5	105.6	203.5	325.6	574.7	1,169.2
240	8.4	17.6	33.1	68.2	102.2	196.5	314.2	554.9	1,129.6
255	8.2	17.0	32.0	66.0	98.8	190.2	302.9	535.1	1,092.8
270	7.9	16.5	31.1	64.0	95.7	184.6	294.4	520.9	1,058.8
285	7.7	16.1	30.3	62.0	93.1	179.2	285.9	503.9	1,030.5
300	7.5	15.6	29.4	60.3	90.6	174.1	277.7	489.8	1,002.2
330	7.1	14.8	27.9	57.5	85.8	165.3	263.8	467.1	951.2
360	6.8	14.2	26.6	54.6	82.1	158.0	251.7	444.5	905.9
390	6.5	13.5	25.5	52.4	78.4	151.2	240.9	424.7	869.1
420	6.2	13.0	24.5	50.4	75.3	145.2	231.6	410.5	835.1
450	6.0	12.5	23.6	48.4	72.8	139.9	223.1	393.5	804.0
480	5.8	12.1	22.8	46.7	70.2	135.0	215.4	379.4	775.7
510	5.6	11.7	22.1	45.3	67.9	130.8	208.4	368.0	750.2
540	5.4	11.4	21.4	43.9	66.0	126.8	202.1	356.7	727.6
570	5.3	11.0	20.8	0.0	64.0	123.1	196.2	348.2	707.8
600	5.1	10.7	20.2	41.6	62.3	119.8	190.8	336.9	687.9

Note: All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3$ $ft.^3$; 1bar = 14.5 psi

Table 12-11 Semi-Rigid Copper Tubing [NFPA 54: Table 6.2(f)]

					Gas:	Natural			
					Inlet Pressure:	Less than 0.138bar			
					Pressure Drop:	7.5mm in. w.c.			
					Specific Gravity:	0.6			
	Tube Size (mm)								
DN: K&L:	8	10	15	18	20	25	32	40	50
DN: ACR:	9.5	15	18	20	22	28	35	----	----
Length (m)	Capacity in m^3/h								
3	0.6	1.2	2.4	4.2	5.9	12.7	22.8	36.0	75.0
6	0.4	0.8	1.6	2.9	4.1	8.7	15.7	24.7	51.5
9	0.3	0.7	1.3	2.3	3.3	7.0	12.6	19.8	41.3
12	0.3	0.6	1.1	2.0	2.8	6.0	10.8	17.0	35.4
15	NA	0.5	1.0	1.8	2.5	5.3	9.5	15.1	31.4
18	NA	0.5	0.9	1.6	2.2	4.8	8.7	13.6	28.3
21	NA	0.4	0.8	1.5	2.1	4.4	8.0	12.5	26.2
24	NA	0.4	0.8	1.4	1.9	4.1	7.4	11.7	24.3
27	NA	0.4	0.7	1.3	1.8	3.9	6.9	11.0	22.8
30	NA	0.3	0.7	1.2	1.7	3.7	6.6	10.4	21.5
38	NA	0.3	0.6	1.1	1.5	3.2	5.8	9.2	19.1
45	NA	0.3	0.6	1.0	1.4	2.9	5.3	8.3	17.3
53	NA	NA	0.5	0.9	1.3	2.7	4.8	7.6	15.9
60	NA	NA	0.5	0.8	1.2	2.5	4.5	7.1	14.8
75	NA	NA	0.4	0.7	1.0	2.2	4.0	6.3	13.1
90	NA	NA	0.4	0.7	0.9	2.0	3.6	5.7	11.9
105	NA	NA	0.3	0.6	0.9	1.8	3.3	5.3	11.0
120	NA	NA	0.3	0.6	0.8	1.7	3.1	4.9	10.2
135	NA	NA	0.3	0.5	0.8	1.6	2.9	4.6	9.6
150	NA	NA	0.3	0.5	0.7	1.5	2.7	4.3	9.0
165	NA	NA	NA	0.5	0.7	1.4	2.6	4.1	8.6
180	NA	NA	NA	0.5	0.7	1.4	2.5	3.9	8.2
195	NA	NA	NA	0.4	0.6	1.3	2.4	3.8	7.8
210	NA	NA	NA	0.4	0.6	1.3	2.3	3.6	7.5
225	NA	NA	NA	0.4	0.6	1.2	2.2	3.5	7.2
240	NA	NA	NA	0.4	0.6	1.2	2.1	3.4	7.0
255	NA	NA	NA	0.4	0.5	1.1	2.1	3.3	6.8
270	NA	NA	NA	0.4	0.5	1.1	2.0	3.1	6.6
285	NA	NA	NA	0.4	0.5	1.1	2.0	3.1	6.4
300	NA	NA	NA	0.3	0.5	1.0	1.9	3.0	6.2
330	NA	NA	NA	0.3	0.5	1.0	1.8	2.8	5.9
360	NA	NA	NA	0.3	0.5	1.0	1.7	2.7	5.6
390	NA	NA	NA	0.3	0.4	0.9	1.6	2.6	5.4
420	NA	NA	NA	0.3	0.4	0.9	1.6	2.5	5.2
450	NA	NA	NA	NA	0.4	0.8	1.5	2.4	5.0
480	NA	NA	NA	NA	0.4	0.8	1.5	2.3	4.8
510	NA	NA	NA	NA	0.4	0.8	1.4	2.2	4.6
540	NA	NA	NA	NA	0.4	0.8	1.4	2.2	4.5
570	NA	NA	NA	NA	0.3	0.7	1.3	2.1	4.4
600	NA	NA	NA	NA	0.3	0.7	1.3	2.0	4.3

NA means a flow of less than $0.3m^3/h$

Note: All table entries are rounded to 3 significant digits.

*Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3 ft.^3$; 1bar = 14.5 psi

Table 12-12 Semi-Rigid Copper Tubing [NFPA 54: Table 6.2(g)]

					Gas:	Natural			
					Inlet Pressure:	Less than 0.138bar			
					Pressure Drop:	12.7mm w.c.			
					Specific Gravity:	0.6			
	Tube Size (mm)								
DN: K&L:	8	10	15	18	20	25	32	40	50
DN: ACR:	9.5	15	18	20	22	28	35	----	----
Length (m)	Capacity in m^3/h								
3	0.8	1.6	3.1	5.5	7.8	16.7	30.0	47.6	98.8
6	0.5	1.1	2.2	3.8	5.4	11.5	20.7	32.6	67.9
9	0.4	0.8	1.7	3.0	4.3	9.2	16.6	26.2	54.6
12	0.4	0.7	1.5	2.6	3.7	7.9	14.2	22.4	46.7
15	0.3	0.7	1.3	2.3	3.3	7.0	12.6	19.8	41.3
18	0.3	0.6	1.2	2.1	3.0	6.3	11.4	18.0	37.4
21	NA	0.5	1.1	1.9	2.7	5.8	10.5	16.6	34.5
24	NA	0.5	1.0	1.8	2.5	5.4	9.8	15.4	32.0
27	NA	0.5	1.0	1.7	2.4	5.1	9.2	14.4	30.0
30	NA	0.5	0.9	1.6	2.2	4.8	8.7	13.6	28.3
38	NA	0.4	0.8	1.4	2.0	4.3	7.7	12.1	25.2
45	NA	0.4	0.7	1.3	1.8	3.9	6.9	11.0	22.8
53	NA	0.3	0.7	1.2	1.7	3.5	6.4	10.1	21.0
60	NA	0.3	0.6	1.1	1.6	3.3	5.9	9.4	19.5
75	NA	NA	0.6	1.0	1.4	2.9	5.3	8.3	17.3
90	NA	NA	0.5	0.9	1.2	2.7	4.8	7.5	15.7
105	NA	NA	0.5	0.8	1.1	2.4	4.4	6.9	14.4
120	NA	NA	0.4	0.7	1.1	2.3	4.1	6.5	13.4
135	NA	NA	0.4	0.7	1.0	2.1	3.8	6.1	12.6
150	NA	NA	0.4	0.7	0.9	2.0	3.6	5.7	11.9
165	NA	NA	0.4	0.6	0.9	1.9	3.5	5.4	11.3
180	NA	NA	0.3	0.6	0.8	1.8	3.3	5.2	10.8
195	NA	NA	0.3	0.6	0.8	1.8	3.1	5.0	10.3
210	NA	NA	0.3	0.6	0.8	1.7	3.0	4.8	9.9
225	NA	NA	0.3	0.5	0.8	1.6	2.9	4.6	9.6
240	NA	NA	0.3	0.5	0.7	1.6	2.8	4.4	9.2
255	NA	NA	0.3	0.5	0.7	1.5	2.7	4.3	8.9
270	NA	NA	NA	0.5	0.7	1.5	2.6	4.2	8.7
285	NA	NA	NA	0.5	0.7	1.4	2.5	4.0	8.4
300	NA	NA	NA	0.5	0.7	1.4	2.5	3.9	8.2
330	NA	NA	NA	0.4	0.6	1.3	2.4	3.7	7.8
360	NA	NA	NA	0.4	0.6	1.2	2.3	3.6	7.4
390	NA	NA	NA	0.4	0.6	1.2	2.2	3.4	7.1
420	NA	NA	NA	0.4	0.5	1.2	2.1	3.3	6.8
450	NA	NA	NA	0.4	0.5	1.1	2.0	3.1	6.6
480	NA	NA	NA	0.4	0.5	1.1	1.9	3.1	6.3
510	NA	NA	NA	0.3	0.5	1.0	1.9	2.9	6.1
540	NA	NA	NA	0.3	0.5	1.0	1.8	2.9	5.9
570	NA	NA	NA	0.3	0.5	1.0	1.8	2.8	5.8
600	NA	NA	NA	0.3	0.5	1.0	1.7	2.7	5.6

NA means a flow of less than $0.3m^3/h$

Note: All table entries are rounded to 3 significant digits.

*Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3$ ft.^{3}; 1bar = 14.5 psi

Table 12-13 Semi-Rigid Copper Tubing [NFPA 54: Table 6.2(h)]

		Gas:	Natural
		Inlet Pressure:	Less than 0.138bar
		Pressure Drop:	25mm w.c.
		Specific Gravity:	0.6

INTENDED USE: Tube Sizing Between House Line Regulator and the Appliance.

		Tube Size (mm)								
DN:	K&L:	8	10	15	18	20	25	32	40	50
	ACR:	9.5	15	18	20	22	28	35	----	----
Length (m)		Capacity in m^3/h								
3		1.1	2.3	4.6	8.0	11.4	24.3	43.9	69.1	143.8
6		0.8	1.6	3.1	5.5	7.8	16.7	30.0	47.6	98.8
9		0.6	1.2	2.5	4.4	6.3	13.4	24.1	38.2	79.3
12		0.5	1.1	2.2	3.8	5.4	11.5	20.7	32.6	67.9
15		0.5	0.9	1.9	3.4	4.8	10.2	18.3	28.9	60.3
18		0.4	0.8	1.7	3.0	4.3	9.2	16.6	26.2	54.6
21		0.4	0.8	1.6	2.8	4.0	8.5	15.3	24.1	50.1
24		0.4	0.7	1.5	2.6	3.7	7.9	14.2	22.4	46.7
27		0.3	0.7	1.4	2.4	3.5	7.4	13.3	21.0	43.9
30		0.3	0.7	1.3	2.3	3.3	7.0	12.6	19.8	41.3
38		NA	0.6	1.2	2.0	2.9	6.2	11.2	17.6	36.5
45		NA	0.5	1.0	1.8	2.6	5.6	10.1	15.9	33.1
53		NA	0.5	1.0	1.7	2.4	5.2	9.3	14.7	30.6
60		NA	0.5	0.9	1.6	2.2	4.8	8.7	13.6	28.3
75		NA	0.4	0.8	1.4	2.0	4.3	7.7	12.1	25.2
90		NA	0.4	0.7	1.3	1.8	3.9	6.9	11.0	22.8
105		NA	0.3	0.7	1.2	1.7	3.5	6.4	10.1	21.0
120		NA	0.3	0.6	1.1	1.6	3.3	5.9	9.4	19.5
135		NA	0.3	0.6	1.0	1.4	3.1	5.6	8.8	18.3
150		NA	NA	0.6	1.0	1.4	2.9	5.3	8.3	17.3
165		NA	NA	0.5	0.9	1.3	2.8	5.0	7.9	16.4
180		NA	NA	0.5	0.9	1.2	2.7	4.8	7.5	15.7
195		NA	NA	0.5	0.8	1.2	2.5	4.6	7.2	15.0
210		NA	NA	0.5	0.8	1.1	2.4	4.4	6.9	14.4
225		NA	NA	0.5	0.8	1.1	2.3	4.2	6.7	13.9
240		NA	NA	0.4	0.7	1.1	2.3	4.1	6.5	13.4
255		NA	NA	0.4	0.7	1.0	2.2	4.0	6.2	13.0
270		NA	NA	0.4	0.7	1.0	2.1	3.8	6.1	12.6
285		NA	NA	0.4	0.7	1.0	2.1	3.7	5.9	12.2
300		NA	NA	0.4	0.7	0.9	2.0	3.6	5.7	11.9
330		NA	NA	0.4	0.6	0.9	1.9	3.5	5.4	11.3
360		NA	NA	0.3	0.6	0.8	1.8	3.3	5.2	10.8
390		NA	NA	0.3	0.6	0.8	1.8	3.1	5.0	10.3
420		NA	NA	0.3	0.6	0.8	1.7	3.0	4.8	9.9
450		NA	NA	0.3	0.5	0.8	1.6	2.9	4.6	9.6
480		NA	NA	0.3	0.5	0.7	1.6	2.8	4.4	9.2
510		NA	NA	0.3	0.5	0.7	1.5	2.7	4.3	8.9
540		NA	NA	NA	0.5	0.7	1.5	2.6	4.2	8.7
570		NA	NA	NA	0.5	0.7	1.4	2.5	4.0	8.4
600		NA	NA	NA	0.5	0.7	1.4	2.5	3.9	8.2

NA means a flow of less than $0.3m^3/h$

Note: All table entries are rounded to 3 significant digits.

*Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3\ ft.^3$; 1bar = 14.5 psi

TABLE 12-14 Semi-Rigid Copper Tubing [NFPA 54: Table 6.2(i)]

					Gas:	Natural			
					Inlet Pressure:	Less than 0.138bar			
					Pressure Drop:	0.049bar			
					Specific Gravity:	0.6			
	Tube Size (mm)								
DN: K&L:	8	10	15	18	20	25	32	40	50
DN: ACR:	9.5	15	18	20	22	28	35	----	----
Length (m)	Capacity in m^3/h								
3	5.4	11.1	22.5	39.4	55.8	119.5	214.9	339.7	704.9
6	3.7	7.6	15.5	27.1	38.5	82.1	147.8	233.0	484.1
9	3.0	6.1	12.4	21.7	30.9	66.0	118.6	187.1	390.7
12	2.5	5.2	10.6	18.6	26.4	56.3	101.6	160.0	334.1
15	2.2	4.6	9.4	16.5	23.4	50.1	90.0	141.8	294.4
18	2.0	4.2	8.5	14.9	21.2	45.3	81.5	128.5	267.8
21	1.9	3.9	7.9	13.8	19.5	41.6	75.0	118.3	246.3
24	1.8	3.6	7.3	12.8	18.1	38.8	69.6	110.1	229.0
27	1.6	3.4	6.9	12.0	17.0	36.2	65.4	103.3	214.9
30	1.6	3.2	6.5	11.3	16.1	34.3	61.7	97.4	203.0
38	1.4	2.8	5.7	10.1	14.2	30.6	54.9	86.3	180.1
45	1.2	2.5	5.2	9.1	12.9	27.6	49.5	78.4	163.1
53	1.1	2.3	4.8	8.4	11.9	25.4	45.6	71.9	150.0
60	1.1	2.2	4.4	7.8	11.0	23.6	42.5	67.1	139.6
75	0.9	2.0	4.0	6.9	9.8	20.9	37.7	59.5	123.7
90	0.8	1.8	3.6	6.3	8.9	19.0	34.3	53.8	112.1
105	0.8	1.6	3.3	5.7	8.2	17.4	31.4	49.5	103.0
120	0.7	1.5	3.1	5.4	7.6	16.2	29.2	46.1	96.0
135	0.7	1.4	2.9	5.0	7.1	15.2	27.4	43.3	90.0
150	0.7	1.3	2.7	4.8	6.7	14.4	25.9	40.8	84.9
165	0.6	1.3	2.6	4.5	6.4	13.6	24.6	38.8	80.7
180	0.6	1.2	2.5	4.3	6.1	13.0	23.5	37.1	77.0
195	0.6	1.2	2.3	4.1	5.8	12.5	22.4	35.4	73.9
210	0.5	1.1	2.3	4.0	5.6	12.0	21.6	34.0	70.8
225	0.5	1.1	2.2	3.8	5.4	11.6	20.8	32.8	68.2
240	0.5	1.0	2.1	3.7	5.2	11.2	20.1	31.7	66.0
255	0.5	1.0	2.0	3.6	5.0	10.8	19.4	30.6	63.7
270	0.5	1.0	2.0	3.5	4.9	10.5	18.8	29.7	61.7
285	0.5	0.9	1.9	3.3	4.8	10.2	18.3	28.9	60.0
300	0.5	0.9	1.9	3.3	4.6	9.9	17.8	28.1	58.3
330	0.4	0.9	1.8	3.1	4.4	9.4	16.9	26.6	55.5
360	0.4	0.8	1.7	2.9	4.2	8.9	16.1	25.4	52.9
390	0.4	0.8	1.6	2.8	4.0	8.6	15.4	24.3	50.7
420	0.4	0.8	1.6	2.7	3.9	8.2	14.8	23.4	48.7
450	0.4	0.7	1.5	2.6	3.7	7.9	14.3	22.5	47.0
480	0.3	0.7	1.4	2.5	3.6	7.7	13.8	21.7	45.3
510	0.3	0.7	1.4	2.4	3.5	7.4	13.4	21.1	43.9
540	0.3	0.7	1.4	2.4	3.4	7.2	12.9	20.4	42.5
570	0.3	0.7	1.3	2.3	3.3	7.0	12.6	19.8	41.3
600	0.3	0.6	1.3	2.2	3.2	6.8	12.2	19.3	40.2

Note: All table entries are rounded to 3 significant digits.
*Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3\ ft.^3$; 1bar = 14.5 psi

TABLE 12-15 Semi-Rigid Copper Tubing [NFPA 54: Table 6.2(j)]

						Gas:		Natural		
						Inlet Pressure:		0.138bar		
						Pressure Drop:		0.069bar		
						Specific Gravity:		0.6		
		Tube Size (mm)								
DN:	K&L:	8	10	15	18	20	25	32	40	50
	ACR:	9.5	15	18	20	22	28	35	----	----
Length (m)		Capacity in m^3/h								
3		6.9	14.3	29.2	51.0	72.2	154.3	278.0	438.8	911.6
6		4.8	9.9	20.0	35.1	49.8	106.2	191.1	300.1	628.5
9		3.8	7.9	16.1	28.1	39.9	85.2	153.4	242.1	503.9
12		3.3	6.8	13.8	24.1	34.3	73.0	131.4	206.9	430.3
15		2.9	6.0	12.2	21.3	30.3	64.5	116.4	183.4	382.2
18		2.6	5.4	11.1	19.3	27.4	58.6	105.6	166.2	345.4
21		2.4	5.0	10.2	17.8	25.2	53.8	97.1	152.9	319.9
24		2.3	4.6	9.5	16.5	23.5	50.1	90.3	142.4	297.3
27		2.1	4.4	8.9	15.5	22.0	47.0	84.6	133.6	278.0
30		2.0	4.1	8.4	14.7	20.8	44.4	80.1	126.0	262.7
38		1.8	3.7	7.4	13.0	18.4	39.4	70.8	111.8	232.7
45		1.6	3.3	6.7	11.8	16.7	35.7	64.3	101.3	210.9
53		1.5	3.1	6.2	10.8	15.4	32.8	59.2	93.1	193.9
60		1.4	2.8	5.8	10.1	14.3	30.6	54.9	86.6	180.6
75		1.2	2.5	5.1	8.9	12.7	27.1	48.7	76.7	160.0
90		1.1	2.3	4.6	8.1	11.5	24.5	44.2	69.6	144.9
105		1.0	2.1	4.2	7.4	10.6	22.6	40.5	64.0	133.3
120		0.9	2.0	4.0	6.9	9.8	21.0	37.7	59.5	124.0
135		0.9	1.8	3.7	6.5	9.2	19.7	35.4	55.8	116.4
150		0.8	1.7	3.5	6.1	8.7	18.6	33.4	52.9	109.8
165		0.8	1.6	3.3	5.8	8.3	17.7	31.7	50.1	104.5
180		0.8	1.6	3.2	5.5	7.9	16.8	30.3	47.8	99.7
195		0.7	1.5	3.1	5.3	7.6	16.1	29.2	45.9	95.4
210		0.7	1.4	2.9	5.1	7.2	15.5	27.9	43.9	91.7
225		0.7	1.4	2.8	4.9	7.0	14.9	26.9	42.5	88.3
240		0.7	1.3	2.7	4.8	6.8	14.4	26.0	41.0	85.2
255		0.6	1.3	2.6	4.6	6.5	14.0	25.1	39.6	82.7
270		0.6	1.2	2.5	4.5	6.3	13.5	24.4	38.5	80.1
285		0.6	1.2	2.5	4.3	6.1	13.1	23.7	37.4	77.6
300		0.6	1.2	2.4	4.2	6.0	12.8	23.0	36.2	75.6
330		0.5	1.1	2.3	4.0	5.7	12.1	21.9	34.5	71.9
360		0.5	1.1	2.2	3.8	5.4	11.6	20.9	32.8	68.5
390		0.5	1.0	2.1	3.7	5.2	11.1	20.0	31.4	65.7
420		0.5	1.0	2.0	3.5	5.0	10.6	19.2	30.3	63.1
450		0.5	1.0	1.9	3.4	4.8	10.3	18.5	29.2	60.6
480		0.5	0.9	1.9	3.3	4.6	9.9	17.8	28.1	58.6
510		0.4	0.9	1.8	3.2	4.5	9.6	17.3	27.2	56.6
540		0.4	0.8	1.8	3.1	4.4	9.3	16.8	26.4	54.9
570		0.4	0.8	1.7	3.0	4.2	9.0	16.3	25.6	53.5
600		0.4	0.8	1.7	2.9	4.1	8.8	15.8	24.9	51.8

Note: All table entries are rounded to 3 significant digits.
*Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3 ft.^3$; 1bar = 14.5 psi

TABLE 12-16 Semi-Rigid Copper Tubing [NFPA 54: Table 6.2(k)]

						Gas:	**Natural**			
						Inlet Pressure:	**0.138bar**			
						Pressure Drop:	**0.104bar**			
						Specific Gravity:	**0.6**			
INTENDED USE: Pipe Sizing Between Point of Delivery and the House Line Regulator. Total Load Supplied by a Single House Line Regulator Not Exceeding .42 m³/h.†										
		Tube Size (mm)								
DN:	**K&L:**	**8**	**10**	**15**	**18**	**20**	**25**	**32**	**40**	**50**
	ACR:	**9.5**	**15**	**18**	**20**	**22**	**28**	**35**	**----**	**----**
Length (m)		**Capacity in m³/h**								
3		8.6	17.7	36.0	62.8	89.2	190.8	342.6	540.7	1,126.7
6		5.9	12.2	24.7	43.3	61.4	131.1	235.8	370.9	775.7
9		4.7	9.8	19.9	34.8	49.3	105.3	189.4	300.1	622.8
12		4.0	8.4	17.0	29.7	42.2	90.0	162.2	255.6	532.2
15		3.6	7.4	15.1	26.4	37.4	79.8	143.8	226.5	472.8
18		3.3	6.7	13.6	23.9	34.0	72.5	130.2	205.2	427.5
21		3.0	6.2	12.6	22.0	31.1	66.5	119.8	188.8	393.5
24		2.8	5.7	11.7	20.4	28.9	62.0	111.5	175.8	365.2
27		2.6	5.4	11.0	19.2	27.2	58.0	104.5	164.8	342.6
30		2.5	5.1	10.4	18.1	25.7	54.9	98.8	155.7	325.6
38		2.2	4.5	9.2	16.1	22.8	48.7	87.5	138.2	288.8
45		2.0	4.1	8.3	14.6	20.6	44.2	79.3	125.1	260.5
53		1.8	3.8	7.6	13.4	19.0	40.5	73.0	114.9	239.5
60		1.7	3.5	7.1	12.5	17.7	37.7	67.9	107.0	222.8
75		1.5	3.1	6.3	11.0	15.7	33.4	60.3	94.8	197.6
90		1.4	2.8	5.7	10.0	14.2	30.3	54.6	86.1	178.9
105		1.2	2.6	5.3	9.2	13.1	27.9	50.1	79.0	164.8
120		1.2	2.4	4.9	8.5	12.1	25.9	46.7	73.6	153.2
135		1.1	2.3	4.6	8.0	11.4	24.3	43.9	69.1	143.8
150		1.0	2.1	4.3	7.6	10.8	23.0	41.3	65.1	135.9
165		1.0	2.0	4.1	7.2	10.2	21.8	39.4	62.0	129.1
180		0.9	1.9	3.9	6.9	9.7	20.8	37.4	59.2	123.1
195		0.9	1.8	3.8	6.6	9.3	19.9	36.0	56.6	117.8
210		0.8	1.8	3.6	6.3	9.0	19.1	34.5	54.4	113.2
225		0.8	1.7	3.5	6.1	8.6	18.5	33.1	52.4	109.0
240		0.8	1.6	3.4	5.9	8.4	17.8	32.0	50.7	105.3
255		0.8	1.6	3.3	5.7	8.1	17.2	31.1	49.0	101.9
270		0.8	1.6	3.1	5.5	7.8	16.7	30.0	47.6	98.8
285		0.7	1.5	3.1	5.4	7.6	16.2	29.2	46.1	96.0
300		0.7	1.5	3.0	5.2	7.4	15.8	28.3	44.7	93.4
330		0.7	1.4	2.8	5.0	7.0	15.0	27.0	42.5	88.6
360		0.7	1.3	2.7	4.7	6.7	14.3	25.8	40.5	84.6
390		0.6	1.3	2.6	4.5	6.4	13.7	24.7	38.8	81.0
420		0.6	1.2	2.5	4.3	6.2	13.2	23.7	37.4	77.9
450		0.6	1.2	2.4	4.2	5.9	12.7	22.8	36.0	75.0
480		0.5	1.1	2.3	4.0	5.7	12.2	22.1	34.8	72.5
510		0.5	1.1	2.2	3.9	5.5	11.9	21.3	33.7	69.9
540		0.5	1.1	2.2	3.8	5.4	11.5	20.7	32.6	67.9
570		0.5	1.0	2.1	3.7	5.2	11.2	20.1	31.7	66.0
600		0.5	1.0	2.0	3.6	5.1	10.8	19.5	30.9	64.3

Note: All table entries are rounded to 3 significant digits.
*Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
†When this table is used to size the tubing upstream of a line pressure regulator, the pipe or tubing downstream of the line pressure regulator shall be sized using a pressure drop no greater than 1 in. w.c.
SI: 1m = 3.3 ft.; 1mm = 0.04 in.; 1m^3 = 33.3 ft.^{3}; 1bar = 14.5 psi

TABLE 12-17 Semi-Rigid Copper Tubing [NFPA 54: Table 6.2(l)]

					Gas:	Natural			
					Inlet Pressure:	0.345bar			
					Pressure Drop:	0.241bar			
					Specific Gravity:	0.6			
	Tube Size (mm)								
DN: K&L:	8	10	15	18	20	25	32	40	50
DN: ACR:	9.5	15	18	20	22	28	35	----	----
Length (m)	Capacity in m^3/h								
3	14.5	29.7	60.6	106.2	150.6	322.7	577.5	911.6	1,899.6
6	9.9	20.5	41.6	73.0	103.3	220.8	396.3	628.5	1,305.1
9	8.0	16.5	33.4	58.6	82.9	177.5	319.9	503.9	1,047.5
12	6.8	14.1	28.6	50.1	71.1	151.7	273.5	430.3	897.4
15	6.1	12.5	25.4	44.4	63.1	134.5	242.3	382.2	795.5
18	5.5	11.3	23.0	40.2	57.2	122.0	219.4	345.4	721.9
21	5.0	10.4	21.2	37.1	52.7	112.1	201.9	317.1	662.5
24	4.7	9.7	19.7	34.5	49.0	104.5	188.0	297.3	617.2
27	4.4	9.1	18.5	32.3	45.9	98.0	176.4	278.0	569.0
30	4.2	8.6	17.5	30.6	43.3	92.6	166.5	262.4	546.4
38	3.7	7.6	15.5	27.0	38.5	82.1	147.5	232.7	484.1
45	3.3	6.9	14.0	24.5	34.8	74.2	133.6	210.9	438.8
53	3.1	6.3	12.9	22.5	32.0	68.2	123.1	193.9	404.8
60	2.9	5.9	12.0	21.0	29.7	63.7	114.4	180.3	376.5
75	2.5	5.2	10.6	18.6	26.4	56.3	101.3	160.0	334.1
90	2.3	4.7	9.6	16.8	23.9	51.0	92.0	144.9	302.9
105	2.1	4.4	8.9	15.5	22.0	47.0	84.6	133.3	277.7
120	2.0	4.0	8.2	14.4	20.4	43.6	78.7	124.0	258.2
135	1.8	3.8	7.7	13.5	19.2	41.0	73.9	116.4	242.3
150	1.8	3.6	7.3	12.8	18.1	38.8	69.6	109.8	229.0
165	1.6	3.4	6.9	12.1	17.2	36.8	66.2	104.5	217.4
180	1.6	3.3	6.6	11.6	16.4	35.1	63.1	99.7	207.5
195	1.5	3.1	6.3	11.1	15.7	33.7	60.6	95.4	198.7
210	1.4	3.0	6.1	10.6	15.1	32.3	58.0	91.7	190.8
225	1.4	2.9	5.9	10.2	14.6	31.1	56.1	88.3	183.7
240	1.4	2.8	5.7	9.9	14.1	30.0	54.1	85.2	177.5
255	1.3	2.7	5.5	9.6	13.6	29.2	52.4	82.4	171.8
270	1.3	2.6	5.3	9.3	13.2	28.3	50.7	79.8	166.5
285	1.2	2.5	5.2	9.0	12.8	27.4	49.3	77.6	161.7
300	1.2	2.5	5.0	8.8	12.5	26.6	47.8	75.6	157.4
330	1.1	2.3	4.8	8.4	11.8	25.3	45.6	71.6	149.5
360	1.1	2.2	4.6	8.0	11.3	24.1	43.3	68.5	142.7
390	1.0	2.2	4.4	7.6	10.8	23.1	41.6	65.7	136.5
420	1.0	2.1	4.2	7.3	10.4	22.2	39.9	62.8	131.1
450	1.0	2.0	4.0	7.0	10.0	21.4	38.5	60.6	126.3
480	0.9	1.9	3.9	6.8	9.7	20.6	37.1	58.6	122.0
510	0.9	1.8	3.8	6.6	9.3	20.0	36.0	56.6	118.1
540	0.9	1.8	3.7	6.4	9.1	19.4	34.8	54.9	114.4
570	0.8	1.8	3.5	6.2	8.8	18.8	34.0	53.5	111.3
600	0.8	1.7	3.5	6.0	8.5	18.3	32.8	51.8	108.1

Note: All table entries are rounded to 3 significant digits.
*Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3 ft.^3$; 1bar = 14.5 psi

TABLE 12-18 Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.2(m)]

											Gas:	**Natural**		
											Inlet Pressure:	**Less than 0.138bar**		
											Pressure Drop:	**12.7mm w.c.**		
											Specific Gravity:	**0.6**		
	Tube Size (EHD)*													
Flow Designation:	**13**	**15**	**18**	**19**	**23**	**25**	**30**	**31**	**37**	**39**	**46**	**48**	**60**	**62**
Length (m)	**Capacity in m^3/h**													
1.6	1.3	1.8	3.3	3.8	6.4	7.6	13.3	15.5	25.3	29.4	50.7	58.6	103.6	117.2
3	0.9	1.2	2.3	2.7	4.6	5.4	9.3	10.8	18.1	21.1	35.7	41.6	73.6	82.9
4.5	0.7	1.0	1.9	2.2	3.7	4.4	7.6	8.8	14.8	17.4	29.2	34.0	60.6	67.9
6	0.6	0.9	1.6	1.9	3.3	3.9	6.5	7.6	12.9	15.2	25.1	29.7	52.4	58.9
7.5	0.5	0.8	1.5	1.7	2.9	3.5	5.8	6.8	11.6	13.6	22.4	26.5	47.0	52.7
9	0.5	0.7	1.3	1.6	2.7	3.2	5.3	6.2	10.6	12.5	20.5	24.2	43.0	48.1
21	0.4	0.6	1.2	1.3	2.3	2.7	4.6	5.3	9.2	10.9	17.7	21.0	37.4	41.6
15	0.4	0.5	1.0	1.2	2.1	2.5	4.1	4.8	8.3	9.8	15.8	18.8	33.4	37.4
18	0.3	0.5	1.0	1.1	1.9	2.3	3.7	4.3	7.6	9.0	14.4	17.2	30.6	34.0
21	0.3	0.5	0.9	1.0	1.8	2.1	3.4	4.0	7.0	8.4	13.3	15.9	28.3	31.4
24	0.3	0.4	0.8	0.9	1.7	2.0	3.2	3.7	6.6	7.8	12.5	14.9	26.6	29.4
27	0.3	0.4	0.8	0.9	1.6	1.8	3.0	3.5	6.2	7.4	11.7	14.1	25.1	27.8
30	0.3	0.4	0.7	0.8	1.5	1.8	2.9	3.3	5.9	7.0	11.1	13.4	23.9	26.4
45	0.2	0.3	0.6	0.7	1.2	1.4	2.2	2.6	4.8	5.8	9.1	11.0	19.6	21.6
60	0.2	0.3	0.5	0.6	1.1	1.2	2.0	2.3	4.2	5.1	7.8	9.5	17.0	18.7
75	0.1	0.2	0.5	0.5	1.0	1.1	1.8	2.1	3.8	4.6	7.0	8.5	15.2	16.7
90	0.1	0.2	0.4	0.5	0.9	1.0	1.6	1.9	2.7	4.2	6.4	7.8	13.9	15.3

*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.

Notes:

(1) Table includes losses for four 90 degree bends and two end fittings. Tubing runs with larger numbers of bends and/or fillings shall be increased by an equivalent length of tubing to the following equation: L = 1.3n, where L is additional length (ft) of tubing and n is the number of additional fittings and/or bends.

(2) All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3 ft.^3$; 1bar = 14.5 psi

TABLE 12-19 Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.2(n)]

									Gas:	**Natural**			
									Inlet Pressure:	**Less than 0.138bar**			
									Pressure Drop:	**75mm w.c.**			
									Specific Gravity:	**0.6**			
	Tube Size (EHD)*												
Flow Designation:	**13**	**15**	**18**	**19**	**23**	**25**	**30**	**31**	**37**	**46**	**48**	**60**	**62**
Length (m)	**Capacity in m^3/h**												
1.6	3.4	4.5	7.8	9.3	15.0	18.4	33.4	38.8	60.6	116.9	141.8	249.1	285.9
3	2.3	3.2	5.6	6.5	10.8	13.1	23.4	27.1	43.3	90.6	100.8	177.5	202.7
4.5	1.9	2.5	4.6	5.4	8.9	10.7	19.1	22.0	35.4	71.9	82.4	145.5	165.6
6	1.6	2.2	4.0	4.6	7.7	9.3	16.4	19.0	30.9	62.3	71.6	126.3	143.5
7.5	1.4	2.0	3.5	4.2	6.9	8.4	14.7	17.0	27.7	55.5	64.3	113.2	128.5
9	1.3	1.8	3.3	3.8	6.4	7.6	13.3	15.5	25.3	50.7	58.6	103.6	117.2
21	1.1	1.5	2.8	3.3	5.5	6.6	11.5	13.3	22.0	43.9	51.0	90.0	101.6
15	1.0	1.4	2.5	2.9	5.0	5.9	10.3	11.9	19.8	39.1	45.6	80.7	90.9
18	0.9	1.2	2.3	2.7	4.6	5.4	9.3	10.8	18.1	35.7	41.6	73.6	82.9
21	0.8	1.2	2.2	2.5	4.2	5.0	8.7	10.1	16.8	33.1	38.5	68.5	77.0
24	0.8	1.1	2.0	2.3	4.0	4.7	8.1	9.4	15.7	30.9	36.2	64.0	71.9
27	0.7	1.0	1.9	2.2	3.8	4.4	7.6	8.8	14.8	29.2	34.0	60.6	67.9
30	0.7	1.0	1.8	2.1	3.6	4.2	7.2	8.4	14.1	27.6	32.3	57.5	64.5
45	0.5	0.8	1.5	1.7	2.9	3.5	5.8	6.8	11.6	22.4	26.5	47.0	52.7
60	0.5	0.7	1.3	1.5	2.6	3.0	5.0	5.9	10.1	19.4	23.0	40.8	45.6
75	0.4	0.6	1.1	1.3	2.3	2.7	4.5	5.2	9.0	17.4	20.6	36.5	40.8
90	0.4	0.5	1.0	1.2	2.1	2.5	4.1	4.8	6.6	15.8	18.8	33.4	37.4

*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.

Notes:

(1) Table includes losses for four 90 degree bends and two end fittings. Tubing runs with larger numbers of bends and/or fillings shall be increased by an equivalent length of tubing to the following equation: L = 1.3n, where L is additional length (ft) of tubing and n is the number of additional fittings and/or bends.

(2) All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; 1m^3 = 33.3 ft.^{3}; 1bar = 14.5 psi

TABLE 12-20 Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.2(o)]

										Gas:	**Natural**		
										Inlet Pressure:	**Less than 0.138bar**		
										Pressure Drop:	**150mm w.c.**		
										Specific Gravity:	**0.6**		
	Tube Size (EHD)*												
Flow Designation:	**13**	**15**	**18**	**19**	**23**	**25**	**30**	**31**	**37**	**46**	**48**	**60**	**62**
Length (m)	**Capacity in m^3/h**												
1.6	4.9	6.5	11.0	13.1	20.9	25.8	47.8	55.2	84.9	177.8	199.6	351.0	403.7
3	3.4	4.5	7.8	9.3	15.0	18.4	33.4	38.8	60.6	125.4	141.8	249.1	285.9
4.5	2.7	3.7	6.4	7.6	12.3	15.1	27.2	31.4	49.8	102.2	116.1	204.1	233.8
6	2.3	3.2	5.6	6.5	10.8	13.1	23.4	27.1	43.3	88.3	100.8	177.5	202.7
7.5	2.1	2.8	5.0	5.9	9.7	11.7	20.9	24.2	38.8	79.0	90.3	159.1	181.2
9	1.9	2.5	4.6	5.4	8.9	10.7	19.1	22.0	35.4	71.9	82.4	145.5	165.6
21	1.6	2.2	4.0	4.6	7.7	9.3	16.4	19.0	30.9	62.3	71.6	126.3	143.5
15	1.4	2.0	3.5	4.2	6.9	8.4	14.7	17.0	27.7	55.5	64.3	113.2	128.5
18	1.3	1.8	3.3	3.8	6.4	7.6	13.3	15.5	25.3	50.7	58.6	103.6	117.2
21	1.2	1.6	3.0	3.5	5.9	7.1	12.3	14.3	23.5	47.0	54.4	96.0	108.7
24	1.1	1.5	2.8	3.3	5.5	6.6	11.5	13.3	22.0	43.9	51.0	90.0	101.6
27	1.0	1.4	2.7	3.1	5.2	6.3	10.8	12.6	20.8	41.3	48.1	84.9	96.0
30	1.0	1.4	2.5	2.9	5.0	5.9	10.3	11.9	19.8	39.1	45.6	80.7	90.9
45	0.8	1.1	2.1	2.4	4.1	4.9	8.3	9.7	16.2	32.0	37.4	66.2	74.5
60	0.7	1.0	1.8	2.1	3.6	4.2	7.2	8.4	14.1	27.6	32.3	57.5	64.5
75	0.6	0.8	1.6	1.9	3.2	3.8	6.4	7.4	12.7	24.6	28.9	51.5	57.8
90	0.5	0.8	1.5	1.7	2.9	3.5	5.8	6.8	11.6	22.4	26.5	47.0	52.7

*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.

Notes:

(1) Table includes losses for four 90 degree bends and two end fittings. Tubing runs with larger numbers of bends and/or fillings shall be increased by an equivalent length of tubing to the following equation: L = 1.3n, where L is additional length (ft) of tubing and n is the number of additional fittings and/or bends.

(2) All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3 ft.^3$; 1bar = 14.5 psi

TABLE 12-21 Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.2(p)]

											Gas:	**Natural**		
											Inlet Pressure:	**0.138bar**		
											Pressure Drop:	**0.068bar**		
											Specific Gravity:	**0.6**		
	Tube Size (EHD)*													
Flow Designation:	**13**	**15**	**18**	**19**	**23**	**25**	**30**	**31**	**37**	**39**	**46**	**48**	**60**	**62**
Length (m)	**Capacity in m^3/h**													
10	270	353	587	700	1,100	1,370	2,590	2,990	4,510	5,037	9,600	10,700	18,600	21,600
25	166	220	374	444	709	876	1,620	1,870	2,890	3,258	6,040	6,780	11,900	13,700
30	151	200	342	405	650	801	1,480	1,700	2,640	2,987	5,510	6,200	10,900	12,500
40	129	172	297	351	567	696	1,270	1,470	2,300	2,605	4,760	5,380	9,440	10,900
50	115	154	266	314	510	624	1,140	1,310	2,060	2,343	4,260	4,820	8,470	9,720
75	93	124	218	257	420	512	922	1,070	1,690	1,932	3,470	3,950	6,940	7,940
80	89	120	211	249	407	496	892	1,030	1,640	1,874	3,360	3,820	6,730	7,690
100	79	107	189	222	366	445	795	920	1,470	1,685	3,000	3,420	6,030	6,880
150	64	87	155	182	302	364	646	748	1,210	1,389	2,440	2,800	4,940	5,620
200	55	75	135	157	263	317	557	645	1,050	1,212	2,110	2,430	4,290	4,870
250	49	67	121	141	236	284	497	576	941	1,090	1,890	2,180	3,850	4,360
300	44	61	110	129	217	260	453	525	862	999	1,720	1,990	3,520	3,980
400	38	52	96	111	189	225	390	453	749	871	1,490	1,730	3,060	3,450
500	34	46	86	100	170	202	348	404	552	783	1,330	1,550	2,740	3,090

*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.

Notes:

(1) Table includes losses for four 90 degree bends and two end fittings. Tubing runs with larger numbers of bends and/or fillings shall be increased by an equivalent length of tubing to the following equation: L = 1.3n, where L is additional length (ft) of tubing and n is the number of additional fittings and/or bends.

(2) All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3$ = 33.3 $ft.^3$; 1bar = 14.5 psi

TABLE 12-22 Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.2(q)]

													Gas:	Natural
													Inlet Pressure:	0.345bar
													Pressure Drop:	0.241bar
													Specific Gravity:	0.6
	Tube Size (EHD)*													
Flow Designation:	**13**	**15**	**18**	**19**	**23**	**25**	**30**	**31**	**37**	**39**	**46**	**48**	**60**	**62**
Length (m)	Capacity in m^3/h													
3	14.8	19.1	30.6	36.8	56.6	71.6	139.3	160.2	235.0	258.8	512.4	560.5	973.9	1,143.7
7.5	9.1	11.9	19.6	23.4	36.5	45.9	87.2	100.2	150.3	167.3	322.7	356.7	622.8	724.7
9	8.3	10.8	17.9	21.4	33.4	41.9	79.3	91.4	137.6	153.4	294.4	325.6	569.0	662.5
12	7.1	9.3	15.5	18.5	29.2	36.2	68.5	79.0	119.8	133.8	253.9	283.1	492.6	571.9
15	6.3	8.3	13.9	16.6	26.2	32.6	61.1	70.5	107.3	120.3	227.0	252.8	441.6	512.4
22.5	5.1	6.7	11.4	13.6	21.6	26.7	49.5	57.2	88.0	99.3	184.9	207.2	362.4	419.0
24	4.9	6.5	11.1	13.1	20.9	25.9	47.8	55.5	85.5	96.3	178.9	200.7	351.0	404.8
30	4.4	5.8	9.9	11.7	18.8	23.2	42.7	49.3	76.7	86.5	160.0	179.8	314.2	362.4
45	3.5	4.7	8.1	9.6	15.5	19.0	34.8	40.2	62.8	71.4	130.2	147.2	258.5	297.3
60	3.0	4.0	7.0	8.3	13.5	16.5	30.0	34.5	54.6	62.3	112.7	127.7	224.5	257.3
75	2.7	3.6	6.3	7.4	12.2	14.8	26.8	30.9	49.0	56.0	100.5	114.4	201.3	230.4
90	2.4	3.3	5.8	6.8	11.2	13.6	24.3	28.2	45.0	51.3	91.7	104.5	184.0	210.3
120	2.1	2.8	5.0	5.9	9.7	11.8	21.0	24.3	39.1	44.8	79.3	90.9	160.0	182.3
150	1.9	2.5	4.5	5.3	8.7	10.6	18.7	21.7	29.4	40.3	70.8	81.2	143.2	163.1

* 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.

Notes:

(1) Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds .052 bar, do not use this table. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator may vary with flow rate.

(2) CAUTION: Capacities shown in table may exceed maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.

(3) Table includes losses for four 90-degree bends and two end fittings. Tubing runs with larger number of bends and/or fittings shall be increased by an equivalent length of tubing according to the following equation: L = 1.3n, where L is additional length (ft) of tubing and n is the number of additional fittings and/or bends.

(4) All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3$ ft.^{3}; 1bar = 14.5 psi

TABLE 12-23 Polyethylene Plastic Pipe [NFPA 54: Table 6.2(r)]

			Gas:	Natural		
			Inlet Pressure:	Less than 0.138bar		
			Pressure Drop:	7.5mm w.c.		
			Specific Gravity:	0.6		
	Pipe Size (mm)					
Nominal OD:	15	20	25	32	38	50
Designation:	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	SDR 11.00
Length (m)	Capacity in m^3/h					
3	4.3	8.6	15.6	27.0	40.8	73.3
6	3.0	5.9	10.7	18.6	28.1	50.4
9	2.4	4.8	8.6	14.9	22.5	40.5
12	2.0	4.1	7.4	12.8	19.3	34.5
15	1.8	3.6	6.5	11.3	17.1	30.6
18	1.6	3.3	5.9	10.2	15.5	27.8
21	1.5	3.0	5.4	9.4	14.2	25.6
24	1.4	2.8	5.1	8.8	13.2	23.8
27	1.3	2.6	4.8	8.2	12.4	22.3
30	1.2	2.5	4.5	7.8	11.7	21.1
37.5	1.1	2.2	4.0	6.9	10.4	18.7
45	1.0	2.0	3.6	6.3	9.4	16.9
52.5	0.9	1.8	3.3	5.7	8.7	15.6
60	0.8	1.7	3.1	5.4	8.1	14.5
75	0.8	1.5	2.7	4.7	7.2	12.9
90	0.7	1.4	2.5	4.3	6.5	11.6
105	0.6	1.3	2.3	3.9	6.0	10.7
120	0.6	1.2	2.1	3.7	5.5	10.0
135	0.5	1.1	2.0	3.5	5.2	9.3
150	0.5	1.0	1.9	3.3	4.9	8.8

Note: All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3 ft.^3$; 1bar = 14.5 psi

TABLE 12-24 Polyethylene Plastic Pipe [NFPA 54: Table 6.2(s)]

			Gas:	Natural		
			Inlet Pressure:	Less than 0.138bar		
			Pressure Drop:	12.7mm w.c.		
			Specific Gravity:	0.6		
	Pipe Size (mm)					
Nominal OD:	**15**	**20**	**25**	**32**	**38**	**50**
Designation:	**SDR 9.33**	**SDR 11.0**	**SDR 11.00**	**SDR 10.00**	**SDR 11.00**	**SDR 11.00**
Length (m)	**Capacity in m^3/h**					
3	5.7	11.4	20.6	35.7	53.8	96.5
6	3.9	7.8	14.1	24.5	37.1	66.5
9	3.1	6.3	11.4	19.7	29.7	53.2
12	2.7	5.4	9.7	16.8	25.4	45.6
15	2.4	4.8	8.6	14.9	22.5	40.5
18	2.2	4.3	7.8	13.5	20.4	36.8
21	2.0	4.0	7.2	12.4	18.8	33.7
24	1.8	3.7	6.7	11.6	17.5	31.4
27	1.7	3.5	6.3	10.8	16.4	29.4
30	1.6	3.3	5.9	10.2	15.5	27.8
37.5	1.4	2.9	5.2	9.1	13.7	24.7
45	1.3	2.6	4.8	8.2	12.4	22.3
52.5	1.2	2.4	4.4	7.6	11.4	20.6
60	1.1	2.3	4.1	7.0	10.6	19.1
75	1.0	2.0	3.6	6.3	9.4	16.9
90	0.9	1.8	3.3	5.7	8.5	15.3
105	0.8	1.7	3.0	5.2	7.9	14.1
120	0.8	1.6	2.8	4.8	7.3	13.1
135	0.7	1.4	2.6	4.5	6.9	12.3
150	0.7	1.4	2.5	4.3	6.5	11.6

Note: All table entries are rounded to 3 significant digits.
SI: 1m = 3.3 ft.; 1mm = 0.04 in.; 1m^3 = 33.3 $ft.^3$; 1bar = 14.5 psi

TABLE 12-25 Polyethylene Plastic Pipe [NFPA 54: Table 6.2(t)]

		Gas:	Natural			
		Inlet Pressure:	0.138bar			
		Pressure Drop:	0.069bar			
		Specific Gravity:	0.6			
	Pipe Size (mm)					
Nominal OD:	**15**	**20**	**25**	**32**	**38**	**50**
Designation:	**SDR 9.33**	**SDR 11.0**	**SDR 11.00**	**SDR 10.00**	**SDR 11.00**	**SDR 11.00**
Length (m)	**Capacity in m^3/h**					
3	52.7	105.3	190.0	328.4	498.3	894.6
6	36.2	72.5	130.5	226.2	342.6	614.3
9	29.2	58.0	105.0	181.8	274.3	492.6
12	24.9	49.8	89.7	155.4	235.0	421.8
15	22.0	44.2	79.6	137.9	208.1	373.7
18	20.0	39.9	72.2	124.8	188.5	339.7
21	18.4	36.8	66.2	114.9	173.5	311.4
24	17.1	34.3	61.7	107.0	161.4	288.8
27	16.0	32.0	58.0	100.2	151.5	272.1
30	15.1	30.3	54.6	94.8	143.0	257.1
37.5	13.4	26.9	48.4	84.1	126.8	227.9
45	12.1	24.3	43.9	76.2	114.9	206.4
52.5	11.2	22.4	40.5	69.9	105.6	190.0
60	10.4	20.8	37.7	65.1	98.2	176.7
67.5	9.2	18.5	33.4	57.8	87.2	156.6
90	8.4	16.7	30.3	52.4	79.0	141.8
105	7.7	15.4	27.8	48.1	72.8	130.5
120	7.2	14.3	25.8	44.7	67.7	121.4
135	6.7	13.4	24.2	41.9	63.4	113.8
150	6.3	12.7	22.9	39.6	60.0	107.6
550	6.0	12.1	21.7	37.7	56.9	102.2
180	5.7	11.5	20.8	36.0	54.4	97.4
195	5.5	11.0	19.9	34.5	52.1	93.4
210	5.3	10.6	19.1	33.1	49.8	89.7
750	5.1	10.2	18.4	32.0	48.1	86.3
240	4.9	9.9	17.8	30.9	46.4	83.5
255	4.8	9.5	17.2	29.7	45.0	80.7
270	4.6	9.2	16.6	28.9	43.6	78.4
285	4.5	9.0	16.2	28.0	42.5	76.2
300	4.4	8.7	15.7	27.3	41.0	73.9
330	4.1	8.3	14.9	25.9	39.1	70.2
360	3.9	7.9	14.3	24.7	37.4	67.1
390	3.8	7.6	13.6	23.7	35.7	64.3
420	3.6	7.3	13.1	22.7	34.3	61.7
450	3.5	7.0	12.6	21.9	33.1	59.5
480	3.4	6.8	12.2	21.1	32.0	57.5
510	3.3	6.5	11.8	20.5	30.9	55.5
540	3.2	6.3	11.4	19.8	30.0	53.8
570	3.1	6.2	11.1	19.3	29.2	52.4
600	3.0	6.0	10.8	18.7	28.3	51.0

Note: All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3\ ft.^3$; 1bar = 14.5 psi

TABLE 12-26 Polyethylene Plastic Tubing [NFPA 54: Table 6.2(u)]

	Gas:	Natural
	Inlet Pressure:	Less than 0.138bar
	Pressure Drop:	7.5mm w.c.
	Specific Gravity:	0.6
	Plastic Tubing Size (CTS)* (mm)	
Nominal OD:	15	20
Designation:	SDR 7.00	SDR 11.00
Length (m)	Capacity in m^3/h	
3	1.5	10.5
6	1.0	7.2
9	0.8	5.8
12	0.7	5.0
15	0.7	4.4
18	0.6	4.0
21	0.5	3.7
24	0.5	3.4
27	0.5	3.2
30	0.5	3.0
37.5	0.4	2.7
45	0.4	2.4
52.5	0.3	2.2
60	0.3	2.1
67.5	0.3	2.0
75	NA	1.8
82.5	NA	1.8
90	NA	1.7
105	NA	1.5
120	NA	1.4
135	NA	1.3
150	NA	1.3

*CTS = Copper tube size.

NA means a flow of less than $0.3m^3/h$

Note: All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3 ft.^3$; 1bar = 14.5 psi

TABLE 12-28 Schedule 40 Metallic Pipe [NFPA 54: Table 6.3(a)]

							Gas:	Undiluted Propane
							Inlet Pressure:	0.69bar
							Pressure Drop:	0.069bar
							Specific Gravity:	1.5

INTENDED USE: Pipe Sizing Between First Stage (High Pressure Regulator) and Second Stage (Low Pressure Regulator)									
	Pipe Size (mm)								
DN:	15	20	25	32	40	50	65	80	100
Length (m)	Capacity in kW								
3	973	2,036	3,838	7,882	11,808	22,737	36,332	64,167	130,678
6	668	1,401	2,637	5,421	8,116	15,617	24,905	43,950	89,658
9	536	1,125	2,115	4,336	6,505	12,540	19,983	35,453	72,078
12	460	961	1,811	3,721	5,567	10,724	17,111	30,179	61,823
15	407	853	1,606	3,311	4,952	9,523	15,148	26,810	54,791
18	369	774	1,456	2,989	4,483	8,614	13,742	24,290	49,517
21	340	712	1,339	2,748	4,131	7,940	12,628	22,356	45,708
24	316	662	1,245	2,558	3,838	7,384	11,749	20,774	42,485
27	296	621	1,169	2,400	3,604	6,915	11,046	19,514	39,848
30	280	586	1,105	2,265	3,399	6,534	10,431	18,430	37,504
38	248	519	979	2,007	3,018	5,801	9,230	16,320	33,402
45	225	472	885	1,820	2,725	5,245	8,380	14,797	30,179
53	207	434	815	1,673	2,508	4,835	7,706	13,625	27,747
60	193	401	759	1,559	2,332	4,483	7,149	12,658	25,813
75	171	357	671	1,380	2,069	3,985	6,358	11,222	22,883
90	155	322	609	1,251	1,875	3,604	5,743	10,167	20,744
105	142	299	560	1,151	1,723	3,311	5,303	9,347	19,074
120	132	277	522	1,069	1,603	3,077	4,922	8,702	17,756
135	124	260	489	1,005	1,506	2,898	4,629	8,175	16,642
150	117	245	463	949	1,421	2,737	4,366	7,706	15,734
165	111	233	440	900	1,351	2,599	4,131	7,325	14,943
180	106	222	419	858	1,289	2,479	3,956	7,003	14,240
195	102	213	401	823	1,234	2,376	3,780	6,680	13,654
210	98	205	384	791	1,184	2,282	3,633	6,417	13,126
225	94	197	372	762	1,143	2,198	3,516	6,182	12,628
240	91	190	357	735	1,102	2,121	3,370	5,977	12,189
255	88	184	346	712	1,067	2,054	3,282	5,801	11,808
270	85	178	337	691	1,034	1,992	3,164	5,626	11,456
285	83	173	325	671	1,005	1,934	3,077	5,450	11,105
300	81	168	316	653	976	1,881	2,989	5,303	10,812
330	76	160	302	618	929	1,787	2,848	5,040	10,255
360	73	153	288	592	885	1,705	2,716	4,805	9,786
390	70	146	275	565	847	1,632	2,602	4,600	9,376
420	67	141	265	542	815	1,568	2,499	4,424	9,024
450	65	135	255	524	785	1,512	2,408	4,249	8,673
480	62	131	246	507	759	1,459	2,326	4,102	8,380
510	60	127	238	489	733	1,412	2,250	3,985	8,116
540	59	123	231	475	712	1,368	2,183	3,868	7,882
570	57	119	224	460	691	1,330	2,118	3,750	7,647
600	55	116	218	448	671	1,292	2,060	3,633	7,442

Note: All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; 1m^3 = 33.3 ft.^{3}; 1bar = 14.5 psi

TABLE 12-29 Schedule 40 Metallic Pipe [NFPA 54: Table 6.3(b)]

							Gas:	Undiluted Propane
							Inlet Pressure:	0.69bar
							Pressure Drop:	0.207bar
							Specific Gravity:	1.5
INTENDED USE: Pipe Sizing Between First Stage (High Pressure Regulator) and Second Stage (Low Pressure Regulator)									
	Pipe Size (mm)								
DN:	**15**	**20**	**25**	**32**	**40**	**50**	**65**	**80**	**100**
Length (m)	**Capacity in kW**								
3	1,726	3,604	6,798	13,947	20,891	40,141	64,167	113,391	231,177
6	1,187	2,479	4,659	9,581	14,357	27,659	43,950	77,938	159,099
9	952	1,989	3,750	7,706	11,544	22,209	35,453	62,702	127,748
12	815	1,702	3,223	6,593	9,874	19,016	30,179	53,619	109,289
15	721	1,509	2,845	5,831	8,761	16,848	26,839	47,466	96,690
18	653	1,368	2,575	5,303	7,940	15,265	24,319	43,071	87,607
21	601	1,260	2,370	4,864	7,296	14,035	22,385	39,555	80,575
24	560	1,172	2,206	4,542	6,798	13,068	20,832	36,918	75,008
27	524	1,099	2,069	4,249	6,358	12,247	19,543	34,574	70,320
30	495	1,037	1,954	4,014	6,007	11,574	18,459	32,523	66,511
38	440	920	1,732	3,545	5,333	10,255	16,349	28,919	58,893
45	398	832	1,570	3,223	4,835	9,288	14,826	26,194	53,326
53	366	768	1,444	2,959	4,454	8,556	13,625	24,114	49,165
60	340	712	1,342	2,757	4,131	7,970	12,687	22,415	45,737
75	302	633	1,190	2,444	3,663	7,061	11,251	19,865	40,551
90	274	571	1,078	2,215	3,311	6,387	10,196	18,020	36,742
105	252	527	993	2,036	3,047	5,889	9,376	16,555	33,783
120	234	489	923	1,896	2,839	5,479	8,731	15,412	31,439
135	220	460	867	1,779	2,663	5,128	8,175	14,474	29,505
150	208	434	817	1,679	2,517	4,835	7,735	13,654	27,864
165	197	413	776	1,597	2,391	4,600	7,325	12,980	26,458
180	188	393	741	1,524	2,280	4,395	7,003	12,365	25,257
195	180	378	709	1,459	2,183	4,219	6,710	11,867	24,173
210	173	363	683	1,401	2,098	4,043	6,446	11,398	23,235
225	167	349	656	1,348	2,022	3,897	6,212	10,958	22,385
240	161	337	636	1,304	1,951	3,750	6,007	10,607	21,594
255	156	325	615	1,260	1,890	3,633	5,801	10,255	20,920
270	151	316	595	1,222	1,831	3,516	5,626	9,933	20,276
285	147	308	577	1,187	1,779	3,428	5,450	9,640	19,690
300	143	299	563	1,154	1,729	3,340	5,303	9,376	19,162
330	136	284	533	1,096	1,644	3,164	5,040	8,907	18,195
360	130	270	510	1,046	1,568	3,018	4,805	8,497	17,346
390	124	259	489	1,002	1,500	2,892	4,600	8,145	16,613
420	119	249	469	961	1,442	2,778	4,424	7,823	15,969
450	115	240	451	926	1,389	2,675	4,278	7,530	15,383
480	111	231	437	897	1,342	2,584	4,131	7,266	14,855
510	107	224	422	867	1,298	2,499	3,985	7,032	14,357
540	104	217	410	841	1,260	2,423	3,868	6,827	13,947
570	101	211	398	815	1,222	2,356	3,750	6,622	13,537
600	98	205	387	794	1,190	2,291	3,663	6,446	13,156

Note: All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; 1m^3 = 33.3 ft.^{3}; 1bar = 14.5 psi

TABLE 12-30 Schedule 40 Metallic Pipe [NFPA 54: Table 6.3(c)]

							Gas:	**Undiluted Propane**	
							Inlet Pressure:	**0.138bar**	
							Pressure Drop:	**0.069bar**	
							Specific Gravity:	**1.5**	
INTENDED USE: Pipe Sizing Between 0.138bar Service and Line Pressure Regulator									
	Pipe Size (mm)								
DN:	**15**	**20**	**25**	**32**	**40**	**50**	**65**	**80**	**100**
Length (m)	**Capacity in kW**								
3	785	1,638	3,077	6,329	9,493	18,283	29,154	51,568	105,187
6	539	1,128	2,121	4,366	6,534	12,570	20,041	35,453	72,371
9	434	905	1,705	3,487	5,245	10,109	16,086	28,450	58,014
12	369	774	1,459	2,989	4,483	8,644	13,771	24,348	49,810
15	328	686	1,292	2,655	3,985	7,647	12,218	21,594	43,950
18	296	621	1,172	2,406	3,604	6,944	11,046	19,543	39,848
21	274	571	1,078	2,212	3,311	6,387	10,167	17,990	36,625
24	255	533	1,002	2,057	3,077	5,948	9,464	16,730	33,988
27	239	498	941	1,931	2,895	5,567	8,878	15,705	31,937
30	226	472	888	1,825	2,734	5,274	8,380	14,826	30,179
38	200	419	788	1,617	2,423	4,659	7,442	13,156	26,810
45	181	378	715	1,465	2,195	4,219	6,739	11,925	24,290
53	167	349	656	1,348	2,019	3,897	6,212	10,958	22,356
60	155	325	609	1,254	1,878	3,604	5,772	10,196	20,803
75	137	287	542	1,110	1,664	3,194	5,098	9,024	18,430
90	125	260	489	1,008	1,509	2,907	4,629	8,175	16,701
105	115	239	451	926	1,389	2,672	4,249	7,530	15,353
120	107	223	419	861	1,292	2,488	3,956	7,003	14,298
135	100	209	393	809	1,210	2,332	3,721	6,563	13,419
150	94	197	372	765	1,146	2,203	3,516	6,212	12,658
165	90	188	355	727	1,087	2,092	3,340	5,889	12,042
180	86	179	337	691	1,037	1,998	3,194	5,626	11,486
195	82	171	322	662	993	1,913	3,047	5,391	10,988
210	79	165	311	636	955	1,837	2,927	5,186	10,548
225	76	159	299	612	920	1,770	2,822	4,981	10,167
240	73	153	289	592	888	1,708	2,725	4,805	9,816
255	71	148	279	574	858	1,653	2,637	4,659	9,493
270	69	144	271	557	832	1,603	2,555	4,512	9,230
285	67	139	263	539	809	1,556	2,482	4,395	8,937
300	65	136	256	524	785	1,515	2,414	4,278	8,702
330	62	129	243	498	747	1,439	2,294	4,043	8,263
360	59	123	232	475	712	1,371	2,189	3,868	7,882
390	56	118	222	454	683	1,316	2,095	3,692	7,559
420	54	113	213	437	656	1,263	2,013	3,545	7,266
450	52	109	205	422	633	1,216	1,940	3,428	7,003
480	50	105	198	407	609	1,175	1,872	3,311	6,739
510	49	102	192	393	589	1,137	1,811	3,194	6,534
540	47	99	186	381	571	1,102	1,758	3,106	6,329
570	46	96	181	372	557	1,069	1,705	3,018	6,153
600	45	93	176	360	539	1,040	1,658	2,930	5,977

Note: All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3 ft.^3$; 1bar = 14.5 psi

TABLE 12-31 Schedule 40 Metallic Pipe [NFPA 54: Table 6.3(d)]

						Gas:	Undiluted Propane	
						Inlet Pressure:	279mm w.c.	
						Pressure Drop:	12.7mm w.c.	
						Specific Gravity:	1.50	

INTENDED USE: Pipe Sizing Between Single or Second Stage (Low Pressure Regulator) and Appliance									
	Pipe Size (mm)								
DN:	**15**	**20**	**25**	**32**	**40**	**50**	**65**	**80**	**100**
Length (m)	**Capacity in kW**								
3	85	178	337	689	1,031	1,989	3,164	5,596	11,427
6	59	122	231	475	709	1,365	2,177	3,838	7,852
9	47	98	185	381	568	1,099	1,749	3,106	6,300
12	40	84	159	325	486	941	1,497	2,646	5,391
15	36	75	141	289	434	832	1,327	2,344	4,776
18	32	68	127	261	393	753	1,201	2,124	4,336
24	30	62	117	241	360	694	1,105	1,954	3,985
30	28	58	109	224	334	645	1,028	1,820	3,721
37.5	26	54	102	210	314	607	964	1,705	3,487
45	25	51	97	198	296	571	911	1,612	3,282
52.5	22	45	86	176	263	507	809	1,430	2,915
60	20	41	78	159	239	460	733	1,295	2,640
75	18	38	71	147	219	422	674	1,190	2,429
90	17	35	67	136	204	393	627	1,108	2,259
105	15	31	59	121	181	349	557	982	2,004
120	13	28	53	109	164	316	504	891	1,814
135	12	26	49	101	151	290	463	817	1,670
150	12	24	46	94	140	270	431	762	1,553
165	11	23	43	88	132	253	404	715	1,456
180	10	21	40	83	124	239	381	674	1,377
195	10	21	38	79	118	227	363	642	1,307
210	9	19	37	75	113	217	346	612	1,248
225	9	19	35	72	108	208	331	586	1,195
240	8	18	34	69	104	200	319	563	1,149
255	8	17	33	67	100	192	308	542	1,105
270	8	17	31	64	96	186	296	524	1,067
285	8	16	30	62	93	180	287	507	1,034
300	7	16	29	60	91	174	278	492	1,002
330	7	15	28	59	88	169	270	478	973
360	7	15	28	57	86	165	262	463	946
390	7	14	26	54	81	156	249	440	900
420	6	13	25	52	77	149	238	419	858
450	6	13	24	50	74	143	228	401	820
480	6	12	23	47	71	137	219	387	788
510	6	12	22	46	69	117	211	372	612
540	6	11	22	44	66	128	203	360	586
570	5	11	21	43	64	124	197	349	709
600	5	11	20	42	62	120	176	322	674

Note: All table entries are rounded to 3 significant digits.

*Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3 ft.^3$; 1bar = 14.5 psi

TABLE 12-32 Semi-Rigid Copper Tubing [NFPA 54: Table 6.3(e)]

					Gas:	**Undiluted Propane**			
					Inlet Pressure:	**0.69bar**			
					Pressure Drop:	**0.069bar**			
					Specific Gravity:	**1.50**			
INTENDED USE: Tube Sizing Between First Stage (High Pressure Regulator) and Second Stage (Low Pressure Regulator)									
DN: K&L:	**8**	**10**	**15**	**18**	**20**	**25**	**32**	**40**	**50**
DN: ACR:	**9.5**	**15**	**18**	**20**	**22**	**28**	**35**	**----**	**----**
Length (m)	**Capacity in kW**								
3	150	311	630	1,102	1,562	3,340	6,007	9,464	19,748
6	103	213	434	756	1,075	2,294	4,131	6,505	13,566
9	83	171	349	609	861	1,843	3,311	5,245	10,900
12	71	147	299	522	738	1,576	2,839	4,483	9,317
15	63	130	264	460	653	1,398	2,517	3,956	8,263
18	57	117	239	419	592	1,266	2,280	3,604	7,501
21	52	108	220	384	545	1,166	2,098	3,311	6,886
24	49	100	205	357	507	1,084	1,951	3,077	6,417
27	46	94	192	337	478	1,017	1,831	2,886	6,007
30	43	89	181	316	451	961	1,729	2,728	5,684
38	38	79	161	281	398	853	1,532	2,417	5,040
45	35	71	146	255	360	771	1,389	2,189	4,571
53	32	66	134	234	331	709	1,277	2,016	4,190
60	30	61	125	218	311	659	1,190	1,875	3,897
75	26	54	110	193	274	586	1,055	1,661	3,457
90	24	49	100	175	248	530	955	1,506	3,135
105	22	45	92	161	228	486	879	1,386	2,883
120	21	42	86	150	212	454	817	1,289	2,684
135	19	40	80	141	199	425	768	1,210	2,517
150	18	37	76	133	188	401	724	1,143	2,379
165	17	35	72	126	179	381	689	1,084	2,259
180	16	34	69	120	171	363	656	1,034	2,154
195	16	33	66	115	163	349	627	990	2,063
210	15	31	63	111	157	334	604	952	1,984
225	15	30	61	107	151	322	580	917	1,910
240	14	29	59	103	146	311	563	885	1,843
255	13	28	57	100	141	302	542	856	1,784
270	13	27	55	97	137	293	527	832	1,732
285	13	26	54	94	133	284	513	806	1,679
300	12	26	52	91	130	277	498	785	1,635
330	12	24	50	87	123	263	472	744	1,553
360	11	23	47	83	117	251	451	712	1,480
390	11	22	45	79	112	240	431	680	1,418
420	10	21	43	76	108	231	416	653	1,362
450	10	21	42	73	104	222	398	630	1,313
480	10	20	40	71	100	214	387	609	1,269
510	9	19	39	69	97	207	372	589	1,228
540	9	19	38	67	94	201	363	571	1,190
570	9	18	37	64	91	195	352	554	1,154
600	8	18	36	63	89	190	343	539	1,122

Note: All table entries are rounded to 3 significant digits.
*Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; 1m^3 = 33.3 ft.^{3}; 1bar = 14.5 psi

TABLE 12-33 Semi-Rigid Copper Tubing [NFPA 54: Table 6.3(f)]

							Gas:	Undiluted Propane		
							Inlet Pressure:	279mm w.c.		
							Pressure Drop:	12.7mm w.c.		
							Specific Gravity:	1.50		
INTENDED USE: Tube Sizing Between Single or Second Stage (Low Pressure Regulator) and Appliance										
		Tube Size (mm)								
DN:	**K&L:**	**8**	**10**	**15**	**18**	**20**	**25**	**32**	**40**	**50**
	ACR:	**9.5**	**15**	**18**	**20**	**22**	**28**	**35**	**----**	**----**
Length (m)		**Capacity in kW**								
3		13.2	27.2	55.1	96.4	136.8	292.1	527.4	829.2	1725.8
6		9.1	18.8	37.8	66.2	94.1	200.7	360.4	571.4	1186.7
9		7.3	14.9	30.5	53.3	75.6	161.2	290.4	457.1	952.3
12		6.2	12.9	26.1	45.4	64.5	138.0	248.5	392.6	814.5
15		5.6	11.4	23.1	40.4	57.1	122.2	220.3	345.7	723.7
18		5.0	10.3	20.8	36.6	51.9	110.8	199.5	313.5	656.3
21		4.7	9.4	19.3	33.7	47.8	102.0	183.4	289.5	603.6
24		4.4	8.8	17.9	31.4	44.5	94.9	170.8	269.3	559.6
27		4.1	8.2	16.7	29.3	41.6	89.1	160.3	252.6	527.4
30		3.8	7.9	15.8	27.8	39.3	84.1	151.5	238.5	498.1
38		3.2	7.0	14.1	24.6	34.9	74.4	134.2	211.5	439.5
45		2.9	6.2	12.9	22.3	31.6	67.4	121.6	191.6	398.5
53		NA	5.9	11.7	20.5	29.0	62.1	111.9	176.4	366.3
60		NA	5.3	10.8	19.0	27.0	57.7	104.0	164.1	342.8
75		NA	4.7	9.7	17.0	24.0	51.3	92.3	145.3	301.8
90		NA	4.4	8.8	15.2	21.7	46.3	83.5	131.6	274.2
105		NA	4.1	8.2	14.1	19.9	42.8	76.8	121.3	252.3
120		NA	3.8	7.6	13.2	18.5	39.8	71.5	112.8	234.7
135		NA	3.5	7.0	12.3	17.6	37.2	67.1	105.8	220.3
150		NA	3.2	6.7	11.7	16.4	35.2	63.3	99.9	208.0
165		NA	3.2	6.4	11.1	15.5	33.4	60.1	94.9	197.5
180		NA	2.9	6.2	10.5	14.9	31.9	57.4	90.5	188.4
195		NA	NA	5.9	10.0	14.4	30.5	55.1	86.7	180.5
210		NA	NA	5.6	9.7	13.8	29.3	52.7	83.2	173.5
225		NA	NA	5.3	9.4	13.2	28.1	51.0	80.3	167.0
240		NA	NA	5.3	9.1	12.9	27.2	49.2	77.4	161.4
255		NA	NA	5.0	8.8	12.3	26.4	47.5	75.0	156.2
270		NA	NA	5.0	8.5	12.0	25.5	46.0	72.7	151.5
285		NA	NA	4.7	8.2	11.7	24.9	44.8	70.6	147.1
300		NA	NA	4.7	7.9	11.4	24.3	43.7	68.6	143.0
330		NA	NA	4.4	7.6	10.8	22.9	41.3	65.3	136.0
360		NA	NA	4.1	7.3	10.3	22.0	39.6	62.1	129.5
390		NA	NA	4.1	7.0	10.0	21.1	37.8	59.5	123.9
420		NA	NA	3.8	6.7	9.4	20.2	36.3	57.1	119.3
450		NA	NA	3.8	6.4	9.1	19.3	34.9	55.1	114.9
480		NA	NA	3.5	6.2	8.8	18.8	33.7	53.3	110.8
510		NA	NA	3.5	5.9	8.5	18.2	32.8	51.6	107.2
540		NA	NA	3.2	5.9	8.2	17.6	31.6	49.8	104.0
570		NA	NA	3.2	5.6	7.9	17.0	30.8	48.6	101.1
600		NA	NA	3.2	5.6	7.9	16.7	29.9	47.2	98.2

Note: All table entries are rounded to 3 significant digits.
*Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
SI: 1m = 3.3 ft.; 1mm = 0.04 in.; 1m^3 = 33.3 ft.^{3}

TABLE 12-34 Semi-Rigid Copper Tubing [NFPA 54: Table 6.3(g)]

					Gas:	Undiluted Propane			
					Inlet Pressure:	0.014bar			
					Pressure Drop:	0.069bar			
					Specific Gravity:	1.50			
INTENDED USE: Tube Sizing Between 0.138bar Service and Line Pressure Regulator									
	Tube Size (mm)								
DN: K&L:		8	10	15	18	20	25	32	40	50
DN: ACR:		9.5	15	18	20	22	28	35	----	----
Length (m)	Capacity in kW								
3	121.0	249.6	506.9	887.8	1,259.9	2,686.8	4,834.5	7,618.0	15,880.6
6	83.2	171.4	348.7	609.4	864.4	1,848.8	3,340.2	5,244.7	10,928.9
9	66.8	137.7	280.1	489.3	694.4	1,482.6	2,672.2	4,219.2	8,760.7
12	57.1	117.8	239.7	419.0	594.8	1,268.7	2,285.4	3,603.9	7,500.8
15	50.7	104.3	212.4	372.1	527.4	1,125.1	2,027.6	3,193.7	6,651.1
18	46.0	94.6	192.5	337.0	477.6	1,019.6	1,837.1	2,894.8	6,035.8
21	42.2	87.0	177.3	310.6	439.5	937.6	1,687.7	2,663.4	5,537.7
24	39.3	80.9	164.7	288.0	407.3	873.1	1,570.5	2,475.9	5,156.8
27	36.9	75.9	154.7	270.1	383.8	817.5	1,473.8	2,323.5	4,834.5
30	34.9	71.8	145.9	255.2	363.3	773.5	1,391.8	2,194.6	4,570.8
38	30.8	63.6	129.5	226.2	322.3	685.6	1,233.5	1,945.5	4,043.4
45	27.8	57.7	117.2	205.1	290.7	621.2	1,119.3	1,763.9	3,662.5
53	25.8	53.0	107.8	188.7	267.5	571.4	1,028.4	1,623.2	3,369.5
60	24.0	49.2	100.5	175.5	248.8	530.3	958.1	1,509.0	3,135.1
75	21.1	43.7	89.1	155.6	220.6	471.7	849.7	1,336.1	2,786.4
90	19.3	39.6	80.6	140.9	199.8	427.8	767.7	1,213.0	2,522.7
105	17.6	36.3	74.1	129.5	184.0	392.6	706.1	1,113.4	2,320.6
120	16.4	34.0	68.9	120.4	171.1	366.3	659.3	1,037.2	2,159.4
135	15.5	31.9	64.8	113.1	160.6	342.8	618.2	972.8	2,027.6
150	14.7	30.2	61.2	106.9	151.5	325.2	583.1	920.0	1,913.3
165	13.8	28.4	58.0	101.4	143.9	307.7	553.8	873.1	1,819.5
180	13.2	27.2	55.4	96.7	137.4	293.0	527.4	832.1	1,734.6
195	12.6	26.1	53.0	92.6	131.6	281.0	506.9	797.0	1,661.3
210	12.0	25.2	51.0	89.1	126.3	269.9	486.4	767.7	1,596.9
225	11.7	24.0	49.2	85.8	121.6	260.2	468.8	738.4	1,538.3
240	11.4	23.4	47.5	82.9	117.5	251.1	451.2	712.0	1,485.5
255	10.8	22.6	46.0	80.3	113.7	242.9	436.6	688.6	1,435.7
270	10.5	22.0	44.5	77.6	110.2	235.6	424.9	668.0	1,391.8
285	10.3	21.1	43.1	75.6	107.2	228.8	413.1	650.5	1,353.7
300	10.0	20.8	41.9	73.5	104.3	222.7	401.4	632.9	1,315.6
330	9.4	19.6	39.8	69.7	99.0	211.3	380.9	600.7	1,251.1
360	9.1	18.8	38.1	66.5	94.3	201.6	363.3	571.4	1,192.5
390	8.8	17.9	36.3	63.6	90.5	193.1	348.7	547.9	1,142.7
420	8.2	17.3	35.2	61.2	86.7	185.5	334.0	527.4	1,095.8
450	7.9	16.7	33.7	58.9	83.8	178.7	322.3	506.9	1,057.7
480	7.6	16.1	32.5	56.8	80.9	172.6	310.6	489.3	1,019.6
510	7.6	15.5	31.6	55.1	78.2	167.0	301.8	474.7	987.4
540	7.3	14.9	30.5	53.3	75.9	162.0	293.0	460.0	958.1
570	7.0	14.7	29.6	51.9	73.5	157.3	283.0	445.4	928.8
600	6.7	14.1	29.0	50.4	71.5	152.9	275.4	433.6	905.4

Note: All table entries are rounded to 3 significant digits.
*Table capacities are based on Type K copper tubing inside diameter (shown), which has the smallest inside diameter of the copper tubing products.
SI: 1m = 3.3 ft.; 1mm = 0.04 in.; 1m^3 = 33.3 ft.^{3}; 1bar = 14.5 psi

TABLE 12-35 Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.3(h)]

										Gas:		**Undiluted Propane**		
										Inlet Pressure:		**279mm w.c.**		
										Pressure Drop:		**12.7mm 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)*													
Flow Designation:	**13**	**15**	**18**	**19**	**23**	**25**	**30**	**31**	**37**	**39**	**46**	**48**	**60**	**62**
Length (m)	**Capacity in kW**													
1.6	21.1	29.0	53.0	61.8	104.0	124.8	218.0	252.9	416.1	479.9	829.2	958.1	1,693.5	1,919.2
3	14.7	20.2	37.8	44.0	74.4	88.8	152.7	177.3	284.5	345.4	583.1	679.8	1,204.2	1,359.5
4.5	11.4	16.1	30.5	35.5	60.9	72.7	123.6	143.6	227.1	284.8	474.7	556.7	987.4	1,110.5
6	10.0	14.4	26.7	31.1	53.6	63.3	106.9	124.5	193.7	248.2	410.2	483.5	858.5	964.0
7.5	8.8	12.3	24.0	27.5	48.1	56.3	95.2	111.0	170.8	223.3	366.3	433.6	770.6	861.4
9	8.2	11.4	21.7	25.5	44.2	51.9	87.0	100.8	154.7	204.5	334.0	395.6	703.2	785.2
12	6.7	9.7	18.8	21.7	38.4	44.8	75.0	87.0	131.6	178.7	289.5	342.8	612.4	682.7
15	5.9	8.8	17.0	19.3	34.6	40.1	66.5	77.6	116.3	160.6	259.0	307.7	547.9	609.4
18	5.6	7.6	15.5	17.6	31.4	36.9	60.7	70.6	105.2	147.1	235.9	281.6	501.0	556.7
21	5.0	7.3	14.4	16.7	29.0	34.3	56.0	65.0	96.7	136.5	218.3	260.8	465.9	515.7
24	4.4	6.7	13.2	15.2	27.5	31.9	52.2	60.9	90.0	128.3	203.9	244.1	436.6	483.5
27	4.4	6.4	12.9	14.7	26.4	29.9	49.5	57.7	83.8	121.3	192.2	230.6	410.2	454.2
30	4.1	5.9	12.0	13.8	24.9	28.7	46.6	54.5	79.1	115.1	182.0	218.6	389.7	433.6
45	3.2	4.4	9.1	10.5	19.3	22.0	36.0	41.9	63.6	94.9	148.3	179.0	319.4	354.5
60	2.6	4.1	8.2	9.7	17.6	20.2	32.8	37.8	53.6	82.9	128.3	155.6	277.8	307.7
75	2.3	3.5	7.3	8.8	15.5	17.9	29.0	34.3	47.8	74.4	114.3	139.5	249.1	273.7
90	2.3	3.2	6.7	7.6	14.7	16.7	26.4	31.4	43.1	68.6	104.6	127.2	227.7	250.2

*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.

Notes:

(1) Table includes losses for four 90 degree bends and two end fittings. Tubing runs with larger numbers of bends and/or fittings shall be increased by an equivalent length of tubing to the following equation: L= 1.3n, where L is additional length (ft) of tubing and n is the number of additional fittings and/or bends.

(2) All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3$ = 33.3 $ft.^3$; 1bar = 14.5 psi

TABLE 12-36 Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.3(i)]

									Gas:			**Undiluted Propane**		
									Inlet Pressure:			**0.138bar**		
									Pressure Drop:			**0.069bar**		
									Specific Gravity:			**1.50**		
INTENDED USE: CSST Sizing Between 0.138bar Service and Line Pressure Regulator														
	Tube Size (EHD)*													
Flow Designation:	**13**	**15**	**18**	**19**	**23**	**25**	**30**	**31**	**37**	**39**	**46**	**48**	**60**	**62**
Length (m)	**Capacity in kW**													
3	124.8	163.5	271.6	325.2	509.8	635.8	1,201.3	1,383.0	2,089.1	2,331.7	4,453.6	4,922.4	8,614.2	10,020.6
7.5	76.8	101.7	173.2	205.4	328.2	404.3	750.1	864.4	1,336.1	1,508.1	2,798.2	3,135.1	5,508.4	6,358.1
9	69.7	92.6	158.2	187.5	301.8	372.1	682.7	788.2	1,224.7	1,382.7	2,552.0	2,868.5	5,039.6	5,801.4
12	59.5	79.4	137.4	162.3	262.5	322.3	588.9	679.8	1,063.6	1,206.0	2,206.3	2,490.5	4,365.7	5,039.6
15	53.0	71.2	123.1	145.3	236.2	288.9	524.5	606.5	955.2	1,084.7	1,971.9	2,229.7	3,926.2	4,512.2
22.5	43.1	57.4	100.8	119.0	194.3	237.0	427.8	495.2	785.2	894.5	1,605.6	1,825.4	3,223.0	3,691.8
24	41.0	55.4	97.6	115.1	188.4	225.0	413.1	477.6	758.9	867.6	1,552.9	1,769.7	3,105.8	3,574.6
30	36.3	49.5	87.3	102.6	169.4	206.0	369.2	424.9	682.7	780.0	1,388.8	1,585.1	2,792.3	3,193.7
45	29.6	40.1	71.8	84.1	139.8	168.5	298.9	345.7	559.6	643.1	1,131.0	1,298.0	2,288.3	2,604.8
60	25.2	34.6	62.4	72.7	121.6	146.8	257.8	298.9	486.4	561.1	978.6	1,125.1	1,986.5	2,259.0
75	22.6	30.8	56.0	65.0	109.3	131.3	230.0	266.6	436.6	504.5	873.1	1,007.9	1,781.4	2,021.7
90	20.2	28.1	50.7	59.5	100.5	120.4	209.8	242.9	398.5	462.4	797.0	923.0	1,629.1	1,845.9
120	17.6	24.0	44.2	51.3	87.3	104.0	180.5	209.8	339.9	403.2	688.6	799.9	1,415.2	1,599.8
150	15.5	21.1	39.6	46.3	78.5	93.5	161.2	186.9	301.8	362.4	615.3	717.9	1,268.7	1,429.8

*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.

Notes:

(1) Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 0.035 bar (based on 330 mm w.c. outlet pressure), do not use this table. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator may vary with flow rate.

(2) CAUTION: Capacities shown in table may exceed maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.

(3) Table includes losses for four 90 degree bends and two end fittings. Tubing runs with larger number of bends and/or fittings shall be increased by an equivalent length of tubing according to the following equation:
L = 1.3n, where L is additional length (ft) of tubing and 11, is the number of additional fittings and/or bends.

(4) All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; 1m^3 = 33.3 ft.^{3}; 1bar = 14.5 psi

TABLE 12-37 Corrugated Stainless Steel Tubing (CSST) [NFPA 54: Table 6.3(j)]

											Gas:	**Undiluted Propane**		
											Inlet Pressure:	**0.345bar**		
											Pressure Drop:	**0.241bar**		
											Specific Gravity:	**1.50**		
	Tube Size (EHD)*													
Flow Designation:	**13**	**15**	**18**	**19**	**23**	**25**	**30**	**31**	**37**	**39**	**46**	**48**	**60**	**62**
Length (m)	**Capacity in kW**													
3	242.0	313.5	501.0	603.6	923.0	1,172.0	2,294.2	2,622.4	3,838.3	4,231.2	8,379.8	9,141.6	15,939.2	18,693.4
7.5	149.1	194.6	319.4	383.8	597.7	747.2	1,424.0	1,640.8	2,461.2	2,736.3	5,274.0	5,830.7	10,167.1	11,837.2
9	135.1	176.7	292.7	348.7	547.9	685.6	1,298.0	1,494.3	2,250.2	2,509.3	4,805.2	5,332.6	9,288.1	10,811.7
12	116.0	152.4	254.0	301.8	477.6	594.8	1,119.3	1,289.2	1,957.2	2,188.4	4,160.6	4,629.4	8,086.8	9,376.0
15	103.1	135.7	227.7	271.3	427.8	533.3	999.1	1,151.5	1,755.1	1,968.1	3,721.1	4,131.3	7,237.1	8,379.8
22.5	83.2	110.2	186.6	221.8	354.5	436.6	811.6	934.7	1,441.6	1,622.9	3,017.9	3,398.8	5,947.9	6,856.2
24	80.6	106.4	181.1	214.2	342.8	424.9	785.2	905.4	1,397.6	1,574.0	2,927.1	3,281.6	5,742.8	6,651.1
30	71.2	94.9	162.0	192.2	307.7	380.9	700.3	808.7	1,254.0	1,415.2	2,616.5	2,930.0	5,156.8	5,947.9
45	57.4	76.8	132.7	156.8	253.7	310.6	568.4	656.3	1,028.4	1,167.0	2,130.1	2,405.5	4,219.2	4,863.8
60	49.5	66.2	115.1	136.0	221.2	270.4	492.2	565.5	893.7	1,017.9	1,843.0	2,089.1	3,662.5	4,219.2
75	44.0	59.2	103.1	121.6	198.9	242.6	436.6	506.9	802.8	915.3	1,646.7	1,872.3	3,281.6	3,779.7
90	39.8	53.6	94.3	111.0	182.2	221.8	398.5	460.0	735.4	839.4	1,500.2	1,711.1	3,017.9	3,428.1
120	34.3	46.3	81.7	96.1	158.8	192.5	342.8	398.5	638.7	731.9	1,298.0	1,485.5	2,613.6	2,988.6
150	30.5	41.0	73.5	86.1	143.0	172.6	307.7	354.5	571.4	658.4	1,160.3	1,330.2	2,344.0	2,669.2

*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.

Notes:

(1) Table does not include effect of pressure drop across the line regulator. Where regulator loss exceeds 0.035 bar (based on 330 mm w.c. outlet pressure), do not use this table. Consult with regulator manufacturer for pressure drops and capacity factors. Pressure drops across a regulator may vary with flow rate.

(2) CAUTION: Capacities shown in table may exceed maximum capacity for a selected regulator. Consult with regulator or tubing manufacturer for guidance.

(3) Table includes losses for four 90 degree bends and two end fittings. Tubing runs with larger number of bends and/or fittings shall be increased by an equivalent length of tubing according to the following equation:
L = 1.3n, where L is additional length (ft) of tubing and 11, is the number of additional fittings and/or bends.

(4) All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3 ft.^3$; 1bar = 14.5 psi

TABLE 12-38 Polyethylene Plastic Pipe [NFPA 54: Table 6.3(k)]

			Gas:	Undiluted Propane		
			Inlet Pressure:	279mm w.c.		
			Pressure Drop:	12.7mm w.c.		
			Specific Gravity:	1.50		
INTENDED USE: PE Pipe Sizing Between Integral 2-Stage Regulator at Tank or Second Stage (Low Pressure Regulator) and Building						
	Plastic Tubing Size (CTS) (mm)					
Nominal OD:	15	20	25	32	38	50
Designation:	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	SDR 11.00
Length (m)	Capacity in kW					
3	99.6	199.2	360.4	624.1	940.5	1,690.6
6	68.3	137.1	247.3	427.8	647.5	1,163.2
9	54.8	109.9	198.4	342.8	518.6	931.7
12	46.9	94.1	169.9	293.0	445.4	799.9
15	41.6	83.5	150.6	260.8	392.6	709.1
18	37.8	75.6	136.5	236.5	357.5	641.7
21	34.9	69.4	125.4	217.4	328.2	588.9
24	32.2	64.8	116.6	202.2	304.7	547.9
27	30.2	60.7	109.6	189.9	286.6	515.7
30	28.7	57.4	103.4	179.3	270.7	486.4
37.5	25.5	50.7	91.7	158.8	240.0	430.7
45	22.9	46.0	83.2	143.9	217.4	389.7
52.5	21.1	42.5	76.5	132.4	200.1	360.4
60	19.6	39.6	71.2	123.1	186.1	334.0
75	17.6	34.9	63.0	109.3	165.0	295.9
90	15.8	31.6	57.1	99.0	149.4	268.4
105	14.7	29.0	52.4	91.1	137.4	247.0
120	13.5	27.0	48.9	84.7	127.7	229.7
135	12.6	25.5	46.0	79.4	119.8	215.6
150	12.0	24.0	43.4	75.0	113.4	203.6

Note: All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3$ = 33.3 $ft.^3$; 1bar = 14.5 psi

TABLE 12-39 Polyethylene Plastic Pipe [NFPA 54: Table 6.3(l)]

			Gas:	Undiluted Propane		
			Inlet Pressure:	0.138bar		
			Pressure Drop:	0.069bar		
			Specific Gravity:	1.50		
INTENDED USE: PE Pipe Sizing Between 0.138bar Sevice Regulator and Line Pressure Regulator						
	Pipe Size (mm)					
Nominal OD:	15	20	25	32	38	50
Designation:	SDR 9.33	SDR 11.0	SDR 11.00	SDR 10.00	SDR 11.00	SDR 11.00
Length (m)	Capacity in kW					
3	917	1,834	3,311	5,743	8,644	15,558
6	630	1,260	2,274	3,926	5,948	10,695
9	507	1,011	1,825	3,164	4,776	8,585
12	434	867	1,562	2,707	4,102	7,354
15	384	768	1,386	2,400	3,633	6,505
18	349	694	1,254	2,174	3,282	5,889
21	319	639	1,154	2,001	3,018	5,421
24	296	595	1,075	1,861	2,810	5,040
27	279	560	1,008	1,746	2,637	4,747
30	263	527	952	1,650	2,491	4,483
38	234	469	844	1,462	2,206	3,956
45	212	425	765	1,324	2,001	3,604
53	195	390	703	1,219	1,840	3,311
60	181	363	653	1,134	1,711	3,077
75	161	322	580	1,005	1,518	2,725
90	145	291	524	911	1,374	2,470
105	134	268	483	838	1,266	2,274
120	125	249	448	779	1,178	2,115
135	117	234	422	733	1,105	1,984
150	110	221	398	691	1,043	1,872
165	105	210	378	656	990	1,779
180	100	200	360	627	943	1,696
195	96	192	346	598	905	1,626
210	92	184	331	574	870	1,562
225	88	177	319	554	838	1,506
240	86	171	308	536	809	1,453
255	83	166	299	519	782	1,406
270	80	161	290	501	759	1,362
285	78	156	282	489	738	1,324
300	76	152	274	475	718	1,289
330	72	144	260	451	680	1,222
360	69	138	248	431	650	1,166
390	66	132	238	413	621	1,116
420	63	127	228	396	598	1,072
450	61	122	220	381	574	1,034
480	59	118	212	369	557	999
510	57	114	206	357	539	967
540	55	110	199	346	522	938
570	54	107	194	334	507	911
600	52	104	188	325	492	885

Note: All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; $1m^3 = 33.3 ft.^3$; 1bar = 14.5 psi

TABLE 12-40 Polyethylene Plastic Tubing [NFPA 54: Table 6.3(m)]

	Gas:	Natural
	Inlet Pressure:	279mm w.c.
	Pressure Drop:	12.7mm w.c.
	Specific Gravity:	1.50
INTENDED USE: PE Tube Sizing Between Integral 2-Stage Regulator at Tank or Second Stage (Low Pressure Regulator) and Building		
	Plastic Tubing Size (CTS) (mm)	
Nominal OD:	**15**	**20**
Designation:	**SDR 7.00**	**SDR 11.00**
Length (m)	**Capacity in kW**	
3	35.5	242.6
6	24.3	166.7
9	19.6	133.9
12	16.7	114.6
15	14.9	101.7
18	13.5	92.0
21	12.3	84.7
24	11.4	78.8
27	10.8	73.8
30	10.3	69.7
37.5	9.1	61.8
45	8.2	56.0
52.5	7.6	51.6
60	7.0	48.1
67.5	6.4	45.1
75	6.2	42.5
82.5	5.9	40.4
90	5.6	38.7
105	5.3	35.5
120	4.7	33.1
135	4.4	31.1
150	4.4	29.3

*CTS = Copper tube size.

Note: All table entries are rounded to 3 significant digits.

SI: 1m = 3.3 ft.; 1mm = 0.04 in.; 1m^3 = 33.3 ft.^{3}; 1bar = 14.5 psi

CHAPTER 13

HEALTH CARE FACILITIES AND MEDICAL GAS AND VACUUM SYSTEMS

Part I
Special Requirements for
Health Care Facilities.

1301.0 Application.

1301.1 Construction and equipment requirements shall be applied only to new construction and new equipment, except as modified in individual chapters. Only 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 standard. If 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]

1301.2 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.

1301.3 This chapter shall not apply to Breathing Air Replenishment (BAR) systems.

1302.0 Medical Gas and Vacuum Piping Systems – Installation Requirements.

The installation of medical gas and vacuum piping systems shall be in accordance with the requirements of this chapter and/or the appropriate standards adopted by the Authority Having Jurisdiction. For additional standards, see Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

1302.1 The installation of individual components shall be made in accordance with the instructions of the manufacturer. 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]

1302.2 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 Standard 6000, *Professional Qualification Standard for Medical Gas and Vacuum System Installers* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 99:5.1.10.10.11.1 - 5.1.10.10.11.2]

1302.3 Brazing shall be performed by individuals who are qualified under the provisions of Section 1310.6. [NFPA 99:5.1.10.10.11.3]

1302.4 Prior to any 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 shall be flush-mounted or fully recessed when installed in corridors or other areas where patients are transported on a gurney, bed, or wheelchair.

1303.2 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.

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.

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 airgap 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 4.6m (15 ft.) 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 80mm (3 in.) shall be provided in the indirect waste pipe for a bedpan steamer.

1307.0 Vapor Vents and Stacks for Sterilizers.

1307.1 General. When 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 instructions and shall not be connected to any drainage system vent.

1308.0 Aspirators.

1308.1 (See Section 603.4.9, Water Inlets to Water Supplied Aspirators.) Provisions for aspirators or other water-supplied suction devices shall be installed only 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 airgap 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 603.4.9.

Part II
Medical Gas and Vacuum Systems.

1309.0 Application.

1309.1 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 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 Wherever 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. Wherever the name of a specific gas or vacuum service occurs, the provision shall apply only to that gas. [NFPA 99:5.1.1.2]

1309.4 This chapter does not apply to portable compressed gas systems.

1309.5 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 The requirements of this chapter shall not be interpreted to conflict with the requirements of NFPA 99, *Standard for Health Care Facilities* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. 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, *Standard for Health Care Facilities* or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

1309.7 An existing system that is not in strict compliance with the provisions of the standard (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, *Cleaning Equipment for Oxygen Service*, or equivalent International Standard(s) approved by the Authority Having Jurisdiction 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 include but are not limited to containers, valves, valve seats, lubricants, fittings, gaskets, and interconnecting equipment including hose. Easily ignitable materials should 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 can call for other materials (usually copper or its alloys) because of their greater resistance to ignition and lower rate of combustion. Similarly, materials that can be ignited in air have lower ignition energies in oxygen. Many such materials can be ignited by friction at a valve seat or stem packing or by adiabatic compression produced when oxygen at high pressure is rapidly introduced into a system initially at low pressure.

1310.1.2 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 21bar (300 psi), material construction shall be compatible with oxygen under the temperatures and pressures to which the components can be 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(1), (2)]

1310.2 Certification of medical gas and medical vacuum systems shall conform to the requirements of Section 1327.0 of this code, the Authority Having Jurisdiction and NFPA 99, *Standard for Health Care Facilities* or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

1310.3 Prior to any 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 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 and 5.1.10.1.3]

1310.4 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 shall be permitted to install piping systems if the requirements of this chapter are met during installation. [NFPA 99:5.1.10.10.11.5]

1310.6 Brazing procedures and brazer performance for the installation of medical gas and vacuum piping shall be qualified in accordance with either Section IX, "Welding and Brazing Qualifications," of the ASME *Boiler and Pressure Vessel Code*, or AWS B2.2, *Standard for Brazing Procedure and Performance Qualifications,* both as modified below or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 99:5.1.10.10.12.1]

1310.6.1 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 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 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 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 standard.

(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 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 Performance qualifications of brazers shall remain in effect indefinitely unless the brazer does not braze with the qualified procedure for a period exceeding six 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 Before any medical gas or medical vacuum system is installed or altered in any 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 any permit by the Authority Having Jurisdiction.

1311.2 Plans and specifications shall show the following, in detail:

1311.2.1 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.

Manifolds and cylinders located outdoors shall be provided with an enclosure to protect from heat and dust. Such enclosures (wall or fencing and roof) shall be constructed of non-combustible material.

1311.2.2 Piping layout of the proposed piping system or alteration, including alarms, valves, origin of gases, and user outlets/inlets. The demand and loading of any piping, existing or future, shall also be indicated.

1311.2.3 Complete specification of materials.

1311.3 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 A record of as-built plans and valve identification records shall remain on the site at all times.

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 13-1.

1312.2 Minimum Flow Rates. Medical gas and medical vacuum systems shall be capable of supplying the flow rates listed in Table 13-2.

1312.3 Minimum Station Outlets/Inlets. Station outlets and inlets for medical gas and medical vacuum systems shall be provided as listed in Table 13-3.

1313.0 Required Pipe Sizing.

1313.1 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 13-6, the size of pipe of each section of the system shall be determined using Tables 13-4 and 13-6. The size for systems beyond the range of Table 13-6 shall be determined by using the methods set forth in Section 1313.3 of this chapter.

1313.2 To determine the size of each section of pipe in any system within the range of Table 13-6, proceed as follows:

1313.2.1 Measure the length of the pipe from the source equipment location to the most remote station inlet/outlet on the system.

1313.2.2 In Table 13-6, select the column showing that distance, or the next longer distance if the table does not give the exact length.

1313.2.3 Starting at the most remote outlet/inlet, find in the vertical column just selected the medical gas or vacuum demand for that inlet/outlet. If the exact figure of demand is not shown, choose the next larger figure below in the column.

1313.2.4 Opposite this demand figure, in the first column at the left in Table 13-6, will be found the correct size of pipe.

1313.2.5 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 13-4.

1313.2.6 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 Sections 1313.2.2, 1313.2.3, 1313.2.4, and 1313.2.5.

Note: Size branch piping in the order of the distance from the source location, beginning with the most distant outlet not previously sized.

1313.3 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 any inlet/outlet shall not exceed the allowable pressures shown in Table 13-1.

1314.0 Workmanship.

1314.1 Design, construction, and workmanship shall be in conformity with accepted engineering practices and shall meet the requirements of this code.

1314.2 Cracks, holes, or other imperfections in materials shall not be concealed by welding, brazing, or soldering, or by using paint, wax, tar, or other leak-sealing or repair agents.

1314.3 Burred ends of all tubing shall be deburred using a deburring tool to the full bore of the tube, and all chips shall be removed.

1315.0 Materials.

The provisions of this section apply to the field-installed piping for the distribution of medical piped gases.

1315.1 Tubes shall be hard-drawn seamless copper ASTM B 819, Type L, medical gas tubing or equivalent International Standard(s) approved by the Authority Having Jurisdiction except that where operating pressures are exceeding a gauge pressure of 13bar (185 psi), Type K shall be used for sizes exceeding DN80, 80mm O.D. (3-1/8 in. O.D.).

ASTM B 819 medical gas tubing or equivalent International Standard(s) approved by the Authority Having Jurisdiction 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 any of the following:

(1) Hard-drawn seamless copper tube:

(a) ASTM B 88, *Standard Specification for Seamless Copper Water Tube*, copper tube (Types K, L, M) or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

(b) ASTM B 280, *Standard Specification for Seamless Copper Tubing for Air Conditioning and Refrigeration Field Service*, copper ACR tube or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

(c) ASTM B 819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems*, copper medical gas tubing (Type K or L) or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

(2) Stainless steel tube [NFPA 99:5.1.10.2.1]:

Piping systems shall be designed and sized to deliver the required flow rates at the utilization pressures.

Mains and branches in medical gas-piping systems shall be not less than DN15, 16mm O.D. (5/8 in. O.D.) size.

Mains and branches in medical-surgical vacuum systems shall be not less than DN20, 22mm O.D. (7/8 in. O.D.) size.

Drops to individual station outlets and inlets shall be not less than DN15, 16mm O.D. (5/8 in. O.D.) size.

Runouts to alarm panels and connecting tubing for gauges and alarm devices shall be permitted to be DN8, 10mm O.D. (3/8 in. O.D.) size. [NFPA 99:5.1.10.10.1.1 - 5.1.10.10.1.5]

1315.2 Turns, offsets, and other changes in direction in welded or brazed medical gas and vacuum piping shall be made with wrought-copper capillary fittings complying with ASME B16.22, *Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings*, brazed fittings complying with ASME B16.50, *Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 99:5.1.10.3.1]

1315.2.1 Cast-copper alloy fittings shall not be permitted. [NFPA 99:5.1.10.3.2]

1315.2.2 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]

1315.3 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, when 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, when complete, are permanent and nonseparable. [NFPA 99:5.1.10.7]

1315.4 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]

1315.4.1 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 complying with ASME B1.20.1, *Pipe Threads, General Purpose* or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

(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]

1315.4.2 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]

1315.5 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]

1315.6 Soldered joints in copper Level 3 vacuum and Level 3 gas-powered systems piping shall be made in accordance with ASTM B 828, *Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings* or equivalent International Standard(s) approved by the Authority Having Jurisdiction, 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 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 454g to 11L (1 lb. to 3 gal.) 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 Pamphlet G-4.1, *Cleaning Equipment for Oxygen Service*, and are listed in CGA Pamphlet O2-DIR, *Directory of Cleaning Agents for Oxygen Service* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 99:5.1.10.5.3.10 and 5.1.10.5.3.11]

1316.2 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 Piping shall be protected against corrosion and physical damage. [NFPA 99:5.1.10.10.2]

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]

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 Piping risers shall be permitted to be installed in pipe shafts if protected from physical damage, effects of excessive heat, corrosion, or contact with oil.

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 NFPA 70, *National Electrical Code* or equivalent International Standard(s) approved by the Authority Having Jurisdiction, 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 54ºC (130ºF).

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]

1317.3 The installation procedure for underground piping shall protect the piping from physical damage while being backfilled. [NFPA 99:5.1.10.10.5.2]

If underground piping is protected by a conduit, cover, or other enclosure, the following requirements shall be met [NFPA 99:5.1.10.10.5.3]:

(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.

Buried piping that will be subject to surface loads shall be buried at a depth that will protect the piping and 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 90cm (36 in.), except that the minimum cover shall be permitted to be reduced to 46cm (18 in.) 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 or its 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]

1317.4 Hose and flexible connectors, both metallic and nonmetallic, shall be no 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 69bar (1,000 psi). [NFPA 99:5.1.10.10.7.1 - 5.1.10.10.7.2]

1317.5 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 1317.0 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]

1317.6 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]

1317.7 Piping shall be supported from the building structure in accordance with MSS Standard Practice SP-69, *Piping Hangers and Supports - Selection and Application* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 99:5.1.10.10.4.1]

Hangers and supports shall comply with MSS Standard Practice SP-58, *Pipe Hangers and Supports - Materials, Design, and Manufacture* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [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 potentially 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 13-7.

1317.8 Where required, medical gas and vacuum piping shall be seismically restrained against earthquakes in accordance with the applicable building code. Seismic considerations shall conform to the requirements of this code and the Authority Having Jurisdiction. [NFPA 99:5.1.10.10.4.6]

1317.9 Two or more medical gas-piping systems shall not be interconnected for testing or any other reason. Leak testing shall be accomplished by separately charging and testing the individual piping system. [NFPA 99:5.1.10.10.8.1 - 5.1.10.10.8.2]

1317.10 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 per Table 13-1.

(2) The gas or vacuum system color code per Table 13-1.

(3) Where positive-pressure gas piping systems operate at pressures other than the standard gauge pressure in Table 13-1, 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.

This section sets forth the requirements for pipe joint installation for positive-pressure medical gas systems.

1318.1 Brazed joints shall be made using a brazing alloy that exhibits a melting temperature in excess of 538°C (1,000°F) 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 A.5.8, *Specification for Brazing Filler Metal* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [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 when 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]

1318.2 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]

1318.3 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 any surface oxides. [NFPA 99:5.1.10.5.3.2]

When cleaning the exterior surfaces of tube ends, no matter shall be permitted to enter the tube. [NFPA 99:5.1.10.5.3.3]

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 454g to 11L (1 lb. to 3 gal.) 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]

1318.4 Flux shall only be used when 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 1318.3. [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]

Where possible, 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, 22mm (7/8 in.) 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]

1318.5 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]

Techniques for heating the joint; applying the brazing filler metal; and making horizontal, vertical, and large-diameter joints shall be as stated in sections on *Applying Heat and Brazing and Horizontal and Vertical Joints in Chapter VII, Brazed Joints, in the CDA Copper Tube Handbook* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 99:5.1.10.5.6.4]

1318.6 When 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 when 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 all 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 Section 1326.0. [NFPA 99:5.1.10.5.5.11]

When 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]

1318.7 After brazing, the outside of all joints shall be cleaned by washing with water and a wire brush to remove any 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 (when flux or flux-coated BAg series rods are used with dissimilar metals).
(2) Base metal melting or erosion.
(3) Unmelted filler metal.
(4) Failure of the filler metal to be clearly visible all the way 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 1318.7(2) or (5) shall be replaced. [NFPA 99:5.1.10.5.7.5]

Brazed joints that are identified as defective under Sections 1318.7(1), (3), (4), (6), or (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 Where valves are concealed in any 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 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 1322.0. [NFPA 99:5.1.4.9.1]

1319.3 Shutoff valves provided for the connection of future piping shall meet the following requirements:

(1) Be locked in a restricted area.

(2) Be locked or latched closed.

(3) Be identified in accordance with Section 1322.0. [NFPA 99:5.1.4.10]

1319.3.1 Future connection valves shall be labeled as to gas content. [NFPA 99:5.1.4.10.1]

1319.3.2 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 A zone valve shall be located immediately outside each vital life-support, critical care, and anesthetizing location in each medical gas and/or vacuum line, and located so as to be readily accessible in an emergency. [NFPA 99:5.1.4.8.7]

1319.3.4 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 Zone valves shall be so arranged that shutting off the supply of gas to any one operating room or anesthetizing location will not affect the others. [NFPA 99:5.1.4.8.7.2]

1319.4 Source Valve. A shutoff valve shall be placed at the immediate connection of each source system to the distribution piping to permit the entire source, including all accessory devices (such as hair dryers, final line regulators, etc.), to be isolated from the facility. [NFPA 99:5.1.4.4]

1319.4.1 The source valve shall be located in the immediate vicinity of the source equipment. [NFPA 99:5.1.4.4.1]

1319.4.2 The source valve shall be labeled in accordance with Section 1322.0, Source Valve for the (Source Name). [NFPA 99:5.1.4.4.2, 5.1.11.2.3]

1319.5 Main Valve. 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 The main line valve shall be located to permit access by authorized personnel only (i.e., by locating above a ceiling or behind a locked access door). [NFPA 99:5.1.4.5.1]

1319.5.2 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 The main line shall be labeled in accordance with Section 1322.0. [NFPA 99:5.1.4.5.3 and 5.1.11.2.4]

1319.6 Riser Valve. 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 Valve. 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 only outlets/inlets located on that same story. [NFPA 99:5.1.4.8]

1319.7.1 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 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 any zone valve box assembly on that branch. [NFPA 99:5.1.4.7.2]

1319.8.1 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 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 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 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 any 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 Pressure-relief valves shall close automatically when excess pressure has been released.

1320.2.2 Pressure-relief valves set at 50 percent shall be vented to the outside from gas systems, except medical air, or if the total capacity of the supply system is in excess of $85m^3$ ($3,000 ft.^3$) of gas.

1320.2.3 Pressure-relief valves shall be of brass or bronze and specially designed for the gas service involved.

1320.2.4 A pressure-relief valve shall not be isolated from its intended use by any 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.

Station outlets and inlets shall be installed in strict accordance with the manufacturer's instructions.

1321.1 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.

The gas content of medical gas piping systems shall be readily identifiable by appropriate 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 Pamphlet C-9, *Standard Color-Marking of Compressed Cylinders Intended for Medical Gas Use,* (See Table 13-1) or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

1322.1 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 per Table 13-1.

(2) The gas or vacuum system color code per Table 13-1.

(3) Where positive-pressure gas piping systems operate at pressures other than the standard gauge, 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:

(1) At intervals of not more than 6m (20 ft.).

(2) Not less than once in or above every room.

(3) On both sides of walls or partitions penetrated by the piping.

(4) Not less than once in every story height traversed by risers. [NFPA 99:5.1.11.1.2]

1322.2 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]

1322.3 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]

1322.4 The shutoff valves described in Sections 1319.4, 1319.5, and 1319.6 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 99:5.1.11.2.6]

1323.0 Alarms.

Master, area, and local alarm systems used for medical gas and vacuum systems shall include the following [NFPA 99:5.1.9.1]:

(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 level of not less than 80 decibels at 92cm (3 ft.).

(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.

(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 NFPA 70, *National Electrical Code* or equivalent International Standard(s) approved by the Authority Having Jurisdiction, 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 ten seconds (e.g., during generator startup) without giving false signals or requiring manual reset.

1323.1 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.

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.

1324.1 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) An automatic means to prevent backflow from on-cycle compressors through off-cycle compressors.

(2) 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.

(3) Intake filter-mufflers of the dry type.

(4) Pressure relief valves set at 50 percent above line pressure.

(5) 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) Materials and devices used between the medical air intake and the medical air source valve shall be permitted to be of any design or construction appropriate for the service, as determined by the manufacturer. [NFPA 99:5.1.3.5.3.2]

1324.2 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 of any type. [NFPA 99:5.1.3.5.13.1]

1324.3 Compressor intake piping shall be hard-drawn seamless copper, and one of the following:

(1) ASTM B 819, *Standard Specification for Seamless Copper Tube for Medical Gas Systems*, medical gas tube or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

(2) ASTM B 88, *Standard Specification for Seamless Copper Water Tube*, water tube (Type K or L) or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

(3) ASTM B 280, *Standard Specification for Seamless Copper Tubing for Air Conditioning and Refrigeration Field Service*, 280ACR tube or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 99:5.1.3.5.13.4]

The compressor air intake shall be located outdoors above roof level, at a distance of not less than 3m (10 ft.) from any door, window, exhaust, other intake, or opening in the building and a distance of not less than 6m (20 ft.) above ground. [NFPA 99:5.1.3.5.13.2]

If 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 back pressure 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 when compressors are removed from service and consequent backflow of room air into the other compressor(s). [NFPA 99:5.1.3.5.13.5]

1324.3.1 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).

1324.4 Drains shall be installed on dryers, aftercoolers, separators, and receivers.

1324.5 Medical air receivers shall be provided with proper valves to allow the flow of compressed air to enter and exit out of separator receive 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]

1324.6 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, Unfired Pressure Vessels, of the *ASME Boiler and Pressure Vessel Code* or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

(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 Sections 1315.0 and 1318.0, except that stainless steel shall be permitted to be used as a piping material.

1325.0 Medical Vacuum Pump System.

The vacuum plant shall be installed in a well-lit, ventilated, and clean location with ample accessibility. The location shall be provided with drainage facilities. The vacuum plant, when installed as a source, shall be located separately from other medical vacuum system sources, and shall be readily accessible for maintenance.

1325.1 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 any on-cycle vacuum pumps through any 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 1315.1, 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 any design or construction appropriate for the service, as determined by the manufacturer. [NFPA 99 5.1.3.6.1.2(1), (2), (3), (4), (5), (6)]

1325.1.1 Additional pumps shall automatically activate when the pumps in operation are incapable of adequately maintaining the required vacuum.

Automatic or manual alternation of pumps shall allow division of operating time. If 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]

1325.2 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 3m (10 ft.) from any 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 1315.1 (Vacuum tubes).

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]

1325.2.1 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 back-pressure in accordance with the pump manufacturer's recommendations.

(2) Each pump can be isolated by manual or check valve, blind flange, or tube cap to prevent open exhaust piping when pumps are removed for service and consequent flow of exhaust air into the room. [NFPA 99:5.1.3.6.7.6]

1325.3 Receivers for vacuum shall meet the following requirements:

(1) Be made of ferrous and/or nonferrous materials.

(2) Comply with Section VIII, Unfired Pressure Vessels, of the *ASME Boiler and Pressure Vessel Code* or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

(3) Be capable of withstanding a gauge pressure of 4.1bar (60 psi) and 76cm (29.9 in.) 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]

1325.4 Piping between vacuum pumps, discharges, receivers, and the vacuum main line valve shall be in accordance with Section 1315.0, except that stainless, galvanized, or black steel pipe shall be permitted to be used. [NFPA 99:5.1.3.6.1.2(5)]

Drains shall be installed and terminate in an approved location.

1326.0 Testing and Inspection.

1326.1 Inspection and testing shall be performed on new piped gas systems, additions, renovations, temporary installations, or repaired systems, to ensure 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 Tests and inspections required by this section shall not be interpreted to conflict with the requirements of NFPA 99, *Standard for Health Care Facilities* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. 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, *Standard for Health Care Facilities* or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

1326.2 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 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 only 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. If 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 1-1/2 times the working pressure [minimum 10bar (150 psi)] 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, if any, shall be located, repaired, and retested in accordance with this paragraph. [NFPA 99:5.1.12.2.3.7]

1326.8 Cross-Connection Test – Piped Gas Systems. 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]

Piping systems shall be reduced to atmospheric pressure. [NFPA 99:5.1.12.2.4.1]

Sources of test gas shall be disconnected from piping systems except for the one system being tested. [NFPA 99:5.1.12.2.4.2]

The system under test shall be charged with oil-free, dry nitrogen NF to a gauge pressure of 3.5bar (50 psi). [NFPA 99:5.1.12.2.4.3]

After the installation of the individual faceplates with appropriate 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 only from the piping system being tested. [NFPA 99:5.1.12.2.4.4]

1326.8.1 The source of test gas shall be disconnected, and the system tested shall be reduced to atmospheric pressure. The cross-connection test shall be repeated for each installed medical gas and vacuum piping system. [NFPA 99:5.1.12.2.4.1, 5.1.12.2.4.5]

1326.8.2 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 shall be in operation so that these vacuum systems are tested at the same time the medical gas systems are tested. 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 Final Testing 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. [NFPA 99:5.1.12.2.6]

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]

1326.9.1 After the piping system is filled with test gas, the supply valve and all 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, if any, shall be located, repaired (if permitted), or replaced (if 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. [NFPA 99:5.1.12.2.3.1]

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.). [NFPA 99:5.1.12.2.3.2]

The source shutoff valve shall remain closed during these tests. [NFPA 99:5.1.12.2.3.3]

The test pressure for pressure gases shall be 1.5 times the system working pressure but not less than a gauge pressure of 10bar (150 psi). [NFPA 99:5.1.12.2.3.4]

The test pressure for vacuum shall be not less than a gauge pressure of 4.1bar (60 psi). [NFPA 99:5.1.12.2.3.5]

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. [NFPA 99:5.1.12.2.3.6]

Leaks, if any, shall be located, repaired (if permitted), replaced (if required), and retested. [NFPA 99:5.1.12.2.3.7]

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. [NFPA 99:5.1.12.2.7]

Tests shall be conducted after installation of components of the vacuum system. [NFPA 99:5.1.12.2.7.1]

The piping systems shall be subjected to a 24 hour standing vacuum test. [NFPA 99:5.1.12.2.7.2]

Test pressure shall be between 30cm (12 in.) gauge HgV and full vacuum. [NFPA 99:5.1.12.2.7.3]

During the test, the source of test vacuum shall be disconnected from the piping system. [NFPA 99:5.1.12.2.7.4]

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 the following [NFPA 99:5.1.12.2.7.5]:

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 1bar (14.7 psi).

(3) Absolute temperature is the temperature reading plus 238°C (146ºF).

(4) The final allowable gauge pressure reading equals the final allowable absolute pressure minus a gauge pressure of 1bar (14.7 psi). [NFPA 99:5.1.12.2.7.6]

Leaks, if any, shall be located, repaired (if permitted), or replaced (if required), and retested. [NFPA 99:5.1.12.2.7.7]

1326.12 Corrections. Notices of correction or violation shall be written by the Authority Having Jurisdiction and posted at the site of the work or mailed or delivered to the permittee or an authorized representative. Refusal or failure to comply with any such notice or order within ten 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 all 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. Any 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 Prior to any medical gas system being placed in service, each and every system shall be certified, as described in Section 1327.2.

1327.1.1 Verification tests shall be performed only after all tests required in Section 1326.0, Installer-Performed Tests, 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 Standard

6030, *Medical Gas Verifiers Professional Qualifications Standard* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [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]

When systems have been installed by inhouse 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, verified and attested to by the certification agency, shall include the following:

1327.2.1 Verifying compliance with the installation requirements.

1327.2.2 Testing and checking for leakage, correct zoning, and identification of control valves.

1327.2.3 Checking for identification and labeling of pipelines, station outlets, and control valves.

1327.2.4 Testing for cross-connection, flow rate, system pressure drop, and system performance.

1327.2.5 Functional testing of pressure relief valves and safety valves.

1327.2.6 Functional testing of all sources of supply.

1327.2.7 Functional testing of alarm systems, including accuracy of system components.

1327.2.8 Purge flushing of system and filling with specific source gases.

1327.2.9 Testing for purity and cleanliness of source gases.

1327.2.10 Testing for specific gas identity at each station outlet.

1327.3 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 any others that are required. [NFPA 99:5.1.12.1.6]

Reports shall contain detailed listings of all findings and results. [NFPA 99:5.1.12.1.7]

1327.4 A report that includes the specific items mentioned in Section 1327.2 and other information required by NFPA 99, *Standard for Health Care Facilities* or equivalent International Standard(s) approved by the Authority Having Jurisdiction shall be delivered to the Authority Having Jurisdiction prior to acceptance of the system.

TABLE 13-1
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	3.5–3.8bar
Carbon dioxide	CO_2	Gray/black or gray/white	3.5–3.8bar
Helium	He	Brown/white	3.5–3.8bar
Nitrogen	N_2	Black/white	11.0–12.8bar
Nitrous oxide	N_2O	Blue/ white	3.5–3.8bar
Oxygen	O_2	Green/white or white/green	3.5–3.8bar
Oxygen/carbon dioxide mixture	O_2/CO_2 n (n is % of CO_2)	Green/white	3.5–3.8bar
Medical–surgical vacuum	Med Vac	White/black	38cm to 76cm Hg
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 checkerboard/black	None
Laboratory vacuum		White-and-black checkerboard/black boxed	None
Instrument air		Red/white	11.0–12.8bar

SI: 1bar = 14.5 psi; 1cm = 0.39 in.

TABLE 13-2
Minimum Flow Rates

Oxygen	20L/min per outlet[1]
Nitrous Oxide	20L/min per outlet[1]
Medical Compressed Air	20L/min per outlet[1]
Nitrogen	$0.42m^3$/min. free air per outlet
Vacuum	$0.03m^3$/min per inlet[2]
Carbon Dioxide	20L/min per outlet[1]
Helium	20L/min per outlet

1 Any room designed for a permanently located respiratory ventilator or anesthesia machine shall have an outlet capable of a flow rate of 180L/min (6.36 $ft.^3$/min) at the station outlet.

2 For testing and certification purposes, individual station inlets shall be capable of a flow rate of 0.08 m^3/min (3 cfm), while maintaining a system pressure of not less than 305mm (12 in.) at the nearest adjacent vacuum inlet.

SI: 1L/min. = 0.04 $ft.^3$/min; $1m^3$/min = 35.3 $ft.^3$/min.

TABLE 13-3
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	2/bed	2/bed	1/bed	—	—	—	—
labor/delivery/recovery rooms[2]	2/room	3/room[4]	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	—	—	—	—

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 any inlets used as part of a scavenging system for removal of anesthetizing gases.

TABLE 13-4
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[2] L/min All Pressurized Medical Gas Systems	Vacuum Systems
1–10	100%	Actual Demand	See
11–25	75%	200	Table
26–50	50%	375	13-5
51–100	50%	500	

[1] Flow rates of station inlets/outlets per Table 13-2.
[2] The minimum system flow is the average inlet/outlet flow times the number of station inlets/outlets times the diversity percentage.
SI: 1L/min = 0.04 ft.^{3}/min

TABLE 13-5
Outlet Rating for Vacuum Piping Systems

	Free-Air Allowance, Expressed as L/min at 1 Atmosphere		Zone Allowances Corridors-Risers Main Supply Line-Valves	
Location of Medical-Surgical Vacuum Outlets	**Per Room**	**Per Outlet**	**Simultaneous Usage Factor Percent**	**Air to Be Transported L/min**
Operating				
Major "A" (Radical, Open Heart)	100	–	100	100
(Organ Transplant)	100	–	100	100
(Radical Thoracic)	100	–	100	100
Major " B" (All Other Major ORs)	57	–	100	57
Minor	28	–	100	28
Delivery Rooms	28	–	100	28
Recovery Rooms (Post-Anesthesia) and Intensive Care Units (a minimum of 2 outlets per bed in each such department)				
1st outlet at each bed	–	85	50	43
2nd outlet at each bed	–	28	50	14
3rd outlet at each bed	–	28	10	3
All others at each bed	–	28	10	3
Emergency Rooms	–	28	100	28
Patient Rooms				
Surgical	–	28	50	14
Medical	–	28	10	3
Nurseries	–	28	10	3
Treatment and Examining Rooms	–	14	10	2
Autopsy Area	–	57	20	11
Inhalation Therapy, Central Supply and Instructional Areas	–	28	10	3

SI: 1L/min = 0.04 ft.^{3}/min; 1bar = 1 atmosphere

TABLE 13-6
Size of Gas/Vacuum Piping

Medical System	Gas Pipe Size[2] mm	Maximum Delivery Capacity[3] in L/min — Length of Piping in metres[1]: 30	80	150	225	300
Oxygen	15	425	300	210	167	144
	20	1,133	801	555	445	377
	25	1,416	1,416	1,138	912	784
Nitrous Oxide	15	425	269	184	150	127
	20	849	699	484	388	331
	25	1,133	1,133	983	799	688
Medical Air	15	513	314	221	178	150
	20	1,133	847	595	467	399
	25	1,416	1,416	1,192	1,014	827
Vacuum	25	646	388	269	215	184
	32	1,135	694	473	377	317
	40	1,804	1,102	759	598	507
	50	3,758	2,305	1,586	1,274	1,085
Nitrogen	15	708	708	708	674	583
	20	1,699	1,699	1,699	1,699	1,535
	25	3,115	3,115	3,115	3,115	3,115

[1] Length of piping includes a 30% allowance for fittings.

[2] 15mm (0.5 in.) diameter pipe is the minimum size allowed in medical gas systems.

[3] Based on the following maximum pressure drops:
Oxygen, nitrous oxide, and medical air – 25cm Hg (10 in. Hg)
Vacuum – 10cm Hg (4 in. Hg)
Nitrogen – 104cm Hg (40 in. Hg)

SI: 1mm = 0.04 in.; 1m = 3.3 ft.; 1cm Hg = 0.4 in. Hg; 1L/min = 0.04 ft.^{3}/min

TABLE 13-7
Maximum Pipe Support Spacing
[NFPA 99:5.1.10.10.4.5]

Pipe Size	Outside Dimension mm	Hanger Spacing m
DN8	10	1.5
DN10	13	1.8
DN15	16	1.8
DN20	22	2.1
DN25	29	2.4
DN32	35	2.7
DN40 and larger	42	3.0
Vertical risers, all sizes		
Every floor but not to exceed:		4.6

SI: 1mm = 0.04 in.; 1m = 3.3 ft.

CHAPTER 14

REFERENCED STANDARDS

TABLE 14-1
Standards for Materials, Equipment, Joints and Connections
Where more than one standard has been listed for the same material or method, the relevant portions of all such standards shall apply.

Standard Number	Standard Title	Application
AHAM DW-1-2005	Household Electric Dishwashers	Appliances
AHAM FWD-1-2005	Food Waste Disposers	Appliances
APSP 1-2003	Public Swimming Pools	Swimming Pools and Spas
ARI 550/590-2003	Performance Rating of Water Chilling Packages Using the Vapor Compression Cycle	Chiller
ASCE 25-2006	Earthquake Actuated Automatic Gas Shutoff Devices	Fuel Gas
ASHRAE 15-2004	Safety Standard for Refrigeration Systems	Refrigeration
ASHRAE 34-2007	Designation and Safety Classification of Refrigerants	Refrigerants
ASHRAE 90.1-2004	Energy Standard for Buildings Except Low-Rise Residential Buildings	Miscellaneous
ASME A13.1-2007	Scheme for the Identification of Piping Systems	Piping
ASME A112.1.2-2004	Air Gaps in Plumbing Systems (for Plumbing Fixtures and Water Connected Receptors)	Fittings
ASME A112.1.3-2000 (R2005)	Air Gap Fittings for Use with Plumbing Fixtures, Appliances, and Appurtenances	Fittings
ASME A112.3.1-1993	Performance Standard and Installation Procedures for Stainless Steel Drainage Systems for Sanitary, Storm, and Chemical Applications, Above and Below Ground	Piping, Ferrous
ASME A112.3.4-2000 (R2004)	Macerating Toilet Systems and Related Components	Fixtures
ASME A112.4.1-1993 (R2002)	Water Heater Relief Valve Drain Tubes	Appliances
ASME A112.4.2-2003	Water Closet Personal Hygiene Devices	Fixtures
ASME A112.4.3-1999 (R2004)	Plastic Fittings for Connecting Water Closets to the Sanitary Drainage System	Fittings
ASME A112.4.7-2002	Point of Use and Branch Water Submetering Systems	Miscellaneous
ASME A112.4.14-2004	Manually Operated Quarter Turn Shutoff Valves for Use in Plumbing Systems Valves	Valves, Metallic ball
ASME A112.6.1M-1997 (R2002)	Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use	Fixtures
ASME A112.6.2-2000 (R2004)	Framing-Affixed Supports for Off-the-Floor Water Closets with Concealed Tanks	Fixtures
ASME A112.6.3-2001 (R2007)	Floor and Trench Drains	DWV Components
ASME A112.6.4-2003	Roof, Deck, and Balcony Drains	DWV Components
ASME A112.6.7-2001 (R2007)	Enameled and Epoxy Coated Cast-Iron and PVC Plastic Sanitary Floor Sinks	Fixtures
ASME A112.6.9-2005	Siphonic Roof Drains	DWV Components

Table 14-1 continued

Standard Number	Standard Title	Application
ASME A112.14.1-2003	Backwater Valves	Valves
ASME A112.14.3-2000 (R2004)	Grease Interceptors	Fixtures
ASME A112.14.4-2001 (R2007)	Grease Removal Devices	Fixtures
ASME A112.14.6-2006	FOG (Fats, Oils, and Greases) Disposal Systems	Fixtures
ASME A112.18.1-2005/CSA B125.1-2005	Plumbing Supply Fittings	Fittings
ASME A112.18.2-2005/CSA B125.2-2005	Plumbing Waste Fittings	Fittings
ASME A112.18.3-2002	Performance Requirements for Backflow Protection Devices and Systems in Plumbing Fixtures Fittings	Kitchen, Lavatory, Shampoo bowls, and Shower Fittings with Flexible Hose
ASME A112.18.6-2003	Flexible Water Connectors	Piping
ASME A112.18.7-1999 (R2004)	Deck Mounted Bath/Shower Transfer Valves with Integral Backflow Protection	Valves
ASME A112.19.1M-1994 (R2004)	Enameled Cast-Iron Plumbing Fixtures (Supplement 1-1998)	Fixtures
ASME A112.19.2-2003	Vitreous China Plumbing Fixtures and Hydraulic Fixtures Requirements for Water Closets and Urinals	Fixtures
ASME A112.19.3-2000 (R2004)	Stainless Steel Plumbing Fixtures (Designed for Residential Use)	Fixtures
ASME A112.19.4M-1994 (R2004)	Porcelain-Enameled Formed Steel Plumbing Fixtures (Supplement 1-1998)	Fixtures
ASME A112.19.5-2005	Trim for Water-Closet Bowls, Tanks, and Urinals	Fixtures
ASME A112.19.7-2006	Hydromassage Bathtub Appliances	Fixtures
ASME A112.19.8M-2007	Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, and Hot Tubs	Swimming Pools and Spas
ASME A112.19.9M-1991 (R2002)	Non-Vitreous Ceramic Plumbing Fixtures	Fixtures
ASME A112.19.10-2003	Dual Flush Devices for Water Closets	Fixtures
ASME A112.19.12-2006	Wall Mounted, Pedestal Mounted Adjustable, Elevating, Tilting and Pivoting Lavatory, Sink and Shampoo Bowl Carrier Systems and Drainage Waste Systems	Fixtures
ASME A112.19.13-2001 (R2007)	Electrohydraulic Water Closets	Fixtures
ASME A112.19.14-2006	Six-Liter Water Closets Equipped with a Dual Flushing Device	Fixtures
ASME A112.19.15-2005	Bathtub/Whirlpool Bathtubs with Pressure Sealed Doors	Fixtures
ASME A112.19.19-2006	Vitreous China Nonwater Urinals	Fixtures
ASME A112.20.1-2004	Qualification of Installers of High Purity Piping Systems	Certification
ASME A112.20.2-2004	Qualification of Installers of Firestop Systems and Devices for Piping Systems	Certification
ASME A112.21.3M-1985 (R2007)	Hydrants for Utility and Maintenance Use	Valves
ASME A112.36.2M-1991 (R2002)	Cleanouts	DWV Components

Standard Number	Standard Title	Application
ASME B1.20.1-1983 (R2006)	Pipe Threads, General Purpose, Inch	Joints
ASME B1.20.3-1976 (R2003)	Dryseal Pipe Threads, Inch	Joints
ASME B16.1-2005	Gray-Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, 250)	Piping, Ferrous
ASME B16.3-2006	Malleable-Iron Threaded Fittings Classes 150 and 300	Piping, Ferrous
ASME B16.4-1998 (R2006)	Gray Iron Threaded Fittings, Classes 125 and 250 (Includes Revision Services)	Piping, Ferrous
ASME B16.5-2003	Pipe Flanges and Flanged Fittings: NPS 1/2 through 24 Metric/Inch	Fittings
ASME B16.12-1998 (R2006)	Cast-Iron Threaded Drainage Fittings	Fittings
ASME B16.15-2006	Cast Copper Alloy Threaded Fittings: Classes 125 and 250	Fittings
ASME B16.18-2001 (R2005)	Cast Copper Alloy Solder Joint Pressure Fittings	Fittings
ASME B16.20-1998 (R2004)	Metallic Gaskets For Pipe Flanges: Ring Joint Spiral Wound and Jacketed	Joints
ASME B16.21-2005	Nonmetallic Flat Gaskets for Pipe Flanges	Joints
ASME B16.22-2001 (R2005)	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings Alloy	Fittings
ASME B16.23-2002 (R2006)	Cast Copper Alloy Solder Joint Drainage Fittings – DWV	Fittings
ASME B16.24-2006	Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 400, 600, 900, 1,500 and 2,500	Fittings
ASME B16.26-2006	Cast Copper Alloy Fittings for Flared Copper Tubes	Fittings
ASME B16.29-2007	Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings–DWV	Fittings
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 24)	Valves
ASME B16.34-2004	Valves – Flanged, Threaded, and Welding End	Valves
ASME B16.39-1998 (R2006)	Malleable Iron Threaded Pipe Unions (Classes 150, 250 and 300) (Includes Revision Services)	Fittings
ASME B16.40-2002	Manually Operated Thermoplastic Gas Shutoff and Valves in Gas Distribution Systems	Valves
ASME B16.47-2006	Large Diameter Steel Flanges: NPS 26 through NPS 60 Metric/Inch Standard	Fittings
ASME B16.50-2001	Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings	Fittings
ASME B31.1-2007	Power Piping	Piping
ASME B36.10M-2004	Welded and Seamless Wrought Steel Pipe	Piping, Ferrous
ASME B36.19M-2004	Stainless Steel Pipe	Piping, Ferrous
ASME Section IV	Rules for Construction of Heating Boilers	Miscellaneous
ASME Section VIII	Rules for Construction of Pressure Vessels	Miscellaneous
ASME Section IX	Welding and Brazing Qualifications	Certification
ASPE 45-2007	Siphonic Roof Drainage System	Design Manual
ASSE 1001-2008	Atmospheric-Type Vacuum Breakers	Backflow Protection
ASSE 1002-1999	Anti-Siphon Fill Valves (Ballcocks) for Gravity Water Closet Flush Tank	Backflow Protection
ASSE 1003-2001	Water Pressure Reducing Valves	Valves
ASSE 1004-1990	Backflow Prevention Requirements for Commercial Dishwashing Machines	Backflow Protection

Standard Number	Standard Title	Application
ASSE 1006-1986	Residential Use Dishwashers	Appliances
ASSE 1007-1986	Home Laundry Equipment	Appliances
ASSE 1008-2006	Plumbing Aspects of Residential Food Waste Disposer Units	Appliances
ASSE 1009-1990	Commercial Food Waste Grinder Units	Appliances
ASSE 1010-2004	Water Hammer Arresters	Miscellaneous, Water Supply Component
ASSE 1011-2004	Hose-Connection Vacuum Breakers	Backflow Protection
ASSE 1012-2002	Backflow Preventer with Intermediate Atmospheric Vent	Backflow Protection
ASSE 1013-2005	Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers	Backflow Protection
ASSE 1014-2005	Backflow Prevention Devices for Hand-Held Showers	Backflow Protection
ASSE 1015-2005	Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies	Backflow Protection
ASSE 1016-2005	Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations	Valves
ASSE 1017-2003	Temperature Actuated Mixing Valves for Hot Water Distribution Systems	Valves
ASSE 1018-2001	Trap Seal Primer Valves-Potable Water Supplied	Valves
ASSE 1019-2004	Vacuum Breaker Wall Hydrant, Freeze-Resistant Automatic Draining Type	Backflow Protection
ASSE 1020-2004	Pressure Vacuum Breaker Assembly	Backflow Protection
ASSE 1021-2001	Drain Air Gaps for Domestic Dishwasher Applications	Backflow Protection
ASSE 1022-2003	Backflow Preventer for Beverage Dispensing Equipment	Backflow Protection
ASSE 1023-1979	Hot Water Dispensers, Household Storage Type-Electrical	Appliances
ASSE 1024-2004	Dual Check Valve Backflow Preventers	Backflow Prevention
ASSE 1032-2004	Dual Check Valve Type Backflow Preventers for Carbonated Beverage Dispensers, Post Mix Types	Backflow Protection
ASSE 1035-2002	Laboratory Faucet Backflow Preventers	Backflow Protection
ASSE 1037-1990	Pressurized Flushing Devices (Flushometers) for Plumbing Fixtures	Backflow Protection
ASSE 1044-2001	Trap Seal Primer Devices-Drainage Types and Electronic Design Types	DWV Components
ASSE 1047-2005	Reduced Pressure Detector Fire Protection Backflow Prevention Assemblies	Backflow Protection
ASSE 1048-2005	Double Check Detector Fire Protection Backflow Prevention Assemblies	Backflow Protection
ASSE 1050-2002	Stack Air Admittance Valves for Sanitary Drainage Systems	DWV Components
ASSE 1051-2002	Individual and Branch Type Air Admittance Valves for Sanitary Drainage Systems	DWV Components
ASSE 1052-2004	Hose Connection Backflow Preventers	Backflow Protection

Standard Number	Standard Title	Application
ASSE 1055-1997	Chemical Dispensing Systems	Backflow Protection
ASSE 1056-2001	Spill Resistant Vacuum Breakers	Backflow Protection
ASSE 1060-2006	Outdoor Enclosures for Backflow Prevention Assemblies	Miscellaneous
ASSE 1061-2006	Removable and Non-Removable Push-Fit Fittings	Fittings
ASSE 1062-2006	Temperature Actuated Flow Reduction (TAFR) Valves for Individual Fixture Fittings	Valves
ASSE 1066-1997	Individual Pressure Balancing In-Line Valves for Individual Fixture Fittings	Valves
ASSE 1069-2005	Automatic Temperature Control Mixing Valves	Valves
ASSE 1070-2004	Water Temperature Limiting Devices	Valves
ASSE 1079-2005	Dielectric Pipe Unions	Joints
ASSE Series 5000-2004	Professional Qualification Standard for Backflow Prevention Assemblies, Testers, Repairers, and Surveyors	Certification
ASSE 6000-2006	Professional Qualifications Standard for Medical Gas Systems, Personnel	Certification
ASTM A 47-1999 (R2004)	Ferritic Malleable Iron Castings	Piping, Ferrous
ASTM A 48-2003	Gray Iron Castings	Piping, Ferrous
ASTM A 53-2007	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless	Piping, Ferrous
ASTM A 74-2006	Cast Iron Soil Pipe and Fittings	Piping, Ferrous
ASTM A 126-2004	Gray Iron Castings for Valves, Flanges, and Pipe Fittings	Piping, Ferrous
ASTM A 197-2000 (R2006)	Cupola Malleable Iron	Piping, Ferrous
ASTM A 269-2007a	Seamless and Welded Austenitic Stainless Steel Tubing for General Service	Piping, Ferrous
ASTM A 312-2007	Seamless, Welded and Heavy Cold Worked Austenitic Stainless Steel Pipes	Piping, Ferrous
ASTM A 377-2003	Ductile-Iron Pressure Pipe	Piping, Ferrous
ASTM A 479-2006a	Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels	Piping, Ferrous
ASTM A 518-1999 (R2003)	Corrosion-Resistant High-Silicon Iron Castings	Piping, Ferrous
ASTM A 536-1984 (R2004)	Ductile Iron Castings	Piping, Ferrous
ASTM A 653-2007	Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process	Piping, Ferrous
ASTM A 733-2003	Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples	Piping, Ferrous
ASTM A 861-2004	High-Silicon Iron Pipe and Fittings	Piping, Ferrous
ASTM A 888-2007a	Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain Waste and Vent Piping Applications	Piping, Ferrous
ASTM B 29-2003	Refined Lead	Joints
ASTM B 32-2004	Solder Metal	Joints
ASTM B 42-2002^{e1}	Seamless Copper Pipe, Standard Sizes	Piping, Copper Alloy
ASTM B 43-1998 (R2004)	Seamless Red Brass Pipe, Standard Sizes	Piping, Copper Alloy
ASTM B 75-2002	Seamless Copper Tube	Piping, Copper Alloy
ASTM B 88-2003	Seamless Copper Water Tube	Piping, Copper Alloy

Table 14-1 continued

Standard Number	Standard Title	Application
ASTM B 135-2002	Seamless Brass Tube (Metric)	Piping, Copper Alloy
ASTM B 152-2006a	Copper Sheet, Strip, Plate, and Rolled Bar	Miscellaneous
ASTM B 187-2006	Copper Bar, Bus Bar, Rod and Shapes	Miscellaneous
ASTM B 251-2002^{e1}	General Requirements for Wrought Seamless Copper and Copper-Alloy Tube	Piping, Copper Alloy
ASTM B 280-2003	Seamless Copper Tube for Air Conditioning and Refrigeration Field Service	Piping, Copper Alloy
ASTM B 302-2007	Threadless Copper Pipe, Standard Sizes	Piping, Copper Alloy
ASTM B 306-2002	Copper Drainage Tube (DWV)	Piping, Copper Alloy
ASTM B 370-2003	Copper Sheet and Strip for Building Construction	Miscellaneous
ASTM B 447-2007	Welded Copper Tube	Piping, Copper Alloy
ASTM B 584-2006a	Copper Alloy Sand Casting for General Applications	Piping, Copper Alloy
ASTM B 587-2006	Welded Brass Tube	Piping, Copper Alloy
ASTM B 687-1999 (R2005)^{e1}	Brass, Copper, and Chromium-Plated Pipe Nipples	Piping, Copper Alloy
ASTM B 813-2000^{e1}	Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube	Joints
ASTM B 819-2000 (R2006)	Seamless Copper Tube for Medical Gas Systems	Piping, Copper Alloy
ASTM B 828-2002	Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings	Joints
ASTM C 14-2007	Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe	Piping, Non-Metallic
ASTM C 296-2000 (R2004)^{e1}	Asbestos-Cement Pressure Pipe	Piping, Non-Metallic
ASTM C411-2005	Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus	Certification
ASTM C 412-2005a	Concrete Drain Tile	Piping, Non-Metallic
ASTM C 425-2004	Compression Joints for Vitrified Clay Pipe and Fittings	Joints
ASTM C 428-2005 (R2006)	Asbestos-Cement Nonpressure Sewer Pipe	Piping, Non-Metallic
ASTM C 443-2005a	Joints for Concrete Pipe and Manholes, Using Rubber Gaskets	Joints
ASTM C 478-2007	Precast Reinforced Concrete Manhole Sections	Miscellaneous
ASTM C 564-2003a	Rubber Gaskets for Cast-Iron Soil Pipe and Fittings	Joints
ASTM C 700-2007a	Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated	Piping, Non-Metallic
ASTM C 1053-2000 (R2005)	Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications	Piping, Non-Metallic
ASTM C 1173-2006	Flexible Transition Couplings for Underground Piping Systems	Joints
ASTM C 1277-2006	Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings	Joints
ASTM C 1440-2007	Thermoplastic Elastomeric (TPE) Gasket Materials for Drain, Waste, and Vent (DWV), Sewer, Sanitary and Storm Plumbing Systems	Joints
ASTM C 1460-2004	Shielded Transition Couplings for Use with Dissimilar DWV Pipe and Fittings Above Ground	Joints

Standard Number	Standard Title	Application
ASTM C 1461-2007	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
ASTM C 1540-2004	Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings	Joints
ASTM D 1527-1999 (R2005)	Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80	Piping, Plastic
ASTM D 1784-2007	Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds	Miscellaneous
ASTM D 1785-2006	Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120	Piping, Plastic
ASTM D 1869-1995 (R2005)[e1]	Rubber O-rings for Asbestos-Cement Pipe	Joints
ASTM D 2104-2003	Polyethylene (PE) Plastic Pipe, Schedule 40	Piping, Plastic
ASTM D 2122-1998 (R2004)	Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings	Fittings, Pipe
ASTM D 2235-2004	Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings	Joints
ASTM D 2239-2003	Polyethylene (PE) Plastic Pipe, (SDR-PR) Based on Controlled Inside Diameter	Piping, Plastic
ASTM D 2241-2005	Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)	Piping, Plastic
ASTM D 2321-2005	Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications	Piping, Plastic
ASTM D 2447-2003	Polyethylene (PE) Plastic Pipe, Schedules 40 and 80 Based on Outside Diameter	Piping, Plastic
ASTM D 2464-2006	Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80	Fittings
ASTM D 2466-2006	Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40	Fittings
ASTM D 2467-2006	Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80	Fittings
ASTM D 2513-2007b	Thermoplastic Gas Pressure Pipe Tubing and Fittings	Piping, Plastic
ASTM D 2517-2006	Reinforced Epoxy Resin Gas Pressure Pipe and Fittings	Piping, Plastic
ASTM D 2564-2004[e1]	Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems	Joints
ASTM D 2609-2002	Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe	Joints
ASTM D 2657-2007	Heat Fusion Joining of Polyolefin Pipe Fittings	Joints
ASTM D 2659-2005	Standard Test Method for Column Crush Properties of Blown Thermostatic Containers	Joints
ASTM D 2661-2006	Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings	Piping, Plastic
ASTM D 2665-2008	Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings	Piping, Plastic

Standard Number	Standard Title	Application
ASTM D 2672-1996a (R2003)	Joints for IPS PVC Pipe Using Solvent Cement	Joints
ASTM D 2680-2001	Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping	Piping, Plastic
ASTM D 2683-2003	Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing	Fittings
ASTM D 2729-2003	Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings	Piping, Plastic
ASTM D 2737-2003	Polyethylene (PE) Plastic Tubing	Piping, Plastic
ASTM D 2751-2005	Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings	Piping, Plastic
ASTM D 2774-2004^{e1}	Underground Installation of Thermoplastic Pressure Piping	Piping, Plastic
ASTM D 2846-2006	Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems	Piping, Plastic
ASTM D 2855-1996 (R2002)	Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings	Joints
ASTM D 2996-2001 (R2007)^{e1}	Filament-Wound “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe	Piping, Plastic
ASTM D 3034-2006	Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings	Piping, Plastic
ASTM D 3035-2006	Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter	Piping, Plastic
ASTM D 3122-1995 (R2002)	Solvent Cements for Styrene-Rubber (SR) Plastic Pipe and Fittings	Joints
ASTM D 3138-2004	Solvent Cements for Transition Joints, Acrylonitrile-Butadiene- Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Non-Pressure Piping Components	Joints
ASTM D 3139-1998 (R2005)	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals	Joints
ASTM D 3212-1996a (R2003)^{e1}	Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals	Joints
ASTM D 3261-2003	Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing	Fittings
ASTM D 3311-2006a	Drain, Waste, and Vent (DWV) Plastic Fittings Patterns	Miscellaneous
ASTM D 3965-2005	Rigid Acrylonitrile-Butadiene-Styrene (ABS) Materials for Pipe and Fittings	Miscellaneous
ASTM D 4068-2001	Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane	Fixtures
ASTM D 4101-2007	Polypropylene Injection and Extrusion Materials	Miscellaneous
ASTM D 4551-1996 (R2001)	Poly(Vinyl Chloride) (PVC) Plastic Flexible Concealed Water-Containment Membrane	Fixtures
ASTM D 6104-1997 (R2003)	Determining the Performance of Oil/Water Separators Subjected to Surface Run-Off	Fixtures
ASTM E 84-2007b	Surface Burning Characteristics of Building Materials	Miscellaneous
ASTM E 119-2007a	Fire Tests of Building Construction and Materials	Miscellaneous

Standard Number	Standard Title	Application
ASTM E 814-2006	Fire Tests of Through-Penetration Fire Stops	Miscellaneous
ASTM E 2231-2007	Standard Practice for Specimen Preparation and Mounting of Pipe and Duct Insulation Materials to Assess Surface Burning Characteristics	Insulation
ASTM F 402-2005	Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings	Joints
ASTM F 405-2005	Corrugated Polyethylene (PE) Pipe and Fittings	Piping, Plastic
ASTM F 409-2002	Thermoplastic Accessible and Replaceable Plastic Tube and Tubular Fittings	Piping, Plastic
ASTM F 437-2006	Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80	Fittings
ASTM F 438-2004	Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40	Fittings
ASTM F 439-2006	Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80	Fittings
ASTM F 441-2002	Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80	Piping, Plastic
ASTM F 442-1999 (R2005)	Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)	Piping, Plastic
ASTM F 446-1985 (R2004)^{e1}	Grab Bars and Accessories Installed in the Bathing Area	Miscellaneous
ASTM F 480-2006b	Thermoplastic Well Casing Pipe and Couplings Made in Standard Dimension Ratios (SDR) Schedules 40 and 80	Piping, Plastic
ASTM F 493-2004	Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings	Joints
ASTM F 628-2006^{e1}	Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core	Piping, Plastic
ASTM F 656-2002	Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings	Joints
ASTM F 667-2006	Large Diameter Corrugated Polyethylene Pipe and Fittings	Piping, Plastic
ASTM F 714-2006a	Polyethylene (PE) Plastic Pipe (SDR-PR) (Based on Outside Diameter)	Piping, Plastic
ASTM F 794-2003	Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter	Piping, Plastic
ASTM F 810-2007	Smoothwall Polyethylene (PE) Pipe for Use in Drainage and Waste Disposal Absorption Fields	Piping, Plastic
ASTM F 876-2006	Crosslinked Polyethylene (PEX) Tubing	Piping, Plastic
ASTM F 877-2005^{e1}	Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems	Piping, Plastic
ASTM F 891-2007	Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core	Piping, Plastic
ASTM F 894-2007	Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe	Piping, Plastic
ASTM F 949-2006a	Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings	Piping, Plastic

Standard Number	Standard Title	Application
ASTM F 1055-1998 (R2006)	Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing	Fittings
ASTM F 1216-2007b	Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube	Piping, Plastic
ASTM F 1281-2007	Crosslinked Polyethylene/Aluminum/Cross-linked Polyethylene (PEX-AL-PEX) Pressure Pipe	Piping, Plastic
ASTM F 1282-2006	Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe	Piping, Plastic
ASTM F 1290-2004	Electrofusion Joining Polyolefin Pipe and Fittings	Piping, Plastic
ASTM F 1335-2004	Pressure-Rated Composite Pipe and Fittings for Elevated Temperature Service	Piping, Plastic
ASTM F 1336-2007	Poly(Vinyl Chloride) (PVC) Gasketed Sewer Fittings	Fittings
ASTM F 1412-2001^{e1}	Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems	Piping, Plastic
ASTM F 1476-2007	Performance of Gasketed Mechanical Couplings for Use in Piping Application	Joints
ASTM F 1488-2003	Coextruded Composite Pipe	Piping, Plastic
ASTM F 1499-2001	Coextruded Composite Drain, Waste, and Vent Pipe (DWV)	Piping, Plastic
ASTM F 1673-2004	Polyvinylidene Fluoride (PVDF) Corrosive Waste Drainage Systems	Piping, Plastic
ASTM F 1743-1996 (R2003)	Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)	Piping, Plastic
ASTM F 1807-2007a^{e1}	Metal Insert Fittings Utilizing Copper Crimp Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing	Joints
ASTM F 1866-2007	Poly(Vinyl Chloride) (PVC) Plastic Schedule 40 Drainage and DWV Fabricated Fittings	Piping, Plastic
ASTM F 1924-2005	Plastic Mechanical Fitting for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing	Fittings
ASTM F 1948-2005	Metallic Mechanical Fittings for Use on Outside Diameter Controlled Thermoplastic Gas Distribution Pipe and Tubing	Fittings
ASTM F 1960-2007a	Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-Linked Polyethylene (PEX) Tubing	Fittings
ASTM F 1961-2002a	Metal Metallic Cold Flare Compression Fittings with Disc Springs for Cross-linked Polyethylene (PEX) Tubing	Fittings
ASTM F 1970-2005	Special Engineered Fittings or Appurtenances or Valves for Use in Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Systems	Miscellaneous
ASTM F 1973-2005	Factory Assembled Anodeless Riser and Transition Fitting in Polyethylene (PE) and Polymide 11 (PA11) Fuel Gas Distribution Systems	Fuel Gas

Standard Number	Standard Title	Application
ASTM F 1974-2004	Metal Insert Fittings for Polyethylene/Aluminum/Polyethylene and Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene Composite Pressure Pipe	Joints
ASTM F 1986-2001 (R2006)	Multilayer Pipe Type 2, Compression Fittings, and Compression Joints for Hot and Cold Drinking-Water Systems	Fittings
ASTM F 2080-2005	Cold-Expansion Fittings With Metal Compression Sleeves for Cross-linked Polyethylene (PEX) Pipe	Fittings
ASTM F 2098-2004^{e1}	Stainless Steel Clamps for Securing SDR9 Cross-linked Polyethylene (PEX) Tubing to Metal Insert Fittings	Joints
ASTM F 2159-2005	Plastic Insert Fittings Utilizing a Copper Ring for SDR9 Cross-linked Polyethylene (PEX) Tubing	Joints
ASTM F 2165-2002	Flexible Pre-Insulated Piping	Piping, Plastic
ASTM F 2262-2005	Cross-linked Polyethylene/Aluminum/Cross-linked Polyethylene Tubing OD Controlled SDR9	Piping, Plastic
ASTM F 2389-2007	Pressure-Rated Polypropylene (PP) Piping Systems	Piping, Plastic
ASTM F 2434-2005	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	Joints
ASTM F 2509-2006	Field-Assembled Anodeless Riser Kits for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing	Fuel Gas
AWS A5.8-2004	Specification for Filler Metals for Brazing and Braze Welding	Joints
AWS B2.2-1991	Brazing Procedure and Performance Qualification	Certification
AWS B2.4-2006	Welding Procedure and Performance Qualification for Thermoplastics	Joints, Certification
AWWA C110-2003	Ductile-Iron and Gray-Iron Fittings, for Water (same as ANSI A 21.10)	Fittings
AWWA C111-2007	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings (same as ANSI A 21.11)	Joints
AWWA C151-2002	Ductile-Iron Pipe, Centrifugally Cast, for Water	Piping, Ferrous
AWWA C153-2006	Ductile-Iron Compact Fittings, for Water Service	Fittings
AWWA C203-2002	Coal-Tar Protective Coatings and Linings for Steel Water Pipelines Enamel and Tape – Hot Applied	Miscellaneous
AWWA C213-2001	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines	Miscellaneous
AWWA C215-2004	Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines	Miscellaneous
AWWA C400-2003	Asbestos-Cement Pressure Pipe, 4 in. through 16 in. (100mm through 400mm) for Water Distribution and Transmission	Piping, Non-Metallic
AWWA C500-2002	Metal-Seated Service Gate Valves for Water Supply Service	Valves
AWWA C504-2006	Rubber-Seated Butterfly Valves	Valves

Standard Number	Standard Title	Application
AWWA C507-2005	Ball Valves, 6 in. through 48 in. (150mm through 1,200mm)	Valves
AWWA C510-1997	Double Check Valve Backflow Prevention Assembly	Backflow Protection
AWWA C511-1997	Reduced-Pressure Principle Backflow Prevention Assembly	Backflow Protection
AWWA C606-2006	Grooved and Shouldered Joints	Joints
AWWA C652-2002	Disinfection of Water-Storage Facilities	Storage
AWWA C900-2007	Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings 4 in. through 12 in. (100mm through 300mm), for Water Distribution	Piping, Plastic
AWWA C901-2002	Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. (13mm) through 3 in. (76mm), for Water Service	Piping, Plastic
AWWA C904-2006	Cross-linked Polyethylene (PEX) Pressure Pipe, 1/2 in. (12mm) through 3 in. (76mm), for Water Service	Piping, Plastic
AWWA C907-2004	Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings 4 in. through 12 in. (100mm through 300mm)	Fittings
AWWA D 100-2005	Welded Carbon Steel Tanks for Water Storage	Tanks
AWWA D 102-2006	Coating Steal Water-Storage Tanks	Coating
AWWA D 103-1997	Factory-Coated Bolted Steel Tanks for Water Storage	Tanks
AWWA D 120-2002	Standard for Thermosetting Fiberglass-Reinforced Plastic Tanks	Tanks
CGA C 9-2008	Standard Color Marking of Compressed Gas Containers for Medical Use	Miscellaneous
CGA G 4.1-2004	Cleaning Equipment for Oxygen Service	Miscellaneous
CGA O 2-Dir-2000	Directory of Cleaning Agents for Oxygen Service	Miscellaneous
CGA V-1-2005	Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connection	Valves
CGA S-1.3-2005	Pressure Relief Device Standards-Part 3- Stationary Storage Containers for Compressed Gases	Fuel Gas
CISPI 301-2005	Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications	Piping, Ferrous
CISPI 310-2004	Couplings for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications	Joints
CSA No. 3-1992	U.S. Requirements for Excess Flow Valves	Valves
CSA A257-2003	Concrete Pipe and Manhole Sections	Piping
CSA B45.0-2002	General Requirements for Plumbing Fixtures	Fixtures
CSA B45.1-2002	Ceramic Plumbing Fixtures	Fixtures
CSA B45.2-2002	Enameled Cast-Iron Plumbing Fixtures	Fixtures
CSA B45.3-2002	Porcelain-Enameled Steel Plumbing Fixtures	Fixtures
CSA B45.4-2002	Stainless Steel Plumbing Fixtures	Fixtures
CSA B45.5-2002	Plastic Plumbing Fixtures	Fixtures
CSA B45.9-2002	Macerating Systems and Related Components	DWV Components
CSA B45.10-2001 (R2006)	Hydromassage Bathtubs	Fixtures
CSA B45.11-2004	Glass Lavatories	Fixtures
CSA B64-2007	Backflow Preventers and Vacuum Breakers	Backflow Protection

Standard Number	Standard Title	Application
CSA B64.1.1-2007	Atmospheric Vacuum Breakers (AVB)	Backflow Protection
CSA B64.1.2-2007	Pressure Vacuum Breakers (PVB)	Backflow Protection
CSA B64.2-2007	Hose Connection Vacuum Breakers (HCVB)	Backflow Protection
CSA B64.2.1.1-2001 (R2006)	Hose Connection Vacuum Breaker, Hose Connection Dual Check Type (HCDVB)	Backflow Protection
CSA B64.4-2007	Reduced Pressure Principle Backflow Preventers (RP)	Backflow Protection
CSA B64.4.1-2001 (R2006)	Reduced Pressure Principle Backflow Preventers for Fire System (RPF)	Backflow Protection
CSA B64.5-2001 (R2006)	Double Check Valve (DVCA) Backflow Preventers	Backflow Protection
CSA B64.5.1-2001 (R2006)	Double Check Valve Backflow Preventers for Fire System (DVCAF)	Backflow Protection
CSA B64.7-2001	Laboratory Faucet Vacuum Breakers (LFVB)	Backflow Protection
CSA B79-2005	Floor Drains, Area Drains, Shower Drains, and Cleanouts for Residential Construction	DWV Components
CSA B125.3-2005	Plumbing Fittings	Valves
CSA B128.1-2006/B128.2-2006	Design and Installation of Non-Potable Water Systems/ Maintenance and Field Testing of Non-Potable Water Systems	Miscellaneous
CSA B137.1-2005	Polyethylene (PE) Pipe, Tubing, and Fittings for Cold Water Pressure Services	Piping, Plastic
CSA B137.5-2005	Crosslinked Polyethylene (PEX) Tubing Systems for Pressure Applications	Piping, Plastic
CSA B137.9-2005	Polyethylene/Aluminum/Polyethylene Composite Pressure-Pipe Systems	Piping, Plastic
CSA B137.10-2005	Cross linked Polyethylene/Aluminum/Cross linked Polyethylene Composite Pressure-Pipe Systems	Piping, Plastic
CSA B137.11-2008	Polypropylene (PP-R) Pipe and Fittings for Pressure Applications-Plumbing Products and Materials	Piping, Plastic
CSA B181.3-2006	Polyolefin Laboratory Drainage Systems	Piping, Plastic
CSA B242-2005	Groove and Shoulder Type Mechanical Pipe Couplings	Fittings
CSA B356-2000 (R2005)	Water Pressure Reducing Valves for Domestic Water Supply Systems	Valves
CSA G401-2007	Corrugated Steel Pipe Products	Miscellaneous
CSA LC 1-2005	Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing (CSST) (same as CSA 6.26)	Fuel Gas
CSA LC 3-2000	Appliance Stands and Drain Pans	Miscellaneous
CSA LC4-2007	Press-Connect Copper and Copper Alloy Fittings for Use in Fuel Gas Distribution Systems (same as CSA 6.32)	Fuel Gas
CSA Z21.5.1-2006	Gas Clothes Dryers -Volume I- Type 1 Clothes Dryers (same as CSA 7.1)	Fuel Gas
CSA Z21.5.2a-2006	Gas Clothes Dryers -Volume 2- Type 2 Clothes Dryers (same as CSA 7.2)	Fuel Gas
CSA Z21.10.1b-2006	Gas Water Heaters – Volume I – Storage Water Heaters with Input Ratings of 75,000 Btu per Hour or Less (same as CSA 4.1)	Appliances

Standard Number	Standard Title	Application
CSA Z21.10.3a-2007	Gas Water Heaters – Volume III, Storage, with Input Ratings Above 75,000 BTu per Hour, Circulating and Instantaneous (same as CSA 4.3)	Appliances
CSA Z21.12b-1994 (R2000)	Draft Hoods	Appliances
CSA Z21.13b-2007	Gas-Fired Low-Pressure Steam and Hot-Water Boilers	Appliances
CSA Z21.15b-2006	Manually Operated Gas Valves for Appliances, Appliance Connector, Valves, and Hose End Valves (same as CSA 9.1)	Valves
CSA Z21.22b-2001 (R2003)	Relief Valves for Hot-Water Supply Systems (same as CSA 4.4)	Valves
CSA Z21.24-2006	Connectors for Gas Appliances (same as CSA 6.10)	Appliances
CSA Z21.40.1a-1997 (R2002)	Quick Connect Devices for Use with Gas Fuel (same as CSA 2.91)	Joints
CSA Z21.41a-2005	Quick-Disconnect Devices for Use with Gas Fuel Appliances (same as CSA CGA 6.9)	Joints
CSA Z21.47a-2007	Gas-Fired Central Furnaces (same as CSA 2.3)	Fuel Gas
CSA Z21.56-2006	Gas-Fired Pool Heaters (same as CSA 4.7)	Swimming Pools and Spas
CSA Z21.69b-2006	Connectors for Movable Gas Appliances (same as CSA 6.16)	Appliances
CSA Z21.80a-2005	Line Pressure Regulators (same as CSA 6.22)	Fuel Gas
CSA Z21.81a-2007	Cylinder Connection Devices (same as CSA 6.25)	Fuel Gas
CSA Z21.86b-2007	Vented Gas-Fired Space-Heating Appliances (same as CSA 2.32)	Appliances
CSA Z83.11-2006	Gas Food Service Equipment (same as CSA 1.8)	Fuel Gas
CSA Z317.1-1999 (R2002)	Special Requirements for Plumbing Installations in Health Care Facilities.	Miscellaneous
FCI 74-1-1991	Spring Loaded Lift Disc Check Valve	Valves
IAPMO IGC 154-2006a	Tub/Shower Enclosures with Factory-Installed Fittings Shower Panel, Shower Door, and Threshold Assemblies	Fixtures
IAPMO IGC 157-2007	Ball Valves	Valves
IAPMO IGC 172-2005	Glass Lavatories and Sinks	Fixtures
IAPMO IGC 193-2006	Safety Plates and Plate Straps	Miscellaneous
IAPMO IGC 194-2004a	Copper Alloy or Aluminum Alloy Sinks and Lavatories	Fixtures
IAPMO IGC 217-2007	Metallic Bathtub Shower Pans and Whirlpool Bathtubs	Fixtures
IAPMO IGC 223-2007	Polypropylene-Aluminum-Polypropylene Multilayer Piping Systems for Hot and Cold Water	Piping, Plastic
IAPMO IGC 226-2006a	Drinking Water Fountains With or Without Chiller or Heater	Fixtures
IAPMO PS 23-2006a	Dishwasher Drain Air Gaps	Backflow Protection
IAPMO PS 25-2002	Metallic Fittings for Joining Polyethylene Pipe for Water Service and Yard Piping	Joints
IAPMO PS 33-2007a	Flexible PVC Hose for Pools, Hot Tubs, Spas and Jetted Bathtub	Miscellaneous
IAPMO PS 34-2003	Encasement Sleeve for Potable Water Pipe and Tubing	Piping
IAPMO PS 36-1990	Lead Free Sealing Compounds for Threaded Joints	Joints

Standard Number	Standard Title	Application
IAPMO PS 37-1990	Black Plastic PVC or PE Pressure-Sensitive Corrosion Preventive Tape	Miscellaneous
IAPMO PS 42-1996	Pipe Alignment and Secondary Support Systems	Miscellaneous
IAPMO PS 43-2007	Cushioned Bathtubs and Whirlpool Bathtub Appliances	Fixtures
IAPMO PS 46-2006a	Field Fabricated Tiling Kits	Miscellaneous
IAPMO PS 50-2005	Flush Valves with Dual Flush Devices For Water Closets or Water Closet Tank with Integral Flush Valves with a Dual Flush Device	Fixtures
IAPMO PS 51-1998	Plastic and Metallic Expansion Joints	Joints
IAPMO PS 52-2006	Sumps and Sewage Ejector Tanks with or without a Pump	DWV Components
IAPMO PS 53-1992	Grooved Mechanical Pipe Couplings and Grooved End Fittings	Joints
IAPMO PS 54-2006	Metallic and Plastic Utility Boxes	Miscellaneous
IAPMO PS 55-1992	Bathwaste Strainer Drains	Fixtures
IAPMO PS 57-2002	PVC Hydraulically Actuated Diaphragm Type Water Control Valves	Valves
IAPMO PS 59-1992	Septic Effluent and Waste Water Diverter Valves	DWV Components
IAPMO PS 60-1996	Sewage Holding Tank Containing Sewage Ejector Pump for Direct Mounted Water Closet	DWV Components
IAPMO PS 61-2006a	Fabricated Stainless Steel Water Closets or Urinals	Fixtures
IAPMO PS 63-2005	Plastic Leaching Chambers	DWV Components
IAPMO PS 64-2007	Pipe Flashings	Miscellaneous
IAPMO PS 65-2002	Airgap Units for Water Conditioning Equipment Installation	Backflow Protection
IAPMO PS 66-2000	Dielectric Waterway Fittings	Fittings
IAPMO PS 67-1993	Early-Closure Replacement Flappers or Early-Closure Replacement Flapper With Mechanical Assemblies	Fixtures
IAPMO PS 69-2006	Bathwaste and Overflow Assemblies with Tub Filler Spout	Piping, Plastic
IAPMO PS 72-2007	Valves with Atmospheric Vacuum Breakers	Valves
IAPMO PS 73-1993	Dental Vacuum Pumps	Miscellaneous
IAPMO PS 76-1995	Ballcock or Flushometer Valve Tailpiece Trap Primers and Trap Primer Receptors/Adapters	DWV Components
IAPMO PS 79-2005	Multiport Electronic Trap Primer	DWV Components
IAPMO PS 80-2007	Clarifiers	DWV Components
IAPMO PS 81-2006	Precast Concrete Seepage Pit Liners and Covers	DWV Components
IAPMO PS 82-1995	Fiberglass (Glass Fiber Reinforced Thermosetting Resin) Fittings	Fittings
IAPMO PS 85-1995	Tools for Mechanically Formed Tee Connections in Copper Tubing	Miscellaneous
IAPMO PS 86-1995	Rainwater Diverter Valve for Non-Roofed Area Slabs	DWV Components
IAPMO PS 87-1995	Diverter and Shutoff Valves for Pool/Spas	Valves
IAPMO PS 88-2002	Pre-Pressurized Potable Water Tanks	Miscellaneous

Standard Number	Standard Title	Application
IAPMO PS 89-1995	Soaking and Hydrotherapy (Whirlpool) Bathtubs with Hydraulic Seatlift	Fixtures
IAPMO PS 90- 2006	Elastomeric Test Caps/Cleanout Caps	DWV Components
IAPMO PS 91-2005a	Plastic Stabilizers for Use with Plastic Closet Bends	Piping, Plastic
IAPMO PS 92-2003	Heat Exchangers	Miscellaneous
IAPMO PS 93-2004a	Water Closet Seats with Spray, Water Closet Seats with Spray and Other Devices with Spray for Water Closets Supplied with Hot and Cold Water	Fixtures
IAPMO PS 94-2001a	P-Trap, Supply Stop, and Riser Insulated Protector	Miscellaneous
IAPMO PS 95-2001	Drain, Waste, and Vent Hangers and Plastic Pipe Support Hooks Piping	Fixtures
IAPMO PS 96-2002	Passive Direct Solar Water Heaters	Miscellaneous
IAPMO PS 98-1996	Prefabricated Fiberglass Church Baptisteries	Fixtures
IAPMO PS 99-2007	Terrazzo Marble, Concrete, Granite, and Slate Plumbing Fixtures	Fixtures
IAPMO PS 100-1996	Porous Filter Protector for Subdrain Weep Holes	DWV Components
IAPMO PS 101-1997	Suction Relief Valves	Valves
IAPMO PS 104-1997	Pressure Relief Connection for Dispensing Equipment	Valves
IAPMO PS 105-1997	Polyethylene Distribution Boxes	DWV Components
IAPMO PS 106-2006	Prefabricated, Tileable Shower Receptors	Fixtures
IAPMO PS 107-1998	Aramid Reinforced Rubber Hose for Use in Non-Potable Water Radiant Heating and Snow Melting	Piping, Plastic
IAPMO PS 108-1998	Restaurant Fire Suppression Systems	Appliances
IAPMO PS 110-2006a	PVC Cold Water Compression Fittings	Fittings
IAPMO PS 111-1999	PVC Cold Water Gripper Fittings	Fittings
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
IAPMO PS 113-1999^{e1}	Hydraulically Powered Household Food Waster Disposers	Appliances
IAPMO PS 114-1999^{e1}	Remote, Floor Box Industrial Water Supply, Air Supply, Drainage	Miscellaneous
IAPMO PS 115-2007	Hot Water On-Demand or Automatic Activated Hot Water Pumping Systems	Miscellaneous
IAPMO PS 116-1999	Hot Water Circulating Devices Which Do Not Use a Pump	Miscellaneous
IAPMO PS 117-2006	Copper and Copper Alloy Fittings with Press-Type or Nail-Type Connections for Installation on Copper Tubing	Fittings
IAPMO PS 119-2006	Water Energized Sump Pump	Miscellaneous
IAPMO Z124.1.2-2005	Plastic Bathtub and Shower Units	Fixtures
IAPMO Z124.3-2005	Plastic Lavatories	Fixtures
IAPMO Z124.4-2006	Plastic Water Closet Bowls and Tanks	Fixtures
IAPMO Z124.5-2006	Plastic Toilet (Water Closet) Seats	Fixtures
IAPMO Z124.6-2006	Plastic Sinks	Fixtures

Standard Number	Standard Title	Application
IAPMO Z124.7-1997	Prefabricated Plastic Spa Shells	Fixtures
IAPMO Z124.8-1990	Plastic Bathtub Liners	Fixtures
IAPMO Z124.9-2004	Plastic Urinal Fixtures	Fixtures
IAPMO PS Z1000- 2007	Prefabricated Septic Tanks	DWV Components
IAPMO PS Z1001-2007	Prefabricated Gravity Grease Interceptors	Fixtures
ICC A117.1-2003	Accessible and Usable Buildings and Facilities	Miscellaneous
ISEA Z358.1-2004	Emergency Eyewash and Shower Equipment	Miscellaneous
ISO Guide 65-1996	General Requirements for Bodies Operating Product Certification Systems	Certification
MSS SP-25-1998	Standard Marking System for Valves, Fittings, Flanges, and Unions	Miscellaneous
MSS SP-42-2004	Class 150 Corrosion-Resistant Gate, Globe, Angle, and Check Valves with Flanged and Butt Weld Ends	Piping, Ferrous
MSS SP-44- 2006	Steel Pipeline Flanges	Fittings
MSS SP-58-2002	Pipe Hangers and Supports – Materials, Design, and Manufacture	Miscellaneous
MSS SP-67-2002a	Butterfly Valves	Valves
MSS SP-69-2003	Pipe Hangers and Supports - Selection and Application	Miscellaneous
MSS SP-70- 2006	Gray-Iron Gate Valves, Flanged and Threaded Ends	Valves
MSS SP-71- 2005	Gray-Iron Swing Check Valves, Flanged and Threaded Ends	Valves
MSS SP-72-1999	Ball Valves with Flanged or Butt-Welding Ends for General Service	Valves
MSS SP-78-2005a	Gray-Iron Plug Valves, Flanged and Threaded Ends	Valves
MSS SP-80-2003	Bronze Gate, Globe, Angle, and Check Valves	Valves
MSS SP-83-2006	Class 3000 Steel Pipe Unions Socket Welding and Threaded	Joints
MSS SP-89-2003	Pipe Hangars and Supports - Fabrication and Installation Practices	Miscellaneous
MSS SP-104-2003	Wrought Copper Solder Joint Pressure Fittings	Fittings
MSS SP-106-2003	Cast Copper Alloy Flanges and Flanged Fittings, Class 125, 150, and 300	Fittings
MSS SP-109-1997 (R2006)	Welded Fabricated Copper Solder Joint Pressure Fittings	Fittings
MSS SP-123-1998 (R2006)	Non-Ferrous Threaded and Solder-Joint Unions for Use with Copper Water Tube	Joints
NEMA 250-2003	Enclosures for Electrical Equipment	Enclosures
NFPA 13R-2007	Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height	Miscellaneous
NFPA 13D-2007	Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes	Miscellaneous
NFPA 31-2006	Installation of Oil-Burning Equipment	Miscellaneous
NFPA 54/Z223.1-2006	National Fuel Gas Code (same as ANSI Z 223.1)	Fuel Gas
NFPA 58-2004	Liquefied Petroleum Gas Code	Fuel Gas
NFPA 70-2008	National Electrical Code	Miscellaneous

Standard Number	Standard Title	Application
NFPA 85-2007	Boiler and Combustion Systems Hazards Code	Appliances
NFPA 99-2005	Health Care Facilities	Piping
NFPA 99C-2005	Gas and Vacuum Systems	Piping
NFPA 130-2007	Fixed Guideway Transit and Passenger Rail Systems	Miscellaneous
NFPA 211-2006	Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances	Miscellaneous
NFPA 255-2006	Standard Method of Test for Surface Burning Characteristics of the Building Material	Miscellaneous
NFPA 274-2003	Standard Test Method to Evaluate Fire Performance Characteristics of Pipe Insulation	Insulation, Pipe
NFPA 501A-2005	Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities	Manufactured Home
NFPA 502-2008	Road Tunnels, Bridges, and Other Limited Access Highways	Miscellaneous
NFPA 1981-2006	Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency	Miscellaneous
NFPA 1989-2008	Breathing Air Quality for Fire and Emergency Services Respiratory Protection	Miscellaneous
NFPA 5000-2005	Building Construction and Safety Code	Miscellaneous
NSF 2-2007	Food Equipment Appliances	Appliances
NSF 3-2007	Commercial Warewashing Equipment	Appliances
NSF 4-2007e	Commercial Cooking, Rethermalization, and Powered Hot Food Holding and Transport Equipment	Appliances
NSF 5-2005	Water Heaters, Hot Water Supply Boilers, and Heat Recovery Equipment	Appliances
NSF 12-2007	Automatic Ice Making Equipment	Appliances
NSF 14-2007	Plastic Piping System Components and Related Materials	Piping, Plastic
NSF 18-2007	Manual Food and Beverage Dispensing Equipment	Appliances
NSF 29-2007	Detergent and Chemical Feeders for Commercial Spray-type Dishwashing Machines	Appliances
NSF 40-2005	Residential Wastewater Treatment Systems	DWV Components
NSF 41-2005	Non-Liquid Saturated Treatment Systems	DWV Components
NSF 42-2007e	Drinking Water Treatment Units–Aesthetic Effects	Appliances
NSF 44-2007	Residential Cation Exchange Water Softeners	Appliances
NSF 46-2007	Evaluation of Components and Devices Used in Wastewater Treatment Systems	DWV Components
NSF 53-2007a	Drinking Water Treatment Units–Health Effects	Appliances
NSF 55-2007	Ultraviolet Microbiological Water Treatment Systems	Appliances
NSF 58-2007	Reverse-Osmosis Drinking Water Treatment Systems	Appliances
NSF 61-2007a	Drinking Water System Components– Health Effects	Miscellaneous
NSF 62-2007	Drinking Water Distillation Systems	Appliances
NSF 169-2007	Special Purpose Food Equipment and Devices	Appliances
PDI G-101-2007	Testing and Rating Procedure for Grease Interceptors with Appendix of Sizing and Installation Data	Fixtures

Standard Number	Standard Title	Application
PDI-WH 201-2006	Water Hammer Arresters	Miscellaneous, Water Supply Component
PSAI Z4.1-1986 (R2005)	Sanitation in Places of Employment - Minimum Requirements	Miscellaneous
SAE J 512-1997	Automotive Tube Fittings	Fittings
SAE J1670-2005	Type F Clamps for Plumbing Applications	Joints
TCNA A118.10-2005	Load, Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone Installations	Fixtures
TCNA A137.1-1988	Ceramic Tile (surfaces)	Miscellaneous
UL 70-2001	Septic Tanks, Bituminous Coated Metal	DWV Components
UL 80-2007	Steel Tanks for Oil-Burner Fuel	Miscellaneous
UL 103-2001	Factory-Built Chimneys for Residential Type and Building Heating Appliances (with revisions through June 30, 2006)	Miscellaneous
UL 125-2007	Valves for Anhydrous Ammonia and LP-Gas (Other than Safety Relief with revisions through September 17, 2001)	Valves
UL 132-2007	Safety Relief Valves for Anhydrous Ammonia and LP-Gas (with revisions through November 15, 2002)	Valves
UL 144-1999	LP-Gas Regulators (with revisions through January 18, 2002)	Valves
UL 174-2004	Household Electric Storage Tank Water Heaters (with revisions through May 19, 2006)	Appliances
UL 252-2003	Compressed Gas Regulators	Valves
UL 263-2003	Fire Tests of Building Construction and Materials	Miscellaneous
UL 296-2003	Oil Burners (with revisions through February 24, 2006)	Appliances
UL 343-1997	Pumps for Oil-Burning Appliances (with revisions through May 4, 2006)	Pumps
UL 352-2006	Constant-Level Oil Valves	Valves
UL 378-2006	Draft Equipment	Miscellaneous
UL 399-1993	Drinking-Water Coolers (with revisions through March 3, 2006)	Appliances
UL 404-2005	Gauges, Indicating Pressure for Compressed Gas Service	Fuel Gas
UL 429-1999	Electrically Operated Valves	Valves
UL 430-2004	Waste Disposers (with revisions through May 9, 2006)	Appliances
UL 441-1996	Gas Vents (with revisions through August 9, 2006)	Fuel Gas
UL 443-2006	Steel Auxiliary Tanks for Oil-Burner Fuel	Miscellaneous
UL 499-2005	Electric Heating Appliances (with revisions through March 31, 2006)	Appliances
UL 536-1997	Flexible Metallic Hose	Fuel Gas
UL 563-1995	Ice Makers (with revisions through February 27, 2006)	Appliances
UL 565-1998	Liquid-Level Gauges and Indicators for Anhydrous Ammonia and LP-Gas	Miscellaneous
UL 569-1995	Pigtails and Flexible Hose Connectors for LP-Gas (with revisions through January 31, 2001)	Fuel Gas

Table 14-1 continued

Standard Number	Standard Title	Application
UL 723-2007	Test for Surface Burning Characteristics of Building Materials (with revisions through May 27, 2005)	Miscellaneous
UL 726-1995	Oil-Fired Boiler Assemblies (with revisions through March 8, 2006)	Appliances
UL 732-1995	Oil-Fired Storage Tank Water Heaters (with revisions through February 3, 2005)	Appliances
UL 749-1997	Household Dishwashers (with revisions through March 31, 2003)	Appliances
UL 778-2002	Motor-Operated Water Pumps (with revisions through February 1, 2006)	Pumps
UL 834-2004	Heating, Water Supply, and Power Boilers–Electric (with revisions through March 30, 2006)	Appliances
UL 921-2006	Commercial Dishwashers	Appliances
UL 959-2001	Medium Heat Appliance Factory Built Chimneys (with revisions through September 29, 2006)	Appliances
UL 1081-1997	Swimming Pool Pumps, Filters, and Chlorinators	Swimming Pools and Spas
UL 1206-2003	Electric Commercial Clothes Washing Equipment	Appliances
UL 1261-2001	Electric Water Heaters for Pools and Tubs	Appliances
UL 1331-2005	Station Inlets and Outlets	Miscellaneous
UL 1453-2004	Electric Booster and Commercial Storage Tank Water Heaters (with revisions through May 19, 2006)	Appliances
UL 1469-2006	Strength of Body and Hydraulic Pressure Loss Testing of Backflow Special Check Valves	Valves
UL 1479-2003	Fire Tests of Through-Penetration Firestops	Miscellaneous
UL 1746-2007	External Corrosion Protection Systems for Steel Underground Storage Tanks	Tanks
UL 1951-1994	Electric Plumbing Accessories (with revisions through October 22, 2003)	Miscellaneous
UL 2157-1997	Electric Clothes Washing Machines and Extractors	Appliances
WQA S-300-2000	Point-of-Use Low Pressure Reverse Osmosis Drinking Water Systems	Appliances

ABBREVIATIONS IN TABLE 14-1

AHAM	Association of Home Appliance Manufacturers, 1111 19th Street, N.W., Suite 402, Washington DC 20036.
APSP	Association of Pool and Spa Professionals, 2111 Eisenhower Avenue, Alexandria, VA 22314.
ARI	Air-Conditioning and Refrigeration Institute, 4100 N. Fairfax Drive, Suite 200, Arlington, VA 22203.
ASCE	The American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191.
ASHRAE	The American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., 1791 Tullie Circle, NE, Atlanta, GA 30329-2305.
ASME	The American Society of Mechanical Engineering, Three Park Avenue, New York, NY 10016.
ASPE	American Society of Plumbing Engineers, 8614 Catalpa Ave, Suite 1007, Chicago, IL 60656.
ASSE	American Society of Sanitary Engineering, 901 Canterbury, Suite A, Westlake, Ohio 44145.
ASTM	American Society of Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.
AWS	American Welding Society, 550 NW LeJuene Road, Miami, FL 33126.
AWWA	American Water Works Association, 6666 W. Quincy Avenue, Denver, CO 80235.
CGA	Compressed Gas Association, 4221 Walney Road, 5th Floor, 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, L4W 5N6, Canada.
FCI	Fluids Control Institute, 1300 Sumner Avenue, Cleveland, Ohio 44115.
IAPMO	International Association of Plumbing and Mechanical Officials, 5001 E. Philadelphia Street, Ontario, CA 91761.
ICC	International Code Council, 5203 Leesburg Pike, Suite 600, Falls Church, VA 22041.
ISEA	International Safety Equipment Association, 1901 N. Moore Street, Arlington, VA 22209-1762.
ISO	International Organization for Standardization, 1 Rue de Varebre, 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.
NEMA	National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1752, Rosslyn, VA 22209.
NFPA	National Fire Protection Association, P.O. Box 9101, 1 Batterymarch Park, Quincy, MA 02269-9101.
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	28535 Orchard Calle Road, Suite 206, Farmington Hills, MI 48334.
TCNA	Tile Council of North America, Inc. 100 Clemson Research Blvd., Anderson, SC 29625.
UL	Underwriters' Laboratories, Inc., 333 Pfingsten Road, Northbrook, IL 60062.
WQA	Water Quality Association, 4151 Naperville Road, Lisle, IL 60532-1088.

CHAPTER 15

FIRESTOP PROTECTION

1501.0 General Requirements.

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 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 Firestop materials shall be installed in accordance with this chapter, the Building Code, and the manufacturer's instructions.

1504.0 Combustible Piping Installations.

1504.1 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 When 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 Penetrations shall be protected by an approved penetration firestop system installed as tested in accordance with ASTM E119, ASTM E814, UL 263, UL 1479 or equivalent International Standard(s) approved by the Authority Having Jurisdiction with a positive pressure differential of not less than 0.25mm (0.01 in.) of water. 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 When piping penetrates a rated assembly, combustible piping shall not connect to non-combustible piping unless it can be demonstrated that the transition complies with the requirements 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 should 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 the requirements for a sleeve penetrating item.

1505.0 Noncombustible Piping Installations.

1505.1 Noncombustible piping installations shall be protected in accordance with the appropriate fire resistance rating requirements in the Building Code that lists the acceptable area, height, and type of construction for use in specific occupancies to ensure the compliance and integrity of the fire-resistance rating prescribed.

1505.2 When 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 150mm (6 in.), and the opening size shall not exceed 929cm^2 (144 in.^{2}).

The thickness of concrete, mortar, or grout should 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, or

(2) The material used to fill the annular space shall prevent the passage of flame and hot gases sufficient to ignite cotton waste for the time period equivalent to the fire-resistance

rating of the assembly, when tested to standard(s) referenced in Section 1505.3.

1505.3 Penetrations shall be protected by an approved penetration firestop system installed as tested in accordance with ASTM E119, ASTM E814, UL 263, UL 1479 or equivalent International Standard(s) approved by the Authority Having Jurisdiction with a positive pressure differential of not less than 0.25mm (0.01 in.) of water. 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 When piping penetrates a rated assembly, combustible piping shall not connect to non-combustible piping unless it can be demonstrated that the transition complies with the requirements of Section 1505.3.

1505.5 Unshielded couplings shall not be used to connect noncombustible piping unless it can be demonstrated that the fire-resistive integrity of the penetration is maintained.

1505.6 Sleeves. Where sleeves are used, the sleeves should 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 the requirements for a sleeve-penetrating item.

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 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 standards applied by the installer, construction documents, specifications, and applicable manufacturer's product information.

1506.3 The Authority Having Jurisdiction shall determine the type, size, and quantity of penetrations to be inspected.

1506.4 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, 2, 3, or 4 hour) and T ratings (0, 1, 2, 3, or 4 hour) of the firestop penetration firestop systems are suitable for the assembly being penetrated.

(2) The penetrating firestop systems are appropriate for the penetrating items, as documented through testing of the systems conducted by an independent testing agency.

(3) The penetrating firestop system is installed as tested.

Chapter 16

NONPOTABLE WATER REUSE

Part I

1601.0 Gray Water Systems – General.

(A) The provisions of Part I shall apply to the construction, alteration, and repair of gray water systems for underground landscape irrigation. Gray water installations shall be designed by a registered or licensed person to perform plumbing design work.

(B) The type of gray water system shall depend on the level of treatment (primary, secondary, specific treatment process such as filtration, disinfection and nutrient removal), effluent water quality, effluent quantity (daily use, seasonal, minimum and maximum flows) and location of treatment (onsite, regionally or supplied by the public utility company) for its intended uses.

(C) Sanitary drainage systems shall be designed as a dual plumbed gray water system in accordance with this chapter. Gray water systems shall be designed to separate gray water from black water. Black water shall discharge into the sanitary drainage system in accordance with Chapter 7 of this code.

1602.0 Permit.

It shall be unacceptable for any person to construct, install, or alter, or cause to be constructed, installed, or altered any dual plumbed system for the installation of a gray water system in a building or on a premise without first obtaining a permit to do such work from the Authority Having Jurisdiction.

1603.0 Location of Treatment.

The location of the treatment of gray water systems shall be approved by the Authority Having Jurisdiction and in accordance with the Guide to Water Supply Regulations.

(A) Onsite Treatment. Onsite treatment is the collection, treatment and reuse of wastewater at or near the point of generation.

(B) Regional Treatment. Regional treatment is the collection, treatment and reuse of wastewater at a centralized location.

(C) Public Utility Treatment Plant. Public utility treatment is the collection, treatment and reuse of wastewater at a centralized location for large scale operations or industrial scale treatment.

1604.0 Materials.

Above-ground and underground building drainage and vent pipe for gray water systems shall comply with Table 7-1. Distribution piping intended to supply uses for water closets, urinals, trap primers for floor drains, floor sinks, irrigation, industrial process and water features for gray water systems shall comply with Table 6-4.

1605.0 Wastewater Connections.

Gray water systems shall only receive the discharge of bathtubs, showers, and bathroom wash basins, clothes washers, and laundry tubs.

1606.0 Potable Water Connections. Potable water connections between a gray water system for makeup water shall be protected against back-pressure and back-siphonage in accordance with Sections 602.0 and 603.0.

1607.0 Holding Tanks.

Gray water shall be collected in an approved holding tank of corrosion-resistant material, shall meet approved applicable recognized standards for the intended use, and approved by the Authority Having Jurisdiction. Holding tanks constructed of alternate material shall be approved by the Authority Having Jurisdiction provided they comply with approved applicable standards.

1608.0 Landscape Irrigation - General.

(A) Gray water systems for subsurface landscape irrigation shall discharge gray water below the ground surface. Where gray water is treated and disinfected to acceptable effluent quality guidelines in accordance with the provisions set forth by the Authority Having Jurisdiction shall be permitted to be discharged to a land application area by surface irrigation.

(B) The gray water system for subsurface irrigation/disposal fields shall consist of a holding tank or tanks and shall be sized to limit the retention time of gray water to a maximum of 24 hours. The gray water system for surface irrigation shall consist of a holding tank or tanks and shall be sized to limit the retention time of gray water to a maximum of 72 hours.

(C) No gray water system for irrigation purposes or part thereof shall be located on any plot other than the plot that is the site of the building or structure that discharges the gray water, nor shall any gray water system or part thereof be located at any point having less than the minimum distances in accordance with Table 16-1.

(D) No permit for any gray water system shall be issued until a plot plan with appropriate data satisfactory to the Authority Having Jurisdiction has been submitted and approved. When there is insufficient plot area or inappropriate soil conditions for adequate absorption of the gray water, as determined by the Authority Having Jurisdiction, no gray water system shall be permitted.

(E) No permit shall be issued for a gray water system on any property in a geologically sensitive area as determined by the Authority Having Jurisdiction.

(F) Private sewage disposal systems existing or to be constructed on the premises shall comply with this chapter. In addition, appropriate clearances from the gray water systems shall be maintained in accordance with Table 16-1. The capacity of the private sewage disposal system, including required future areas, shall not be decreased or otherwise affected by the existence or proposed installation of a gray water system servicing the premises.

1609.0 Drawings and Specifications.

The Authority Having Jurisdiction shall be permitted to require any or all of the following information to be included with or in the plot plan before a permit is issued for a gray water system, or at any time during the construction thereof:

(A) Plot plan drawn to scale and completely dimensioned, showing plot lines and structures, direction and approximate slope of surface, location of all 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 100 percent expansion area or building sewer connecting to the public sewer, and location of the proposed gray water system.

TABLE 16-1
Location of Gray Water System

Minimum Horizontal Distance in Clear Required From:	Holding Tank m	Irrigation/ Disposal Field m
Building structures or mosques[1]	1.5[2]	0.6[3]
Property line adjoining private property	1.5	1.5
Water supply wells[4]	15.0	30.0
Streams and lakes[4]	15.0	15.0[5]
Ocean or sea[4]	15.0	15.0[5]
Sewage pits or cesspools	1.5	1.5
Disposal field and 100% expansion area	1.5	1.2[6]
Septic tank	0	1.5
On-site domestic water service line	1.5	1.5
Pressurized public water main	3.0	3.0[7]

Note: When irrigation/disposal fields are installed in sloping ground, the minimum horizontal distance between any part of the distribution system and the ground surface shall be 4.6m (15 ft.).

1 Including porches and steps, whether covered or uncovered, breezeways, roofed patios, carports, covered walks, covered driveways, and similar structures or appurtenances.

2 The distance shall be permitted to be reduced to 0mm (0 ft.) for above ground tanks when first approved by the Authority Having Jurisdiction.

3 Assumes a 0.8 radian (45 degrees) angle from foundation.

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 also apply between the irrigation/disposal field and the ocean mean higher high-tide line.

6 Plus 60cm (2 ft.) for additional 30cm (1 ft.) of depth in excess of 30cm (1 ft.) below the bottom of the drain line.

7 For parallel construction/for crossings, approval by the Authority Having Jurisdiction shall be required.

SI: 1m = 3.3 ft.

(B) 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 as required by the Authority Having Jurisdiction.

(C) A log of soil formations and groundwater level as determined by test holes dug in proximity to any proposed irrigation area, together with a statement of water absorption characteristics of the soil at the proposed site as determined by approved percolation tests.

Exception: The Authority Having Jurisdiction shall be permitted to use Table 16-2 in lieu of percolation tests.

1610.0 Inspection and Testing.

(A) Inspection.

(1) Applicable provisions of this chapter and of Section 103.5 of this code.

(2) System components shall be properly identified as to manufacturer.

(3) Holding tanks shall be installed on dry, level, well-compacted soil if underground or on a level 80mm (3 in.) concrete slab if above ground.

(4) Holding tanks shall be anchored against overturning.

(5) If a design is predicated on soil tests, the irrigation/disposal field shall be installed at the same location and depth as the tested area.

(6) Installation shall conform with the equipment and installation methods identified in the approved plans.

(B) Testing.

(1) Holding 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 water-tight.

(2) A flow test shall be performed through the system to the point of gray water irrigation/disposal. Lines and components shall be water-tight.

1611.0 Procedure for Estimating Gray Water Discharge.

(A) Single-Family Dwellings and Multi-Family Dwellings. The gray water discharge for single family and multi-family dwellings 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 flow of each occupant shall be calculated as follows:

Showers, bathtubs, and wash basins	95L/day (25 gpd)/occupant
Laundry	57L/day (15 gpd)/occupant

(B) Commercial, Mosques, Industrial, and Institutional. The gray water discharge for mosques and commercial, industrial, and institutional occupancies shall be calculated based on the number of occupants, type of fixtures or the water use records minus the discharge of fixtures other than those discharging gray water.

(C) Daily Discharge. All gray water systems shall be designed to distribute the total amount of estimated gray water on a daily basis.

Example 1:

Single-family dwelling; 3 bedrooms with showers, bathtubs, washbasins; and laundry facilities connected to the gray water system:

Total number of occupants = 2 + 1 + 1 = 4

Estimated gray water flow = 4x(95+57) = 608L/day
(4x(25+15) =160 gpd)

Example 2:

Single-family dwelling; 4 bedrooms with only the clothes washer connected to the gray water system:

Total number of occupants = 2 + 1 + 1 + 1 = 5

Estimated gray water flow = 5 x 57 = 285L/day
(5 x 15 = 75 gpd)

1612.0 Required Area of Subsurface Irrigation/Disposal Fields (See Figure 16-5).

Each valved zone shall have a minimum effective irrigation area in m^2 as determined by Table 16-3 for the type of soil found in the excavation, based upon a calculation of estimated gray water discharge pursuant to Section 1611.0 of this chapter, or the size of the holding tank, whichever is larger. The area of the irrigation/ disposal field shall be equal to the aggregate length of the perforated pipe sections within the valved zone multiplied the width of the proposed irrigation/disposal field. Each proposed gray water system shall include not less than three zones isolated by valves, and each zone shall be in compliance with the provisions of the section. No excavation for an irrigation/disposal field shall extend within 1.5m (5 ft.) vertical of the highest known seasonal groundwater, nor to a depth where gray water contaminates the ground-water or surface water. The applicant shall supply evidence of groundwater depth to the satisfaction of the Authority Having Jurisdiction.

1613.0 Determination of Maximum Absorption Capacity.

(A) Irrigation/disposal field size shall be computed from Table 16-3.

(B) In order to determine the absorption quantities of questionable soils other than those listed in Table 16-3, the proposed site shall be permitted to be subjected to percolation tests acceptable to the Authority Having Jurisdiction.

(C) When a percolation test is required, no gray water system shall be permitted if the test shows the absorption capacity of the soil is less than 33.8L/m^2 (0.83 gal./ft.^{2}) or exceeds 208.6L/m^2 (5.12 gal./ft.^{2}) of leaching area per 24 hours.

1614.0 Holding Tank Construction (See Figures 16-1, 16-2, 16-3 and 16-4.).

(A) Plans for holding tanks shall be submitted to the Authority Having Jurisdiction for approval. Such plans shall show all dimensions, structural calculations, bracings, and such other pertinent data as required. A capacity of not less than 189L (50 gal.) is required.

(B) Each holding tank shall be vented as required by Chapter 9 and the vent size shall be determined based on the total gray water drainage fixture units in accordance with Table 7-4 of this code. Holding tanks shall have a locking, gasketed access opening or approved equivalent to allow for inspection and cleaning.

(C) Each holding tank shall have its rated capacity permanently marked on the unit. In addition, a sign stating: "GRAY WATER IRRIGATION SYSTEM, DANGER — UNSAFE WATER" shall be permanently marked on the holding tank.

(D) Each holding tank installed above ground shall have an emergency drain separate from that connecting the tank with the irrigation/disposal fields and an overflow drain. The emergency and overflow drains shall have permanent connections to the building drain or building sewer, upstream of septic tanks, if any. The overflow drain shall not be equipped with a shutoff valve.

(E) Gray water entering the holding tank shall pass through an approved filter. The overflow and emergency drainpipes shall be not less in size than the inlet pipe. Unions or equally effective fittings shall be provided for all piping connected to the holding tank.

(F) Each holding tank 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 1,500kg/m^2 (300 lbs./ft.^{2}) when the tank is designed for underground installation.

(G) If a holding tank is installed underground, the system must 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.

1615.0 Color and Information (see Figures 16-1, 16-2, 16-3, and 16-4).

All gray water systems shall have a purple background with black uppercase lettering, with the words:

"CAUTION: NONPOTABLE WATER,
DO NOT DRINK."

The minimum size of the letters and length of the color field shall conform to Table 6-1 of this code. Where used, a colored identification band shall be indicated every 6m (20 ft.), not less than once per room, and shall be visible from the floor level. Marking is not required for pipe manufactured with purple color integral to the pipe, and marked with black uppercase lettering to read, "CAUTION: NONPOTABLE WATER, DO NOT DRINK" in intervals not to exceed 1.5m (5 ft.). All valves, except fixture supply control valves, shall be equipped with a locking feature.

1616.0 Valves.

All valves, including the three-way valve, shall be readily accessible and approved by the Authority Having Jurisdiction. A backwater valve installed pursuant to this code shall be provided on all holding tank drain connections to the sanitary drain or sewer piping.

1617.0 Trap.

Gray water piping discharging into the holding tank or having a direct connection to the sanitary drain or sewer piping shall be downstream of an approved liquid seal type trap(s). If no such trap(s) exists, an approved vented running trap shall be installed upstream of the connection to protect the building from any possible waste or sewer gases.

1618.0 Irrigation/Disposal Field Construction (See Figure 16-5).

(A) Perforated sections shall be not less than 80mm (3 in.) in diameter and shall be constructed of perforated high-density polyethylene pipe, perforated ABS pipe, perforated PVC pipe, or other approved materials, provided that sufficient openings are available for distribution of the gray water into the trench area. Material, construction, and perforation of the pipe shall be in compliance with the appropriate absorption

TABLE 16-2
Irrigation/Disposal Field Construction

	Minimum	Maximum
Number of drain lines per valved zone	1	—
Length of each perforated line	—	30m
Bottom width of trench	30cm	46cm
Spacing of lines, center to center	1.2m	—
Depth of earth cover of lines	25cm	—
Depth of filter material cover of lines	50mm	—
Depth of filter material beneath lines	76mm	—
Grade of perforated lines	level	2mm/m

SI: 1mm = 0.04 in.; 1cm = 0.39 in.; 1m = 3.3 ft.

fields drainage piping standards and shall be approved by the Authority Having Jurisdiction.

(B) Filter material, clean stone, gravel, slag, or similar filter material acceptable to the Authority Having Jurisdiction, varying in size from 20mm (3/4 in.) to 65mm (2-1/2 in.) 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.

(C) Irrigation/disposal fields shall be constructed as follows (see Table 16-2):

When necessary on sloping ground to prevent excessive line slopes, irrigation/disposal lines shall be stepped. The lines between each horizontal leaching section shall be made with approved water-tight joints and installed on natural or unfilled ground.

1619.0 Special Provisions.

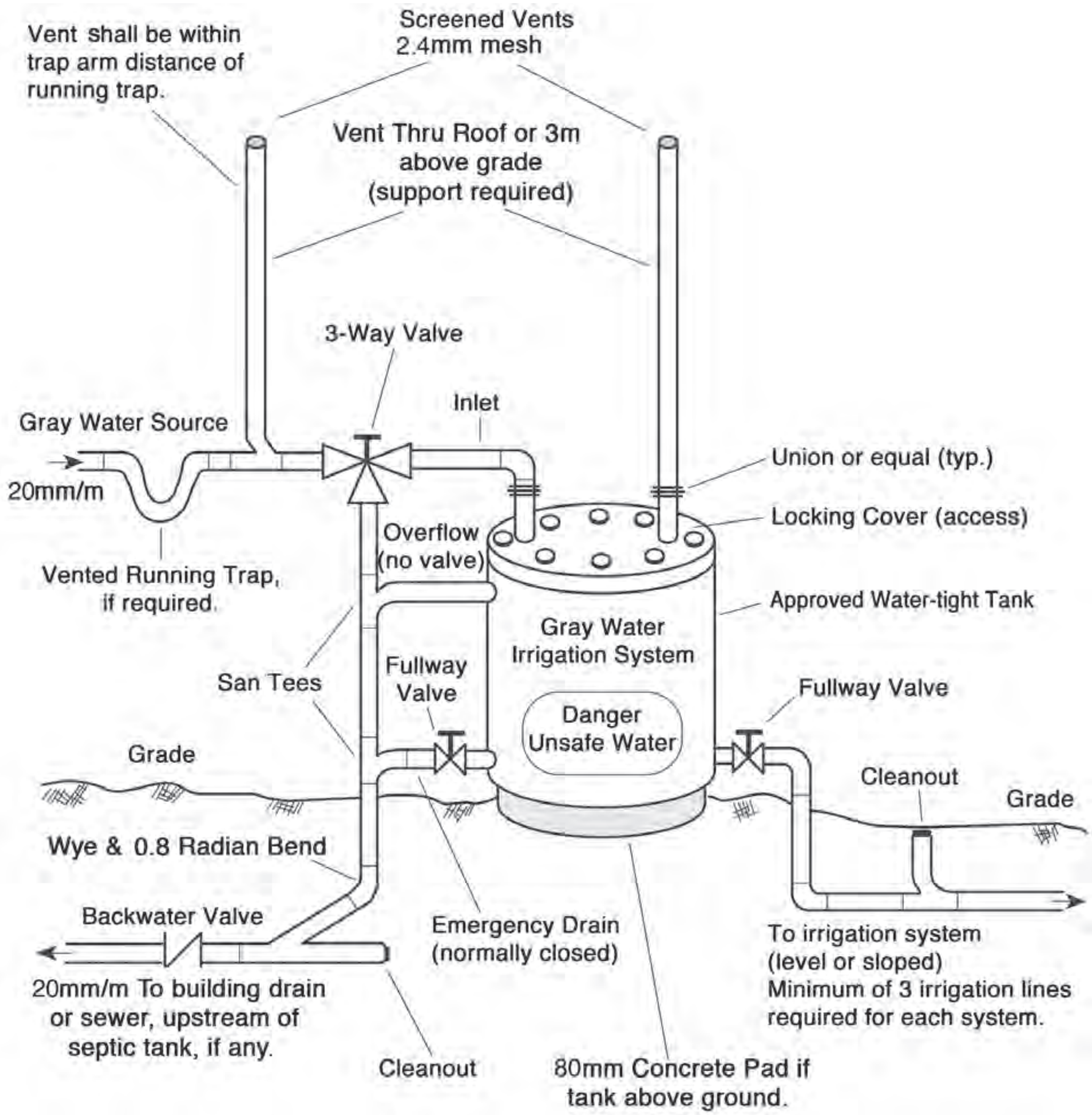
(A) Other collection and distribution systems shall be permitted by the local Authority Having Jurisdiction, as allowed by Section 301.0 of this code.

(B) Nothing contained in this chapter shall be construed to prevent the Authority Having Jurisdiction from requiring compliance with higher requirements than those contained herein, where such higher requirements are essential to maintain a safe and sanitary condition.

TABLE 16-3
Design Criteria of Six Typical Soils

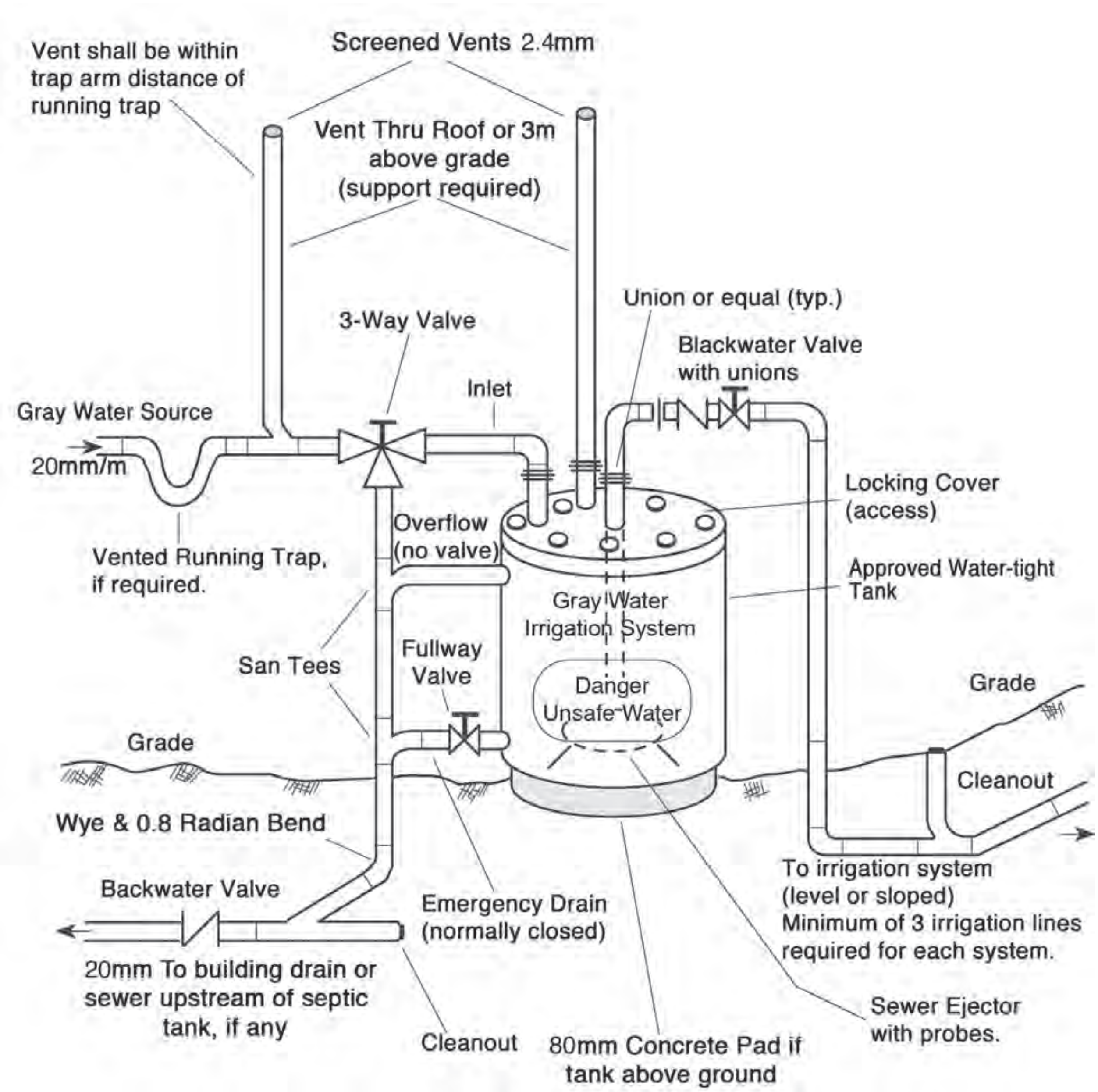
Type of Soil	Minimum m^2 of Irrigation/Leaching Area per L of Estimated Gray Water Discharge Per Day	Maximum Absorption Capacity in L/m^2 of Irrigation/Leaching Area for a 24-hour Period
Course sand or gravel	0.005	204
Fine sand	0.006	163
Sandy loam	0.010	101
Sandy clay	0.015	69
Clay with considerable sand or gravel	0.022	45
Clay with small amounts of sand or gravel	0.030	33

SI: $1m^2 = 10.8$ ft.^{2}; 1L = 0.26 gal.; 1 L/m^2 = 0.02 gal./ft.^{2}



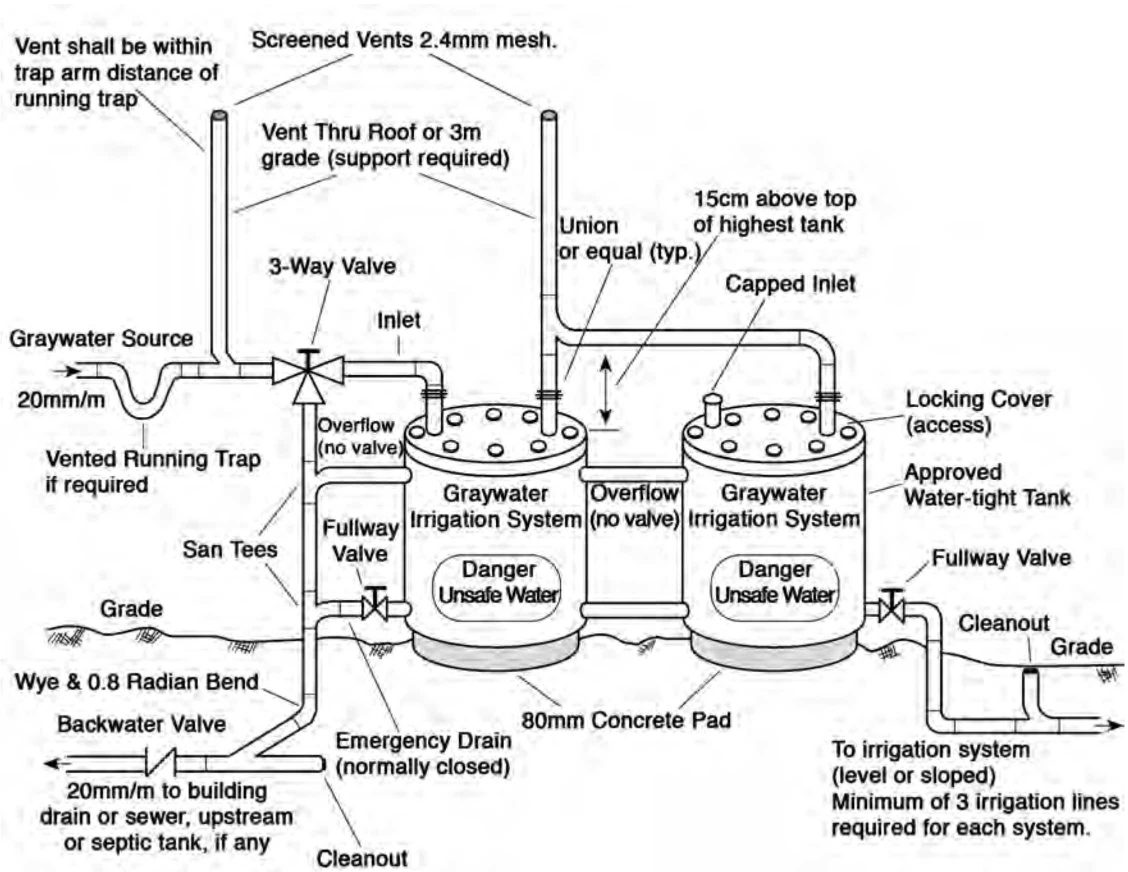
SI: 1m = 3.3 ft.; 1mm = 0.04 in.

FIGURE 16-1 Gray Water System Tank – Gravity.



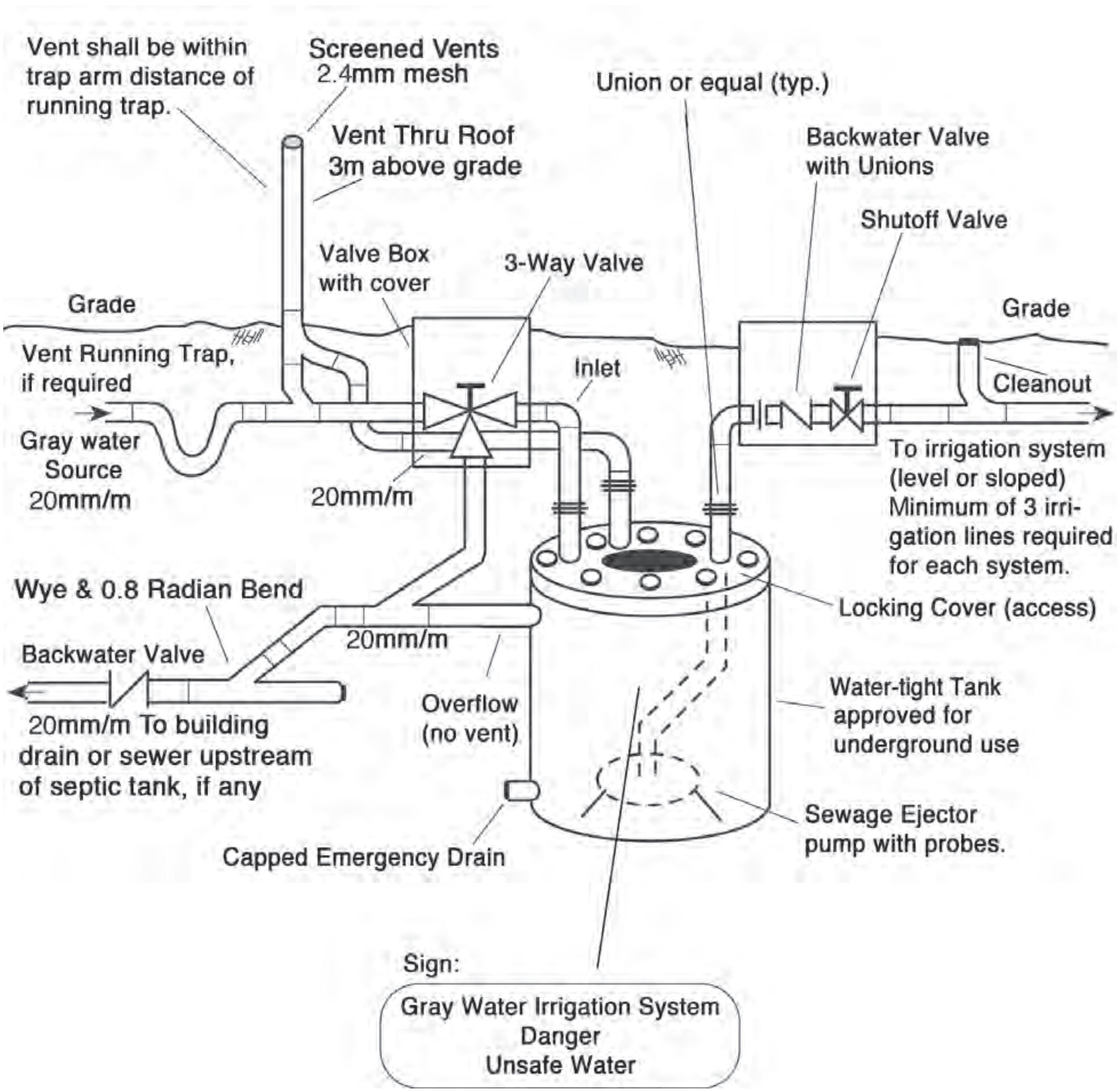
SI: 1m = 3.3 ft.; 1mm = 0.04 in.

FIGURE 16-2 Gray Water System Tank – Pumped.



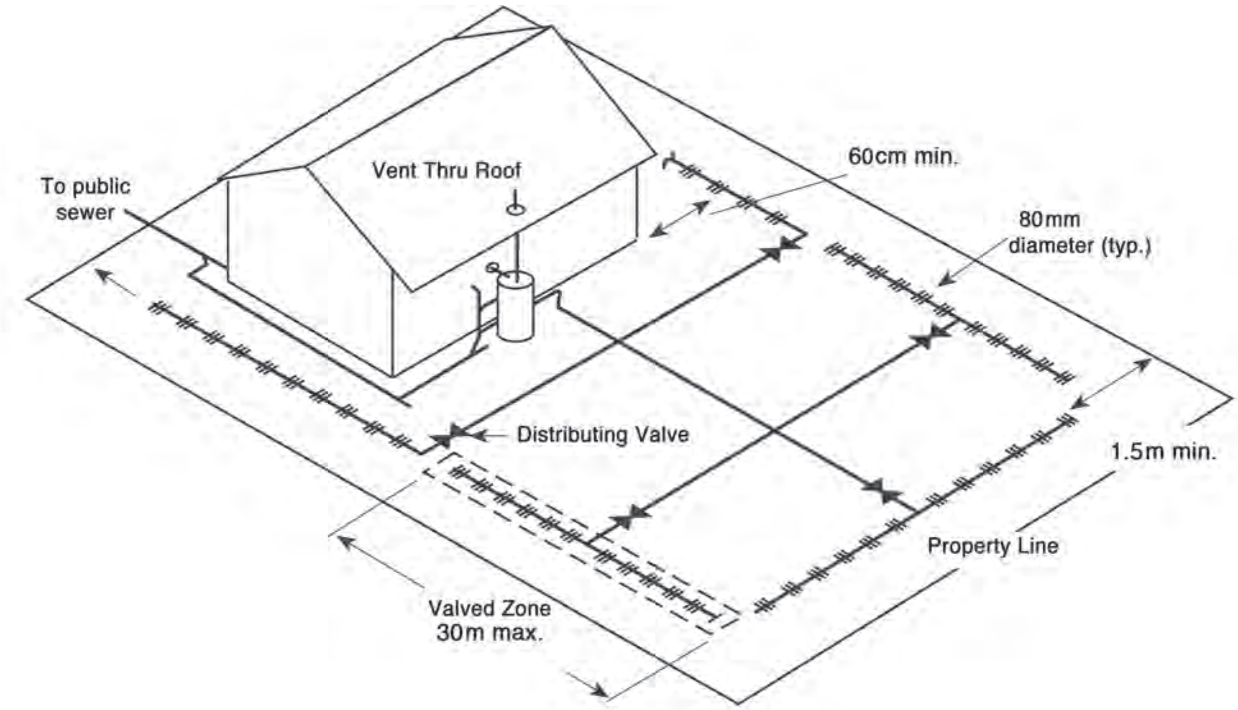
SI: 1m = 3.3 ft.; 1mm = 0.04 in.; 1cm = 0.39 in.

FIGURE 16-3 Gray Water System Multiple-Tank Installation.

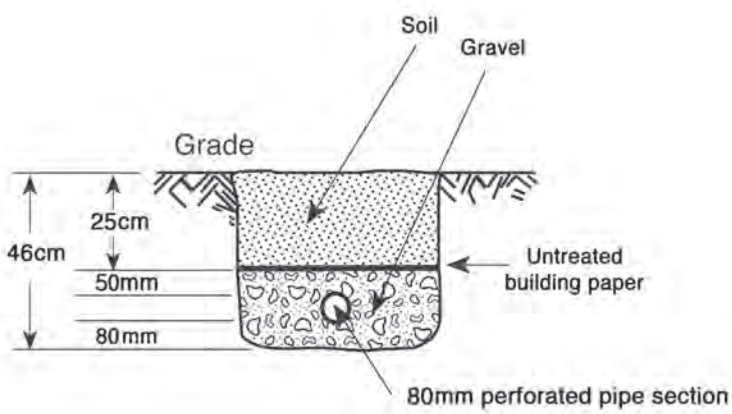


SI: 1m = 3.3 ft.; 1mm = 0.04 in.

FIGURE 16-4 Gray Water System Underground Tank – Pumped.



Note: Each valved zone shall have a minimum effective absorption/irrigation area in square millimeters predicted on the estimated graywater discharge in liters per day and on the type of solid found in the area. The area of the field shall be equal to the aggregate length of perforated pipe sections within the valved zone times the width of proposed field.



SI: 1m = 3.3 ft.; 1mm = 0.04 in.; 1cm = 0.39 in.

FIGURE 16-5 Gray Water System Typical Irrigation Layout.

Part II

1620.0 Systems For Supplying Uses Other than Irrigation - General.

(A) The provisions of Part II of this chapter shall apply to the installation, construction, alteration, and repair of gray water systems intended to supply uses such as water closets, urinals, trap for floor drains and floor sinks, industrial processes, water features, and other uses approved by the Authority Having Jurisdiction.

(B) Gray water systems intended to supply uses other than irrigation shall be defined as nonpotable water that meets, or as a result of disinfection and treatment, meets requirements for its intended uses. The level of treatment and quality of the gray water shall be approved by the Authority Having Jurisdiction.

(C) Makeup potable water shall be supplied as a source of makeup water for gray water systems supplying uses other than irrigation. Potable water supplies shall be protected in accordance with Section 1606.0. A fullway value shall be installed on the makeup potable water supply line to the holding tank.

(D) The holding capacity shall be twice the volume of water required to meet the daily requirements of the fixtures supplied with gray water, but not less than 189L (50 gal.). The gray water system shall consist of a holding tank or tanks and shall be sized to limit the retention time of gray water to a maximum of 72 hours.

(E) It shall be unacceptable for any person to construct, install, alter, or cause to be constructed, or alter any gray water system within a building or on a premises without first obtaining a permit to do such work from the Authority Having Jurisdiction. No permit for any gray 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 gray water system or the potable water system within any site containing a gray water system without approval by the Authority Having Jurisdiction.

(F) Before the building is occupied, 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.

1621.0 Drawings and Specifications.

The Authority Having Jurisdiction shall be permitted to require any or all of the following information to be included with or in the plot plan before a permit is issued for a gray water system.

(A) A plot plan drawn to scale and completely dimensioned, showing plot lines and structures, location of present and proposed potable water supplies and meters, water wells, streams, auxiliary water supply and systems, gray water supply and meters, drain lines, locations of private sewage disposal systems and 100 percent expansion areas or building sewer connected to the public sewer.

(B) Details of construction including riser diagrams or isometrics and a full description of the complete installation, including installation methods, construction, and materials as required by the Authority Having Jurisdiction. To the extent permitted by structural conditions, gray water risers within the toilet room, including appurtenances such as air/vacuum relief valves, pressure reducing valves, etc., shall be installed in the opposite end of the room containing the served fixtures from the potable water risers or opposite walls, as applicable. To the extent permitted by structural conditions, gray water headers and branches off risers shall not be run in the same wall or ceiling cavity of the toilet room where potable water piping is run.

(C) Detailed initial and annual testing requirements as outlined elsewhere in this chapter.

1622.0 Pipe Material/Pipe Identification.

Gray water systems shall comply with Sections 1622.1 and 1622.2.

1622.1 Pipe Materials. Gray water pipe, valves, and fittings shall conform to the requirements of Sections 1604.0.

1622.2 Color and Information. Gray water systems shall have a purple background with black uppercase lettering, with the words:

“CAUTION: GRAY WATER,
DO NOT DRINK.”

The minimum size of the letters and length of the color field shall conform to Table 6-1. Where used, a colored identification band shall be indicated every 6m (20 ft.), not less than once per room, and shall be visible from the floor level. Marking is not required for pipe manufactured with purple color integral to the pipe, and marked with black uppercase lettering to read: “CAUTION: NONPOTABLE GRAY WATER, DO NOT DRINK” in intervals not to exceed 1.5m (5 ft.). All valves, except fixture supply control valves shall be equipped with a locking feature. All mechanical equipment that is appurtenant to the gray water system shall be painted purple.

1623.0 Installation.

(A) Hose bibbs shall not be allowed on gray water piping systems.

(B) The gray 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 deactivation or drainage as required for cross-connection test in Section 1625.0.

(C) Gray water pipes shall not be run or laid in the same trench as potable water pipes. A 3m (10 ft.) horizontal separation shall be maintained between pressurized, buried gray and potable water piping. Buried potable water pipes crossing pressurized gray water pipes shall be laid not less than 30cm (12 in.) above the gray water pipes. Gray water pipes laid in the same trench or crossing building sewer or drainage piping shall be installed in compliance with Sections 609.2 and 720.0 of this code.

1624.0 Signs.

(A) **Commercial, Industrial, and Institutional Room Entrance Signs.** All rooms in commercial, industrial, and institutional occupancies using gray water for water closets and/or urinals shall be identified with signs. Each sign shall contain letters of a highly visible color with a height 15mm (1/2 in.) on a contrasting background. The location of the sign(s) shall be such that the sign(s) shall be visible to all users. The number and location of the signs shall be approved by the Authority Having Jurisdiction and shall contain the following text:

TO CONSERVE WATER, THIS BUILDING USES GRAY WATER TO FLUSH TOILETS AND URINALS.

(B) **Room Signs.** Each room containing gray water equipment shall have a sign posted with the following caption, having a height of 25mm (1 in.) on a purple background.

CAUTION: 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 gray water equipment.

(C) Where tank-type water closets are flushed with gray water, the tank shall be labeled:

NONPOTABLE GRAY WATER – DO NOT DRINK

(D) **Valve Access Door Signs.** Each gray water valve within a wall shall have its access door into the wall equipped with a warning sign approximately 15cm x 15cm (6 in. x 6 in.) with lettering equal to 15mm (1/2 in.) 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 gray water piping and appurtenances.

1625.0 Inspection and Testing.

(A) Gray water piping shall be inspected and tested as outlined in this code for testing of potable water piping.

(B) An initial and subsequent annual inspection and test shall be performed on both the potable and gray water systems. The potable gray water system shall be isolated from each other and independently inspected and tested to ensure there is no cross-connection, as follows:

(1) Visual Dual 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.

(I) If installed, meter locations of the gray water and potable water lines shall be checked to verify that no modifications were made, and that no cross-connections are visible.

(II) Pumps and equipment, equipment room signs, and exposed piping in the equipment room shall be checked.

(III) 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.

(2) Cross-Connection Test. The following procedure 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 occurred.

(I) The potable water system shall be activated and pressurized. The gray water system shall be shut down and completely drained.

(II) The potable water system shall remain pressurized for a minimum period of time specified by the Authority Having Jurisdiction while the gray water system is empty. The minimum period the 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 gray water distribution systems, but in no case shall that period be less than 1 hour.

(III) Fixtures, potable and gray, shall be tested and inspected for flow. Flow from any gray water system outlet shall indicate a cross-connection. No flow from a potable water outlet would indicate that it is connected to the gray water system.

(IV) The drain on the gray 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 drained.

(VI) The gray water system shall then be activated and pressurized.

(VII) The gray 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.

(VIII) Fixtures, potable and gray, shall be tested and inspected for flow. Flow from any potable water system outlet shall indicate a cross-connection. No flow from a gray 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, in the presence of the Authority Having Jurisdiction, shall be activated immediately:

(I) Gray water piping to the building shall be shut down at the meter, and the gray 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 subsections (B)(1) and (B)(2) above.

(V) The potable water system shall be chlorinated with 30 ppm chlorine for 1 hour.

(VI) The potable water system shall be flushed after 1 hour, and a standard bacteriological test shall be performed. If test results are acceptable, the potable water system shall be permitted to be recharged.

(C) An annual inspection of the gray water system, following the procedures listed in Section 1625.0 (B)(1), shall be required. Annual cross-connection testing, following the procedures listed in Section 1625.0(B)(2), shall be required by the Authority Having Jurisdiction, unless site conditions do not require it. In no event shall the test occur less often than once in 4 years. Alternate testing requirements shall be permitted by the Authority Having Jurisdiction.

1626.0 Sizing.

Gray water distribution piping shall be sized as outlined in this code for sizing potable water piping.

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.

CONTENTS

APPENDIX A

RECOMMENDED RULES FOR ALTERNATIVE METHOD 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 must necessarily be limited in length. (See Sections 610.0 and 611.0)

The following is a suggested order of procedure for sizing the water supply system:

A 1.0 Preliminary Information.

A 1.1 Obtain the necessary information regarding the minimum daily service pressure in the area where the building shall be located.

A 1.2 If 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 can be obtained from most manufacturers of water meters. Friction losses for disk-type meters shall be permitted to be obtained from Chart A-1.

A 1.3 Obtain all 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 Estimate the supply demand for the building main and the principal branches and risers of the system by totaling the water supply fixture units on each, Table A-2, and then by reading the corresponding ordinate from Chart A-2 or A-3, whichever is applicable.

A 2.2 Estimate continuous supply demands in L/s (gpm) 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 Decide what is the desirable minimum residual pressure that shall be maintained at the highest fixture in the supply system. If the highest group of fixtures contains flushometer valves, the residual pressure for the group shall be not less than 6.9-1.38bar (10-20 psi). For flush tank supplies, the available residual pressure shall be not less than 1.03bar (15 psi).

A 3.2 Determine the elevation difference of the fixture or group of fixtures either above the water (street) main. Multiply this difference in elevation by 9.8 kPa/m (0.43 psi/ft.). The result is the loss or gain in static pressure in kPa (psi).

A 3.3 Determine the sum of 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, if no water meter is used. If 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 Determine the developed length of pipe from the water (street) main to the highest fixture. If close estimates are desired, compute with the aid of Table A-3, the equivalent length of pipe for all 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 kPa/m (psi/ft.), divided by the developed lengths of pipe from the water (street) main to the highest fixture, times 100m (328 ft.), will be the average permissible friction loss per 100m (328 ft.) length of pipe.

A 4.0 Size of Building Supply.

A 4.1 Knowing the permissible friction loss per 100m (328 ft.) of pipe and the total demand, the diameter of the building supply pipe shall be permitted to be obtained from Charts A-4, A-5, A-6, or A-7, 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 If copper tubing or brass pipe is to be used for the supply piping and if the character of the water is such that only slight changes in the hydraulic characteristics may be expected, Chart A-4 should be used.

A 4.3 Chart A-5 should be used for ferrous pipe with only the most favorable water supply in regards to corrosion and caking. If the water is hard or corrosive, Chart A-6 or A-7 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 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 Fixture branches to the building supply, if they are sized for the same permissible friction loss per 100m (328 ft.) of pipe as the branches and risers to the highest level in the building, may lead to inadequate water supply to the upper floor of a building. This may be controlled by (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 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 shall not exceed 2.4m/s (8 ft./s) or the maximum values given in the appropriate UPC-AD Installation Standard, except as otherwise approved by the Authority Having Jurisdiction.

A 6.2 If a pressure-reducing valve is used in the building supply, the developed length of supply piping and the permissible friction loss should be computed from the building side of the valve.

A 6.3 The allowances in Table A-3 for fittings are based on nonrecessed threaded fittings. For recessed threaded fittings and streamlined soldered fittings, 1/2 of the allowances given in the table will be ample.

A 7.0 Example.

A 7.1 Assume an office building of 4 stories and basement; pressure on the building side of the pressure-reducing valve of 3.8bar (55 psi) (after an allowance for reduced pressure falloff at peak demand); an elevation of highest fixture above the pressure-reducing valve of 14m (45 ft.); a developed length of pipe from the pressure-reducing valve to the most distant fixture of 60m (200 ft.); and fixtures to be installed with flush valves for water closets and urinals as follows:

If the pipe material and water supply are such that Chart A-5 applies, the required diameter of the building supply is 90mm (3-1/2 in.) and the required diameter of the branch to the hot-water heater is 40mm (1-1/2 in.).

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 or A-3 and applying the total demand estimate from the branch, riser, or section thereof to the appropriate flowchart.

A 7.0 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**	**Demand in L/s**	**Number of Fixtures**	**Fixture Unit Demand Calculation**	**Demand in L/s**
Water Closets	130	8.0	1,040	–	–	–	–
Urinals	30	4.0	120	–	–	–	–
Shower heads	12	2.0	24	–	12	12 x 2 x 3/4=18	–
Lavatories	100	1.0	100	–	100	100 x 1 x 3/4=75	–
Service Sinks	27	3.0	81	–	27	27 x 3 x 3/4 =61	–
Total			1,365	15.8		154	3.4L/s

Allowing for 103.4kPa (15 psi) at the highest fixture under the maximum demand of 15.8L/s (252 gpm), the pressure available for friction loss is found by the following:

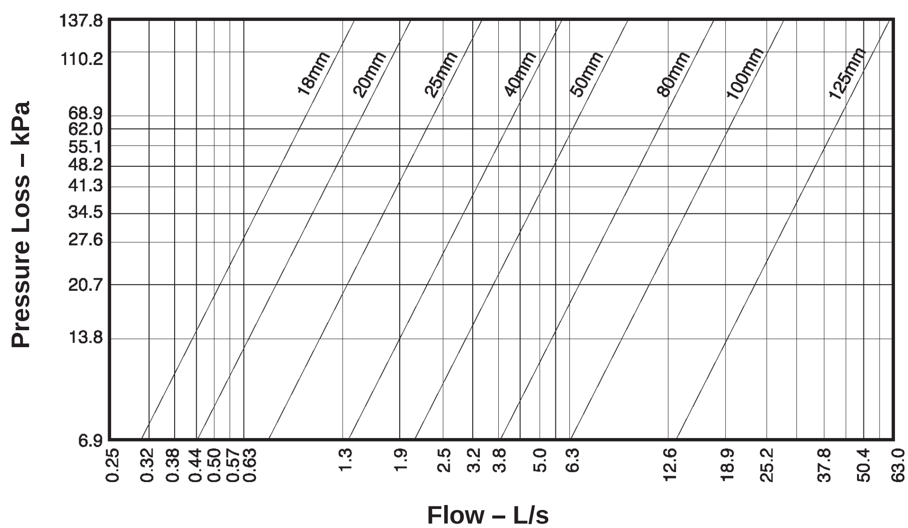
$$379 - [103.4 + (13.7 \times 9.8)] = 142.3\text{kPa}$$

The allowable friction loss per 100m of pipe is therefore:

$$100 \times 142.3 \div 61 = 233.2\text{kPa}$$

SI: 1kPa = 0.15 psi; 1L/s = 15.85 gpm

Chart A-1
Friction Losses for Disk-Type Water Meters



SI: 1kPa = 0.15 psi; 1L/s = 15.85 gpm

Table A-2
Separate Cold and Hot Water Supply Fixture Unit Values

Appliances, Appurtenances or Fixtures[1]	Minimum Fixture Branch Pipe Size mm[2]	Occupancy	Water Supply Fixture Units (WSFU)		
			Cold	Hot	Total
Bathtub or Bath/shower	15	Private	1.0	1.0	1.4
	15	Public	3.0	3.0	4.0
Bidet	15	Private	1.0		1.0
Clothes washer	15	Private or Public	3.0	3.0	4.0
Dental Unit, cuspidor	15	Public	1.0		1.0
Dishwasher, domestic	15	Private or Public		1.5	1.5
Drinking Fountain	15	Private or Public	0.5		0.5
		Assembly	0.75		0.75
Hose Bibb	15	Private or Public	2.5		2.5
Hose Bibb, each additional when used with total demand	15	Private or Public	1.0		1.0
Lavatory	15	Private, Public, or Assembly	0.75	0.75	1.0
Lawn sprinkler, each head[3]		Private or Public	5.0		5.0
Sinks					
Bar	15	Private	0.75	0.75	1.0
		Public	1.5	1.5	2.0
Clinic, Faucet	15	Public	2.25	2.25	3.0
Clinic Flushometer Valve with or without faucet	25	Public	8.0		8.0
Kitchen, domestic	15	Private or Public	1.125	1.125	1.5
Laundry		Private or Public	1.125	1.125	1.5
Service or Mop Basin	15	Private	1.125	1.125	1.5
		Public	2.25	2.25	3.0
Washup, each set of faucets	15	Public	1.5	1.5	2.0
Shower, per head	15	Private or Public	1.5	1.5	2.0
Urinal, 4L/flush flushometer valve	20	Public	4.0		4.0
		Assembly	5.0		5.0
Urinal, flush tank	15	Private or Public	2.0		2.0
		Assembly	3.0		3.0
Wash fountain, circular spray	20	Public	3.0	3.0	4.0
Water closet, 6L/flush gravity tank	15	Private or Public	2.5		2.5
		Assembly	3.5		3.5
Water closet, 6L/flush flushometer tank	15	Private or Public	2.5		2.5
		Assembly	3.5		3.5
Water closet, 6L/flush flushometer valve	25	Public	5.0		5.0
		Assembly	8.0		8.0

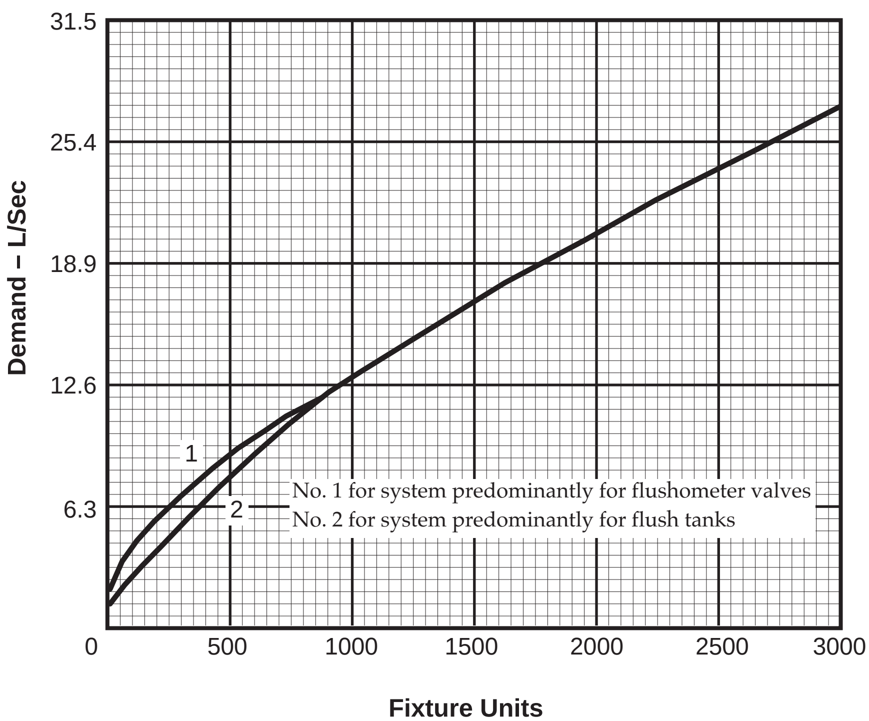
Notes:
1 Appliances, fixtures and appurtenances not included in this table may be sized by reference to fixtures having similar flow rates and frequency of use.
2 The listed minimum supply branch pipe sizes for individual fixtures are the nominal (ID) pipe size.
3 For fixtures or supply connections likely to impose continuous flow demands, determine the required flow in liters per minute and add separately to the demand in liters per minute for the distribution system or portions thereof.
SI: 1mm = 0.04in.; 1L = 0.26 gal.

TABLE A-3
Equivalent Length of Pipe for Various Fittings*

Diameter of Fitting mm	1.6rad Standard Elbow m	0.8rad Standard Elbow m	1.6rad Standard Tee m	Coupling or Straight Run of Tee m	Gate Valve m	Globe Valve m	Angle Valve m
10	0.3	0.2	0.5	0.1	0.1	2.4	1.2
15	0.6	0.4	0.9	0.2	0.1	4.6	2.4
20	0.7	0.5	1.2	0.2	0.2	6.1	3.6
15	0.9	0.6	1.5	0.3	0.2	7.6	4.6
32	1.2	0.7	1.8	0.4	0.2	10.7	5.5
40	1.5	0.9	2.1	0.5	0.3	13.7	6.7
50	2.1	1.2	3.0	0.6	0.4	16.8	8.5
65	2.4	1.5	3.6	0.7	0.5	19.8	10.4
80	3.0	1.8	4.6	0.9	0.6	24.3	12.2
100	4.3	2.4	6.4	1.2	0.8	38.1	16.8
125	5.2	3.0	7.6	1.5	1.0	42.7	21.3
150	6.1	3.7	9.1	1.8	1.2	50.3	24.3

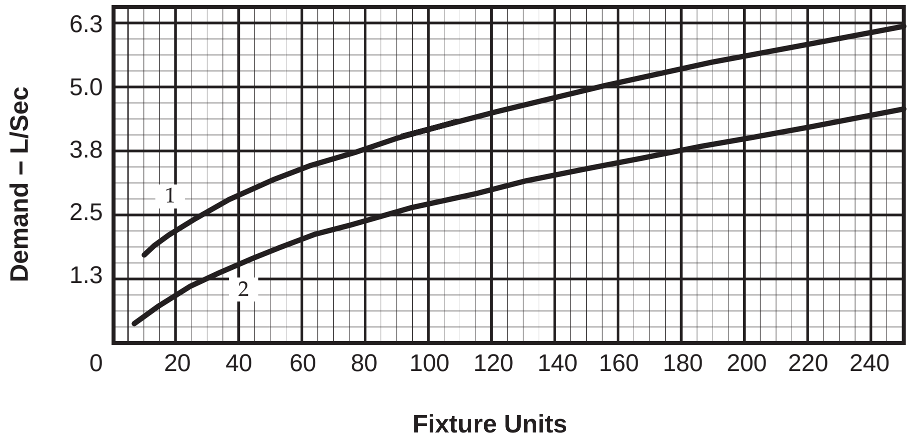
SI: 1mm = 0.04 in.; 1m - 3.3 ft.

Chart A-2
Estimate Curves for Demand Load



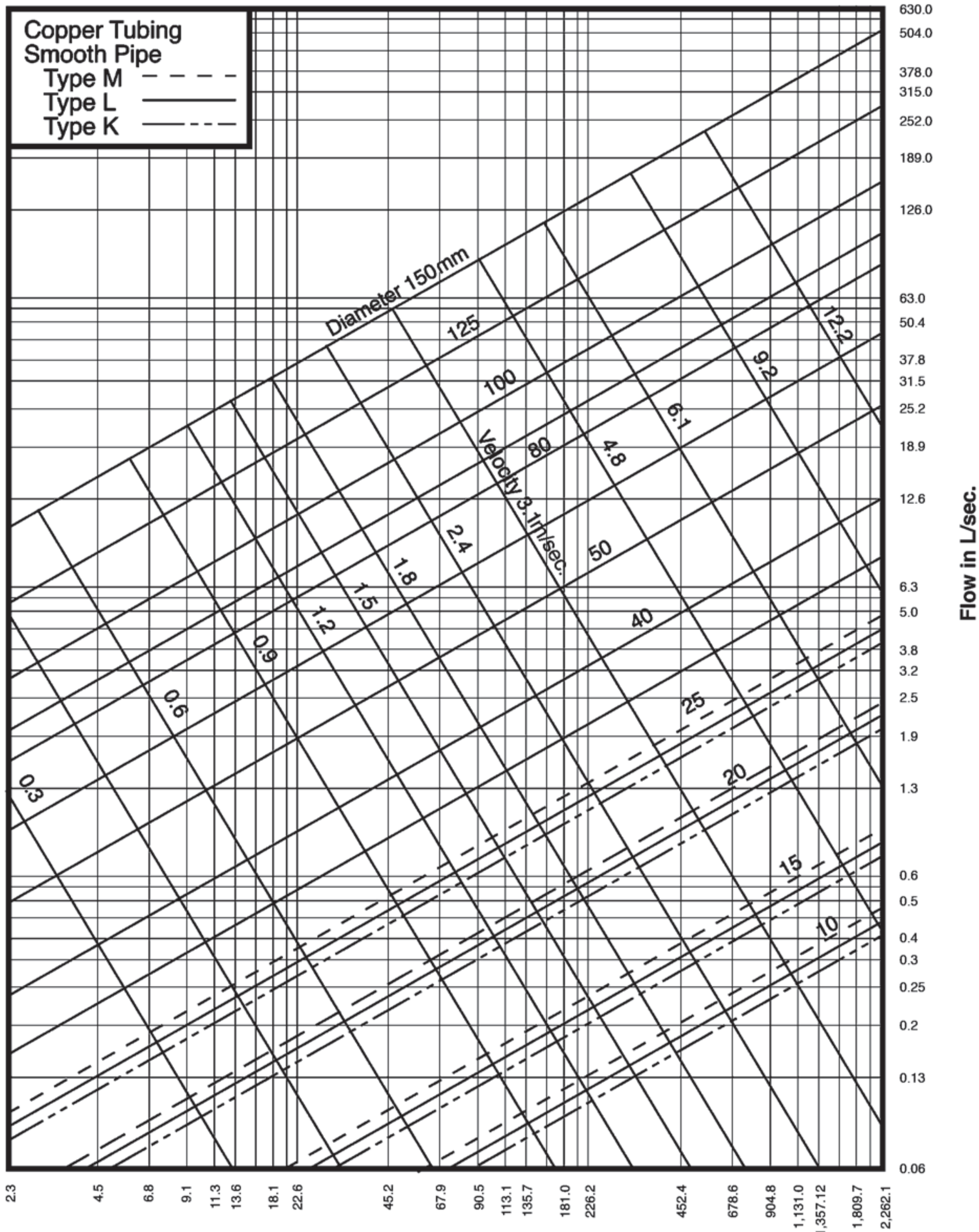
SI: 1L/s = 15.85 gpm

Chart A-3
Enlarged Scale Demand Load



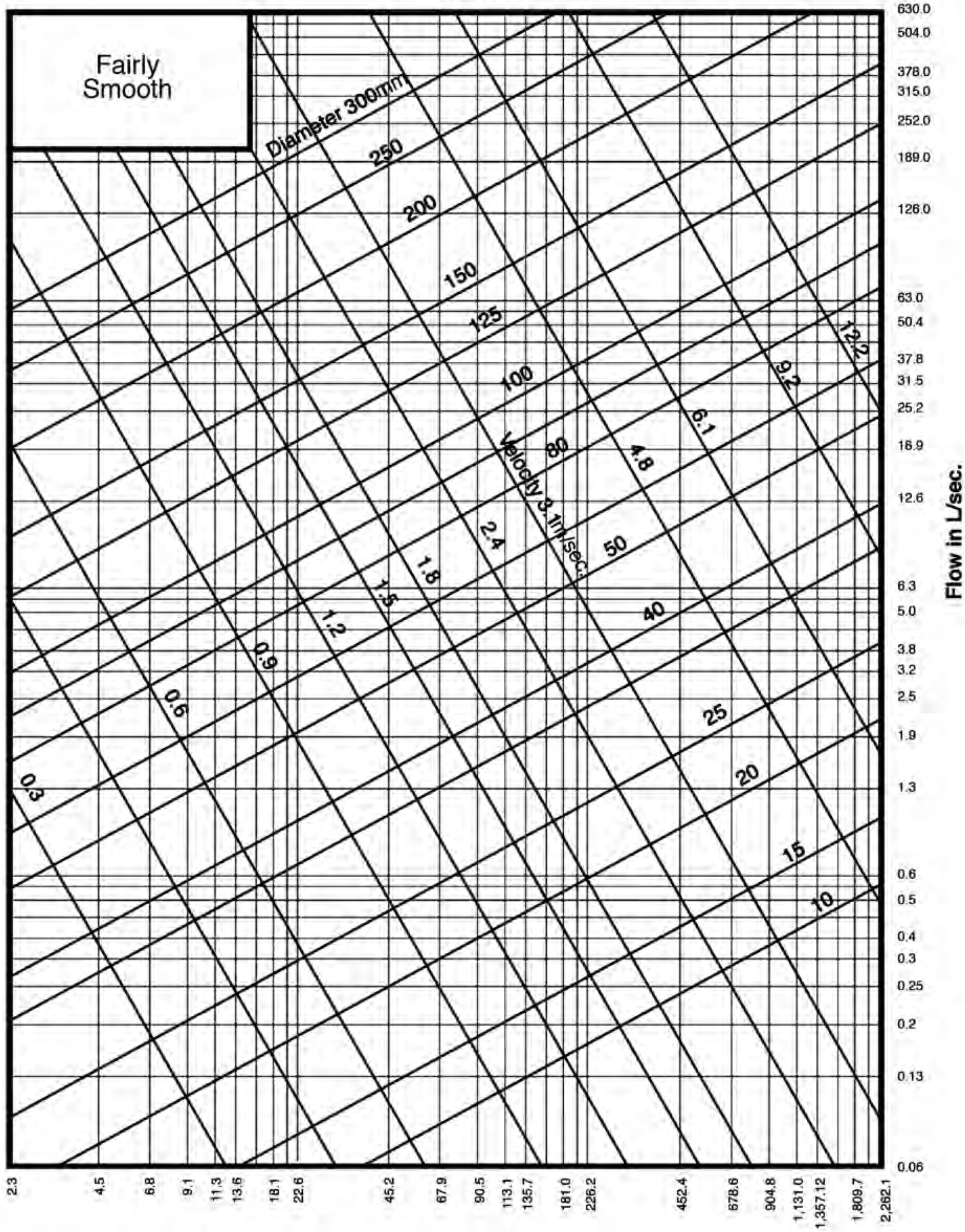
SI: 1L/s = 15.85 gpm

Chart A-4



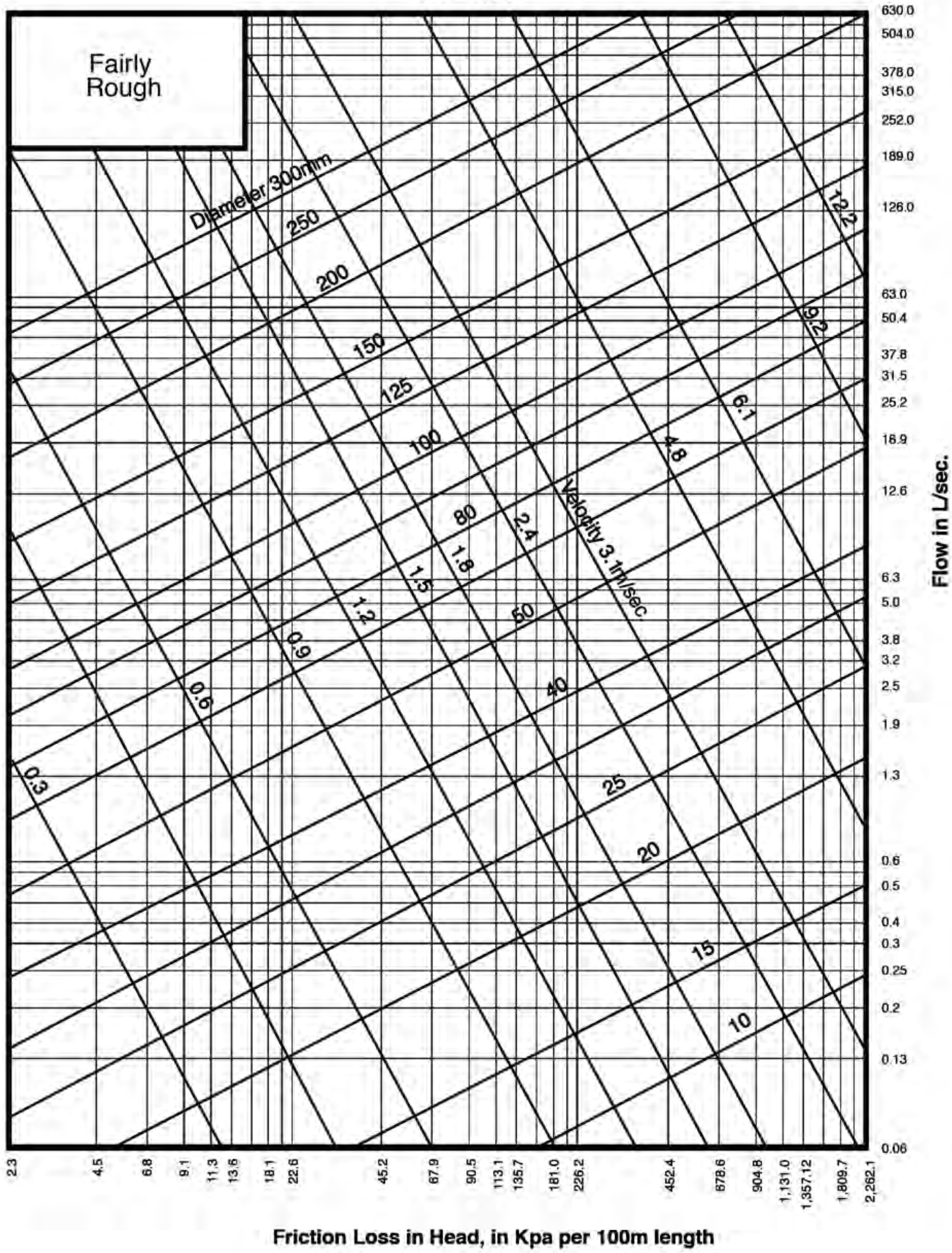
SI: 1L/s = 15.85 gpm; 1kPa = 0.04 psi/ft.

Chart A-5



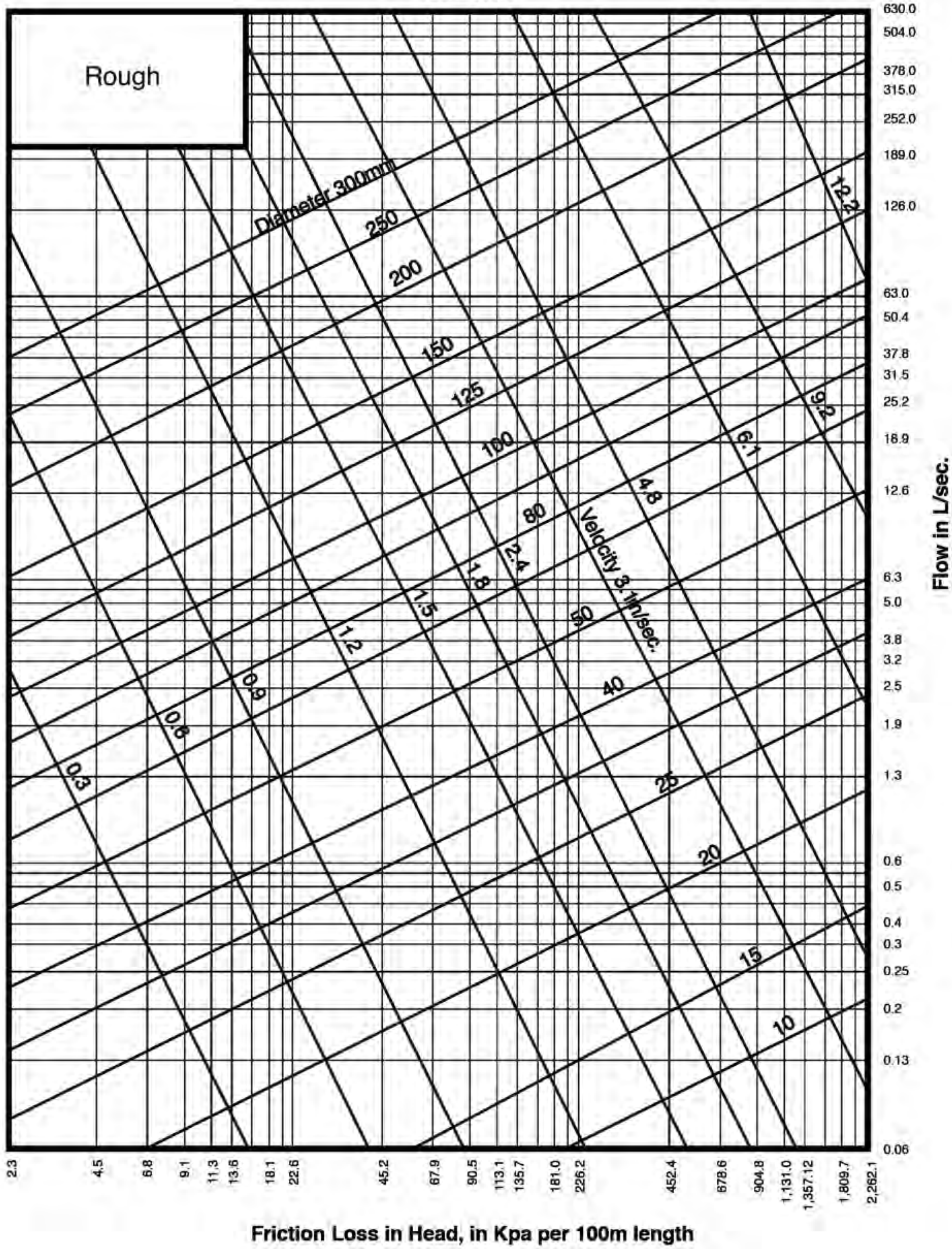
SI: 1L/s = 15.85 gpm; 1kPa = 0.04 psi/ft.

Chart A-6



SI: 1L/s = 15.85 gpm; 1kPa = 0.04 psi/ft.

Chart A-7



SI: 1L/s = 15.85 gpm; 1kPa = 0.04 psi/ft.

APPENDIX B

EXPLANATORY NOTES ON COMBINATION WASTE AND VENT SYSTEMS

(See Section 910.0 of the UPC–AD for Specific Limitations.)

B 1.0

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 should 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 should not be connected to a combination waste and vent system.

B 2.0

Caution must 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 0.5L/s (7.5 gpm) shall be permitted to be safely assigned a loading value of one unit. Long runs should be laid at the minimum permissible slope in order to keep tailpieces as short as possible. Tailpieces shall not exceed 60cm (2 ft.) in length, which may necessitate slopes up to 0.8 radian (45 degrees) (see definition of *horizontal pipe*) on some branches.

B 3.0

It is essential that the pneumatics of such a system be properly engineered, as the air pressure within the line must 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 30m (100 ft.). Each such relief vent shall equal not less than 1/2 of the inside cross-sectional area of the drain pipe served.

B 4.0

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 should be reduced to normal size.

B 5.0

Duplicate layout drawings of each such proposed piping system must be presented to the Authority Having Jurisdiction and approval obtained before any installation is made. Complicated layouts should be checked by qualified personnel.

B 5.1 Example of Sizing.

A floor drain normally requires a 50mm (2 in.) trap and waste. On a combination waste and vent system, both trap and waste must be increased two pipe sizes through 65mm and 80mm (2-1/2 in. and 3 in.), which would make the trap 80mm (3 in.). Pipe sizes recognized for this purpose are 50mm, 65mm, 80mm, 90mm, 100mm, 115mm, 125mm, 150mm, etc (2 in., 2-1/2 in., 3 in., 3-1/2 in., 4 in., 4-1/2 in., 5 in., 6 in., etc.). The tailpiece between the floor drain and its trap should be 50mm (2 in.) (or normal size) to ensure that the amount of wastewater entering the trap only partially fills the waste branch. A 80mm (3 in.) floor drain would thus require a 100mm (4 in.) trap, a 100mm (4 in.) floor drain, and a 125mm (5 in.) trap, etc., for the reasons previously stated.

WHEN IN DOUBT, CHECK WITH YOUR LOCAL AUTHORITY HAVING JURISDICTION.

APPENDIX C

SIZING STORM WATER DRAINAGE SYSTEMS

C 1.0 Roof Drainage.

The rainfall rates should be as per the data available with Meteorological Department of Abu Dhabi.

C 2.0 Sizing by Flow Rate.

Storm drainage systems shall be permitted to be sized by storm water flow rates, using the appropriate L/min./m^2 (gpm/ft.^{2}) of rainfall rate based on the local area (25mm [1 in.] per rain fall converts to 0.0394L/min./m^2 (0.0104 gpm/ft.^{2}). For any given rainfall, multiply the mm/hr by 0.0394 (in./hr by 0.0104) to arrive at the L/min./m^2 (gpm/ft.^{2}) of roof area. Multiplying the listed L/min./m^2 (gpm/ft.^{2}) by the roof area being drained by each inlet (in m^2 [ft.^{2}]) produces the L/min. (gpm) of required flow for sizing each drain inlet. The flow rates (L/min. [gpm]) can then be added to determine the flows in each section of the drainage system. Required pipe sizes for various flow rates (L/min. [gpm]) are listed in Table 11-1 and Table 11-2 of this code.

C 3.0 Sizing by Roof Area.

Storm drainage systems shall be permitted to be sized using the roof area served by each section of the drainage system. Maximum allowable roof areas with various rainfall rates are listed in Table 11-1 and Table 11-2, along with the required pipe sizes. Using this method, it may be necessary to interpolate between two listed rainfall rate columns mm/h (in./h). To determine the allowable roof area for a listed pipe size at a listed slope, divide the allowable m^2 (ft.^{2}) of roof for 25mm/h (1 in./h) rainfall rate by the listed rainfall rate for the local area. For example, the allowable roof area for a 150mm (6 in.) drain at a slope equal to 3mm (1/8 in.) with a rainfall rate of 80mm/h (3.2 in./h) is:

$$\frac{[1{,}988\text{m}^2 \times 25\text{mm/h}]}{80\text{mm/h}} = 621\text{m}^2\ (6{,}688\ \text{ft.}^2)$$

C 4.0 Capacity of Rectangular Scuppers.

Table D-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 should be obtained from the structural engineer, based on the design of the roof.

TABLE C-1[1,4]
Discharge from Rectangular Scuppers – L/sec.

Water Head[2]	Width of Scupper in mm.[3]					
mm	**150**	**300**	**450**	**600**	**750**	**900**
15	0.4	0.8	1.2	1.6	2.0	2.4
25	1.1	2.2	3.3	4.5	5.6	6.8
40	2.0	4.0	6.1	8.2	10.3	12.4
50		6.2	9.4	12.6	15.8	19.1
65		8.6	13.1	17.5	22.0	26.5
80		11.2	17.1	23.0	28.9	34.8
90			21.4	28.8	36.3	43.7
100			26.0	35.1	44.2	53.3

SI: 1mm = 0.04 in.; 1L/s = 0.26gpm

Notes:

1. Table D-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.

APPENDIX D

MANUFACTURED/MOBILE HOME PARKS AND RECREATIONAL VEHICLE PARKS

Part A

Manufactured/Mobile Home (M/H) Park Definitions and General Requirements.

D 1.0 Manufactured/Mobile Home.

A structure transportable in one or more sections, which in the traveling mode is 2.4m (8 ft.) or more in width and 12m (40 ft.) or more in length or, when erected on site, is $30m^2$ ($320 ft.^2$) or more, which is built on a permanent chassis, and designed to be used as a dwelling with or without a permanent foundation when connected to the required utilities. It includes the plumbing, heating, air conditioning, and electrical systems contained therein.

D 1.1 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.

D 2.0 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.

D 3.0 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.

D 4.0 General.

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.

D 5.0 Plans and Specifications.

Before any plumbing or sewage disposal facilities are installed or altered in any 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:

(A) Lot plan of the park drawn to scale, indicating elevations, property lines, driveways, existing or proposed buildings, and the sizes of M/H lots.

(B) Complete specification and piping layout of proposed plumbing systems or alteration.

(C) Complete specification and layout of proposed sewage disposal system or alteration.

(D) 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.

D 6.0 Drainage Systems.

A drainage system shall be provided in all M/H parks for conveying and disposing of sewage. Wherever 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.

D 7.0 Material.

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.

D 8.0 Drainage (Sewage) Lines.

Drainage (sewage) collection lines shall be located in trenches of sufficient 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 Tables E-1 and E-2.

D 9.0 M/H Lot Drainage Inlet and Lateral.

(A) Each lot shall be provided with a drainage inlet not less than 80mm (3 in.) in diameter.

(B) The lateral line from the inlet to the sewage drain line shall slope not less than 20mm/m (1/4 in./ft.). All joints shall be water-tight.

(C) All 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.

(D) Provision shall be made for plugging or capping the sewage drain inlet when a M/H does not occupy the lot. Surface drainage shall be diverted away from the inlet. The rim of the inlet shall extend not more than 100mm (4 in.) above ground elevation.

D 10.0 Location of Lot Drain Inlet.

Each lot drainage inlet shall be located in the rear third section and within 1.2m (4 ft.) of the proposed location of the M/H.

D 11.0 Pipe Size.

(A) Each M/H lot drainage inlet shall be assigned a waste loading value of twelve drainage fixture units, and each park drainage system shall be sized according to Table E-1 or as provided herein. Drainage laterals shall be not less than 80mm (3 in.) in diameter.

(B) A park drainage system that exceeds the fixture unit loading of Table E-1, or in which the grade and slope of drainage pipe does not meet the minimum specified in Table E-2, shall be designed by a registered professional engineer.

D 12.0 M/H Drain Connector.

(A) 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, appropriate 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.

(B) A drain connector shall be installed or maintained with a grade not less than 20mm/m (1/4 in./ft.). A drain connector shall be gas-tight 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 only. Each lot drainage inlet shall be capped gas-tight when not in use.

Part C

M/H Park Water Supply.

D 13.0 General Requirements.

An accessible and adequate supply of potable water shall be provided in each M/H park. Where a public supply of water of satisfactory 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. When a satisfactory public water supply is not available, a private water supply system shall be developed and used as approved by the Authority Having Jurisdiction.

TABLE D-1

Drainage Pipe Diameter and Number of Fixture Units on Drainage System

Size of Drainage Pipe mm	Maximum Number of Fixture Units
50	8
80	35
100	256
125	428
150	720
200	2,640
250	4,680
300	8,200

SI: 1mm = 0.04 in.

TABLE D -2

Minimum Grade and Slope of Drainage Pipe

Pipe Size mm	Slope per 30.5m cm	Pipe Size mm	Slope per 30.5m mm
50	64	150	203
80	64	200	102
100	38	250	89
125	28	300	76

SI: 1mm = 0.04 in.; 1m = 3.3 ft.

D 14.0 Lot Service Outlet Size.

Each M/H lot shall be provided with a water service outlet delivering potable water. The water service outlet riser shall have a nominal pipe size of not less than 20mm (3/4 in.) and be capable of delivering twelve water supply fixture units.

D 15.0 Location of Water Service.

Each lot water service outlet shall be located in the rear third section and within 1.2m (4 ft.) of the proposed location of the M/H.

D 16.0 Pressure.

Each M/H park water distribution system shall be so designed and maintained as to provide a pressure of not less than 1.25bar (18.0 psi) at each M/H lot at maximum operating conditions.

D 17.0 Water Distribution Piping.

Park water distribution systems shall be designed to deliver not less than twelve water supply fixture units to each lot and installed with materials as set forth in Chapter 6 of this code.

D 18.0 Shutoff Valve.

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.

D 19.0 Backflow Preventer.

Whenever 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. When 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.

D 20.0 Pressure-Relief Valve.

Whenever 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 not to exceed 10bar (150 psi). Pressure-relief valves shall discharge toward the ground. Backflow preventers and pressure-relief valves shall be not less than 30cm (12 in.) above the ground.

D 21.0 Mechanical Protection.

Park water service outlets, backflow preventers, and pressure-relief valves shall be protected from damage by vehicles or other causes. Such protection shall consist of posts, fencing, or other permanent barriers.

D 22.0 M/H Water Connector.

A M/H shall be connected to the park water service outlet by a flexible connector, such as copper tubing or other approved material of not less than 20mm (3/4 in.) nominal interior diameter.

D 23.0 Water-Conditioning Equipment.

(A) Permit Required. A permit shall be obtained from the Authority Having Jurisdiction prior to installing any water-conditioning equipment on a M/H lot. Approval of the park operator is required on all applications for a permit to install such equipment. If 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.

(B) Approval. Regenerating water-conditioning equipment shall be listed and labeled by an approved listing agency.

(C) Installation. Regenerating units shall discharge the effluent of regeneration into a trap not less than 40mm (1-1/2 in.) in diameter connected to the M/H park drainage system. An approved air gap shall be installed on the discharge line not less than 30cm (12 in.) above ground.

D 24.0 Testing.

Installations shall be tested and inspected as required by Chapter 3 of this code.

Part D
Fuel Supply.

D 25.0 General.

Fuel gas piping systems serving manufactured homes, accessory buildings, or structures and communities shall be designed and constructed in accordance with any applicable provisions of NFPA 54, *National Fuel Gas Code*, and NFPA 58, *Liquefied Petroleum Gas Code* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Oil fuel-burning systems shall be designed and constructed in accordance with NFPA 31, *Standard for the Installation of Oil-Burning Equipment* or equivalent International Standard(s) approved by the Authority Having Jurisdiction, shall apply to oil fuel-burning systems and shall conform to the criteria of the Authority Having Jurisdiction. [NFPA 501A:4.1.1.2]

D 25.1 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 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, *Liquefied Petroleum Gas Code* or equivalent International Standard(s) approved by the Authority Having Jurisdiction, shall be followed. [NFPA 501A:4.1.2.1, 4.1.2.2]

D 25.2 Location of Gas Supply Connection.

The gas supply to the M/H shall be located within 1.2m (4 ft.) of the M/H stand.

Exception: The above requirements shall not apply to gas supply connections for manufactured homes located on all-weather wood, concrete, or concrete block foundation systems or on foundations constructed in accordance with the Building Code. [NFPA 501A:4.1.3]

D 26.0 Single and Multiple Manufactured Home Site Fuel Supply Systems.

D 26.1 Gas Piping Installations.

D 26.1.1 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, *Liquefied Petroleum Gas Code* or equivalent International Standard(s) approved by the Authority Having Jurisdiction, shall be followed.

D 26.1.2 Underground gas piping system installations shall comply with the Building Code and Sections E 26.1.2.1 and E 26.1.2.2. [NFPA 501A:4.2.1]

D 26.1.2.1 Underground gas piping shall not be installed beneath that portion of an M/H site reserved for the location of a manufactured home or M/H accessory building or structure unless installed in the open-ended gas-tight conduit of Section E 26.1.2.2. [NFPA 501A:4.2.1.1]

D 26.1.2.2 The open-ended gas-tight conduit shall conform to the following [NFPA 501A:4.2.1.2]:

(1) The conduit shall be not less than Schedule 40 pipe that is approved for underground installation beneath buildings. [NFPA 501A:4.2.1.2.1]

(2) The interior diameter of the conduit shall be not less than 15mm (0.5 in.) larger than the outside diameter of the gas piping. [NFPA 501A:4.2.1.2.2]

(3) The conduit shall extend to a point not less than 100mm (4 in.) beyond the outside wall of the M/H, accessory building, or structure, and the outer ends shall not be sealed. [NFPA 501A:4.2.1.2.3]

(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:4.2.1.2.4]

D 27.0 Manufactured Home Site Gas Shutoff Valve.

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 15cm (6 in.) above grade. A gas shutoff valve shall not be located under any M/H. The outlet shall be equipped with a cap or plug to prevent discharge of gas whenever the M/H site outlet is not connected to a M/H. [NFPA 501A:4.2.2.1 - 4.2.2.4]

Exception: Gas shutoff valves for manufactured homes located on foundations constructed in accordance with the Building Code.

D 28.0 Gas Meters.

D 28.1 Support of Meters. Where installed, gas meters shall be adequately 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]

D 28.2 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 motor is removed easily and replaced in an upright position. Meters shall not be installed in unventilated or inaccessible locations or closer than 1m (3 ft.) to sources of ignition. [NFPA 501A:4.2.3.2.1 - 4.2.3.2.2]

D 28.3 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:4.2.4.1 - 4.2.4.3]

D 29.0 Manufactured Home Community Natural Gas Distribution Systems.

Underground metallic fuel piping systems shall comply with the cathodic protection requirements of 49 CFR 191 and 192, *Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 501A:4.3.1]

D 30.0 Manufactured Home Community LPG Supply Systems.

Where ten 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, *Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Other liquefied petroleum gas supply systems and the storage and handling of LPG shall be in accordance with NFPA 58, *Liquefied*

Petroleum Gas Code or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 501A:4.3.2.1 - 4.3.2.2]

D 31.0 Installation of Cathodic Protection Systems.

Where required by 49 CFR 191 and 192, *Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards* or equivalent International Standard(s) approved by the Authority Having Jurisdiction, cathodic protection shall be installed for corrosion control of buried or submerged metallic gas piping. [NFPA 501A:4.3.3]

D 32.0 Required Gas Supply.

The minimum hourly volume of gas required at each M/H site outlet or any section of the M/H community gas piping system shall be calculated as shown in Table E-3. [NFPA 501A:4.3.4.1]

TABLE D-3
Demand Factors for Use in Calculating Gas Piping Systems in M/H Communities

No. of Manufactured Home Sites	Watts per Manufactured Home Site
1	37,000
2	34,000
3	30,000
4	28,000
5	27,000
6	25,000
7	24,000
8	24,000
9	23,000
10	22,500
11–20	19,000
21–30	18,000
31–40	17,000
41–60	16,000
Over 60	15,000

Note: In extreme climate areas, additional capacities shall be considered.
SI: 1kW = 3.4 Btu

D 33.0 Gas Pipe Sizing and Pressure.

D 33.1 The size of each section of a gas piping system shall be determined in accordance with NFPA 54, *National Fuel Gas Code*, by other standard engineering methods acceptable to the Authority Having Jurisdiction or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 501A:4.3.5.1]

D 33.2 Where all connected appliances are operated at their rated capacity, the supply pressure shall be not less than 18cm (7 in.) water column. The gas supply pressure shall not exceed 36cm (14 in.) water column. [NFPA 501A:4.3.5.2]

D 34.0 Gas Piping Materials.

D 34.1 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 as protection against corrosion. [NFPA 501A:4.3.6.1.1 - 4.3.6.1.2]

Seamless copper or steel tubing shall be permitted to be used with gases not corrosive to such material. Steel tubing shall comply with ASTM A539, *Standard Specification for Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines*, ASTM A254, *Standard Specification for Copper-Brazed Steel Tubing* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Copper tubing shall comply with ASTM B88, *Specification for Seamless Copper Water Tubing (Type K or Type L)*, ASTM B280, *Specification for Seamless Copper Tubing for Air Conditioning and Refrigeration Field Service* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Copper tubing (unless tin-lined) shall not be used if the gas contains more than an average of 0.7mg of hydrogen sulfide per 100L of gas (0.3 grains/100scf). [NFPA 501A:4.3.6.1.3 - 4.3.6.1.6]

D 34.2 Protection Coatings for Metal Gas Piping. Buried or submerged metallic gas piping shall be protected from corrosion by approved coatings or wrapping materials. All gas pipe protective coatings shall be approved types, shall be machine applied, and shall conform to recognized standards. Field wrapping shall provide equivalent protection and is restricted to those short sections and fittings that are necessarily stripped for threading or welding. Risers shall be coated or wrapped to a point not less than 15cm (6 in.) above ground. [NFPA 501A:4.3.6.2]

D 34.3 Plastic. Plastic piping shall be used underground only and shall meet the requirements of ASTM D2513, *Thermoplastic Gas Pressure Pipe, Tubing, and Fittings*, or ASTM D2517, *Reinforced Epoxy Resin Gas Pressure Pipe and Fittings* or equivalent International Standard(s) approved by the Authority Having Jurisdiction, as well as the design pressure and design limitations of 49 CFR 192.123, *Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards* or equivalent International Standard(s) approved by the Authority Having Jurisdiction, and shall otherwise conform to the installation requirements thereof. [NFPA 501A:4.3.6.3]

D 35.0 Gas Piping Installations.

D 35.1 Minimum Burial Below Ground Level and Clearances. All gas piping installed below ground level shall have an earth cover of not less than 46cm (18 in.) and shall be installed with not less than 30cm (12 in.) of clearance in any direction from any other underground utility system. [NFPA 501A:4.3.7.1]

D 35.2 Metallic Gas Piping.

D 35.2.1 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 to conform to the provisions of 49 CFR 192, *Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Guidelines* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 501A: 4.3.7.2.1, 4.3.7.2.2]

D 35.2.2 Where the cathodic protection system is designed to protect only the gas piping system, the gas piping system shall be electrically isolated from all other underground metallic systems or installations. Where only 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]

D 35.2.3 Where a cathodic protection system is designed to provide all 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]

D 35.3 Plastic Gas Piping. Plastic gas piping shall only 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 smaller in size than No. 18 AWG, with insulation approved for direct burial. Every portion of a plastic gas piping system consisting of metallic pipe shall be cathodically protected against corrosion. [NFPA 501A:4.3.7.3]

D 35.4 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]

D 36.0 Liquefied Petroleum Gas Equipment.

LPG equipment shall be installed in accordance with the applicable provisions of NFPA 58, *Liquefied Petroleum Gas Code* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 501A:4.3.8]

D 37.0 Oil Supply.

The following three methods of supplying oil to an individual M/H site shall be permitted:

(1) Supply from an outside underground tank.

(2) Supply from a centralized oil distribution system designed and installed in accordance with accepted engineering practices and in compliance with NFPA 31, *Standard for the Installation of Oil-Burning Equipment* or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

(3) Supply from an outside above ground tank.

D 37.1 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]

D 37.2 Oil Supply Connections – General. Oil supply connections at M/H stands, where provided from a centralized oil distribution system, shall be located and arranged to permit attachment in a work-like manner to a manufactured home utilizing the stand. The installation of such facilities shall meet the provisions of NFPA 31, *Standard for the Installation of Oil-Burning Equipment* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 501A:4.3.11]

D 38.0 Fuel Supply Systems Installation.

D 38.1 Flexible Gas Connector. Each gas supply connector shall be listed for outside M/H use, shall not exceed 1.8m (6ft.) in length, and shall have a capacity rating adequate to supply the connected load. [NFPA 501A: 4.4.1]

Exception: Gas supply connections for manufactured homes located on an all-weather wood, concrete, or concrete block foundation system or on a foundation constructed in accordance with the Building Code.

D 38.2 Use of Approved Pipe and Fittings of Extension. Where it is necessary to extend the M/H inlet to permit connection of the 1.8m (6 ft.) 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 adequately supported to not exceed intervals equal to 1.2m (4 ft.) to the M/H. [NFPA 501A:4.4.2]

D 38.3 Mechanical Protection. Gas outlet risers, regulators, meters, valves, or other exposed equipment shall be protected against accidental damage. [NFPA 501A:4.4.3]

D 38.4 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.

D 38.5 Fuel Gas Piping Test. The M/H fuel gas piping system shall be tested only with air before it is connected to the gas supply. The M/H gas piping system shall be subjected to a pressure test with all appliance shutoff valves in their closed positions. [NFPA 501A:4.4.5]

D 38.5.1 The fuel gas piping test shall consist of air pressure at 25cm water column (10 in. water column), to 36cm of water column (14 in. water column). The system shall be isolated from the air pressure source and shall maintain this pressure for 10 minutes or more 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 inches of mercury or psi, with increments of either 2.5mm (1/10 in.) or 1.0kPa (1/10 psi), 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:4.4.5.1.1-4.4.5.1.6]

The following warning shall be supplied to the installer:

> **WARNING:** Do not overpressurize the fuel gas piping system. Damage to valves, regulators, and appliances can occur due to pressurization beyond the maximums specified. [NFPA 501A:4.4.5.2]

D 38.5.2 Gas Appliance 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]

D 38.6 Oil Tanks. A tank of not more than 2,500L (660 gal.) or two tanks having an aggregate capacity, not exceeding 2,500L (660 gal.) shall be connected to one oil-burning appliance. Two supply tanks, where used, shall be cross-connected and provided with a single fill and single vent as described in NFPA 31, *Standard for the Installation of Oil-Burning Equipment* or equivalent International Standard(s) approved by the Authority Having Jurisdiction, and shall be on a common slab and rigidly secured one to the other. Tanks having a capacity of 2,500L (660 gal.) or less shall be securely supported by rigid, noncombustible supports to prevent settling, sliding, or lifting. [NFPA 501A:4.4.6]

D 38.6.1 Installation. Oil supply tanks shall be installed in accordance with the applicable provisions of NFPA 31, *Standard for the Installation of Oil-Burning Equipment* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 501A:4.4.6.1]

D 38.6.2 Minimum Standard. A tank with a capacity no larger than 225L (60 gal.) shall be permitted to be a DOT-5 shipping container (drum) and so marked, or a tank meeting the provisions of UL 80, *Steel Inside Tank for Oil Burner Fuel* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Tanks other than DOT-5 shipping containers having a capacity of not more than 2,500L (660 gal.) shall meet the provisions of UL 80 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Pressure tanks shall be built in accordance with Section VIII, Pressure Vessels, *ASME Boiler, and Pressure Vessel Code* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 501A:4.4.6.2.1-4.4.6.2.2]

D 38.6.3 Separation Distance. Tanks that are adjacent to buildings shall be located not less than 3m (10 ft.) from a property line that is permitted to be built upon. [NFPA 501A:4.4.6.3]

D 38.6.4 Minimum Vent Size. Tanks with a capacity no larger than 2,500L (660 gal.) shall be equipped with an open vent not less than a 40mm (1-1/2 in.) iron pipe size; tanks with a capacity of 1,900L (500 gal.) or less shall have a vent of 32mm (1-1/4 in.) iron pipe size. [NFPA 501A:4.4.6.4]

D 38.6.5 Liquid Level. Tanks shall be provided with a means of determining the liquid level. [NFPA 501A:4.4.6.5]

D 38.6.6 Fill Opening. The fill opening shall be a size and in a location that permits ready filling without spillage. [NFPA 501A:4.4.6.6]

D 39.0 Manufactured Home Accessory Building Fuel Supply Systems.

Fuel gas supply systems installed in a M/H accessory building or structure shall comply with the applicable provisions of NFPA 54, *National Fuel Gas*

Code, NFPA 58, *Liquefied Petroleum Gas Code* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Fuel oil supply systems shall comply with the applicable provisions of NFPA 31, *Standard for the Installation of Oil-Burning Equipment* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 501A:4.5]

D 40.0 Community Building Fuel Supply Systems in Manufactured Home Communities.

D 40.1 Fuel Gas Piping and Equipment Installations. Fuel gas piping and equipment installed within a permanent building in a M/H community shall comply 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 the appropriate provisions of NFPA 54, *National Fuel Gas Code*, NFPA 58, *Liquefied Petroleum Gas Code* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 501A:4.6.1]

D 40.2 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 the applicable provisions of NFPA 31, *Standard for the Installation of Oil-Burning Equipment* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 501A:4.6.2]

D 40.3 Oil-Burning Equipment and Installation. Oil-burning equipment and installation within a building constructed in a M/H community in accordance with the Building Code shall comply 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 the appropriate provisions of NFPA 31, *Standard for the Installation of Oil-Burning Equipment* or equivalent International Standard(s) approved by the Authority Having Jurisdiction. [NFPA 501A:4.6.3]

D 40.4 Inspections and Tests. Inspections and tests for fuel gas piping shall be made in accordance with Chapter 12 of this code.

Part E

Recreational Vehicle Parks Definitions and General Requirements.

D 41.0 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.

D 42.0 Recreational Vehicle Park.

A lot 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.

D 43.0 Recreational Vehicle Site.

Within a recreational vehicle park, a lot of ground intended for the accommodation of a recreational vehicle, a tent, or other individual camping unit on a temporary basis.

D 44.0 General.

All plumbing shall be installed in accordance with the plumbing codes of the Authority Having Jurisdiction and with this appendix.

Part F

Recreational Vehicle Park Toilet and Shower Facilities.

D 45.0 Water Closets.

Water Closets and urinals shall be provided at one or more locations in every recreational vehicle park. They shall be convenient of access and shall be located within a radius equal to 150m (500 ft.) from any recreational vehicle site not provided with an individual sewer connection.

D 46.0 Marking.

Facilities for males and females shall be appropriately marked.

D 47.0 Minimum Number of Water Closets.

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.

D 48.0 Interior Finish.

The interior finish of walls shall be moisture resistant to a height of 1.2m (4 ft.) to facilitate washing and cleaning.

D 49.0 Floors.

The floors shall be constructed of material impervious to water and shall be easily cleanable. Any building having 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 as required by this code.

D 50.0 Water Closets and Lavatories.

Where flush tanks, flushometer tanks or flushometer valves 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. When 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.

D 51.0 Urinals.

Where separate facilities are provided for men and women, urinals shall be acceptable for no more than 1/3 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. Only individual stall or wall-hung types of urinals shall be installed. Floor-type trough units shall be prohibited.

D 52.0 Water Closet Type.

Water closets shall be of an approved, elongated bowl type and shall be provided with seats having open fronts or automatic seat cover dispenser.

D 53.0 Miscellaneous.

Each water closet shall be in a separate compartment and be provided with a door having a latch for privacy and a holder or dispenser for toilet paper. Dividing walls or partitions shall be not less than 1.5m (5 ft.) high and shall be separated from the floor by a space not exceeding 30cm (12 in.).

D 54.0 Water Closet Compartments.

Water closet compartments shall be not less than 76cm (30 in.) in width (no water closet shall be set closer than 38cm (15 in.) from its center to a side wall) and there shall be not less than 76cm (30 in.) of clear space in front of each water closet.

D 55.0 Receptacle for Women Toilet Room.

Each toilet room for women shall be provided with a receptacle for sanitary napkins. The receptacle shall be of durable, impervious, and readily cleanable material, and shall be provided with a lid.

D 56.0 Shower Floor Area.

Each shower, where provided, shall have a floor area of 90cm by 90cm (36 in. x 36 in.) and shall be capable of encompassing a 76cm (30 in.) diameter circle and shall be of the individual type, and each shower area shall be visually screened from view, with a floor area of not less than 90cm by 90cm (36 in. x 36 in.) per shower. Each shall be provided with individual dressing areas screened from view and shall contain not less than one clothing hook and stool (or equivalent bench area).

D 57.0 Floor Surface.

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 vented and trapped inlet. Each such area shall have an impervious, skid-resistant surface; wooden racks (duck boards) over shower floors shall be prohibited.

D 58.0 Height.

Every toilet room shall have a ceiling height of not less than 2m (7 ft.) and, unless artificial light is provided, a window or skylight area not less than or equal to 10 percent of the floor area shall be provided.

All 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 when the exterior doors are open. Such screening shall not be required on single toilet units.

D 59.0 Ventilation.

Every toilet room 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 L/sec. is not less than 25 percent of the total volume of the room(s) served, shall be considered as meeting the requirements of this subsection. All openable windows and vents to the outside shall be provided with fly-proof screens of not less than No. 16 mesh.

Part G

Recreational Vehicle Park Potable Water Supply and Distribution.

D 60.0 Quality.

The supply or supplies of water shall comply with the appropriate potable water standards of the Authority Having Jurisdiction or local health authority.

D 61.0 Sources.

Only 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.

D 62.0 Prohibited Connections.

The potable water supply shall not be connected to any nonpotable or unapproved water supply, nor be subjected to any backflow or back-siphonage.

D 63.0 Supply.

The water supply system shall be designed and constructed in accordance with the following:

(A) Not less than 95L/day (25 gal.) per site for sites without individual water connections.

(B) Not less than 190L/day (50 gal.) per site for sites with individual water connections.

(C) Not less than 190L/day (50 gal.) per site for flush tank, flushometer tank or flushometer valve water closets located in restrooms.

D 64.0 Pressure and Volume.

Where water is distributed under pressure to any individual site, the water supply system shall be designed to provide a flow pressure of not less than 1.25bar (18.0 psi) with a flow of not less than 7.6L/min. (2 gpm) at any outlet. The maximum pressure shall not exceed 5.5bar (80 psi).

D 65.0 Outlets.

Water outlets shall be convenient to access and, where not piped to individual RV sites, shall not exceed 90m (300 ft.) from any site. Provisions shall be made to prevent accumulation of standing water or the creation of muddy conditions at each water outlet.

D 66.0 Storage Tanks.

Water storage tanks shall be constructed of impervious materials, protected against contamination and corrosion, and provided with locked, water-tight covers. Any overflow or ventilation openings shall be down- facing and provided with corrosion-resistant screening of not less than No. 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.

D 67.0

When 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 1.2m (4 ft.) of the stand.

D 68.0

Each potable water connection shall consist of a water riser pipe that shall be equipped with a threaded male spigot located not less than 30cm (12 in.) but not exceeding 60cm (24 in.) above grade level for the attachment of a standard water hose. The water riser pipe shall be protected from physical damage per this code. This connection shall be equipped with a listed backflow prevention device.

D 69.0 Drinking Fountains.

Where provided, drinking fountains shall be in conformance with the requirements of this code.

Part I

Recreational Vehicle Park Drainage System.

D 70.0 Drainage System.

An adequate and approved drainage system shall be provided in all RV parks for conveying and disposing of all sewage. Where available, parks shall be connected to a public sewer system.

D 71.0 Material.

Pipe and fittings installed in the drainage system shall be of material listed, approved, and installed per this code.

D 72.0 Minimum Drainage Size.

The minimum diameters of drainage laterals, branches, and mains serving RV sites shall be in accordance with Table E-4.

D 73.0 Sewer Lines.

The sewer lines shall be located to prevent damage from vehicular traffic.

TABLE D-4

Maximum Number of Recreational Vehicle Stands Served	Minimum Pipe Sizes Nominal ID mm
5	80
36	100
120	150
440	200

SI: 1mm = 0.04 in.

D 74.0 Cleanouts.

Cleanouts shall be provided per Chapter 7 of this code.

Part J
Recreational Vehicle Site Drainage System Inlet.

D 75.0

When 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 diameter of the sewer riser pipe shall be not less than 80mm (3 in.), and it shall be provided with a 100mm (4 in.) inlet or not less than a 80mm (3 in.) female fitting.

D 76.0 Sewer Inlet Distance.

When 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 1.2m (4 ft.) of the stand.

D 77.0 Sewer Riser Pipe.

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.

D 78.0 Minimum Number.

One RV sanitary disposal station shall be provided for each one-hundred RV sites, or part thereof, which are not equipped with individual drainage system connections.

D 79.0 Access.

Each station shall be level and convenient of access from the service road and shall provide easy ingress and egress for recreational vehicles.

D 80.0 Construction.

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 90cm by 90cm (3 ft. x 3 ft.), not less than 90cm (3-1/2 in.) thick and properly reinforced. The slab surface shall have a smooth finish and sloped from each side inward to a drainage system inlet.

The drainage system inlet shall consist of a 100mm (4 in.) 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.

D 81.0 Water Supply.

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 and shall consist 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 60cm (2 ft.) above the ground surface, with a valved outlet equal to 20mm (3/4 in.), 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 60cm by 60cm (2 ft. x 2 ft.) 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.

D 82.0

A potable watering station, where provided for filling recreational vehicle potable water tanks, shall be located not less than 15m (50 ft.) from a sanitary disposal station. When such is provided, adjacent to the potable water outlet shall be posted a sign of durable material not less than 60cm by 60cm (2 ft. x 2 ft.) 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.

D 83.0

Fuel gas equipment and installations shall comply with Part D of this appendix, except as otherwise permitted or required by this code.

APPENDIX E

FIREFIGHTER BREATHING AIR REPLENISHMENT SYSTEMS

E 1.0 Scope.

This chapter covers minimum requirements for installation of firefighter breathing air replenishment systems.

E 2.0 System Components.

Firefighter breathing air replenishment systems shall contain, as a minimum, the following components:

(A) Exterior fire department connection panel

(B) Interior fire department air fill panel or station

(C) Interconnected piping distribution system

(D) Pressure monitoring switch

E 3.0 Required Installations.

A firefighter air system shall be installed in the following buildings:

(1) High-rise buildings.

(2) Underground structures that are 3 or more floors below grade with an area exceeding 1,800m^2 (20,000 ft.^{2}).

(3) Large area structures with an area exceeding 18,000m^2 (200,000 ft.^{2}) and where the travel distance from the building centerline to the closest exit exceeds 150m (500 ft.), such as warehouses, manufacturing complexes, malls, or convention centers.

(4) Underground transportation or pedestrian tunnels exceeding 150m (500 ft.) length.

E 4.0 Exterior Fire Department Connection Panel and Enclosure.

E 4.1 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.

E 4.2 Number of Panels. Each building or structure shall have not less than 2 panels.

E 4.3 Location. Each panel shall be attached to the building or on a remote monument at the exterior of the building with not less than a 1.8m (6 ft.) radius and a clear, unobstructed radius equal to 3.1 radian (180 degrees) 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 15m (50 ft.) of an approved roadway or driveway, or other locations approved by the Authority Having Jurisdiction.

E 4.4 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.

E 4.5 Vehicle Protection. Where the panel is located in an area subject to vehicle traffic, impact protection shall be provided.

E 4.6 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 50mm (2 in.) high with a brush stroke equal to 10mm (3/8 in.).

E 4.7 Enclosure Components. The exterior fire department connection panel shall contain all of 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.

E 4.8 Pressure-Relief Valve. Pressure-relief valves shall be installed downstream of the pressure regulator inlet. The relief valve shall meet the requirements of the CGA S-1.3 or equivalent International Standard(s) approved by the Authority Having Jurisdiction 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.

E 4.9 Security. The fire department connection panel enclosure shall be locked by an approved means.

E 5.0 Interior Cylinder Fill Panels.

E 5.1 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 when 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 not less than an 18 gauge interior panel.

E 5.2 Clearance and Access. The panel shall be located not less than 90cm (36 in.) but not exceeding 1.5m (60 in.) above the finished floor or a stairway landing. Clear unobstructed access shall be provided to each panel.

E 5.3 Door. The door shall be arranged such that when the door is open, it does not reduce the required exit width or create an obstruction in the path of egress.

E 5.4 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 50mm (2 in.) high with a brush stroke equal to 10mm (3/8 in.).

E 5.5 Cabinet Components. The cabinet shall be of sufficient size to allow for the installation of the following components:

> **E 5.5.1** The cylinder fill panel shall contain all of 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.

E 5.6 Cylinder Filling Hose. The design of the cabinet shall provide a means for storing the hose to prevent kinking. When the hose is coiled, the brackets shall be installed so that the hose bend radius is maintained at 100mm (4 in.) or greater. Fill hose connectors for connection to SCBA cylinders shall comply with the requirements of CGA V-1, number 346 or 347, or equivalent International Standard(s) approved by the Authority Having Jurisdiction. No other SCBA cylinder fill connections shall be permitted.

E 5.7 Security. Each panel cover shall be maintained and locked by an approved means.

E 6.0 Interior Cylinder Fill Stations and Enclosures.

E 6.1 Location. The location of the closet or room for each air fill station shall be approved by the Authority Having Jurisdiction. When 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. A radius of not less than 1.8m (6 ft.) and a clear, unobstructed access equal to 3.1 radian (180 degrees) to the front of the air filling station shall be provided. The enclosure shall have emergency lighting installed in accordance with NFPA 70 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

E 6.2 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.

E 6.3 Components. The air fill station shall contain all of 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.

E 6.4 Cylinder Filling Hose. Where hoses are used, the design of the cabinet shall provide a means for storing the hose to prevent kinking. When the hose is coiled, the brackets shall be installed so that the hose bend radius is maintained at not less than 100mm (4 in.). Fill hose connectors for connection to SCBA cylinders shall comply with the requirements of CGA V-1, number 346 or 347, or equivalent International Standard(s) approved by the Authority Having Jurisdiction. For high-pressure SCBA cylinders, 310bar (4,500 psi), No. 347 connectors shall be used or equivalent International Standard(s) approved by the Authority Having Jurisdiction. For low-pressure SCBA cylinder 210bar (3,000 psi) and 150bar (2,200 psi), No. 346 connectors shall be used or equivalent International Standard(s) approved by the Authority Having Jurisdiction. No other SCBA cylinder fill connections shall be permitted.

E 6.5 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 50mm (2 in.) high with a brush stroke equal to 10mm (3/8 in.).

E 7.0 Materials.

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 a working pressure of not less than 350bar (5,000 psi).

E 7.1 Tubing. Tubing shall be stainless steel complying with ASTM A269 or equivalent International Standard(s) approved by the Authority Having Jurisdiction, 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.

E 7.2 Fittings. Fittings shall be constructed of stainless steel complying with ASTM A479 or equivalent International Standard(s) approved by the Authority Having Jurisdiction, or other approved materials that are compatible with breathing air at the system pressure.

E 7.3 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.

E 7.4 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 when 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: "FIRE-FIGHTER 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 50mm (2 in.) high with a brush stroke equal to 10mm (3/8 in.).

E 7.5 Isolation Valve. A system isolation valve shall be installed downstream of each air fill station and shall be located in the panel or within 90cm (3 ft.) of the station. The isolation valve shall be marked with its function in letters that are not less than 5mm (3/16 in.) high with a brush stroke equal to 2mm (1/16 in.).

E 8.0 System Requirements.

E 8.1 Protection. All components of the Firefighter Breathing Air Replenishment System installed in a building or structure shall be protected by not less than a two hour fire-resistive construction. All components shall be protected from physical damage.

E 8.2 Markings. Components shall be clearly identified by means of stainless steel or plastic labels or tags indicating their function. This shall include, as a minimum, all fire department connection panels, air fill stations, air storage system, gauges, valves, air connections, air outlets, enclosures, and doors.

E 8.3 Tubing Markings. All tubing shall be clearly marked: "FIREFIGHTERS AIR SYSTEM" and "HIGH PRESSURE BREATHING AIR" by means of signs or self-adhesive labels. Signs shall be 25mm (1 in.) high and shall be secured to the tubing. Signs shall be made of brass, stainless steel, or plastic and nominally engraved with a height equal to 10mm (3/8 in.) and a brush stroke equal to 2mm (1/16 in.). Whether the tubing is concealed or in plain view, signs or labels shall be placed at intervals, not less than 6m (20 ft.) at each fitting. All tubing shall have a sign or label at any accessible point.

E 8.4 Support. Pipe and tubing shall be supported at the minimum intervals shown in UPC-AD, Table 3-3. Pipe and tubing shall be supported in accordance with UPC-AD, Section 314.0.

E 9.0 Design Criteria.

E 9.1 Fill Time. The system shall be designed to fill, at the most remote fill station or panel, a minimum of 1.9m^3 (66 ft.^{3}) compressed breathing air cylinder to a pressure not exceeding 310bar (4,500 psi) simultaneously in three minutes or less. Where greater capacity is required, the Authority Having Jurisdiction shall specify the required system capacity.

E 9.2 Fill Panels or Stations Location. Cylinder fill panels or stations shall be installed in the interior of buildings as follows:

> **E 9.2.1 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 exceeding 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.
>
> **E 9.2.2 Underground Structures.** For underground floors in buildings exceeding 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.
>
> **E 9.2.3 Installation Locations.** The specific location or locations on each floor shall be approved by the Authority Having Jurisdiction.

E 10.0 System Assembly Requirements.

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. When 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.

E 10.1 Welding Requirements. Welding procedures shall meet ASME B31.1, Part 4 and Chapter V or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Prior to and during the welding of sections of tubing, a continuous, regulated dry nitrogen or argon purge at 20kPa (3 psi gauge) shall be maintained to eliminate contamination with products of the oxidation or welding flux. The purge shall commence not less than two minutes prior to welding operations and continue until the welded joint is at ambient temperature.

E 10.2 Prevention of Contamination. The system components shall not be exposed to contaminants, including but not limited to, oils, solvents, dirt, and construction materials. When contamination of system components has occurred, the affected component shall not be installed in the system.

E 11.0 System Acceptance and Certification.

E 11.1 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 520bar (7,500 psi) using oil-free dry air, nitrogen, or argon. Not less than twenty-four hour pneumatic test 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. Any 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 or equivalent International Standard(s) approved by the Authority Having Jurisdiction shall be permitted.

E 11.2 Low Pressure Switch Test. Upon successful completion of the twenty-four hour static pressure test, the system’s low-pressure monitoring switch shall be calibrated to not less than 210bar (3,000 psi) 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.

E 11.3 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.

E 11.4 Material Certifications. The pipe or tubing material certifications shall be provided to the Authority Having Jurisdiction.

E 11.5 Air Sampling. Before the system is placed into service, not less than 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 complies with the requirements for breathing air in accordance with NFPA 1989, Section 5.6 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. The written report of the analysis shall be submitted to the Authority Having Jurisdiction, documenting that the breathing air complies with this section.

E 11.5.1 During the period of air quality analysis, the air fill panel inlet shall be secured so that no air can be 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 22cm by 28cm (8-1/2 in. by 11 in.) with lettering not less 25mm (1 in.).

E 11.6 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.

E 11.7 Final Proof Test. The Authority Having Jurisdiction shall witness the filling of two empty SCBA cylinders having a capacity of 1.9m^3 (66 ft^{-3}), 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 meets the requirements of NFPA 1989 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. The written report shall be provided to the Authority Having Jurisdiction certifying that the air analysis complies with the above requirements.

"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 F
INSTALLATION STANDARDS

The following IAPMO Installation Standards are included here for the convenience of the users of the Uniform Plumbing Code of Abu Dhabi: An Environmental Guide for Water Supply and Sanitation. They are not considered as a part of the Uniform Plumbing Code of Abu Dhabi: An Environmental Guide for Water Supply and Sanitation 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.

Contents

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]TM 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.*

301.1	Minimum Standards
310.0	Workmanship
311.0	Prohibited Fittings and Practices
313.0	Protection of Piping, Materials, and Structures
315.0	Trenching, Excavation, and Backfill
723.0	Building Sewer Test
103.5.3.3	Exceptions
705.1	Types of Joints
705.2	Use of Joints
316.2.3	Plastic Pipe to Other Materials
316.4	Prohibited Joints and Connections
317.0	Increasers and Reducers
Chapter 7	Sanitary Drainage

2.0 GENERAL REQUIREMENTS

2.1 After inspection of the sewer pipe, carefully backfill the trench as prescribed by Sections 315.0 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 D2661 or ASTM F628. [UPC 716.0]

3.1.2.2 ABS Fittings. ABS fittings markings shall be in accordance with ASTM D2661. [UPC 716.0]

3.1.2.3 PVC Pipe. PVC pipe markings shall be in accordance with ASTM 2665. [UPC 716.0]

3.1.2.4 PVC Fittings. PVC fittings markings shall be in accordance with ASTM F2135. [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 D2321. [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 D3034 and PVC, PS-46, ASTM F789 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 705.1]

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 705.2]

3.2.3 Markings

3.2.3.1 PSM PVC pipe markings shall be in accordance with ASTM D3034. [UPC 716.0]

3.2.3.2 PSM PVC fitting markings shall be in accordance with ASTM D3034. [UPC 716.0]

3.2.3.3 PS-46 PVC pipe markings shall be in accordance with ASTM F789. [UPC 716.0]

3.2.3.4 PS-46 PVC fitting markings shall be in accordance with ASTM F789. [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 D2321. [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 F714 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 D2657 or ASTM D3261. [UPC 705.1]

3.3.3 Markings

3.3.3.1 Markings shall be in accordance with ASTM F714. [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 F949. [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 F949. [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 F477. 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 D2564 and shall be used in conjunction with a primer in compliance with ASTM F656. The solvent cement shall be used only for bushings in accordance with ASTM D2855. [UPC 316.1, 705.1]

3.4.3 Markings

3.4.3.1 Corrugated PVC sewer pipe markings shall be in accordance with ASTM F949. [UPC 716.0]

3.4.3.2 Corrugated PVC fittings markings shall be in accordance with ASTM F949. [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 D2321. [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 705.1]

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 705.1]

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 C14, 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 C443, 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 705.1]

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 705.2]

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 705.1]

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 705.1]

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 705.1]

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 705.1]

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 705.1]

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]

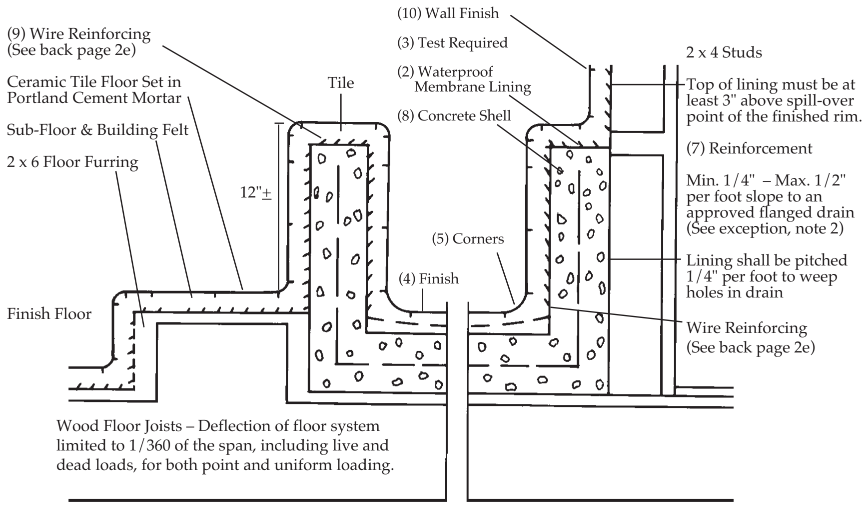
3.7.5 Cleanouts

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

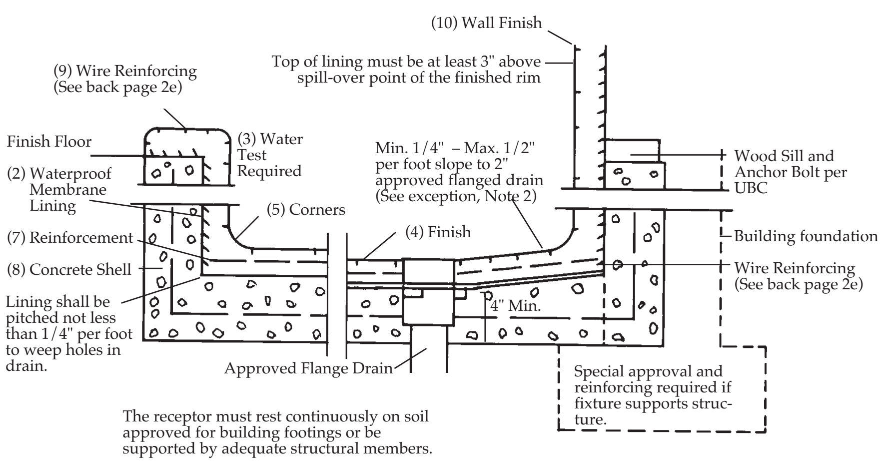
Installation Standard
For
TILE-LINED ROMAN BATH TUBS

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 1-1/2" = 1' - 0"



SCALE 1-1/2" = 1' - 0"

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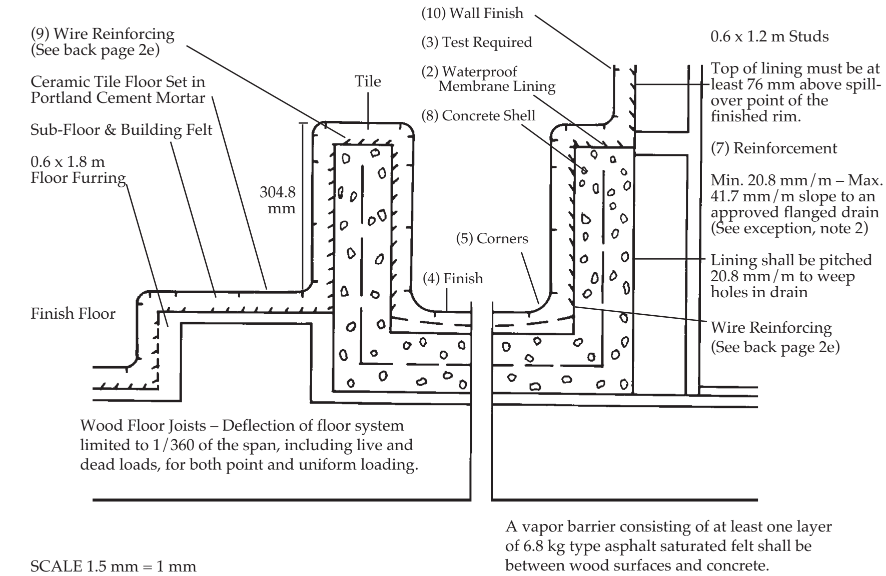
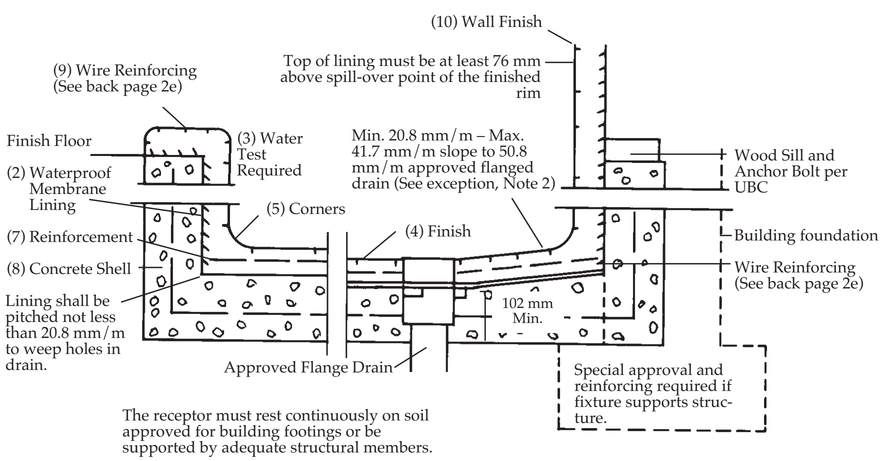
METRIC



SCALE 1.5 mm = 1 mm



SCALE 1.5 mm = 1 mm

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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 C150.

2.3 **Sand –** Sand shall be damp, clean and graded ASTM C778.

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 1-1/2 x 2 (38 mm x 51 mm) mesh, 16 x 13 gage steel wire, conforming to ASTM A82 and A185.

2.6 **Asphalt** shall conform to Federal Specification A-A-50694 or ASTM D1227.

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 D2626.

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 412.0]

3.2 **Sloping Sub-Floor and Membrane** – All lining materials shall be pitched not less than one quarter (1/4) 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.

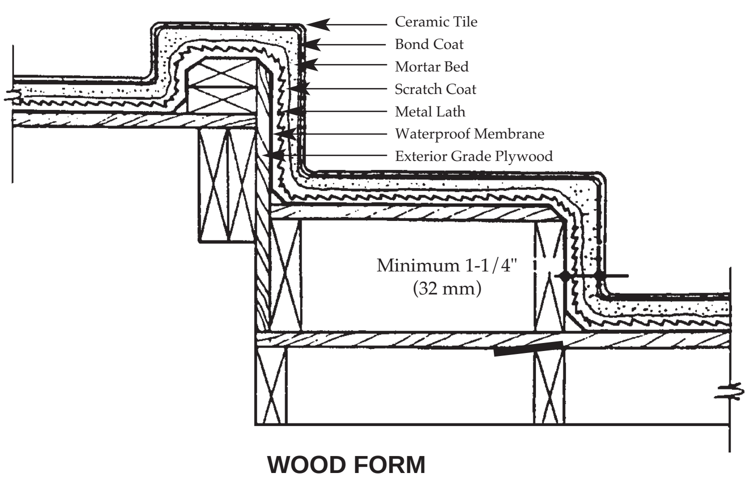
Where flexible plastic sheet membranes are used, corners shall be carefully constructed by folding or bonding of pre-fabricated reinforcing corner. Joints in flexible plastic sheeting shall be constructed with the appropriate solvent bonding liquid, bodied solvent cement, or thermal welding.

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 1-1/2 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 1-1/4 inch (32 mm) at any point. The tile floor shall have a minimum of 1/8 inch (3.2 mm/m) pitch and a maximum of 1/2 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 1/2 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 waterproofing 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.

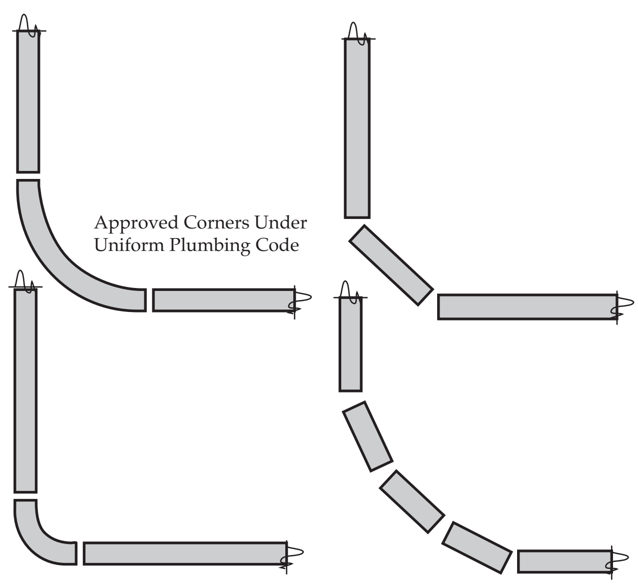
3.4.7 For reinforcement in center of pour, use #30 @ 8 inch (203 mm) O.C. both ways.

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
TILE-LINED SHOWER RECEPTORS (and Replacements)

IAPMO IS 4-2006

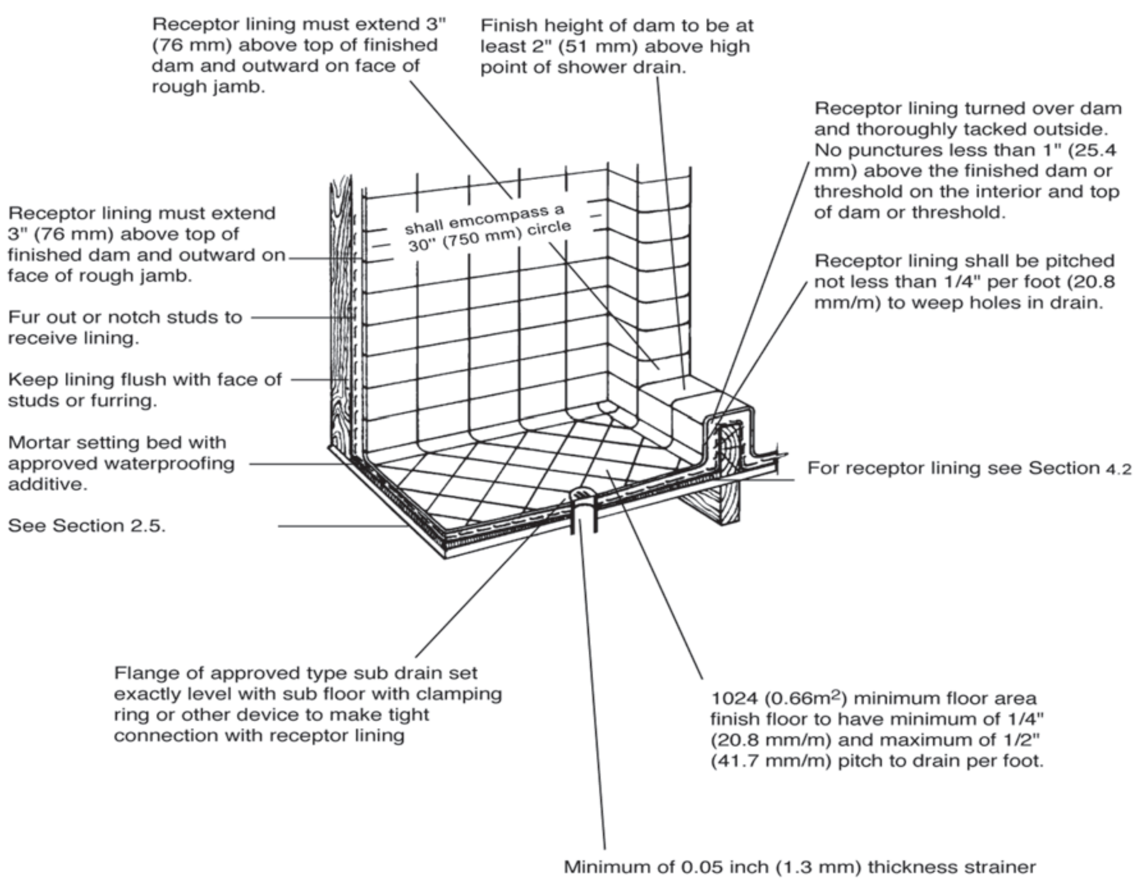
FORWARD

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.

411.1 Floor drains
411.5 Shower receptors
411.6 Shower receptor approval
411.7 Shower compartments
411.8 On-site built-up shower
411.9 Floors of public shower rooms

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 C150.

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 m2) 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 1-1/2 inches x 2 inches (38 mm x 51 mm) mesh, 16 x 13 gage steel, wire conforming to ASTM A82 and A 185.

3.1.6 **Asphalt** shall conform to Federal Specification A-A-50694 OR ASTM D1227.

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 D2626.

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 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

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 411.6]

4.2 **Sloping Sub-Floor and Shower Membrane** All lining materials shall be pitched one quarter (1/4) 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 1-1/2 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 1/4 inch (6.4 mm/m) and a maximum of 1/2 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.

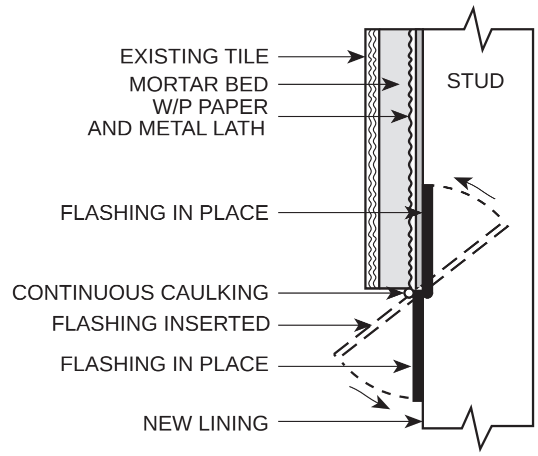


Figure 2

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 D2661, "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.

101.4.1.1	Repair and Alterations
103.5	Inspections
203.0	Definition ABS
301.1	Minimum Standards
311.8	Screwed Fittings
310.0	Workmanship
311.0	Prohibited Fittings and Practices
313.0	Protection of Piping, Materials and Structures
314.0	Hangers and Supports
316.1.1	Threaded Joints
316.1.6	Type of Joints – Solvent Cement Plastic Pipe Joints
316.2.3	Plastic Pipe to Other Material
316.3.1	Flanged Fixture Connections
316.4	Prohibited Joints and Connections
317.0	Increasers and Reducers
408.4	Closet Flanges
701.0	Materials (Drainage)
707.1	Cleanout Fittings
903.0	Materials (Venting)
903.3	Straining or Bending Pipe
1003.0	Traps Described
1101.3	Materials Uses

Table 14-1
Pipe and Fittings

ASTM D2661	ASTM D3311
ASTM D2122	ASTM F402
ASTM F628	

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 D2661 or ASTM F628. [UPC 301.1.2, 716.0]

2.1.2 Fittings

Fittings are black. Refer to Tables in ASTM D2661 and ASTM D3311 for dimensions and tolerances for pipe, fitting sockets, and laying lengths.

ABS fitting markings shall be in accordance with ASTM D2661 or ASTM F628. [UPC 301.1.2, 701.0, 903.0]

2.1.3 Solvent Cement

Solvent cement shall be as specified in ASTM D2235. Solvent cement labels shall be in accordance with ASTM D2235.

2.2 Protection of Piping

2.2.1 Storage

Pipe and fittings should not be stored in direct sunlight. However, exposure 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.

*Although referenced in this standard, some of the fittings shown in the standard are not acceptable under the Uniform Plumbing Code.

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 313.0]

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 313.9]

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) 2-1/2 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 313.6]

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 Building Code, IAPMO Installation Standards and Chapter 15 "Firestop Protection for DWV and Stormwater Applications". [UPC 313.7]

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 314.0]

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 (1/4) inch (6.4 mm) above the finish floor. [UPC 314.0]

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,

TABLE 1
Thermal Expansion Table

Chart Shows Length Changes in Inches vs. Degrees Temperature Change

Coefficient of Linear Expansion: $e = 5.5 \times 10^{-5}$ 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

Coefficient of Linear Expansion: $e = \frac{0.3 \text{ mm}}{\text{mm °C}}$

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
12192	27.2	34.0	40.8	47.8	52.1	61.5	68.3
18288	40.9	51.1	61.2	71.6	81.8	92.0	102.1
24384	54.4	68.1	81.8	95.5	110.0	122.7	136.1
30480	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 (18288 mm) from chart, read 2.010 inches (51 mm) linear expansion that must be provided for.

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]

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 316.1.6]

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 1/3 to 3/4 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 316.1.1]

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 316.2.3]

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 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 316.4]

ADOPTED: 1966

REVISED: 1971, 1974, 1975, 1976, 1977, 1981, 1982, 1983, 1987, 1989, 1990, 1992, 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.

103.5.3	Testing of Systems	
218.0	Definition of PE	
310.0	Workmanship	
313.0	Protection of Piping, Materials, and Structures	
314.0	Supporting in the Ground	
315.0	Backfilling	
316.2.3	Connection to Other Materials	
Chapter 6	Water Distribution	
609.0	Locations	
609.1	Depth of piping	
609.4	Testing	
Table 14-1	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 14-1.

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 D2239 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 301.1.2]

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 301.1.2]

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 301.1.2]

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 313.0]

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 315.0]

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 316.1]

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 313.3. 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 portecocheres, roofed patios, carports, covered walks, covered driveways, and similar structures or appurtenances. [UPC 604.0]

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 (1-1/2) inch (38 mm) and larger pipe. Stiffeners that extend beyond the clamp or nut shall not be used. [UPC 606.0]

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 (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
310.0	Workmanship
313.0	Protection of Piping, Materials and Structures
314.0	Hangers and Supports
315.0	Trenching, Excavation, and Backfill
316.1.6	Solvent-Cement Plastic Pipe Joints
316.2.3	Plastic Pipe to Other Materials
Chapter 6	Water Supply and Distribution
606.2	Use of Joints
604.0	Materials
609.0	Depth of Piping 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	D1784
Pipe		
	Bell-End Poly (vinyl chloride)	
	PVC Pipe	D2672
	PVC Schedule 40	D1785

Type of PVC for Pipe and Fittings		ASTM Standard
	PVC Schedule 80	D1785
	PVC 160 psi (1102.4 kPa)	(SDR 26)
	PVC 200 psi (1378 kPa)	(SDR 21)
	PVC 250 psi (1722.5 kPa)	(SDR 17)
	PVC 315 psi (2170.4 kPa)	(SDR 13.5)
		D 2241
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 14-1 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 D1785 or ASTM D2241. [UPC 301.1.2]

2.3.2 Fittings. PVC fitting markings shall be in accordance with ASTM D2464 or ASTM D2466 or ASTM D2467. [UPC 301.1.2]

*__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 D2564.

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 F656.

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 313.0]

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 315.0]

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 315.4]

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 316.0]

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 F656 and as specified in Section 316.1.6 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 1/3 to 3/4 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 1/2 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 604.0]

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 1/2" to 1-1/4" (12.7 mm) (32 mm)		Sizes 1-1/2" to 3" (38 mm) (76 mm)		Sizes 3-1/2" to 8" (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	22-1/2° Bends	Dead Ends and Tees
1-1/2	415	225	115	295
2	645	350	180	455
2-1/2	935	510	260	660
3	1395	755	385	985
3-1/2	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	22-1/2° 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 1-1/2 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

Soil	Safe Bearing Load 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-5 (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 D2564 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 Schedule	Fittings Sizes	Maximum Working Pressure
160 psi (SDR 26) (1102.4 kPa)	40	1/2" thru 8" incl. (12.7 mm - 203 mm)	160 psi - 1102.4 kPa
	80	1/2" thru 8" incl. (12.7 mm - 203 mm)	160 psi - 1102.4 kPa
200 psi (SDR 21) (1378 kPa)	40	1/2" thru 4" incl. (12.7 mm - 102 mm)	200 psi - 1378 kPa
	80	1/2" thru 8" incl. (12.7 mm - 203 mm)	200 psi - 1378 kPa
250 psi (SDR 17) (1722.5 kPa)	40	1/2" thru 3" incl. (12.7 mm - 76 mm)	250 psi - 1722.5 kPa
	80	1/2" thru 8" incl. (12.7 mm - 203 mm)	250 psi - 1722.5 kPa
315 psi (SDR 13.5) (2170.4 kPa)	40	1/2" thru 1-1/2" incl. (12.7 mm - 38 mm)	315 psi - 2170.4 kPa
	80	1/2" thru 4" incl. (12.7 mm - 102 mm)	315 psi - 2170.4 kPa
Schedule 40	40 80	1/2" thru 1-1/2" incl. (12.7 mm - 38 mm)	320 psi - 2204.8 kPa
	40 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	1/2" thru 1-1/2" 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	1/2" 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

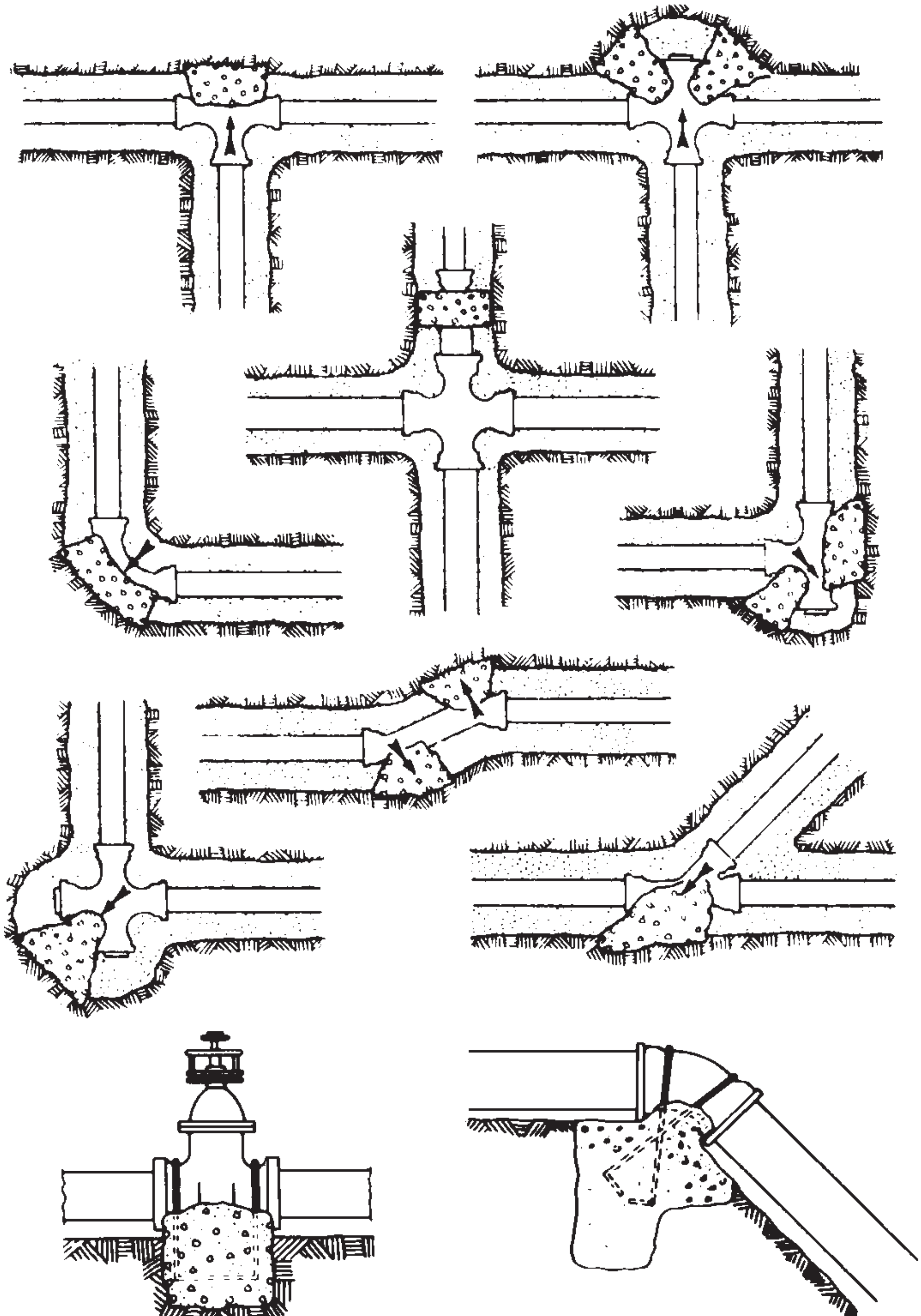


Figure 1

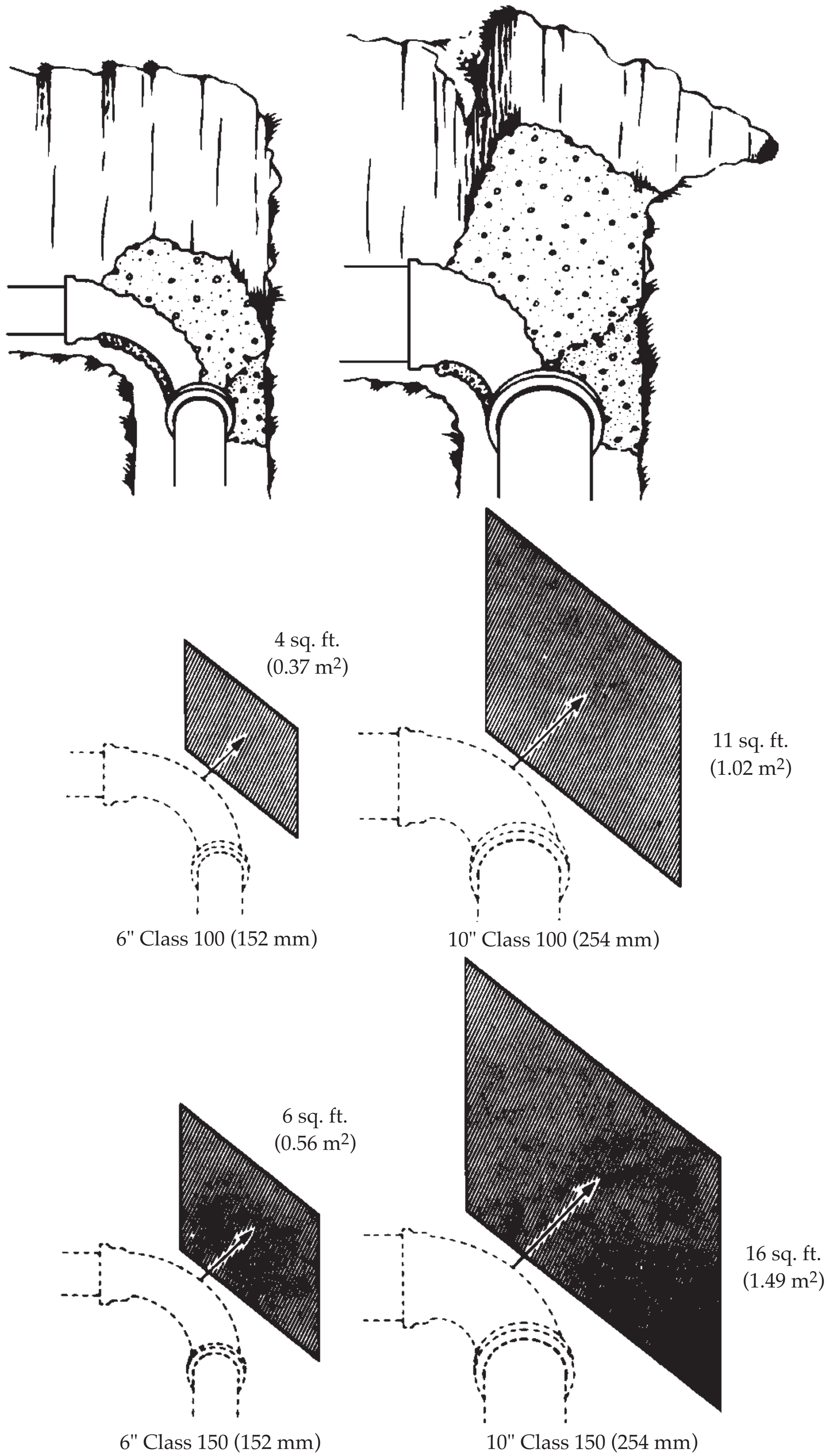

4 sq. ft.
(0.37 m2)
11 sq. ft.
(1.02 m2)
6" Class 100 (152 mm)
10" Class 100 (254 mm)
6 sq. ft.
(0.56 m2)
16 sq. ft.
(1.49 m2)
6" Class 150 (152 mm)
10" Class 150 (254 mm)

Figure 2

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 D2665, "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.

101.4.1.1	Repair and Alterations
103.5	Inspections
103.5.3	Testing of Systems
218.0	Definition PVC
301.1	Minimum Standards
311.8	Screwed Fittings
310.0	Workmanship
311.0	Prohibited Fittings and Practices
313.0	Protection of Piping, Materials, and Structures
314.0	Hangers and Supports
316.1.6	Type of Joints – Solvent Cement Plastic Pipe Joints
316.2	Special Joints
316.3	Flanged Fixture Connections
316.4	Prohibited Joints and Connections
317.0	Increasers and Reducers
408.4	Closet Flanges
701.0	Materials (Drainage)
707.1	Cleanout Fittings
903.0	Materials (Venting)
903.3	Straining or Bending Pipe
1003.0	Traps Described
1101.3	Materials Uses
Table 14-1	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 D2665. [UPC 301.1.2]

2.1.2 **Fittings.** PVC fitting markings shall be in accordance with ASTM D2665 or ASTM D3311. [UPC 301.1.2]

2.1.3 **Solvent Cement.** Solvent cement label markings shall be in accordance with ASTM D2564.

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.

Pipe and fittings shall be so positioned that identifying markings shall be readily visible for inspection. [UPC 310.0]

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

[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.

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 3-1. The linear expansion shown is independent of the diameter of the pipe. [UPC 313.0]

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 313.9]

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) 2-1/2 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 313.6]

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 313.7]

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 314.0]

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 (1/4) inch (6.4 mm) above finish floor. [UPC 314.0]

2.6 Traps

2.6.1 Connection to Traps

Traps shall be connected by means of listed trap adapters. [UPC 1003.0]

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 x 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.

2.7 Joints

2.7.1 Caulked Joints

Make connections or transitions to bell-and-spigot cast iron soil pipe 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 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 705.1.1]

2.7.2 Solvent Cement Joints

(Additional information is available in ASTM D2855.)

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 316.1.6]

2.7.6 **Primers.** A listed primer in compliance with ASTM F656 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 1/3 to 3/4 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 strap-wrench 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 316.2]

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 316.4]

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.*

103.5	Inspection and Testing
101.4.1.1	Repairs and Alterations
203.0	Definition ABS
206.0	Domestic Sewage
301.1	Minimum Standards
310.0	Workmanship
312.0	Independent Systems
313.3 and 313.4	Protection of Piping, Materials, and Structures
314.0	Hangers and Supports
315.0	Trenching, Excavation, and Backfill
316.1	Types of Joint
317.0	Increasers/Reducers
705.1.1	Caulked Joints
705.1.7	Elastomeric Gasketed and Rubber-Ring 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 14-1	ASTM D2751[1]

[1] Although this standard is referenced in Table 14-1, 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 D2751 for dimensions and tolerances for pipe and pipe sockets.

ABS pipe markings shall be in accordance with ASTM D2751. [UPC 301.1.2]

2.1.2 **Fittings**. Refer to Tables in ASTM D2751 for dimensions and tolerances for fitting sockets, spigots, and laying lengths.

ABS fitting markings shall be in accordance with ASTM D2751. [UPC 301.1.2]

2.1.3 **Solvent Cement**. Solvent cement shall be as specified in ASTM D2235.

Solvent cement label markings shall be in accordance with ASTM D2235. [UPC 316.1.6]

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 310.0]

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 315.0]

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 315.4 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 705.1.1]

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 705.1.7]

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 1/3 to 3/4 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
310.0	Workmanship
313.0	Protection of Piping, Materials, and Structures
314.0	Hangers and Supports
315.0	Trenching, Excavation, and Backfill
316.2.3	Plastic Pipe to Other Materials
Chapter 12	Fuel Piping
1204.3.2	Final Piping Inspection
1211.0	Gas Piping Installation
1211.1.7	Tracer Wire
1213.0	Liquified Petroleum Gas Facilities and Piping
Table 14-1	Materials:

Pipe and Tube:
PE3408
PE2406
ASTM D 2513
Fittings:
Copper Alloy ANSI B16.26
PE3408
PE2406
ASTM D 2513
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 14-1 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 1/2 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*
1/4	(6.4)	6
3/8	(9.5)	8
1/2	(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 D2513. [UPC 301.1.2]

2.2.2 Fittings. Fitting markings shall be in accordance with ASTM D1924, ASTM D1948, ASTM D2513 or ASME B16.26. [UPC 301.1.2]

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 315.0, 1211.1.2]

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 x $10^{-5} m^3/s$) 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 315.4, 1211.1.2]

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 1209.5.9]

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 1209.5.9]

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 1214.0]

2.8.2 Piping shall be subjected to the pressure test required in Section 1214.0 of the Uniform Plumbing Code. [UPC 1214.0]

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 1211.0]

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 1209.5.9]

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 1211.16 or 1217.0 of the UPC. [UPC 1211.16, 1217.0]

2.11.2 Tubing. Tubing shall be sized from Table 1. [UPC 1217.0]

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 Inches	Internal Diameter Inches	Length in Feet 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 mm	Internal Diameter mm	Length in Meters 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.*

301.1.2	Marking
302.0	Iron pipe size (IPS) pipe
310.0	Workmanship
311.0	Prohibited fittings and practices
313.5	Protection required
314.0	Hangers and supports
604.0	Materials – water piping
609.3.1	Coated protection required
1209.5	Materials – gas piping
1209.5.6	Coated protection required and coating material approval required

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 301.1.2]

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 313.0]

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 315.0]

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
CPVC SOLVENT CEMENTED HOT AND COLD WATER DISTRIBUTION SYSTEMS

IAPMO IS 20-2006

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
310.0	Workmanship
311.0	Prohibited Fittings and Practices
313.0	Protection of Piping, Materials and Structures
314.0	Hangers and Supports
316.2.3	Plastic Pipe to Other Materials
Chapter 6	Water Supply and Distribution

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 14-1

Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Hot and Cold Water Distribution System ASTM D 2846

Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80 ASTM F 441

Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings Schedule 40 ASTM F 438

Socket Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings Schedule 80 ASTM F 439

Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings ASTM F 493

ABBREVIATIONS

ASTM	American Society for Testing and Materials
IAPMO	International Association of Plumbing and Mechanical Officials
UPC	Uniform Plumbing Code published by IAPMO

*The first three numbers refer to the corresponding section of the UPC.

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 (1/2 in., 3/4 in. and 1 in.) (12.7 mm, 19.1 mm, and 25.4 mm)	F 441
Sch. 80 (1/2 in. – 2 in.) (12.7 mm – 51 mm)	F 441
Tubing	
SDR 11 (1/2 in. thru 2 in.) (12.7 mm – 51mm)	D 2846
Fittings	
Sch. 40 (1/2 in., 3/4 in. & 1 in.) (12.7 mm, 19.1 mm, and 25.4 mm)	F 438
Sch. 80 (1/2 in. – 2 in.) (12.7 mm – 51mm)	F 439
Tube Fittings (1/2 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, 1/2 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 301.1.2]

2.2.2 Fittings. Fitting markings shall be in accordance with F 438 or F 439 or D 2846. [UPC 301.1.2]

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. 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 or yellow.

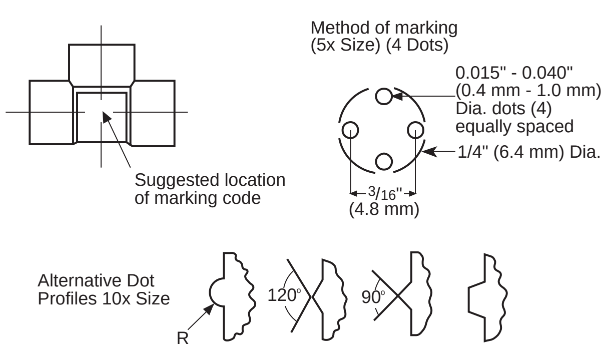
2.2.5 Position of Markings. Identification markings shall be visible for inspection without moving materials.

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 313.0]

2.3.2 Puncture. Steel plate protection shall be installed when required by the Administrative Authority or section 313.9 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.

2.4 Thermal Expansion

2.4.1 General. Allowance for thermal expansion and contraction shall be provided by approved means. Allowance shall be based on an expansion rate of 3.5 inches (89 mm) per 100 feet (30,480 mm) of length of run per 100°F (38°C) temperature change.

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 314.0]

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. Piping 1-1/4 inch (32 mm) or larger shall be supported at maximum 4 foot (1219 mm) intervals.

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%.

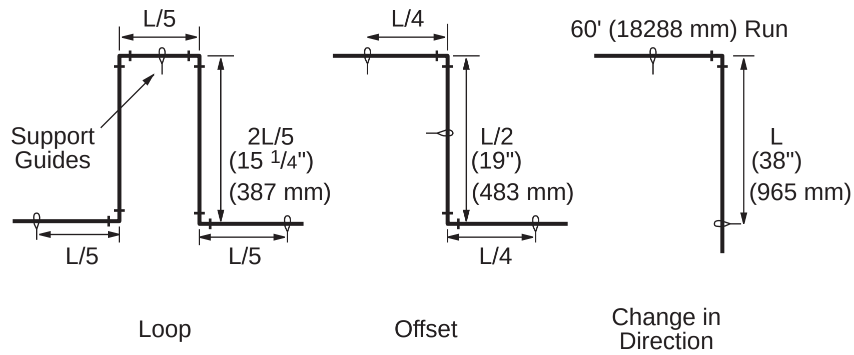
2.7.3 Handling (to maintain effectiveness). Package solvent cement in containers no larger than 1 quart (1 liter). Keep solvent cement can closed and in the shade when not in use. Keep applicator submerged in solvent cement between applications. Discard solvent cement

TABLE 1
Developed Length "L" of Expansion Loops

Nominal Size Inches	(mm)	20	(6096)	40	(12192)	60	(18288)	80	(24384)	100	(30480)
		Loop Length "L" in Inches (mm)									
1/2	(12.7)	22	(6706)	31	(9449)	38	(11582)	44	(13411)	50	(15240)
3/4	(19.1)	26	(7925)	37	(11278)	46	(14021)	52	(15850)	58	(17678)
1	(25.4)	30	(9144)	42	(12802)	52	(15850)	60	(18288)	67	(20422)
1-1/4	(32)	33	(10058)	47	(14326)	57	(17374)	66	(39917)	74	(22555)
1-1/2	(38)	36	(10973)	51	(15545)	62	(18898)	72	(21946)	80	(24384)
2	(51)	41	(12497)	58	(17678)	71	(21641)	82	(24994)	91	(27737)

(Column heads 20–(30480): Length of Run in Feet (mm))

Example: Pipe Size – 1/2 inch (12.7 mm) Length of Run – 60 feet (18288 mm): (38") (965 mm) (from table).



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 hand saw and mitre box, 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 1/4 to 3/4 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 15 seconds 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 following cure times 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 1-1/2 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 316.2]

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.

2.8 **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.

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

TABLE 2
Joint Cure Schedule

Temperature Range of Pipe and Fittings during assembly and cure		Minimum Joint Set Time, hrs. (Sept 12)	Minimum Cure Time before testing, hrs. (Step 14) Pipe Size 1/2 - 1 in. (12.7-25.4 mm)	Minimum Cure Time before testing, hrs. (Step 14) Pipe Size 1-1/4 - 2 in. (32-51 mm)	Minimum Time before putting system into service at 80 psi/160°F (71°C), hrs.
°F	°C				
60-100	16-38	1/2	1	2	24
40-60	4-16	1	2	4	48

TABLE 3
8 Feet per Second

Pipe Size	Pipe GPM	Sch. 40 Ft.* FU	Sch. 40 FV** FU	Pipe GPM	Sch. 80 Ft.* FU	Sch. 80 FV** FU	Tubing GPM	SDR 11 Ft.* FU	SDR 11 FV** FU
1/2	8	9	--	6	7	--	5	6	--
3/4	13	19	--	11	15	--	10	13	--
1	22	33	--	18	26	--	17	24	--
1-1/4	37	74	5	32	55	15	25	42	8
1-1/2	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 L/min	Sch. 40 Ft.* FU	Sch. 40 FV** FU	Pipe L/min	Sch. 80 Ft.* FT	Sch. 80 FV** FU	Tubing L/min	SDR 11 Ft.* FU	SDR 11 FV** FU
12.7	30.3	9	--	22.7	7	--	18.9	6	--
19.1	49.2	19	--	41.6	15	--	37.9	13	--
25.4	83.3	33	--	68.1	26	--	64.3	24	--
32	140.0	74	5	121.1	55	15	94.6	42	8
38	193.0	129	50	166.5	104	36	132.5	66	20
51	306.6	295	170	280.1	245	124	223.3	170	73

*Flush Tank Fixture Units **Flush Valve Fixture Units

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 or 2 as appropriate. Flow velocities shall be limited to a maximum of 8 feet per second (2.4 m/s). See Table 3. [UPC 610.1]

ADOPTED: 1982
REVISED: 1984, 1985, 1989, 1990, 1991, 1992, 1993, 1995, 1996, 1997, 2000, 2003, 2005, 2006

CHART 1

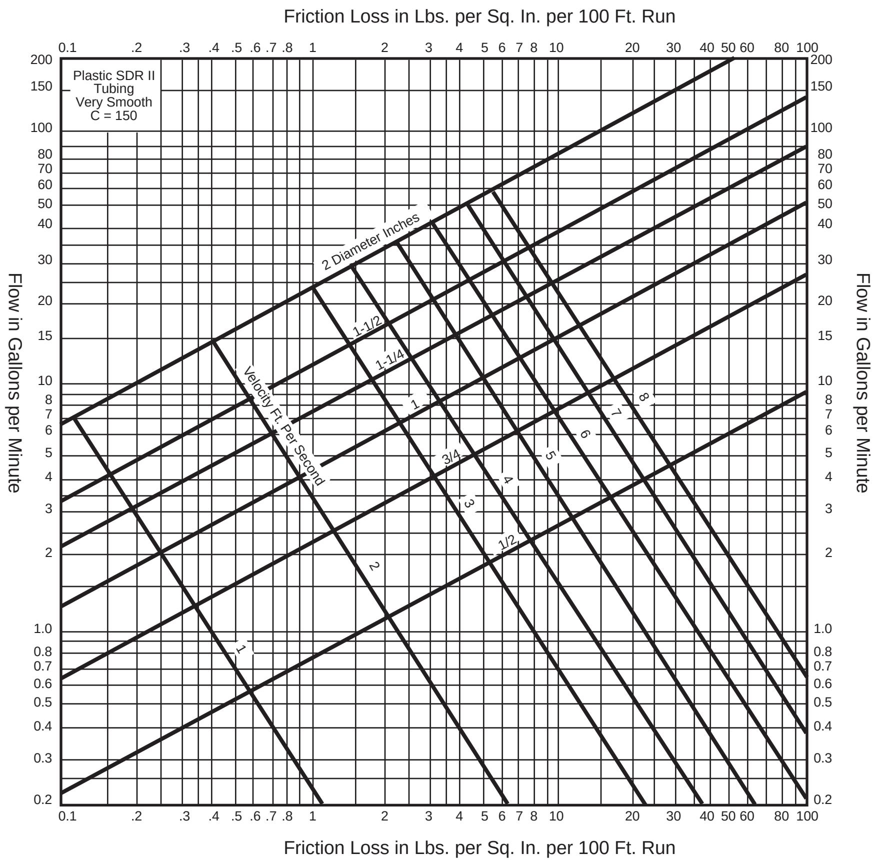

Friction Loss in Lbs. per Sq. In. per 100 Ft. Run
0.1
.2
.3
.4
.5
.6
.7
.8
1
2
3
4
5
6
7
8
10
20
30
40
50
60
80
100
Plastic SDR II
Tubing
Very Smooth
C = 150
2 Diameter Inches
1-1/2
1-1/4
1
3/4
1/2
Velocity Ft. Per Second
Flow in Gallons per Minute
200
150
100
80
70
60
50
40
30
20
15
10
8
7
6
5
4
3
2
1.0
0.8
0.7
0.6
0.5
0.4
0.3
0.2

CHART 2

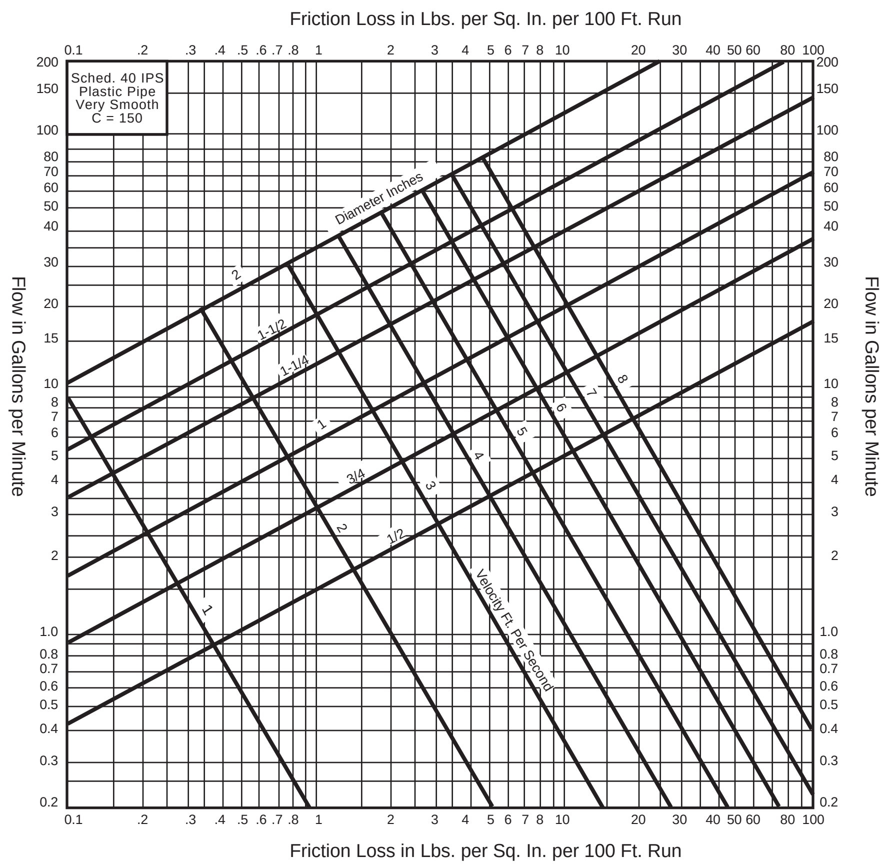
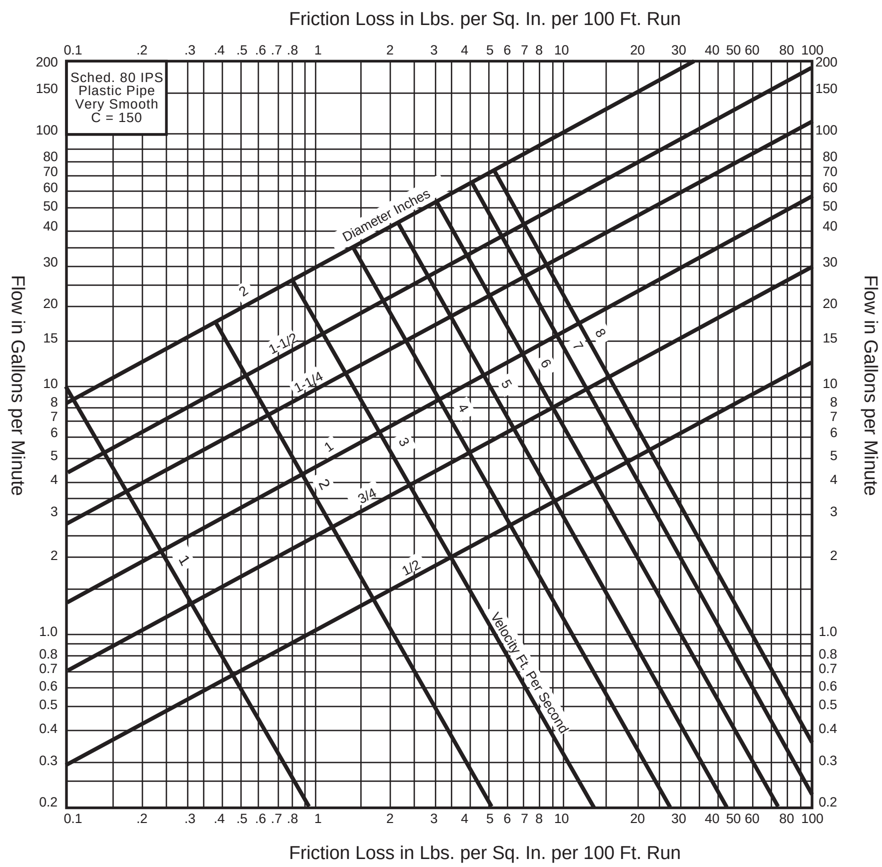

Friction Loss in Lbs. per Sq. In. per 100 Ft. Run
Flow in Gallons per Minute
Sched. 40 IPS
Plastic Pipe
Very Smooth
C = 150
Diameter Inches
Velocity Ft. Per Second
0.1 .2 .3 .4 .5 .6 .7 .8 1 2 3 4 5 6 7 8 10 20 30 40 50 60 80 100
200 150 100 80 70 60 50 40 30 20 15 10 8 7 6 5 4 3 2 1.0 0.8 0.7 0.6 0.5 0.4 0.3 0.2
2
1-1/2
1-1/4
1
3/4
1/2
1 2 3 4 5 6 7 8

CHART 3


Friction Loss in Lbs. per Sq. In. per 100 Ft. Run
Sched. 80 IPS
Plastic Pipe
Very Smooth
C = 150
Flow in Gallons per Minute
Diameter Inches
Velocity Ft. Per Second
1/2
3/4
1
1-1/4
1-1/2
2
3
4
5
6
7
8

CPVC Pipe SDR 11 (ASTM D 2846) Calculated Loop (offset) Lengths with ΔT of approx. 80°F				
	Length of Run in Feet			
Nominal Pipe Size	40	60	80	100
	Loop Length (£) in inches			
1/2"	22	27	31	34
3/4"	26	32	36	41
1"	29	36	41	46
1-1/4"	32	40	46	51
1-1/2"	35	43	50	56
2"	40	49	57	64

Assume Modulus & Stress at 160?F

CPVC Pipe Schedule 80 (ASTM F441) Calculated Loop (offset) Lengths with ΔT of approx. 80°F				
	Length of Run in Feet			
Nominal Pipe Size	40	60	80	100
	Loop Length (£) in inches			
2-1/2"	47	57	66	74
3"	52	63	73	82
4"	58	72	83	92
6"	71	87	100	112
8"	81	99	114	128
10"	90	111	128	143

Assume Modulus & Stress at 160°F

CPVC Pipe Schedule 11 (ASTM D 2846) Calculated Loop (offset) Lengths with ΔT of approx. 100°F					
	Length of Run in Feet				
Nominal Pipe Size	20	40	60	80	100
	Loop Length (£) in inches				
1/2"	17	24	30	34	39
3/4"	20	29	35	41	46
1"	23	33	40	46	52
1-1/4"	26	36	44	51	57
1-1/2"	28	39	48	56	62
2"	32	45	55	64	71

Assume Modulus & Stress at 160°F

£ = √ 3ED(ΔL)/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 F441)
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			
2-1/2"	52	64	74	83
3"	58	71	82	91
4"	65	80	92	103
6"	79	97	112	125
8"	91	111	128	143
10"	101	124	143	160

Assume Modulus & Stress at 160°F

Thermal Expansion (inches)

Length of Run (feet)	ΔT 80°F	ΔT 100°F
20	0.65	0.82
40	1.31	1.63
60	1.96	2.45
80	2.61	3.26
100	3.26	4.08

$\Delta L = L_p \text{ X } C \text{ X } \Delta T$
ΔL = change in length of pipe in inches
L_p = length of pipe in inches
C = coefficient of thermal expansion for CPVC, $3.4 \text{ X } 10^{-5}$ in/in/°F
ΔT = change in temperature in °F

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.*

103.5.3	Testing of Systems
103.5.4.2	Responsibility
103.5.5	Other Inspections
103.5.5.1	Defective Systems
103.6.2	Other Connections
218.0	Definition of PE
301.1	Minimum Standards
310.0	Workmanship
313.0	Protection of Piping, Materials, and Structures
315.0	Trenching, Excavation, and Backfill
316.2.3	Plastic Pipe to Other Materials
Chapter 7	Sanitary Drainage
701.2	Fittings

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 14-1 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 705.1.6.

2.3.2 Shielded Coupling Joints

Shielded coupling joints shall be installed in accordance with Appendix I of the UPC and with Section 705.1.8.

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 705.1.9.

2.3.5 Heat Fusion Joints.

Heat fusion joints shall be made according to the manufacturer's procedure, installation instructions, and either ASTM D2659 or ASTM D3261.

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 D2657 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	Inspection
Chapter 2	Definitions
301.1	Minimum Standards
310.0	Workmanship
311.0	Prohibited Fittings and Practices
311.8	Screwed Fittings
313.0	Protection of Piping, Materials and Structures
314.0	Hangars and Supports
316.0	Joints and Connections
316.4	Prohibited Joints and Connections
317.0	Increasers and Reducers
Chapter 7	Sanitary Drainage
701.0	Materials (Drainage)
701.2	Fittings
903.0	Materials (Venting)
1101.3	Material Uses
Table 14-1	Materials

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 14-1 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 2-1/2 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 1/8" 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 1/4 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)	2-1/2	3	4	5	6	8
Maximum No. of Water Closets	2	3	6	8	10	22

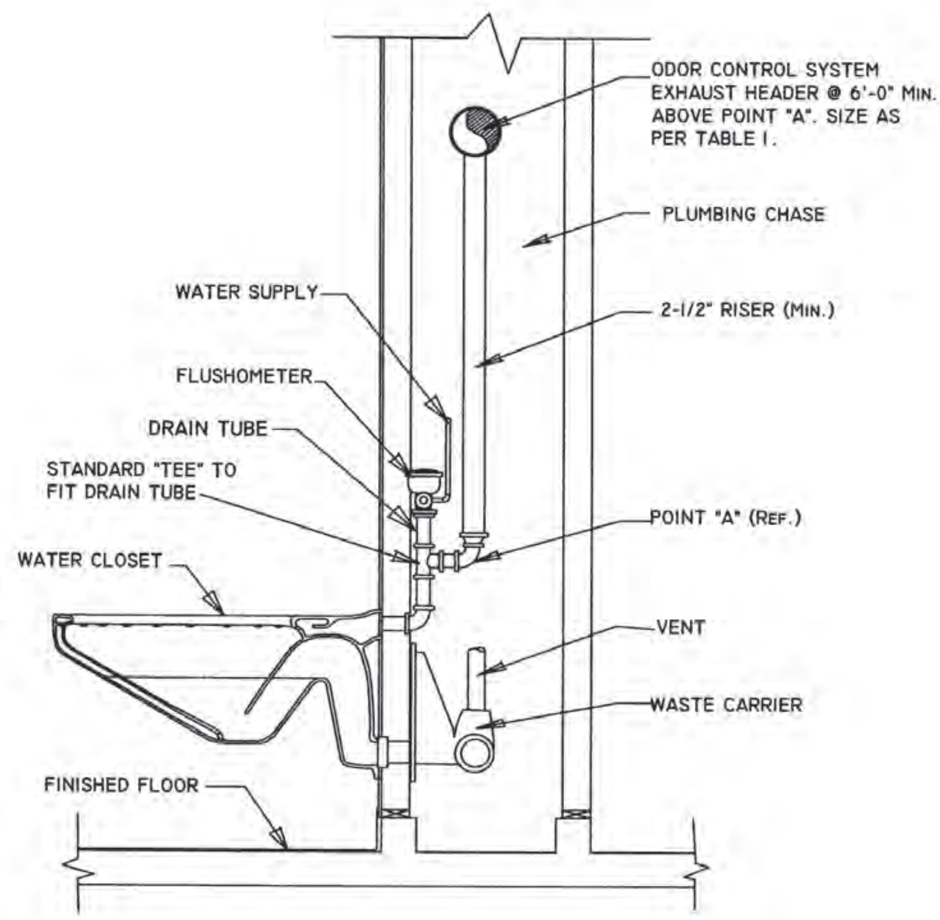


Figure 1

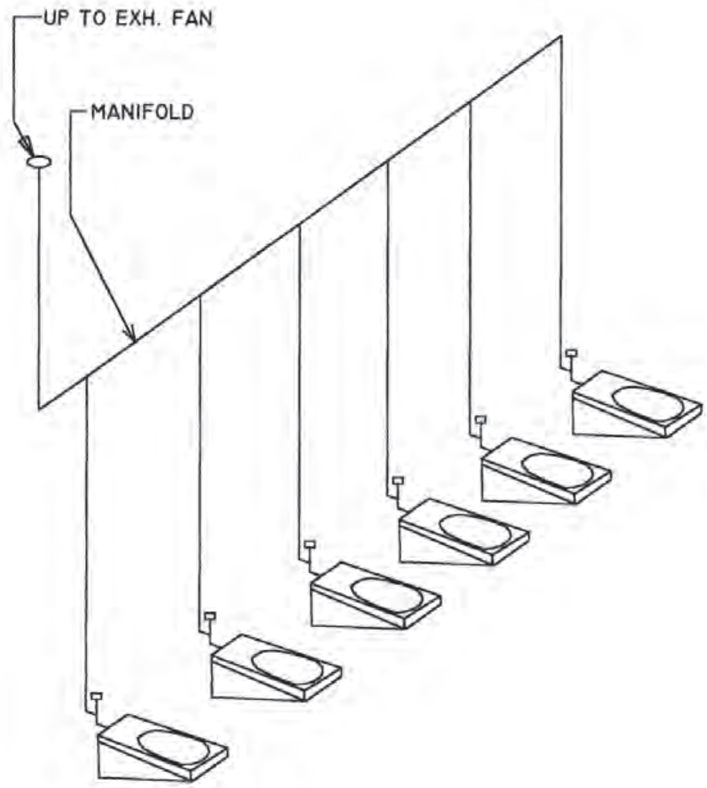


Figure 2

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 F1281 and ASTM F1282 and fittings meeting the requirements of ASTM F1974. 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.*

310.0	Workmanship
313.0	Protection of Piping, Materials, and Structures
316.1	Types of Joints
316.2.3	Plastic Pipe to Other Materials
Chapter 6	Water Supply and Distribution

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	Polyethylen 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 F1281. PE-AL PE composite pipe shall comply with ASTM F1282.

2.1.3 Fittings. Fittings shall be metal insert type and shall comply with ASTM F1974. 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 F1281(PEX-AL-PEX) or ASTM F1282 (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 301.1.2]

The elevated temperature and pressure ratings for PEX-AL-PEX and PE-AL-PE in accordance with ASTM F1281 and ASTM F1282 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 agenc; and

(c) If size permits, ASTM F1974. [UPC 301.1.2]

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 313.9]

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
1/2", 3/4", 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 314.0]

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]

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	1/2"		3/4"		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)
1/2	Couplings	2
	Adapters	2
	Elbows	7.5
	Tees (Branch Flow)	8
	Tees (On the Run)	2.5
3/4	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
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
Table 6-1	Materials
310.0	Piping
316.0	Joints and Connections
319.0	Tests

UPC

218. 0	Definitions of PVC
Table 14-1	Materials
310.0	Workmanship
313.0	Protection of Piping, Material, and Structures
315.0	Backfilling

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 6 -1 of the Uniform Swimming Pool Code.

1.2 Applicable Standards. For applicable standards, see Table 6 -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).

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.

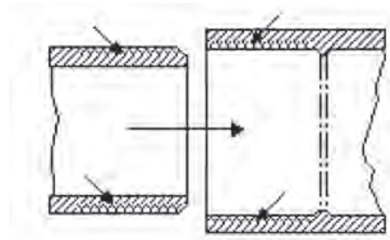


Figure 1
Areas of Hose and Fittings to be Softened (Dissolved) and Penetrated

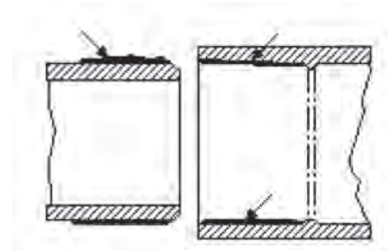


Figure 2
Cement Coatings of Sufficient Thickness

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).

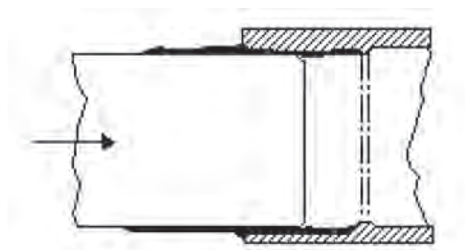


Figure 3
Assembly of Surfaces While They Are Wet and Soft

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).

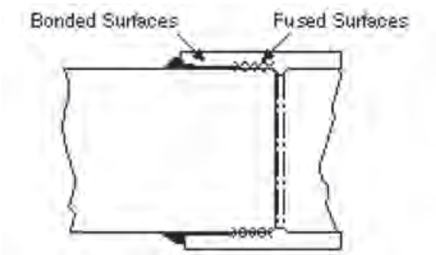


Figure 4
Bonded and Fused Surfaces of Joined Hoses

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 1/3 to 3/4 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.

Table 1
Minimum Cure Time, in Hours[A,B]
Test Pressure for Hose

	Sizes 1/2" to 1 1/4" 12.7 mm to 31.8 mm		Sizes 1-1/2" to 3" 38.1 mm to 76.2 mm		Sizes 3-1/2" to 8" 88.9 mm to 203.2 mm	
Temp. Range During Cure Period	Up to 180psi (1240.2 kPa)	Above 180 to 370psi (1240.2 to 2549.3 kPa)	Up to 180psi (1240.2 kPa)	Above 180 to 315 psi (1240.2 to 2170.4 kPa)	Up to 180psi (1240.2 kPa)	Above 180 to 315psi (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

A It is important to note that at temperatures colder than 20°F (-6.7°C) on sizes 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 tests was 50% or less. Higher relative humidity may require longer cure periods.

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

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

APPENDIX G

PRIVATE SEWAGE DISPOSAL SYSTEMS

G 1.0 Private Sewage Disposal – General.

(A) Where permitted by Section 713.0, the building sewer shall be permitted to be connected to a private sewage disposal system complying 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.

(B) 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 when 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.

(C) Disposal systems shall be designed to utilize the most porous or absorptive portions of the soil formation. Where the groundwater level extends to within 3.7m (12 ft.) 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.

(D) 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.

(E) 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 if the original system cannot absorb the sewage. No division of the lot or erection of structures on the lot shall be made if such division or structure impairs the usefulness of the 100 percent expansion area.

(F) 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.

(G) 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 K-3.

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 when 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 as part of the conditions of ownership of said properties and shall be binding on all heirs, successors, and assigns to such properties. A copy of the instrument recording such proceedings shall be filed with the Authority Having Jurisdiction.

(H) When there is insufficient lot area or improper soil conditions for adequate 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.

(I) 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.

(J) Alternate systems shall be permitted to be used only 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, at least equivalent to systems which are specifically authorized.

If demonstration systems are to be considered for installation, conditions for installation, maintenance, and monitoring at each such site shall first be established by the Authority Having Jurisdiction.

(1) Aerobic Systems. 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 at least equivalent to septic tanks, whether their aeration systems are operating or not.

G 2.0 Capacity of Septic Tanks.

The liquid capacity of all septic tanks shall conform to Tables K-4 and K-5 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 7-3 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, as specified in Table K-6.

G 3.0 Area of Disposal Fields and Seepage Pits.

The minimum effective absorption area in disposal fields in m^2 (ft.^{2}), and in seepage pits in m^2 (ft.^{2}) of sidewall, shall be predicated on the required septic tank capacity in L (gal.) and/or estimated waste/sewage flow rate, whichever is greater, and shall conform to Table K-6 as determined for the type of soil found in the excavation, and shall be as follows:

(A) When disposal fields are installed, not less than fourteen 14m^2 (150 ft.^{2}) of trench bottom shall be provided for each system exclusive of any hard pan, rock, clay, or other impervious formations. Sidewall areas exceeding the required 30cm (12 in.) and not exceeding 90cm (36 in.) below the leach line shall be permitted to be added to the trench bottom area when computing absorption areas.

(B) Where leaching beds are permitted in lieu of trenches, the area of each such bed shall be not less than 50 percent exceeding the tabular requirements for trenches. Perimeter sidewall areas exceeding the required 30cm (12 in.) and not exceeding 90cm (36 in.) below the leach line shall be permitted to be added to the trench bottom area when computing absorption areas.

(C) No excavation for a leach line or leach bed shall be located within 1.5m (5 ft.) of the water table nor to a depth where sewage contaminates 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 1.5m (5 ft.) 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.

(D) 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 be located within 3m (10 ft.) of the water table nor to a depth where sewage contaminates 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 3m (10 ft.) 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.

(E) Leaching chambers shall be sized on the bottom absorption area (nominal unit width) in m^2 (ft.^{2}) The required area shall be calculated using Table K-6 with a 0.70 multiplier.

G 4.0 Percolation Test.

(A) Wherever practicable, disposal field and seepage pit sizes shall be computed from Table K-6. Seepage pit sizes shall be computed by percolation tests, unless use of Table K-6 is approved by the Authority Having Jurisdiction.

(B) In order to determine the absorption qualities of seepage pits and of questionable soils other than those listed in Table K-6, the proposed site shall be subjected to percolation tests acceptable to the Authority Having Jurisdiction.

(C) When a percolation test is required, no private disposal system shall be permitted to serve a building if that test shows the absorption capacity of the soil is less than $34L/m^2$ (0.83 gal./ft.^{2}) or more than $209L/m^2$ (5.12 gal./ft.^{2}) of leaching area per 24 hours. If the percolation test shows an absorption rate exceeding $209L/m^2$ (5.12 gal./ft.^{2}) per 24 hours, a private disposal system shall be permitted if the site does not overlie groundwaters protected for drinking water supplies, a thickness of not less than 60cm (2 ft.) 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.

G 5.0 Septic Tank Construction.

(A) Plans for all septic tanks shall be submitted to the Authority Having Jurisdiction for approval. Such plans shall show all dimensions, reinforcing, structural calculations, and such other pertinent data as required.

(B) 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.

(C) Septic tanks shall be constructed of solid durable materials not subject to excessive corrosion or decay and shall be water-tight.

(D) Septic tanks shall have not less than two compartments. The inlet compartment of any septic tank shall be not less than 2/3 of the total capacity of the tank, nor less than a $2m^3$ (500 gal.) liquid capacity, and shall be not less than 90cm (3 ft.) in width and 15cm (6 in.) in length. Liquid depth shall be not less than 60cm (2 ft.) and 15cm (6 in.) nor more than 1.8m (6 ft.). The secondary compartment of any septic tank shall have a capacity of not less than $1m^3$ (250 gal.) and a capacity exceeding 1/3 of the total capacity of such tank. In septic tanks exceeding a $5.7m^3$ (1,500 gal.) capacity, the secondary compartment shall be not less than 1.5m (5 ft.) in length.

(E) Access to each septic tank shall be provided by not less than two manholes not less than 50cm (20 in.) in 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. Wherever a first compartment exceeds 3.7m (12 ft.) in length, an additional manhole shall be provided over the baffle wall.

(F) 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 be not less in size than the connecting sewer pipe nor less than 100mm (4 in.). A baffle-type fitting shall have the equivalent cross-sectional area of the connecting sewer pipe and not less than a 100mm (4 in.) horizontal dimension when measured at the inlet and outlet pipe inverts.

(G) The inlet and outlet pipe or baffle shall extend 100 mm (4 in.) above and not less than 30cm (12 in.) below the water surface. The invert of the inlet pipe shall be at a level not less than 50mm (2 in.) above the invert of the outlet pipe.

(H) 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.

(I) The sidewalls shall extend not less than 23cm (9 in.) above the liquid depth. The cover of the septic tank shall be not less than 50mm (2 in.) above the back vent openings.

(J) Partitions or baffles between compartments shall be of solid, durable material and shall extend not less than 100mm (4 in.) above the liquid level. An inverted fitting equivalent in size to the tank inlet, but in no case less than 100mm (4 in.) in size, shall be installed in the inlet compartment side of the baffle with the bottom of the fitting placed midway in the depth of the liquid. Wooden baffles are prohibited.

(G) Structural Design.

(1) General. 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 $2500kg/m^2$ (500 lbs/ft.^{2}) when the maximum coverage does not exceed 90cm (3 ft.).

(2) Flood Loads. 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 60cm (2 ft.) 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.

(L) 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.

(M) Materials.

(1) Concrete Septic Tanks. Materials used in constructing a septic tank shall be in accordance with applicable standards referenced in Chapter 14, Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

(2) Steel Septic Tanks. The wall thickness of any steel septic tank shall be not less than 2.8mm (0.109 in.) (No. 12 U.S. gauge), and each such tank shall be protected from corrosion both externally and internally by an approved bituminous coating or by other acceptable means.

(3) Alternate Materials.

(I) Septic tanks constructed of alternate materials shall be permitted to be approved by the Authority Having Jurisdiction when complying with approved applicable standards.

(II) Wooden septic tanks are prohibited.

(N) Prefabricated Septic Tanks.

(1) Manufactured or prefabricated septic tanks shall comply with all 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.

G 6.0 Disposal Fields.

(A) Distribution lines shall be constructed of perforated high-density polyethylene pipe, perforated ABS pipe, perforated PVC pipe, or other approved materials, provided that sufficient openings are available for distribution of the effluent into the trench area.

(B) Before placing filter material or drain lines in a prepared excavation, all smeared or compacted surfaces shall be removed from trenches by raking to a depth of 25mm (1 in.) and the loose material removed. Clean stone, gravel, slag, or similar filter material acceptable to the Authority Having Jurisdiction, varying in size from 20mm to 65mm (3/4 in. to 2-1/2 in.), 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 conform to manufacturer's installation instructions.

(C) A grade board staked in the trench to the depth of filter material shall be utilized when the distribution line is constructed with drain tile or a flexible pipe material that will not maintain alignment without continuous support.

(D) When seepage pits are used in combination with disposal fields, the filter material in the trenches shall terminate not less than 1.5m (5 ft.) from the pit excavation, and the line extending from such points to the seepage pit shall be approved pipe with water-tight joints.

(E) 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 all outlets shall be level, and the invert of the inlet shall be not less than 25mm (1 in.) 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.

(F) All laterals from a distribution box to the disposal field shall be approved pipe with water-tight joints. Multiple disposal field laterals, wherever practicable, shall be of uniform length.

(G) Connections between a septic tank and a distribution box shall be laid with approved pipe with water-tight joints on natural ground or compacted fill.

(H) When the quantity of sewage exceeds the amount that can be disposed in 1.5 lineal m (500 lineal ft.) 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 305 lineal m (1,000 lineal ft.), the dosing tank shall be provided with two siphons or pumps dosing alternately and each serving half of the leach field.

TABLE G-1
Disposal Fields

	Minimum	Maximum
Number of drain lines per field	1	–
Length of each line	–	30m
Bottom width of trench	46cm	0.9m
Spacing of lines, center-to-center	1.8m	–
Depth of earth cover of lines [preferred – 46cm]	30cm	–
Grade of lines	level	25mm/m
Filter material under drain line	30cm	–
Filter material over drain lines	50mm	–

SI: 1mm = 0.04 in.; 1m = 3.3 f.; 1 cm = 0.4 in.

(I) Disposal fields shall be constructed as follows:

(See Table K-1)

Spacing between trenches or leaching beds shall be not less 1.2m (4 ft.) plus 60cm (2 ft.) for each additional 30cm (1 ft.) of depth exceeding 30cm (1 ft.) below the bottom of the drain line. Distribution drain lines in leaching beds shall not exceed 1.8m (6 ft.) apart on centers, and no part of the perimeter of the leaching bed shall exceed 90cm (3 ft.) from a distribution drain line. Disposal fields, trenches, and leaching beds shall not be paved over or covered by concrete or any material that can reduce or inhibit any possible evaporation of sewer effluent.

(J) When 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 water-tight 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 water-tight joints and installed on natural or unfilled ground.

G 7.0 Seepage Pits.

(A) 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 conform to Section K 3.0 of this appendix.

(B) Multiple seepage pit installations shall be served through an approved distribution box or be connected in series by means of a water-tight connection laid on undistributed or compacted soil; the outlet from the pit shall have an approved vented leg fitting extending not less than 30cm (12 in.) below the inlet fitting.

(C) Each seepage pit shall be circular in shape and shall have an excavated diameter of not less than 1.2m (4 ft.). 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 exceeding 1.8m (6 ft.).

(D) The lining in every 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 100mm (4 in.) wall. Brick or block exceeding 30cm (12 in.) 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 15cm (6 in.) and 20mm (3/4 in.) clean gravel or rock.

(E) All brick or block used in seepage pit construction shall have a compressive strength of not less than 170bar (2,500 psi).

(F) Each seepage pit shall have a sidewall (not including the arch) of not less than 3m (10 ft.) below the inlet.

(G) The arch or dome of any 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 50mm (2 in.) in thickness shall be applied, said covering to extend not less than 15cm (6 in.) beyond the sidewalls of the pit.

(3) Approved type one- or two-piece reinforced concrete slab of 170bar (2,500 psi) minimum compressive strength, not less than 13cm (5

in.) thick and designed to support an earth load of not less than 2000kg/m^2 (400lbs./ft.^{2}). Each such cover shall be provided with not less than a 23cm (9 in.) inspection hole with plug or cover and shall be coated on the underside with an approved bituminous or other non-permeable protective compound.

(H) The top of the arch or cover must be not less than 46cm (18 in.) but not exceeding 1.2m (4 ft.) below the surface of the ground.

(I) An approved vented inlet fitting shall be provided in every seepage pit so arranged as to prevent the inflow from damaging the sidewall.

Exception: When using a one- or two-piece concrete slab cover inlet, fitting shall be permitted to be a 1/4 bend fitting discharging through an opening in the top of the slab cover. On multiple seepage pit installations, the outlet fittings shall be per Section K 7.0(B) of this appendix.

G 8.0 Cesspools.

(A) A cesspool shall be considered only as a temporary expedient pending the construction of a public sewer; as an overflow facility when installed in conjunction with an existing cesspool; or as a means of sewage disposal for limited, minor, or temporary uses, when first approved by the Authority Having Jurisdiction.

(B) Where it is established that a public sewer system will be available in less than two 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 when first approved by the Authority Having Jurisdiction.

(C) Each cesspool, when permitted, shall conform to the construction requirements set forth in Section K 7.0 of this appendix for seepage pits and shall have a sidewall (not including arch) of not less than 6m (20 ft.) below the inlet, provided, however, that when a strata of gravel or equally pervious material of 1.2m (4 ft.) in thickness is found, the depth of such sidewall need not exceed 3m (10 ft.) below the inlet.

(D) When 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 30cm (12 in.) downward into such existing pit and having its outlet flow line not less than 15cm (6 in.) below the inlet. All pipe between pits shall be laid with approved water-tight joints.

G 9.0 Commercial or Industrial Special Liquid-Waste Disposal.

(A) When 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.

(B) Installation of such interceptors shall comply with Section 1009.0 of this code, and their location shall be in accordance with Table K-3 of this appendix.

(C) A sampling box shall be installed when required by the Authority Having Jurisdiction.

(D) Interceptors shall be of approved design and be of not less than two compartments. Structural requirements shall be in compliance with the applicable subparts of Section K 5.0 of this appendix.

(E) Interceptors shall be located as close to the source as possible and be accessible for servicing. All necessary manholes for servicing shall be at grade level and be gas-tight.

(F) 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.

(G) **Recommended Design Criteria.** (Formula may be adapted to other types of occupancies with similar wastes.) See Table K-2.

G 10.0 Inspection and Testing.

(A) **Inspection.**

(1) Applicable provision of Section 103.5 of this code and this appendix shall be complied with. Plans shall be permitted to be required per Section 101.3 of this code.

(2) System components shall be properly identified as to the 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) If design is predicated on soil tests, the system shall be installed at the same location and depth as the tested area.

(B) **Testing.**

(1) Septic tanks or other primary components shall be filled with water to flow line prior to requesting inspection. All seams or joints shall be left exposed (except the bottom), and the tank shall remain water-tight.

(2) A flow test shall be performed through the system to the point of effluent disposal. All

TABLE G-2
Recommended Design Criteria

Grease and Garbage, Commercial Kitchens

Number of meals per peak hour	x	Waste flow rate	x	Retention time	x	Storage factor	=	Interceptor size (liquid capacity)

Sand-Silt Oil, Auto Washers

Number of vehicles per hour	x	Waste flow rate	x	Retention time	x	Storage factor	=	Interceptor size (liquid capacity)

Silt-Lint Grease, Laundries, Laundromats

Number of machines	x	2 cycles per hour	x	Waste flow rate	x	Retention time	x	Storage Factor	=	Interceptor size (liquid capacity)

Waste Flow Rate
See Table K-3 of this appendix for estimated flow rates.

Retention Times

Commercial kitchen waste:
Dishwasher and/or disposal ....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

Storage Factors

Fully equipped commercial kitchen ....8 h. operation: 1
16 h. operation: 2
24 h. operation: 3
Single service kitchen 1.5
Auto washers ....self-serve: 1.5
employee operated: 2
Laundries, laundromats ....1.5 (allows for rock filter)

lines and components shall be water-tight. Capacities, required air space, and fittings shall be in accordance with the provisions set forth in this appendix.

G 11.0 Abandoned Sewers and Sewage Disposal Facilities.

(A) Every abandoned building (house) sewer, or part thereof, shall be plugged or capped in an approved manner within 1.5m (5 ft.) of the property line.

(B) Every 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 connected, shall have the sewage removed therefrom and be completely filled with the earth, sand, gravel, concrete, or other approved material.

(C) 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.

(D) No person owning or controlling any 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 comply with the provisions of this section or upon receipt of notice so to comply with the Authority Having Jurisdiction.

(E) Where disposal facilities are abandoned consequent to connecting any premises with the public sewer, the permittee making the connection shall fill all abandoned facilities as required by the Authority Having Jurisdiction within 30 days from the time of connecting to the public sewer.

G 12.0 Drawings and Specifications.

The Authority Having Jurisdiction, Health Officer, or other department having jurisdiction shall be permitted to require any or all of the following information before a permit is issued for a private sewage disposal system or at any time during the construction thereof.

(A) Lot plan drawn to scale, completely dimensioned, showing direction and approximate slope of surface, location of all present or proposed retaining walls, drainage channels, water supply lines or wells, paved areas and structures on the lot, number of bedrooms or plumbing fixtures in each structure, and location of the private sewage disposal system with relation to lot lines and structures.

(B) 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 all materials, equipment, construction, workmanship, and methods of assembly and installation.

(C) A log of soil formations and groundwater levels as determined by test holes dug in close proximity to any 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.

TABLE G-3
Location of Sewage Disposal System

Minimum Horizontal Distance In Clear Required From:	Building Sewer	Septic Tank	Disposal Field	Seepage Pit or Cesspool
	m	m	m	m
Buildings or structures[1]	0.6	1.5	24.0	24.0
Property line adjoining private property	clear[2]	1.5	1.5	24.0
Water supply wells	15.0[3]	15.0	30.0	46.0
Streams and other bodies of water	15.0	15.0	30.0	46.0
Trees	–	3.0	–	3.0
Seepage pits or cesspools	–	1.5	1.5	3.6
Disposal field	–	1.5	1.2[4]	1.5
On-site domestic water service line	0.3[5]	1.5	1.5	1.5
Distribution box	–	–	1.5	1.5
Pressure public water main	3.0[6]	3.0	3.0	3.0

Note:

When disposal fields and/or seepage pits are installed in sloping ground, the horizontal distance between any part of the leaching system and ground surface shall be not less than 4.6m (15 ft.).

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 also Section 315.1 of the UPC-AD.

3 All drainage piping shall clear domestic water supply wells by not less than 15m (50 ft.). This distance may be reduced to not less than 7.6m (25 ft.) when the drainage piping is constructed of materials approved for use within a building.

4 Plus 60cm (2 ft.) for each additional 30cm (1 ft.) of depth exceeding 30cm (1 ft.) below the bottom of the drain line. (See also Section K 6.0.)

5 See Section 720.0 of the UPC-AD.

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.

SI: 1m = 3.3 ft.

TABLE G-4
Capacity of Septic Tanks*

Single-Family Dwellings Number of Bedrooms	Multiple Dwelling Units or Apartments – One Bedroom Each	Other Uses: Maximum Fixture Units Served per Table 7–4	Minimum Septic Tank Capacity in L
1 or 2		15	2,839
3		20	3,785
4	2 units	25	4,542
5 or 6	3	33	5,678
	4	45	7,571
	5	55	8,517
	6	60	9,464
	7	70	10,410
	8	80	11,356
	9	90	12,302
	10	100	13,249

***Note:**

Extra bedroom, 568L (150 gal.) each.

Extra dwelling units over 10: 946L (250 gal.) each.

Extra fixture units over 100: 95L (25 gal.) per fixture unit.

Septic tank sizes in this table include sludge storage capacity and the connection of domestic food waste disposal units without further volume increase.

SI: 1L = 0.26 gal.

TABLE G-5
Estimated Waste/Sewage Flow Rates*

Type of Occupancy	L/day
1. Airports	60 per employee
	20 per passenger
2. Auto washers	Check with equipment manufacturer
3. Bowling alleys (snack bar only)	285 per lane
4. Camps:	
Campground with central comfort station	135 per person
Campground with flush toilets, no showers	95 per person
Day camps (no meals served)	60 per person
Summer and seasonal	190 per person
5. Churches (Sanctuary)	20 per seat
with kitchen waste	30 per seat
6. Dance halls	20 per person
7. Factories	
No showers	95 per employee
With showers	135 per employee
Cafeteria, add	20 per employee
8. Hospitals	950 per bed
Kitchen waste only	95 per bed
Laundry waste only	150 per bed
9. Hotels (no kitchen waste)	230 per bed (2 person)
10. Institutions (Resident)	285 per person
Nursing home	475 per person
Rest home	475 per person

SI: 1L = 0.26 gal.

TABLE G-5 (Continued)

Type of Occupancy	L/day
11. Laundries, self-service	
(minimum 10 hours per day)	190 per wash cycle
Commercial	Per manufacturer's specifications
12. Motel	190 per bed space
with kitchen	230 per bed space
13. Offices	80 per employee
14. Parks, mobile homes	950 per space
picnic parks (toilets only)	80 per parking space
recreational vehicles –	
without water hook-up	285 per space
with water and sewer hook-up	380 per space
15. Restaurants – cafeterias	80 per employee
toilet	7 (26.5) per customer
kitchen waste	25 per meal
add for garbage disposal	5 per meal
add for cocktail lounge	10 per customer
kitchen waste – Disposable service	10 per meal
16. Schools – Staff and office	80 per person
Elementary students	60 per person
Intermediate and high	80 per student
with gym and showers, add	20 per student
with cafeteria, add	15 per student
Boarding, total waste	380 per person
17. Service station, toilets	380 for 1st bay
	1895 for each additional bay
18. Stores	80 per employee
public restrooms, add	4.1/m^2 of floor space
19. Swimming pools, public	40 per person
20. Theaters, auditoriums	20 per seat
drive-in	40 per space

(a) Recommended Design Criteria. Sewage disposal systems sized using the estimated waste/sewage flow rates should be calculated as follows:

(1) Waste/sewage flow, up to 5,678L/day (1,500 gal./day)
Flow x 1.5 = septic tank size

(2) Waste/sewage flow, exceeding 5,678L/day (1,500 gal./day)
Flow x 0.75 + 1,125 = septic tank size

(3) Secondary system shall be sized for total flow per 24 hours.

(b) Also see Section K 2.0 of this appendix.

*__Note:__ 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, if figures in this table need modification, they should be made with the concurrence of the Authority Having Jurisdiction.

SI: 1L = 0.26 gal.

TABLE G-6
Design Criteria of Five Typical Soils

Type of Soil	Required m^2/L . of leaching area/ 380L	Maximum absorption capacity in L/m of leaching area for a 24 hr. period
Coarse sand or gravel	0.5	204
Fine sand	0.6	163
Sandy loam or clay	1.0	101
Clay with considerable sand or gravel	2.2	45
Clay with small amount of sand or gravel	3.0	33

SI: $1m^2/L = 40$ ft.^{2}/gal.; $1L/m^2 = 0.02$ gal./ft.^{2}

TABLE G-7

Required m^2 of Leaching Area/380L Septic Tank Capacity	Maximum Septic Tank Size Allowable Litres
0.005-0.006	28,500
0.010	19,000
0.022	13,500
0.030	11,500

SI: $1m^2/L = 40$ ft.^{2}/gal.; 1L = 0.26 gal.

APPENDIX H

ALTERNATE PLUMBING SYSTEMS

H 1.0 Scope.

H 1.1 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.

H 1.2 The provisions of this appendix apply to the design, installation, and inspection of an engineered plumbing system, alternate material, and equipment.

H 1.3 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.

H 1.4 Components, materials, and equipment must conform to standards and specifications listed in Table 14-1 or equivalent International Standard(s) approved by the Authority Having Jurisdiction of this code and other national consensus standards applicable to plumbing systems and materials.

H 1.5 Where such standards and specifications are not available, alternate materials and equipment must be approved in accordance with Section 301.2 of this code.

H 2.0 Engineered Plumbing Systems.

H 2.1 Definition. An engineered plumbing system is 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.

H 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 found suitable to the Authority Having Jurisdiction. Prior to the final approval, the designer must verify to the Authority Having Jurisdiction that the installation is in compliance with the approved plans, specifications, and data and such amendments thereto. The designer must also certify to the Authority Having Jurisdiction that the installation is in compliance with the applicable engineered design criteria.

H 2.3 Owner Information. The designer of the system must provide the building owner with information concerning the system, considerations applicable for any subsequent modifications to the system, and maintenance requirements as applicable.

H 3.0 Water Heat Exchangers.

H 3.1 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.

H 3.2 Single-wall heat exchangers shall be permitted if they satisfy all of the following requirements:

(1) The heat-transfer medium is either potable water or contains essentially nontoxic transfer fluids having a toxicity rating or class 1 (see Section 207.0).

(2) The pressure of the heat-transfer medium is maintained at less than the average minimum operating pressure of the potable water system.

> **Exception:** Steam complying with Section L 3.2 (1) above.

(3) The equipment is permanently labeled to indicate that only additives recognized as safe by the Authority Having Jurisdiction shall be used in the heat-transfer medium.

H 3.3 Other heat exchanger designs shall be permitted where approved by the Authority Having Jurisdiction.

H 4.0 Fixture Unit Values for Private or Private Use Bathroom Groups.

H 4.1 Tables L-1 and L-2 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.

H 4.2 The listed water supply fixture unit values in Table L-1 reflect the load of entire bathroom groups on the cold-water service. Individual hot and cold water branch piping to the fixtures should be sized according to Chapter 6 and Appendix A.

H 4.3 The listed drainage fixture unit values in Table L-2 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 7-3 of this code.

H 5.0 Drainage System Sizing.

H 5.1 Drainage Fixture Units. Drainage fixture unit values shall be sized in accordance with Table 7–3 and Section 702.0.

H 5.2 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 L-3. The

TABLE H-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 6L/flush Gravity -Tank Water Closets				
Half-bath or Powder Room[2]	3.5	0.8	2.5	0.5
1 Bathroom Group[1]	5.0	2.5	3.5	1.8
1-1/2 Bathrooms	6.0	2.5		
2 Bathrooms	7.0	3.5		
2-1/2 Bathrooms	8.0	3.6		
3 Bathrooms	9.0	4.5		
Each Additional 1/2 Bath	0.5	0.1		
Each Additional Bathroom Group	1.0	0.5		
Bathroom Groups having 6L/flush Pressure-Tank Water Closets				
Half-bath or Powder Room[2]	3.5	0.8	2.5	0.5
1 Bathroom Group[1]	5.0	2.5	3.5	1.8
1-1/2 Bathrooms	6.0	2.5		
2 Bathrooms	7.0	3.5		
2-1/2 Bathrooms	8.0	3.6		
3 Bathrooms	9.0	4.5		
Each Additional 1/2 Bath	0.5	0.1		
Each Additional Bathroom Group	1.0	0.5		
Bath Group (6L/flush Flushometer Valve)	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 heater use the same WSFU as for individual dwellings.

SI: 1L = 0.26 gal.

size of any building drain or building sewer serving a water closet shall be not less than 80mm (3 in.).

H 5.3 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 L-4. Stacks shall be sized based on the total accumulated connected load at each story or branch interval.

H 5.3.1 Horizontal Stack Offsets. Horizontal stack offsets shall be sized in accordance with Table L-3 as required for building drains.

H 5.3.2 Vertical Stack Offsets. Vertical stack offsets shall be sized in accordance with Table L-4 as required for stacks.

H 5.4 Horizontal Stack Offset and Horizontal Branch Connections. Horizontal branch connections shall not connect to a horizontal stack offset or within 60cm (2 ft.) above or below the offset where such horizontal offset is located more than four branch intervals below the top of the stack.

H 6.0 Vent System Sizing.

H 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 thereto as set forth in Table L-6. Vents shall be not less than half the required size of the drainage pipe size served as determined by Table L-4 for Horizontal Fixture Branches and Stacks nor less than 32mm (1-1/4 in.) in diameter. The drainage system shall be vented by not less than one vent pipe which shall be not less than 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.

H 6.2 Vent Stack. A vent stack shall be required for every drainage stack that extends 5 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.

TABLE H-2
Drainage Fixture Unit Values (DFU) for Bathroom Groups[1, 2]

	Private Use Bathroom Group	Serving 3 or more Private Use Bathroom Groups
Bathroom Groups having 6L/flush Gravity-Tank Water Closets		
Half-bath or Powder Room[2]	3.0	2.0
1 Bathroom Group[1]	5.0	3.0
1-1/2 Bathrooms	6.0	
2 Bathrooms	7.0	
2-1/2 Bathrooms	8.0	
3 Bathrooms	9.0	
Each Additional 1/2 Bath	0.5	
Each Additional Bathroom Group	1.0	
Bathroom Groups having 6L/flush Pressure-Tank Water Closets		
Half-bath or Powder Room[2]	3.5	2.5
1 Bathroom Group[1]	5.5	3.5
1-1/2 Bathrooms	6.5	
2 Bathrooms	7.0	
2-1/2 Bathrooms	8.5	
3 Bathrooms	9.5	
Each Additional 1/2 Bath	0.5	
Each Additional Bathroom Group	1.0	
Bath Group (6L/flush Flushometer Valve)	5.0	3.0

Notes:
[1] A bathroom group, for the purposes of this table, consists of not more than 1 water closet, up to 2 lavatories, and either 1 bathtub or 1 shower.
[2] A half-bath or powder room, for the purposes of this table, consists of 1 water closet and 1 lavatory.
SI: 1L = 0.26 gal.

H 6.3 Branch Vents. Where branch vents exceed 12m (40 ft.) in developed length, such vent shall be increased by 1 pipe size for the entire developed length of the vent pipe.

H 6.4 Venting Horizontal Offsets. Drainage stacks with horizontal offsets shall be vented where 5 or more branch intervals are located above the offset. The upper and lower section of the horizontal offset shall be vented in accordance with L 6.4.1 and L 6.4.2.

H 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.

H 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 that, the required size for the vent serving the drainage stack. The yoke vent connection shall be permitted to be a vertical extension of the drainage stack.

H 7.0 Vacuum Drainage Systems.

H 7.1 Vacuum drainage systems shall be considered engineered systems and shall comply with the requirements of L 1.0 and L 2.0.

H 7.2 Vacuum drainage systems, including piping tank assemblies, vacuum pump assembly, and other components necessary for the proper function of the system shall be engineered and installed in accordance with the manufacturer's specifications. Plans and specifications shall be submitted to the Authority Having Jurisdiction for review and approval prior to installation.

H 7.3 Fixtures. Fixtures used in vacuum drainage systems shall comply with L 1.4 and L 1.5.

H 7.4 Drainage Load. The pump discharge load from the collector tanks shall be in accordance with Chapter 7 of this Code.

TABLE H-3
Building Drains and Building Sewers[a]

Diameter of Pipe, mm	Maximum Permissible Fixture Units for Sanitary Building Drains and Runouts from Stacks — Slope, mm/m: 5	10	20	40
50			21	26
65			24	31
80		20	42[b]	50[b]
100		180	216	250
125		390	480	575
150		700	840	1,000
200	1,400	1,600	1,920	2,300
250	2,500	2,900	3,500	4,200
300	2,900	4,600	5,600	6,700
375	7,000	8,300	10,000	12,000

[a] On-site sewers that serve more than one building may be sized according to the current standards and specifications of the Authority Having Jurisdiction for public sewers.
[b] No more than two water closets or two bathroom groups, except in single-family dwellings, where no more than three water closets or three bathroom groups may be installed. Check the local codes in the area served for exact requirements or restrictions.
SI: 1mm = 0.04 in.; 1m = 3.3 ft.

TABLE H-4
Horizontal Fixture Branches and Stacks

Diameter of Pipe mm	Maximum Number of Drainage Fixture Units that May be Connected: Any Horizontal Fixture Branch[a]	1 Stack of 3 or Fewer Branch Intervals	Stacks Exceeding 3 Branch Intervals: Total for Stack	Total at 1 Branch Interval
40	3	4	8	2
50	6	10	24	6
65	12	20	42	9
80	20[b]	48[b]	72[b]	20[b]
100	160	240	500	90
125	360	540	1,100	200
150	620	960	1,900	350
200	1,400	2,200	3,600	600
250	2,500	3,800	5,600	1,000
300	3,900	6,000	8,400	1,500
375	7,000	6,000	8,400	1,500

[a] Does not include branches of the building drain.
[b] No more than 2 water closets or bathroom groups within each branch interval or more than 6 water closets or bathroom groups on the stack.
SI: 1mm = 0.04 in.

H 7.5 Water Supply Fixture Units. Water supply fixture units shall be based on the values in Chapter 6 of this Code. The load requirement of a vacuum-type water closet shall be determined per manufacturer's specification.

H 7.6 Traps and Cleanouts. For gravity fixtures, traps and cleanouts shall be per approved plans.

H 8.0 Circuit Venting.

H 8.1 Circuit Vent Permitted. Circuit venting shall be designed by a registered professional engineer as an engineered design. A maximum of 8 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.

H 8.1.1 Multiple Circuit-Vented Branches. Circuit-vented horizontal branch drains are permitted to be connected together. Each group of a maximum of 8 fixtures shall be considered a separate circuit vent and shall conform to the requirements of this section.

H 8.2 Vent Size and Connection. The circuit vent shall be not less than 50mm (2 in.) 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 any soil or waste.

H 8.3 Slope and Size of Horizontal Branch. The maximum slope of the vent section of the horizontal branch drain shall be 84mm/m (1 in./ft.). The entire length of the vented section of the horizontal branch drain shall be sized for the total drainage discharge to the branch.

H 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 L 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.

H 8.4 Relief Vent. A 50mm (2 in.) relief vent shall be provided for circuit-vented horizontal branches receiving the discharge of 4 or more water closets and connecting to a drainage stack that receives the discharge of soil or waste from upper horizontal branches.

H 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.

H 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 maximum discharge to a relief vent shall be 4 drainage fixture units.

H 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.

H 9.0 Single-Stack Vent System.

H 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 when sized and installed in accordance with Sections L 9.2 through L 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.

H 9.2 Stack Size. Drainage stacks shall two sized according to Table L-5. A maximum of water closets shall be permitted to discharge to a 80mm (3 in.) stack. Stacks shall be uniformly sized based on the total connected drainage fixture unit load, with no reductions in size.

H 9.2.1 Stack Vent. The drainage stack vent shall have a stack vent of the same size terminating to the outdoors.

H 9.3 Branch Size. Horizontal branches connecting to a single-stack vent system shall be sized according to Table 7-4

(1) No more than one water closet within 46cm (18 in.) of the stack horizontally shall be permitted on a 80mm (3 in.) horizontal branch.

(2) A water closet within 46cm (18 in.) of a stack horizontally and one other fixture with up to a 40mm (1-1/2 in.) fixture drain size shall be permitted on a 80mm (3 in.) horizontal branch when connected to the stack through a sanitary tee.

H 9.4 Length of Horizontal Branches.

H 9.4.1 Water closets shall be no more than 1.2m (4 ft.) horizontally from the stack.

Exception: Water closets shall be permitted to be up to 2.4m (8 ft.) horizontally from the stack when connected to the stack through a sanitary tee.

H 9.4.2 Fixtures other than water closets shall be no more than 3.7m (12 ft.) horizontally from the stack.

H 9.4.3 The length of any vertical piping from a fixture trap to a horizontal branch shall not be considered in computing the fixture's horizontal distance from the stack.

H 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 50mm (2 in.) in diameter. Vertical drops shall not exceed 1.2m (4 ft.) in length. Fixture drains that are not increased in size, or have a vertical drop exceeding 1.2m (4 ft.) shall be individually vented.

H 9.6 Additional Venting Required. Additional venting shall be provided when 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 L 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, air admittance valve, or be extended outdoors and terminate to the open air.

H 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 60cm (2 ft.) above and below a horizontal offset.

H 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 ten pipe diameters downstream from the base of the upper stack.

H 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 7-4, and the building sewer shall be sized in accordance with Table 7-7.

H 10.0 Air Admittance Valves.

H 10.1 Definition. One-way valves designed to allow air to enter the plumbing drainage system when negative pressures develop in the piping system. The device shall close by gravity and seal the vent terminal at zero differential pressure (no flow conditions) and under positive internal pressures. The purpose of an air admittance valve is to provide a method of allowing air to enter the plumbing drainage system to prevent siphonage of plumbing fixture traps.

H 10.2 General. Vent systems shall be permitted to utilize air admittance valves. The design and installation of air admittance valves shall comply with this section. Stack-type air admittance valves shall conform to ASSE 1050 or equivalent International Standard(s) approved by the Authority Having Jurisdiction. Individual and branch-type air admittance valves shall conform to ASSE 1051 or equivalent International Standard(s) approved by the Authority Having Jurisdiction.

H 10.2.1 Vent Required. One stack vent or vent stack shall extend outdoors to the open air on every drainage and vent system utilizing air admittance valves.

H 10.3 Installation. Air admittance valves shall be installed in accordance with the manufacturer's installation instructions.

H 10.4 Where Permitted. Individual, branch and circuit vents shall be permitted to terminate with a connection to an individual or branch-type air admittance valve. Stack vents and vent stacks shall be permitted to terminate to stack-type air admittance valves. Individual and branch-type air admittance valves shall vent only fixtures that are located on the same floor level and connect to a horizontal branch drain. The horizontal branch drain having individual and branch-type air admittance valves shall conform to Section L 10.4.1 or L 10.4.2. Stack-type air admittance valves shall conform to Section L10.4.3.

H 10.4.1 Location of Branch. The horizontal branch drain shall connect to the drainage stack or building drain a maximum of five stories from the top of the stack.

H 10.4.2 Relief Vent. Where the horizontal branch is located more than five stories from the top of the stack, the horizontal branch shall be provided with a relief vent that shall connect to a vent stack or stack vent, or extend outdoors to the open air. The relief vent shall connect to the horizontal branch drain between the stack and the most downstream fixture drain connected to the horizontal branch drain. The relief vent shall be not less than 50mm (2 in.) in diameter. The relief vent shall be permitted to serve as the vent for other fixtures.

H 10.4.3 Stack. Stack-type air admittance valves shall not serve as the vent terminal for vent stacks or stack vents that serve drainage stacks exceeding seven stories in height.

TABLE H-5
Single-Stack Size

	Maximum Connected Drainage Fixture Units		
Stack Size mm	**Stacks Less than 23m in Height**	**Stack 23m to Less than 49m in Height**	**Stack 49m or Greater in Height**
80	24	NP	NP
100	225	24	NP
125	480	225	24
150	1,015	480	225
200	2,320	1,015	480
250	4,500	2,320	1,015
300	8,100	4,500	2,320
375	13,600	8,100	4,500

SI: 1mm = 0.04 in.; 1m = 3.3 ft.

TABLE H-6
Size and Length of Vents

Size of Soil or Waste Stack, mm	Fixture Units Connected	Diameter of Vent Required, mm								
		32	**40**	**50**	**65**	**80**	**100**	**125**	**150**	**200**
		Maximum Length of Vent, m								
40	8	15	46							
50	12	9	23	61						
50	20	8	15	46						
65	42		9	31	91					
80	10		9	31	31	183				
80	30			18	61	152				
80	60			15	24	122				
100	100			11	31	79	305			
100	200			9	27	76	274			
100	500			6	21	55	213			
125	200				11	24	107	305		
125	500				9	21	91	274		
125	1100				6	15	61	213		
150	350				8	15	61	122	396	
150	620				5	9	38	91	335	
150	960					7	31	76	305	
150	1900					6	21	61	213	
200	600						15	46	152	396
200	1400						12	31	122	366
200	2200						9	24	107	335
200	3600						8	18	76	244
250	1000							23	38	305
250	2500							15	31	152
250	3800							9	24	107
250	5600							8	18	76

SI: 1mm = 0.04 in.; 1m = 3.3 ft.

H 10.5 Location. Individual and branch-type air admittance valves shall be located not less than 100mm (4 in.) above the horizontal branch drain or fixture drain being vented. Stack-type air admittance valves shall be located not less than 15cm (6 in.) above the flood level rim of the highest fixture being vented. The air admittance valve shall be located within the maximum developed length permitted for the vent. The air admittance valve shall be installed not less than 15cm (6 in.) above insulation materials.

H 10.6 Access and Ventilation. Air admittance valves shall be accessible. The valve shall be located within a ventilated space that allows air to enter the valve.

H 10.7 Size. The air admittance valve shall be sized for the fixture unit discharge and drainage pipe size of the connected drain.

USEFUL TABLES

Conversion Table

TO CONVERT	INTO	MULTIPLY BY
Atmospheres	Centimetres of mercury	76.0
Bar	Pounds/square inch	14.5
Btu	Joules	1,054.8
Btu/hour	Watts	0.2931
Btu/minute	Kilowatts	0.01757
Btu/minute	Watts	17.57
Centigrade	Fahrenheit	(°C x 1.8) + 32°
Centimetre	Inches	0.39
Circumference	Radians	6.283
Cubic centimetres	Cubic inches	0.06102
Cubic feet	Cubic metres	0.02832
Cubic feet	Litres	28.32
Cubic feet/minute	Cubic centimetres/second	472.0
Cubic inches	Cubic centimetres	16.39
Cubic inches	Litres	0.01639
Cubic metres	Gallons (U.S. liquid)	264.2
Feet	Centimetres	30.48
Feet	Metres	0.3048
Feet	Millimetres	304.8
Feet of water	Kilogram/square centimetres	0.03048
Foot-pounds	Joules	1.356
Foot-pounds/minute	Kilowatts	2.260×10^{-5}
Foot-pounds/second	Kilowatts	1.356×10^{-3}
Gallons	Litres	3.785
Horsepower	Watts	745.7
Horsepower-hours	Joules	2.684×10^{6}
Horsepower-hours	Kilowatt-hours	0.7457
Joules	Btu	9.480×10^{-4}
Joules	Foot-pounds	0.7376
Joules	Watt-hours	2.778×10^{-4}
Kilograms	Pounds	2.2
Kilograms	Tons (short)	1.102×10^{-3}
Kilometres	Miles	0.6214
Kilometres/hour	Miles/hour	0.6214
Kilowatts	Horsepower	1.341
Kilowatt-hours	Btu	3,413
Kilowatt-hours	Foot-pounds	2.655×10^{6}
Kilowatt-hours	Joules	3.6×10^{6}
Kilopascal	Pounds/square inch	0.145
Litres	Cubic feet	0.03531

Conversion Table
(Continued)

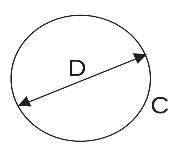
TO CONVERT	INTO	MULTIPLY BY
Litres	Gallons (U.S. liquid)	0.26
Litres/minute	Gallons (U.S. liquid)/ minute	0.26
Metres	Feet	3.3
Metres	Inches	39.37
Metres	Yards	1.094
Metres/second	Feet/second	3.3
Metres/second	Miles/hour	2.237
Miles (statute)	Kilometres	1.609
Miles/hour	Metres/minute	26.82
Millimetres	Inches	0.04
Ounces (fluid)	Litres	0.02957
Pints (liquid)	Cubic centimetres	473.2
Pounds	Kilograms	0.4536
Pounds/square inch	Pascals	6,895
Quarts (liquid)	Litres	0.9463
Radians	Degrees	57.30
Square inches	Square millimetres	645.2
Square metres	Square inches	1,550
Square metres	Square feet	10.76
Square millimetres	Square inches	1.550×10^{-3}
Watts	Btu/hour	3.4129
Watts	Btu/minute	0.05688
Watts	Foot-pounds/second	0.7378
Watts	Horsepower	1.341×10^{-3}

Areas and Circumferences of Circles

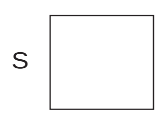
Diameter mm	Circumference mm	Area mm^2
6	10	28
8	20	50
10	30	79
15	40	177
20	60	314
25	80	491
32	100	804
40	120	1257
50	160	1964
65	200	3318
80	240	5027
100	320	7854
125	400	12,272
150	480	17,672
175	560	24,053
200	640	31,416
225	720	39,761
250	800	49,088

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

$C = \pi D = 2\pi R$

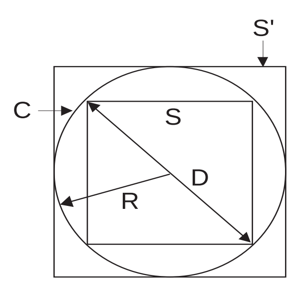
$C = 3.5446\sqrt{area}$

$D = 0.3183\,C = 2R$

$D = 1.1283\sqrt{area}$

$Area = \pi R^2 = 0.7854\,D^2$

$Area = 0.07958\,C^2 = \frac{\pi D^2}{4}$



$\pi = 3.1416$

SI: 1mm =0.04 in.; $1mm^2$ = 0.002 $in.^2$

INDEX

– A –

– B –

– G –

– H –

– I –

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– X –

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