PLAINTIFF'S EXHIBIT

CAP-841

FWPSC

Tentative

AWWA STANDARD

for

POLY(VINYL CHLORIDE) PLASTIC WATER MAINS AND SERVICES

Draft No. 5

May 15, 1972

This standard is based upon the best known available experience and represents a consensus of those responsible for its preparation and approval. It is intended for application only under conditions usually encountered and not for unqualified use under all conditions. In all instances the applicability of this standard should be reviewed by the responsible engineer or person in authority.

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FOREWORD

This foreword is for information only and it is not a part of AWWA Standard ___?___, Poly(Vinyl Chloride) Plastic Water Mains and Services.

1. History of Standard

1.1 This is the first issue of AWWA Standard ___?___. In 1966, the American Water Works Association appointed Committee 8350-D to study and report on the adaptability of plastics pipe and fittings for water-industry use. This committee presented its report on June 6, 1967 at the AWWA Annual Conference. The report included recommendations to the AWWA that a task group be appointed to develop standards applicable to the use of plastic-piping materials. The AWWA Standards Committee on Plastic Pipe was activated in 1968 and charged with the responsibility of drafting standards for use of plastics pipe and fittings to construct underground potable-water mains and services. The subject document is one of four related standards drafted by this standards committee. Individual AWWA standards are available also on the use of Acrylonitrile-Butadiene-Styrene (ABS), Polybutylene (PB) and Polyethylene (PE) materials for potable-water piping. The AWWA Standards Committee intends to revise these standards periodically as necessary and desirable in keeping with advances which may occur in thermoplastic piping materials or use practices.

2. Purpose and Application of Standard

2.1 The purpose of the AWWA Standard ___?___ is to provide direction and guidance in the use of poly(vinyl chloride) (PVC) and chlorinated poly(vinyl chloride) (CPVC) pressure-piping materials by the Water Works Industry through the establishment of use requirements, provisions and limitations which are essential to the proper and successful use of these materials for potable-water service. (Note: Hereafter, when used, the abbreviation "PVC" is intended to apply to both PVC and CPVC materials.)

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2.2 The standard applies specifically to water-utility applications for PVC pipe and fittings in pressure systems intended for the conveyance of potable water.

2.3 The American Water Works Association does endorse the use of PVC thermoplastic piping for potable-water conveyance provided the pipe, tubing and fitting components are manufactured from PVC base compounds covered by AWWA Standard ___?___, and provided further that the base compounds have been qualified for potable-water-piping products by an accredited testing agency such as the National Sanitation Foundation (NSF) Testing Laboratory or the Canadian Standards Association (CSA) Testing Laboratory.

3. Use of Standard

3.1 AWWA Standard ___?___ is intended to apply to the use of PVC pressure-piping products for underground potable-water applications wherein the piping will be subjected to the usual operating and environmental conditions. The standard should not be considered as applicable to all such applications regardless of use conditions. The materials and the methods and conditions of use prescribed in the standard are founded on the knowledge and the use experience known to the AWWA Standards Committee on Plastic Pipe and represents the best collective judgment of its members.

3.2 Users of the standard should be thoroughly familiar with its coverage and with the use requirements, provisions and limitations prescribed therein. They should be familiar also with the definitions of some particular words and phrases used throughout the text which are given in Subsection 1.2 of the standard. As an aid to users, important considerations related to the purchase of materials, piping-system design and contract installations are identified hereafter and referenced to the applicable sections of the standard.

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3.3 Material-Purchase Considerations

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Note 1. Hydrostatic testing of PVC pipe and tubing prior to shipment has not been included as a prescribed requirement. The AWWA Standards Committee on Plastic Pipe believes such testing is not necessary in view of the manufacturing method and the prescribed quality-control requirements. See subsection 1.4.6 of standard.

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3.4 System-Design Considerations

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Note 2. Use requirements are prescribed for some currently available PVC piping products even though applicable product standards are not available for reference. Suitability of such products for potable-water piping is left to the judgment and discretion of potential users until authoritative product standards become available.

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Note 3. Other contract-installation requirements such as special construction specifications, work performance bond, and final-acceptance provisions should be specified in the contract when desired.

3.6 The qualifications, suitability and serviceability of special-engineered PVC piping components and of other piping materials and appurtenances being considered for use in potable-water systems but not specifically covered by the AWWA standard should be investigated and established by the purchaser prior to their use. Special-engineered products should bear the symbol "SE" in addition to and immediately following other markings specified in Subsection 2.4.5 of the standard.

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4. Appendixes

4.1 Supplementary information and recommendations on external-loading provisions and design and on other aspects of PVC plastic-piping use for potable-water service are provided in the appendixes of the AWWA standard. Additional information, technical data, and application recommendations may be obtained directly from the manufacturers and the Plastics Pipe Institute.

5. System Operation

5.1 The operating practices observed in the use of PVC piping systems should be governed by the usual water-industry considerations. Undesirable operating conditions such as excessive system-pressure losses and excessive transient pressures, for example, may, of course, be prevented by proper system design and operating practices. Piping systems should be designed to provide adequate capacity for water distribution at prudent flow velocities and the means for system operation in a manner that will prevent sudden changes in water velocity. The recommendations provided in Appendix B, Subsection B.3.1.5 of the AWWA standard should be observed.

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Tentative

AWWA Standard

for

POLY(VINYL CHLORIDE) PLASTIC WATER MAINS AND SERVICES

1. General

1.1 Scope. This standard covers the use of poly(vinyl chloride) (PVC) pipe, tubing and fittings and other suitable fittings in the construction of underground PVC piping systems for the conveyance of potable water under pressure; and particularly their use to construct water-supply and distribution mains, and water services from mains to water meters or to consumer piping. It specifically covers certain classes (types and grades) of PVC pipe, tubing and fittings; nominal sizes of pipe 1/2 inch through 12 inch with plain or threaded ends, pipe 1/2 inch through 8 inch with solvent-fusion bells, plain-end tubing 1/2 inch through 2 inch, solvent-fusion fittings 1/2 inch through 8 inch, and threaded fittings 1/2 inch through 6 inch manufactured to meet the dimensional requirements tabulated in Section 3 for the schedules and standard-dimension-ratio (SDR) series of sizes included in this standard; and the joining methods provided for in Subsection 4.8 construction. It sets forth engineering requirements applicable to design, joining methods, installation, hydrostatic testing, disinfection and maintenance of PVC water-piping systems which are deemed necessary to insure the dependability and sanitary qualities of the facilities. Supporting standards are incorporated by reference. Material-purchase and construction-contract provisions are included.

Note 1. In this standard, the word "poly(vinyl chloride)" or its symbol "PVC" is intended to apply to both the PVC and chlorinated poly(vinyl chloride) (CPVC) plastic-piping materials except when a distinction is made elsewhere in the document.

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1.2 Definitions. Under this standard, the following definitions shall apply:

1.2.1 Carrier: The person, firm or corporation who enters into a contract to transport materials from the manufacturer or supplier and deliver them to the purchaser at a specified location.

1.2.2 Contractor: The person, firm or corporation who enters into a contract to construct and install a plastic water-piping system in accordance with this standard.

1.2.3 Inspection: The examination of piping materials, the verification of tests, and the observation of material production and construction work by an inspector to insure compliance with all applicable specifications and standards.

1.2.4 Inspector: An authorized representative of the purchaser entrusted with the duties of factory examination of materials, production operations and quality-control tests performed; or of the field examination of materials, appurtenances and their installation; or both such factory and field duties.

1.2.5 Manufacturer: A term used in association with specific piping-system components, appurtenances, or tools to indicate the person, firm or corporation who made or makes the product or products.

1.2.6 Poly(vinyl chloride) pipe and fitting plastics: Thermoplastic compounds prepared by combining poly(vinyl chloride) resin with modifiers to attain desirable properties and with stabilizers, lubricants and pigments essential for processing, property control, and coloring.

1.2.7 Pressure Terms

1. Maximum static pressure: The internal pressure of greatest intensity to which a particular water-piping system, or a portion thereof, would be subjected under static-pressure conditions.

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2. Operating pressure: The observed or calculated internal pressure of greatest intensity within a water-piping system during all normal operating conditions (synonymous with working pressure).

3. Design pressure: The maximum static pressure or the operating pressure of a particular water-piping system, whichever is greater (7.1.1).

4. Pressure class: The maximum allowable water pressure in psi for the particular pipe or tubing, as recommended by the AWWA Committee on Plastic Pipe Standards. The pressure class is determined from the allowable long-term hydrostatic strength of the particular material (2.2.1), certain dimensions of the conduit (7.1.2), and the prescribed factor of safety (1.2.7.5), (7.1.3).

5. Factor of safety: The number with which the allowable long-term hydrostatic strength of the particular PVC material is divided to provide an extra degree of safety in the maximum pressure recommended (1.2.7.4) for use of the pipe or tubing in potable-water systems (7.1.2), (7.1.3).

6. Long-term hydrostatic strength: The estimated tensile stress in the wall of the pipe in the circumferential orientation that when applied continuously for 100,000 hours (11.43 years) will cause failure of the pipe (B.4.3).

7. Transient pressure: A short-term force developed within a piping system as a result of a sudden change in water-flow velocity due to operation of a system valve, pump or other appurtenance; and a force which causes a momentary increase in water-system pressure. (Note: All types of surge pressures including water hammer are classified as transient pressures.)

8. Minimum burst strength: The internal pressure of least magnitude required to cause failure of the pipe, tubing or fitting within a period of 60 to 70 seconds (2.4.4.2d).

1.2.8 Purchaser: A person, firm, corporation or government agency who enters into a contract to acquire piping materials meeting this standard or to engage the services of a contractor for installation of a water-piping system in accordance with this standard.

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1.2.9 Rework materials: Plastic materials of the same virgin ingredients, which have been generated from a manufacturer's own pipe or fitting production (2.4.1).

1.2.10 Schedule numbers: A series of numbers each of which designates a different schedule of nominal pipe sizes; and each of which indicates with respect to metal pipe particularly the approximate value of 1,000 times a selected ratio of operating pressure to allowable hoop stress (B.2.3.5).

1.2.11 Solvent fusion: The process of joining two PVC piping components by application to their engaging surfaces of a PVC liquid containing a solvent which will temporarily dissolve the surfaces so that when immediately joined thereafter the components will fuse together and become essentially one piece of plastic (synonymous with solvent cementing).

1.2.12 Standard thermoplastic-pipe-dimension ratio: A ratio of pipe diameter to wall thickness (B.2.3.3).

1.2.13 Standard-dimension-ratio numbers: Certain numbers each of which designates a different series of nominal pipe sizes with corresponding water-pressure classifications, and each of which indicates the numerical value of the standard-dimension ratio common to all pipe sizes in that series. (Note: For any specific class "type and grade" of PVC material, each SDR number represents a specific AWWA pressure class common to all pipe sizes in that series; B.2.3.3, B.2.3.4)

1.2.14 Standard thermoplastic-pipe-materials-designation code: A means for identifying a thermoplastic-piping material by the use of symbols in designated sequence to indicate the chemical kind of plastic, the pipe class of that kind of plastic, and the commercial hydrostatic-design-stress rating of that material for water at 73°F (B.2.2.3).

1.2.15 Supplier: A person, firm or corporation who enters into a contract to furnish piping materials, appurtenances or both to the purchaser.

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1.2.16 Thermoplastic (adjective): A plastic material capable of being repeatedly softened by increase of temperature and hardened by decrease of temperature, and of which the change upon heating is substantially physical.

1.2.17 Virgin materials: Plastic materials of extrusion or molding grade which have not been previously used in a manufacturing process.

1.2.18 Other definitions: Plastic-piping terms which are not defined herein are covered in ASTM D1600, Standard Abbreviations of Terms Relating to Plastics; or in the Plastics Pipe Institute (PPI) Technical Report TR-1, A Glossary of Plastics Piping Terms.

1.3 Material Specifications To Be Supplied By Purchaser. When buying or specifying plastic materials for use in piping systems conforming to this standard, the purchaser shall specify product compliance with this standard and with the applicable ASTM specification or CSA standard; and shall provide such detailed information on the items desired as prescribed hereunder:

1.3.1 Pipe and Tubing

1. Nominal size. SDR series or the Schedule, pressure class and total linear feet for each item of plain-end, threaded-end and bell-end PVC pipe.

2. Nominal size and total linear feet for each item of plain-end PVC tubing.

3. Length of the individual pieces for each item of pipe and tubing.

4. Specific type and grade, or the new ASTM class designation, and the long-term hydrostatic strength in psi for water at 73° F of the PVC material; or the code designation of the PVC material. Examples: PVC Type I Grade 2, or PVC Class-12454-C, hydrostatic strength 4,000 psi; or PVC 1220; respectively. (2.2.1)

1.3.2 Fittings

1. Nominal size, schedule, and total number for each item of solvent-fusion and threaded PVC fittings.

2. Specific type and grade of PVC material.

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1.3.3 Solvent-Fusion Materials

1. Trade name or specific viscosity requirements or both and quantity for each item of PVC and CPVC solvent-fusion material; and size of individual containers.

2. Number and size for each item of natural-bristle brushes or of other applicators recommended for the purpose by manufacturers of PVC materials.

3. When a manufacturer or supplier is requested to provide solvent-fusion materials of suitable viscosity for a particular project, the purchaser shall specify the number of pipe joints of each nominal size to be made, the code designation of the materials to be joined, and the expected range of ambient temperature during construction. (Note: Material requirements vary with construction conditions. See B.5.1.5, Appendix B. Minimum requirements may be estimated on the basis of manufacturer recommendations or by use of Table B.3, B.5.1.6)

1.3.4 Primers

1. Trade name and quantity for each item of PVC and CPVC primer, and size of individual containers (7.1.14).

1.4 Optional Purchase Specifications. When intended to be included in a contract, the purchaser shall specify such optional requirements as, but not limited to, those listed hereunder:

1. Plant inspection of materials, production, quality-control testing, and related records (1.5).

2. Acceptance provisions for delivered materials (1.7).

3. Furnishing of PVC solvent-fusion materials with suitable viscosity (1.3.3.3).

4. Contract installation conformance with this standard, and field inspection and rejection provisions applicable to materials used and work performed (1.5).

5. Submittal of compliance affidavit (1.8).

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6. Special manufacturing, testing, marking, inspection and delivery requirements. (Note: Hydrostatic testing of PVC pipe and tubing prior to shipment is not a common industry practice. Manufacturers may not be prepared to perform such work.)

1.5 Inspection

1.5.1 When specified in the contract, all work done and all materials used may be inspected by the purchaser during all phases of manufacture, testing and installation; but neither such inspections nor the omission of inspections shall relieve the manufacturer, supplier or contractor of their responsibilities to furnish materials and to perform work in accordance with this standard and with the applicable ASTM specifications or CSA standards and any other supplementary requirements specified by the purchaser in the contract.

1.5.2 When factory inspection is specified in the contract, the manufacturer shall provide the purchaser with sufficient advance notice of the date, time and place of production and testing of materials to be furnished that the purchaser may arrange for a representative to be present.

1.5.3 The inspector shall have free access to those parts of all plant facilities which are utilized in the production, testing and storage of materials to be furnished; and to all storage, construction and installation sites involved in the fulfillment of a contract for a piping installation. In case a manufacturer wishes to exclude inspection of manufacturing processes which are of a proprietary nature, the manufacturer shall advise the purchaser of any and all such inspection limitations prior to consummation of the material-purchase contract.

1.5.4 The manufacturer shall afford the inspector, without charge, all necessary facilities and assistance required, and all necessary liberties to determine whether the piping materials meet the requirements of this standard and of the contract specifications including those of applicable ASTM or CSA standards.

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1.5.5 The contractor shall permit the inspector to examine all materials and to observe and inspect all construction work to ascertain the quality of the materials being used and of the construction-work performed, and to determine the manner and progress of the work.

1.5.6 When requested by the inspector for reasonable cause, the manufacturer shall pressure test specimens of pipe, tubing or fittings, or of all such products, in accordance with the ASTM Test Method D1599, Short-Time Rupture Strength of Plastic Pipe, Tubing and Fittings, at no expense to the purchaser. The products shall meet the quick-burst requirements prescribed in 2.4.4.2d.

1.5.7 The inspector shall reject pipe, tubing and fittings which are not made of the material specified by the purchaser, which are not produced in accordance with the requirements specified in 2.4 or any other section of this standard, or which do not meet supplementary requirements specified by the purchaser in the contract including those of applicable ASTM specifications or CSA standards.

1.5.8 The inspector shall reject damaged or otherwise defective materials intended for use by a contractor, and any work performed by a contractor that does not comply with all requirements prescribed in the contract specifications.

1.5.9 Whenever material or work is rejected by an inspector, he shall immediately notify the manufacturer, the supplier, the carrier, or the contractor, whichever party or parties are responsible for corrective action.

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1.6 Delivery and Replacement

1.6.1 Unless otherwise agreed by mutual consent, the manufacturer or the supplier shall be responsible for delivery of all materials to the purchaser in good condition.

1.6.2 Defective materials shall be replaced by the manufacturer or supplier at no expense to the purchaser.

1.6.3 Damaged materials shall be replaced at the expense of the manufacturer, supplier, or carrier, whichever party or parties are responsible for delivery of the materials in good condition.

1.6.4 The manufacturer, supplier or carrier shall not be liable for materials damaged after acceptance by the purchaser at the agreed point of delivery.

1.7 Final Acceptance. When so specified by the purchaser in the contract, final acceptance of PVC pipe, tubing and fittings, or any other piping materials and appurtenances shall be contingent on the acceptance-test findings of the purchaser. In all such cases, the purchase specifications shall clearly define the acceptance-test requirements and the time limit for testing after delivery of materials.

1.8 Compliance Affidavit. When specified in the contract, the manufacturer, supplier or contractor shall submit to the purchaser an affidavit stating that all materials furnished or work performed or both do in fact comply with all requirements of this standard and with all of the supplementary requirements specified by the purchaser in the contract including those of applicable ASTM specifications or CSA standards.

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2. Materials

2.1 Sanitary Qualifications. All materials and appurtenances used in the construction of piping systems for the conveyance of water intended for human consumption shall be so qualified for such service as to insure that they will not adversely affect the taste, odor, toxicological or aesthetic qualities of the water. The following specific requirements shall apply:

1. All piping system components made of plastic materials shall bear the seal of the National Sanitation Foundation (NSF) Testing Laboratory or the Canadian Standards Association (CSA) Testing Laboratory or of any other similarly accredited testing agency which has qualified the products for potable-water service in accordance with requirements that are no less restrictive in any respect than the applicable requirements specified in Section 3 and 4 of the NSF Standard No. 14 relating to Thermoplastic Materials, Pipe, Fittings, Valves, Traps and Joining Materials.

2. The sanitary qualifications of metal fittings, gaskets, and other non-plastic piping materials and appurtenances shall be established by the purchaser prior to use, and they shall be products recommended for potable-water service by the manufacturer (2.2.4; 7.1.14).

2.2 Basic Materials

2.2.1 PVC pipe, tubing and fittings used in potable-water systems conforming to this standard shall be made from one or another of the specific compounds listed hereunder: (Note 2)

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PVC Pipe, Tubing and Fitting Compounds

Compound Designation			
Former Designation	New Class Number	Standard Code Designation of Compound	Allowable Long-Term Hydrostatic Strength for Water at 73°F, psi
Type I, Grade 1	12454-B	PVC 1120	4000
Type I, Grade 2	12454-C	PVC 1220	4000
Type II, Grade 1	14333-D	PVC 2110	2000
Type II, Grade 1	14333-D	PVC 2112	2500
Type II, Grade 1	14333-D	PVC 2116	3150
Type II, Grade 1	14333-D	PVC 2120	4000
Type IV, Grade 1	23447-B	PVC 4120	4000

Note 2. The PVC extrusion and molding compounds are identified in accordance with the 1969 issue of ASTM Specification D1784 as well as with prior issues of the specification to maintain correspondence with the PVC compounds referenced in the current issues of the ASTM and CSA pipe, tubing and fitting standards. The CPVC compounds are identified in accordance with common practice as PVC 4120 or by the corresponding designations given in the above table. (2.3.7; B.2.2.2)

2.2.2 Metal clamps, screws and bolt sets used with saddle tees and flanges, and with any other fittings and restraining devices shall be made from 300-series, stainless steel; or from brass or bronze materials, such as silicon bronze, ASTM B98, alloy B12 which shall be fully annealed for use in making threaded components.

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2.2.3 Stiffener inserts used in conjunction with mechanically-tightened, compression fittings shall be made of 300-series, stainless steel; or of other corrosion-resistant materials specifically recommended for the purpose by the pipe or fitting manufacturer.

2.2.4 Gaskets and lubricants used to make PVC joints and transition connections shall be made from materials which will be compatible with the PVC material and with each other when used together.

2.3 PVC Pipe, Tubing, Fittings and Solvent-Fusion Materials

2.3.1 The SDR series and the schedules, and the dimensions and tolerances for each specific class and nominal size of pipe, tubing and fittings covered by this standard are tabulated in Section 3 and indexed in the Table of Contents.

2.3.2 The ASTM and CSA documents for the pipe, tubing, fittings and solvent-fusion materials covered by this standard are tabulated hereunder in 2.3.7; and by reference, they are incorporated herein to the extent applicable.

2.3.3 This standard does not cover any piping materials and appurtenances for which there are no design and dimensional requirements given and prescribed herein or in referenced ASTM or CSA documents (7.1.14).

2.3.4 The pressure class for water service at 73°F of each specific kind and size of PVC pipe covered by this standard is given in Section 3, Tables 3 and 7.

2.3.5 The pressure class for water service at 73°F of all kinds and sizes of PVC tubing covered by this standard and prescribed in Section 3, Tables 9 and 10, is 114 psi.

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2.3.6 Plastic pipe, tubing and fittings that have been previously used shall not be reused to construct potable-water systems. They may be reused in temporary construction for maintenance purposes provided the reclaimed materials were previously used for only potable-water service.

2.3.7 Referenced Product Specifications

PVC Pipe, Tubing, Fittings and Solvent-Fusion Materials

Component	Standards ASTM	Standards CSA	Description
Pipe:	D1785		Schedules 40, 80 & 120, Iron-Pipe Sizes.
	D2241		SDR series, Iron-Pipe O.D.'s
	D2672		Solvent-Fusion, Bell-Ends for Schedule 40 and SDR series Pipe.
		B137.3	Schedules 40 and 80, Iron-Pipe Sizes; and SDR series, Iron-Pipe O.D.'s.
Tubing:	D2740		SDR series, Copper-Tube O.D.'s
Fittings:	D2464		Threaded Schedule 80*
	D2466		Solvent-Fusion Socket, Schedule 40*
	D2467		Socket-Fusion Socket, Schedule 80*
			*For I.P.S. - O.D. Pipe
Solvent Fusion Material:	D2564		PVC Solvent Cements (Except PVC 4120)
	D2846		CPVC (PVC 4120) Solvent Cement

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2.4 Manufacturing Requirements

2.4.1 PVC pipe, tubing, fittings and solvent-fusion materials shall be manufactured from virgin compounds which have been qualified by an accredited testing agency as meeting the requirements prescribed in 2.1 of this standard. Clean rework materials as defined in 1.2.9 of this document may be reused for like purpose provided 1) they are the same specific kind and class of material as that specified by the purchaser, 2) they meet the requirements specified for virgin compounds, and 3) the finished products are equal in quality to products made from virgin materials.

2.4.2 PVC pipe, tubing and fittings shall be manufactured to meet the appropriate dimensional requirements tabulated in Section 3 of this standard, supplementary requirements specified by the purchaser in the contract including those in applicable ASTM or CSA product standards, and to meet the following requirements:

1. For any PVC pipe or tubing cross-section, the minimum wall-thickness shall be not less than that prescribed for the particular item in the Section-3 tables of this standard, and shall be not less than 88 percent of the maximum wall-thickness at that section when measured as specified in Section 4 of ASTM D2122.

2. The wall-thickness of the belled section of PVC bell-end pipe shall be such that the pressure class of the bell will not be less than that of the pipe. The bell end may be made as an integral part of the pipe or as a separate component for factory assembly.

3. PVC flanges supplied for use in making plastic-to-metal joints shall be compatible with metal-flange patterns and manufactured to comparable tolerances. Suitable metal-backup rings shall be furnished with all PVC flanges.

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2.4.3 PVC and CPVC (PVC 4120) solvent-fusion materials shall be manufactured to meet the composition, viscosity and performance requirements specified in ASTM D2564 and ASTM D2846, respectively.

2.4.4 Quality

1. All PVC pipe tubing and fittings shall be homogeneous throughout and free of cracks, holes, foreign inclusions and other defects. They shall be as uniform as commercially practicable in smoothness, color, opacity, density, and other physical properties.

2. Quality-control measures shall be practiced in the production of PVC pipe, tubing, fittings and solvent-fusion materials; and they shall be of a nature and frequency adequate to insure product compliance with the requirements of this standard and of referenced ASTM specifications or CSA standards. Appropriate ASTM or CSA test methods shall be used. The quality-control program observed shall include the following tests conducted at the indicated intervals:

a. Material and extrusion-process quality of PVC pipe and tubing shall be verified semi-annually by sustained-pressure tests made in accordance with ASTM Method D1598, Test for Time-To-Failure Of Plastic Pipe Under Long-Term Hydrostatic Pressure, and with the specific requirements of the applicable ASTM or CSA product standard.

b. The dimensions of PVC pipe and tubing produced from each extrusion outlet shall be measured at the beginning of production of a particular material or size; once every hour or once every coil thereafter, whichever is less frequent; and in accordance with ASTM D2122, Method of Determining Dimensions of Thermoplastic Pipe.

c. The dimensions of PVC fittings produced from each mold cavity shall be measured at the beginning of production of a particular material, style or size; once every eight-hour shift thereafter; and in accordance with the applicable ASTM or CSA fitting standard.

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d. The quick-burst strength of PVC pipe, tubing and fittings produced from each extrusion outlet and each mold cavity shall be tested at the beginning of production of a particular material, style or size; once every eight-hour shift thereafter; and in accordance with ASTM Method D1599 during a test-time period of 60 to 70 seconds (1.5.6). The minimum burst-strength of such products shall be not less than that prescribed for the particular items in Section 3 of this standard; Tables 4, 8, 11, 15 and 19.

e. The extrusion quality of PVC pipe and tubing produced from each extrusion outlet shall be tested at the beginning of production of a particular material and semi-annually thereafter. The product shall not flake or disintegrate when tested as specified in ASTM D2152, Test For Quality of Extruded Poly(Vinyl Chloride) By Acetone Immersion. (Note: This test requirement does not apply to CPVC materials known as PVC 4120.)

f. The flattening resistance of PVC pipe and tubing produced from each extrusion outlet shall be tested at the beginning of production of a particular material or size, and once every eight-hour shift thereafter. There shall be no evidence of splitting, cracking or breaking when products are so tested as specified in applicable ASTM or CSA product standards.

g. The viscosity of each batch of PVC and CPVC solvent-fusion materials shall be measured as specified in ASTM D2564 or D2846, and it shall conform with the requirements of the appropriate ASTM specification.

h. When PVC pipe, tubing or fittings fail to meet any test requirement prescribed herein or specified in applicable ASTM or CSA product standards, then like items produced since the last favorable test shall be subjected to the same test for determination of their acceptability and those that fail to meet the requirement shall also be considered as rejects.

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2.4.5 Marking. All PVC pipe, tubing and fittings shall bear identification markings which will remain legible during normal handling, storage and installation, and which have been applied in a manner that will not reduce their strength or otherwise damage the materials. The markings on piping components and the container labels of solvent-fusion materials shall conform with the following requirements and with any other requirements specified by the purchaser or in applicable ASTM or CSA standards:

1. PVC pipe and tubing shall bear the following markings spaced at intervals of not more than 5 feet:

a. Nominal size; example, 1 in.

b. Standard-code designation of the PVC base compound; example, PVC 1120.

c. SDR series or Schedule for pipe, the word "Tubing" for such materials, and the pressure class for water at 73°F; examples, SDR 17-PC179, or Tubing-PC114.

d. The number of the ASTM specification or CSA standard to which the pipe or tubing conforms; example, D1785.

e. The seal of the accredited testing agency which has qualified the pipe or tubing for potable-water service; examples, nsf or CSA.

f. The manufacturer's name or trademark and production code.

2. PVC fittings shall bear the following markings:

a. Nominal size.

b. Abbreviated code designation of the PVC compound used to make the fitting as follows: PVC I for Type I Grade 1, PVC I2 for Type I Grade 2, PVC II for Type II Grade 1, and PVC IV for Type IV Grade 1.

c. The number of the ASTM specification or CSA standard to which the fitting conforms.

d. The seal of the accredited testing agency which has qualified the fitting for potable-water service.

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e. The manufacturer's name or trademark.

f. When the size of fittings does not permit full marking, the above markings may be omitted in the sequence of size, compound designation, and manufacturer's identification; or the fittings may be marked as shown in Figure 2, Subsection 3.7. Individual shipping containers shall bear all specified markings.

3. The label on each container of solvent-fusion material shall bear the following markings:

a. PVC or CPVC Solvent Cement (1.2.11), whichever applies.

b. The designation ASTM D2564 or ASTM D2846, whichever applies.

c. The seal of the accredited testing agency which has qualified the solvent-fusion material for potable-water service.

d. The manufacturer's name or trademark and production code.

4. The label on each container of primer shall bear the following markings:

a. PVC or CPVC Primer, whichever applies.

b. The seal of the accredited testing agency which has qualified the primer for potable-water service.

c. The manufacturer's name or trademark and production code.

2.5 Reference Standards

2.5.1 The requirements prescribed in the latest issues of all documents incorporated herein by reference shall apply to the PVC piping materials covered by this standard.

2.5.2 In any case of confliction with referenced standards, the requirements prescribed in this document shall prevail.

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3. Tables

3.1 Tables 1 through 4, PVC Plastic Pipe, Schedules 40, 80 and 120.

TABLE 1 OUTSIDE DIAMETERS AND TOLERANCES, in.
SCHEDULES 40, 80 AND 120 PVC PLASTIC PIPE

Nominal Pipe Size	Outside Diameter	Tolerances		
		Average	For Maximum and Minimum Diameter (Out-of-Roundness)	
			Schedule 40 sizes 3½ inch and over; Schedule 80 sizes 8 inch and over.	Schedule 40 sizes 3 in. and less; Schedule 80 sizes 6 in. and less; Schedule 120 sizes all.
1/2	0.840	± 0.004	....	± 0.008
3/4	1.050	± 0.004	....	± 0.010
1	1.315	± 0.005	....	± 0.010
1-1/4	1.660	± 0.005	....	± 0.012
1-1/2	1.900	± 0.006	....	± 0.012
2	2.375	± 0.006	....	± 0.012
2-1/2	2.875	± 0.007	....	± 0.015
3	3.500	± 0.008	....	± 0.015
3-1/2	4.000	± 0.008	± 0.050	± 0.015
4	4.500	± 0.009	± 0.050	± 0.015
5	5.563	± 0.010	± 0.050	± 0.030
6	6.625	± 0.011	± 0.050	± 0.035
8	8.625	± 0.015	± 0.075	± 0.045
10	10.750	± 0.015	± 0.075	± 0.050
12	12.750	± 0.015	± 0.075	± 0.060

TABLE 2 WALL THICKNESSES AND TOLERANCES, in.
SCHEDULES 40, 80 AND 120 PVC PLASTIC PIPE[a]

Nominal Pipe Size	Wall Thickness[b]					
	Schedule 40		Schedule 80		Schedule 120	
	Minimum	Tolerance	Minimum	Tolerance	Minimum	Tolerance
1/2	0.109	+0.020	0.147	+0.020	0.170	+0.020
3/4	0.113	+0.020	0.154	+0.020	0.170	+0.020
1	0.133	+0.020	0.179	+0.021	0.200	+0.024
1-1/4	0.140	+0.020	0.191	+0.023	0.215	+0.026
1-1/2	0.145	+0.020	0.200	+0.024	0.225	+0.027
2	0.154	+0.020	0.218	+0.026	0.250	+0.030
2-1/2	0.203	+0.024	0.276	+0.033	0.300	+0.036
3	0.216	+0.026	0.300	+0.036	0.350	+0.042
3-1/2	0.226	+0.027	0.318	+0.038	0.350	+0.042
4	0.237	+0.028	0.337	+0.040	0.437	+0.052
5	0.258	+0.031	0.375	+0.045	0.500	+0.060
6	0.280	+0.034	0.432	+0.052	0.562	+0.067
8	0.322	+0.039	0.500	+0.060	0.718	+0.086
10	0.365	+0.044	0.593	+0.071	0.843	+0.101
12	0.406	+0.049	0.687	+0.082	1.000	+0.120

[a]These dimensions conform to nominal IPS dimensions, with the exception that Schedule 120 wall thickness for pipe sizes 1/2 to 3-1/2 in., inclusive, are special PVC plastic pipe sizes.

[b]The minimum is the least wall thickness of the pipe at any cross section. All tolerances are on the plus side of the minimum requirement.

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3.1 Tables 1 through 4, PVC Plastic Pipe, Schedules 40, 80 and 120.

TABLE 3 PRESSURE CLASSES at 73 F
SCHEDULES 40, 80 And 120 NON-THREADED PVC PLASTIC PIPE

Nominal Pipe Size, in.	PVC 1120, PVC 1220 PVC 2120, PVC 4120	PVC 2116	PVC 2112	PVC 2110
	Schedule 40 Pressure Classes			
1/2	428	343	264	214
3/4	343	278	214	171
1	321	257	200	157
1-1/4	264	207	164	129
1-1/2	236	186	150	121
2	200	157	121	100
2-1/2	214	171	136	107
3	186	150	114	93
3-1/2	171	136	107	86
4	157	129	100	79
5	136	114	86	71
6	129	100	79	64
8	114	86	71	57
10	100	79	64	NC[a]
12	93	79	57	NC
	Schedule 80 Pressure Classes			
1/2	607	486	378	300
3/4	493	393	307	243
1	450	357	278	228
1-1/4	371	300	228	186
1-1/2	336	271	207	171
2	286	228	179	143
2-1/2	300	243	186	150
3	264	214	164	136
3-1/2	250	200	157	121
4	228	186	143	114
5	207	164	129	100
6	200	157	121	100
8	179	143	107	86
10	164	136	107	86
12	164	129	100	79
	Schedule 120 Pressure Classes			
1/2	721	578	450	364
3/4	550	443	343	278
1	514	407	321	257
1-1/4	428	343	264	214
1-1/2	386	307	243	193
2	336	271	207	171
2-1/2	336	264	207	164
3	314	257	200	157
3-1/2	271	221	171	136
4	307	243	193	157
5	286	228	179	143
6	264	214	164	136
8	271	207	164	129
10	264	207	164	129
12	243	193	150	121

[a]NC = Not covered; pressure classes are less than 55 psi.

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3. Tables

3.1 Tables 1 through 4, PVC Plastic Pipe, Schedules 40, 80 and 120.

TABLE 4 BURST PRESSURE REQUIREMENTS FOR WATER AT 73 F
SCHEDULE 40, 80 AND 120 PVC PLASTIC PIPE

Nominal Pipe Size, in.	Minimum Burst Pressures[a], psi					
	Schedule 40		Schedule 80		Schedule 120	
	PVC 1120 PVC 1220 PVC 2120 PVC 4120	PVC 2110 PVC 2112 PVC 2116	PVC 1120 PVC 1220 PVC 2120 PVC 4120	PVC 2110 PVC 2112 PVC 2116	PVC 1120 PVC 1220 PVC 2120 PVC 4120	PVC 2110 PVC 2112 PVC 2116
1/2	1910	1490	2720	2120	3250	2540
3/4	1540	1210	2200	1720	2470	1930
1	1440	1130	2020	1580	2300	1790
1-1/4	1180	920	1660	1300	1900	1490
1-1/2	1060	830	1510	1180	1720	1340
2	890	690	1290	1010	1510	1180
2-1/2	970	760	1360	1060	1490	1170
3	840	660	1200	940	1420	1110
3-1/2	770	600	1110	860	1230	960
4	710	560	1040	810	1380	1080
5	620	390	930	720	1260	990
6	560	440	890	700	1190	930
8	500	390	790	620	1160	910
10	450	350	750	580	1170	920
12	420	330	730	570	1090	850

[a]The fiber stresses used to derive these test pressures are as follows:
PVC 1120, PVC 1220, PVC 2120, PVC 4120 . . . . . 6400 psi; and
PVC 2110, PVC 2112, PVC 2116 . . . . . 5000 psi.

3.2 Tables 5 through 8, PVC Plastic Pipe, Standard-Dimension-Ratio Series.

TABLE 5 OUTSIDE DIAMETERS AND TOLERANCES, in.
STANDARD DIMENSION RATIO (SDR) SERIES

Nominal Pipe Size	Outside Diameter	Tolerances		
		Average	For Maximum and Minimum Diameter (Out-of-Roundness)	
			SDR 41, SDR 32.5 SDR 26, SDR 21	SDR 17, SDR 13.5
1/2	0.840	±0.004	±0.015	±0.008
3/4	1.050	±0.004	±0.015	±0.010
1	1.315	±0.005	±0.015	±0.010
1-1/4	1.660	±0.005	±0.015	±0.012
1-1/2	1.900	±0.006	±0.030	±0.012
2	2.375	±0.006	±0.030	±0.012
2-1/2	2.875	±0.007	±0.030	±0.015
3	3.500	±0.008	±0.030	±0.015
3-1/2	4.000	±0.008	±0.050	±0.015
4	4.500	±0.009	±0.050	±0.015
5	5.563	±0.010	±0.050	±0.030
6	6.625	±0.011	±0.050	±0.035
8	8.625	±0.015	±0.075	±0.045
10	10.750	±0.015	±0.075	±0.050
12	12.750	±0.015	±0.075	±0.060

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3.2 Tables 5 through 8, PVC Plastic Pipe, Standard-Dimension-Ratio Series.

TABLE 6 WALL THICKNESSES AND TOLERANCES, in.
STANDARD DIMENSION RATIO (SDR) SERIES

Nominal Pipe Size	Wall Thickness[a]					
	Minimum	Tolerance	Minimum	Tolerance	Minimum	Tolerance
	SDR 41		SDR 32.5		SDR 26	
1/2	....		....		....	
3/4	....		....		....	
1	....		....		....	
1-1/4	....		....		0.064	+0.020
1-1/2	....		....		0.073	+0.020
2	....		....		0.091	+0.020
2-1/2	....		....		0.110	+0.020
3	....		0.108	+0.020	0.135	+0.020
3-1/2	0.098	+0.020	0.123	+0.020	0.154	+0.020
4	0.110	+0.020	0.138	+0.020	0.173	+0.021
5	0.136	+0.020	0.171	+0.021	0.214	+0.027
6	0.162	+0.020	0.204	+0.024	0.255	+0.031
8	0.210	+0.025	0.265	+0.032	0.332	+0.040
10	0.262	+0.031	0.331	+0.040	0.413	+0.050
12	0.311	+0.037	0.392	+0.047	0.490	+0.059
	SDR 21		SDR 17		SDR 13.5	
1/2	....		....		0.062	+0.020
3/4	....		0.062	+0.020	0.078	+0.020
1	0.063	+0.020	0.077	+0.020	0.097	+0.020
1-1/4	0.079	+0.020	0.098	+0.020	0.123	+0.020
1-1/2	0.090	+0.020	0.112	+0.020	0.141	+0.020
2	0.113	+0.020	0.140	+0.020	0.176	+0.021
2-1/2	0.137	+0.020	0.169	+0.020	0.213	+0.026
3	0.167	+0.020	0.206	+0.025	0.259	+0.031
3-1/2	0.190	+0.023	0.235	+0.028	0.296	+0.036
4	0.214	+0.026	0.265	+0.032	0.333	+0.040
5	0.265	+0.032	0.327	+0.039	0.412	+0.049
6	0.316	+0.038	0.390	+0.047	0.491	+0.059
8	0.410	+0.049	0.508	+0.061	....	
10	0.511	+0.061	0.632	+0.076	....	
12	0.606	+0.073	0.750	+0.090	....	

[a]The minimum is the least wall thickness of the pipe at any cross section. All tolerances are on the plus side of the minimum requirement.

TABLE 7 PRESSURE CLASSES at 73 F
STANDARD DIMENSION RATIO (SDR) NON-THREADED PVC PLASTIC PIPE

SDR	PVC 1120, PVC 1220 PVC 2120, PVC 4120	PVC 2116	PVC 2112	PVC 2110
13.5	225	179	143	114
17	179	143	114	89
21	143	114	89	71
26	114	89	71	57
32.5	89	71	57	NC
41	71	57	NC	NC

NC = Not covered; pressure classes are less than 55 psi.

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3.2 Tables 5 through 8, PVC Plastic Pipe, Standard-Dimension-Ratio Series.

TABLE 8 BURST PRESSURE REQUIREMENTS FOR WATER AT 73 F
STANDARD DIMENSION RATIO (SDR) PVC PLASTIC PIPE

SDR	Minimum Burst Pressure[a], psi	
	PVC 1120, PVC 1220 PVC 2120, PVC 4120	PVC 2110, PVC 2112 PVC 2116
13.5	1000	800
17	800	630
21	630	500
26	500	400
32.5	400	315
41	315	250

[a]The fiber stresses used to derive these test pressures are as follows: PVC 1120, PVC 1220, PVC 2120, PVC 4120 . . 6400 psi; PVC 2110, PVC 2112, PVC 2116 . . 5000 psi. Some minor adjustments have been made to keep test pressures uniform to simplify testing.

3.3 Tables 9 through 11, PVC Plastic Tubing.

TABLE 9 OUTSIDE DIAMETERS AND TOLERANCES, in.

Nominal Tubing Size	Outside Diameter	Tolerance	
		For Average	For Maximum and Minimum (Out-of-Roundness)[a]
1/2	0.625	± 0.004	± 0.015
3/4	0.875	± 0.004	± 0.015
1	1.125	± 0.004	± 0.015
1-1/4	1.375	± 0.004	± 0.015
1-1/2	1.625	± 0.005	± 0.015
2	2.125	± 0.006	± 0.015

[a]The out-of-roundness tolerances apply only to tubing as extruded.

TABLE 10 WALL THICKNESSES AND TOLERANCES, in.

Nominal Tubing Size	Wall Thickness[a]							
	PVC 2110		PVC 2112		PVC 2116		PVC 1120, PVC 1220 PVC 2120, PVC 4120	
	Minimum	Tolerance	Minimum	Tolerance	Minimum	Tolerance	Minimum	Tolerance
1/2	0.062	+0.015	0.062	+0.015	0.062	+0.015	0.062	+0.015
3/4	0.065	+0.015	0.062	+0.015	0.062	+0.015	0.062	+0.015
1	0.083	+0.015	0.066	+0.015	0.062	+0.015	0.062	+0.015
1-1/4	0.102	+0.015	0.081	+0.015	0.065	+0.015	0.062	+0.015
1-1/2	0.121	+0.015	0.096	+0.015	0.078	+0.015	0.063	+0.015
2	0.158	+0.015	0.125	+0.015	0.101	+0.015	0.082	+0.015

[a]The minimum is the least wall thickness of the tubing at any cross section. All tolerances are on the plus side of the minimum requirement. The standard dimension ratios (SDR) are as follows: For PVC 2110 - 13.5; For PVC 2112 - 17; For PVC 2116 - 21; For PVC 1120, PVC 1220, PVC 2120 and PVC 4120 - 26.

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3.3 Tables 9 through 11, PVC Plastic Tubing.

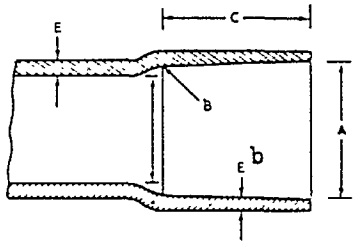
TABLE 11 BURST PRESSURE REQUIREMENTS FOR WATER AT 73 F

Nominal Tubing Size, in.	Minimum Burst Pressure[a], psi			
	PVC 1120, PVC 1220 PVC 2120, PVC 4120	PVC 2116	PVC 2112	PVC 2110
1/2	1410	1100	1100	1100
3/4	980	760	760	800
1	750	470	630	800
1-1/4	580	500	630	800
1-1/2	500	500	630	800
2	500	500	630	800

[a]The fiber stresses used to derive these test pressures are as follows: PVC 1120, PVC 1220, PVC 2120 and PVC 4120 . . 6400 psi; PVC 2110, PVC 2112 and PVC 2116 . . . . . 5000 psi.

3.4 Table 12, PVC Bell-End Plastic Pipe.

TABLE 12 DIMENSIONS AND TOLERANCES FOR TAPERED-SOCKET BELLS, in.



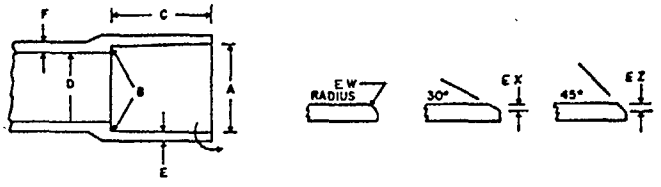
Pipe Size	A Socket Entrance Diameter			B Socket Bottom Diameter			C Socket Length, min.[a]
	Nominal Diameter	Tolerance on Nom. Diameter	Maximum Out-of-Round	Nominal Diameter	Tolerance on Nom. Diameter	Maximum Out-of-Round	
1/2	0.848	±0.004	±0.008	0.836	±0.004	±0.008	1.000
3/4	1.058	±0.004	±0.010	1.046	±0.004	±0.010	1.250
1	1.325	±0.005	±0.010	1.310	±0.005	±0.010	1.500
1-1/4	1.670	±0.005	±0.012	1.655	±0.005	±0.012	1.750
1-1/2	1.912	±0.006	±0.012	1.894	±0.006	±0.012	2.000
2	2.387	±0.006	±0.012	2.369	±0.006	±0.012	2.250
2-1/2	2.889	±0.007	±0.015	2.868	±0.007	±0.015	2.500
3	3.516	±0.008	±0.015	3.492	±0.008	±0.015	3.250
3-1/2	4.016	±0.008	±0.015	3.992	±0.008	±0.015	3.500
4	4.518	±0.009	±0.015	4.491	±0.009	±0.015	4.000
5	5.583	±0.010	±0.030	5.553	±0.010	±0.030	4.000
6	6.647	±0.011	±0.030	6.614	±0.011	±0.030	6.000
8	8.655	±0.015	±0.045	8.610	±0.015	±0.045	6.000

[a]All tolerances on minimum dimensions for socket length shall be on the plus side. [b]The minimum wall thickness "E" of the bell socket shall be not less than the specified minimum wall thickness of the pipe given in Tables 2 and 6.

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3.5 Tables 13 through 16, PVC Plastic Pipe Fittings, Schedule 40 and 80, Socket Type.

TABLE 13 DIMENSIONS AND TOLERANCES FOR TAPERED SOCKETS[a], in.



Nominal Pipe Size	A Socket Entrance Diameter			B Socket Bottom Diameter			C Socket Length, min	D[b], Inside Diameter, min	Wall Thickness, min		Entrance, min		
	Diameter	Tolerance on Diameter	Maximum Out-of-Round	Diameter	Tolerance on Diameter	Maximum Out-of-Round			E	F	EW	EX	EZ
Schedule 40													
½	0.848	±0.004	±0.008	0.836	±0.004	±0.008	0.688	0.618	0.109	0.136	1/32	1/32	1/32
¾	1.058	±0.004	±0.010	1.046	±0.004	±0.010	0.719	0.820	0.113	0.141	1/32	1/32	1/32
1	1.325	±0.005	±0.010	1.310	±0.005	±0.010	0.875	1.044	0.133	0.166	1/16	1/16	1/16
1¼	1.670	±0.005	±0.012	1.655	±0.005	±0.012	0.938	1.375	0.140	0.175	1/16	1/16	1/16
1½	1.912	±0.006	±0.012	1.894	±0.006	±0.012	1.094	1.604	0.145	0.181	1/16	1/16	1/16
2	2.387	±0.006	±0.012	2.369	±0.006	±0.012	1.156	2.061	0.154	0.193	1/16	1/16	1/16
2½	2.889	±0.007	±0.015	2.868	±0.007	±0.015	1.750	2.462	0.203	0.254	3/32	1/8	1/8
3	3.516	±0.008	±0.015	3.492	±0.008	±0.015	1.875	3.060	0.216	0.270	3/32	1/8	1/8
3½	4.016	±0.008	±0.015	3.992	±0.008	±0.015	2.000	3.540	0.226	0.283	3/32	1/8	1/8
4	4.518	±0.009	±0.015	4.491	±0.009	±0.015	2.000	4.017	0.237	0.296	3/32	1/8	1/8
5	5.583	±0.010	±0.030	5.553	±0.010	±0.030	3.000	5.037	0.258	0.323	3/32	1/8	1/8
6	6.647	±0.011	±0.030	6.614	±0.011	±0.030	3.000	6.054	0.280	0.350	1/8	3/16	3/16
8	8.655	±0.015	±0.045	8.610	±0.015	±0.045	4.000	7.966	0.322	0.403	1/8	3/16	3/16
Schedule 80													
½	0.852	±0.004	±0.008	0.840	±0.004	±0.008	0.875	0.542	0.147	0.185	1/32	1/32	1/32
¾	1.062	±0.004	±0.010	1.050	±0.004	±0.010	1.000	0.738	0.154	0.195	1/32	1/32	1/32
1	1.330	±0.005	±0.010	1.315	±0.005	±0.010	1.125	0.952	0.179	0.225	1/16	1/16	1/16
1¼	1.675	±0.005	±0.012	1.660	±0.005	±0.012	1.250	1.273	0.191	0.240	1/16	1/16	1/16
1½	1.918	±0.006	±0.012	1.900	±0.006	±0.012	1.375	1.494	0.200	0.250	1/16	1/16	1/16
2	2.393	±0.006	±0.012	2.375	±0.006	±0.012	1.500	1.933	0.218	0.275	1/16	1/16	1/16
2½	2.896	±0.007	±0.015	2.875	±0.007	±0.015	1.750	2.316	0.276	0.345	3/32	1/8	1/8
3	3.524	±0.008	±0.015	3.500	±0.008	±0.015	1.875	2.892	0.300	0.375	3/32	1/8	1/8
3½	4.024	±0.008	±0.015	4.000	±0.008	±0.015	2.125	3.356	0.318	0.400	3/32	1/8	1/8
4	4.527	±0.009	±0.015	4.500	±0.009	±0.015	2.250	3.817	0.337	0.420	3/32	1/8	1/8
5	5.593	±0.010	±0.030	5.563	±0.010	±0.030	2.625	4.803	0.375	0.470	3/32	1/8	1/8
6	6.657	±0.011	±0.030	6.625	±0.011	±0.030	3.000	5.750	0.432	0.540	1/8	3/16	3/16
8	8.670	±0.015	±0.045	8.625	±0.015	±0.045	4.000	7.610	0.500	0.625	1/8	3/16	3/16

[a] Minimum dimensions have zero negative tolerance.

[b] The minimum inside diameter of the fitting shall not be less than the specified minimum inside diameter of the corresponding size of Schedule 40 or 80 pipe.

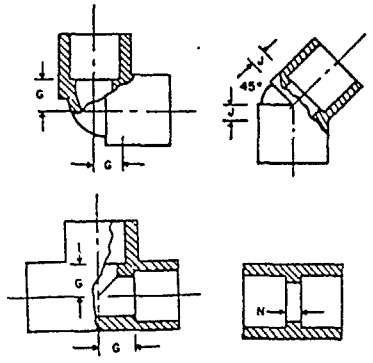
The sketches and designs of fittings shown are illustrative only.

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3. Tables

3.5 Tables 13 through 16, PVC Plastic Pipe Fittings, Schedule 40 and 80, Socket Type.

TABLE 14 MINIMUM DIMENSIONS FROM CENTER TO END OF SOCKETS (LAYING LENGTH) FOR SCHEDULE 40 AND 80 COUPLINGS, TEES, 90-DEGREE AND 45-DEGREE ELBOWS[a,b], in.



Nominal Pipe Size	G, min	J, min	N, min
½	½	¼	9/32
¾	9/16	5/16	3/32
1	11/16	5/16	3/32
1¼	⅞	⅜	3/32
1½	1	7/16	3/32
2	1¼	⅝	3/32
2½	1½	11/16	3/16
3	1¹³/16	¾	3/16
3½	2⅛	1	3/16
4	2⁵/16	1	3/16
5	3	1⅜	3/16
6	3½	1¾	¼
8	4½	2	¼

[a]Minimum dimensions have zero negative tolerance on the basis of conversion to the nearest 0.001 inch.
[b]All dimensions not shown shall conform with those in Table 13 for the corresponding sizes of Schedule 40 or 80 fittings.
The sketches and designs of fittings shown are illustrative only.

TABLE 15 BURST PRESSURE REQUIREMENTS FOR WATER AT 73 F SCHEDULE 40 AND 80 PVC SOCKET-TYPE FITTINGS[a]

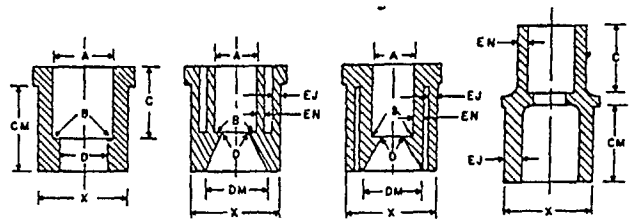
	Minimum Burst Strength, psi			
	Schedule 40		Schedule 80	
Nominal Size, in.	PVC: Type 1, Grades 1 and 2; Type IV, Grade 1.	PVC Type II, Grade 1	PVC: Type 1, Grades 1 and 2; Type IV, Grade 1.	PVC Type II, Grade 1
1/2	1910	1490	2720	2120
3/4	1540	1210	2200	1720
1	1440	1130	2020	1580
1-1/4	1180	920	1660	1300
1-1/2	1060	830	1510	1180
2	890	690	1290	1010
2-1/2	970	760	1360	1060
3	840	660	1200	940
3-1/2	770	600	1110	860
4	710	560	1040	810
5	620	490	930	720
6	560	440	890	700
8	500	390	790	620

[a]These tables were calculated for Schedule 40 and 80 pipe using the ISO formula and the following stress levels for materials:
PVC Type I, Grades 1 and 2, and PVC Type IV, Grade 1 . . . . . 6400 psi;
PVC Type II, Grade 1 . . . . . 5000 psi.

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3.5 Tables 13 through 16, PVC Plastic Pipe Fittings, Schedule 40 and 80, Socket Type.

TABLE 16 DIMENSIONS FOR REDUCER BUSHINGS, in.
SCHEDULE 40 AND 80 PVC SOCKET-TYPE FITTINGS[a,b,c]



Nominal Size	X, Outside Diameter[d]	Tolerance on Outside Diameter (includes out-of-round)
3/4 by 1/2	1.050	± 0.010
1 by 1/2, 3/4	1.315	± 0.010
1-1/4 by 1/2, 3/4, 1	1.660	± 0.012
1-1/2 by 1/2, 3/4, 1, 1-1/4	1.900	± 0.012
2 by 1/2, 3/4, 1, 1-1/4, 1-1/2	2.375	± 0.012
2-1/2 by 2	2.875	± 0.015
3 by 2-1/2, 2	3.500	± 0.015
3-1/2 by 2-1/2, 2	4.000	± 0.015
4 by 3-1/2, 3, 2-1/2, 2	4.500	± 0.015
5 by 4	5.563	± 0.030
6 by 5	6.625	± 0.035
8 by 6	8.625	± 0.045

[a]Dimensions A and B are for the smaller-size-pipe socket and shall be the same as those in Table 13 for the corresponding Schedule 40 or 80 fittings. Dimensions C, D, E and F shall be the same as those for the corresponding schedule in Table 13 where applicable. Dimensions CM and DM apply to the larger-size pipe joined and shall be the same as those in Table 13 for Schedule 40 or 80 fittings. Dimensions EJ and EN apply to the larger and smaller size pipes joined, respectively, and shall be the same as those for the corresponding schedule in Table 13.

[b]Multistep reducer bushings may be cored out. Where coring is used, the inner socket shall be reinforced from the outer wall by a minimum of three ribs extending from the top of the inner socket to the deepest extremity of the coring.

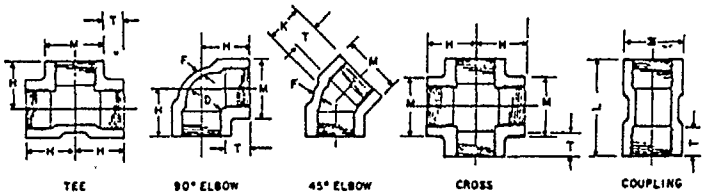
[c]The transition from D to DM may be straight, tapered as shown, or radiused at the discretion of the manufacturer.

[d]A taper on the outside diameter of a bushing is optional. If a taper is not used, then the walls shall be parallel and conforming in dimensions to the maximum and minimum dimensions given in this table for X. If a taper is used, it shall be a positive taper in the same direction as the taper in the socket (see Table 13), and all diameters shall be within the tolerances given for X in this table.

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3.6 Tables 17 through 19, PVC Plastic Pipe Fittings, Threaded, Schedule 80.

TABLE 17 DIMENSIONS FOR SCHEDULE 80 TEES, CROSSES, ELBOWS AND COUPLINGS (STRAIGHT SIZES)[a,c], in.



Nominal Pipe Size	Center to Thread End, 90-Deg Elbows, Tees, Crosses,[b] H, min	Length of Thread, T, min	Center to Thread End, 45-Deg Elbow[b], K, min	Inside Diameter of Fitting, D, min	Nominal Wall Thickness, F, min	Outside Diameter of Band, M, min	Thread End to Thread End of Coupling, L, min
½	1.125	0.64	0.750	0.550	0.198	1.280	1.344
¾	1.250	0.65	1.000	0.750	0.207	1.500	1.500
1	1.500	0.81	1.125	0.960	0.225	1.810	1.688
1¼	1.750	0.85	1.313	1.280	0.261	2.200	1.750
1½	1.938	0.85	1.438	1.500	0.270	2.500	2.000
2	2.250	0.90	1.625	1.940	0.297	3.000	2.063
2½	2.688	1.21	1.938	2.320	0.315	3.560	2.625
3	3.063	1.30	2.125	2.900	0.405	4.300	2.750
4	3.625	1.38	2.625	3.830	0.450	5.430	3.000
6	5.125	1.50	3.250	5.761	0.504	7.625	3.250

[a]Minimum dimensions have zero negative tolerance. Counterbore is optional, not shown in the drawing, and not included in the center-to-end or end-to-end dimensions. The sketches and designs of fittings are illustrative only.
[b]This dimension locates the end of the fitting.
[c]All threads shall conform with ANS B2.1 for Standard Taper Pipe Threads. The starting thread of each fitting may be a standard thread with a 45 degree chamfer one thread deep; or a blunt-start thread as specified in Figure 1, 3.7.

TABLE 18 DIMENSIONS FOR SCHEDULE 80 PVC PLUGS AND CAPS[a,c], in.



Nominal Pipe Size	Length of Male Thread, S, min	Length of Female Thread, T, min	Width of Flats,[b] Q, min	Nominal Wall Thickness, F, min	Height of Head, R, min	Cap Height, W, min	Outisde Diameter of Band, M, min
½	0.53	0.64	0.938	0.198	0.188	0.875	1.280
¾	0.55	0.65	1.125	0.207	0.219	1.000	1.450
1	0.68	0.81	1.375	0.225	0.219	1.188	1.810
1¼	0.71	0.85	1.750	0.261	0.281	1.250	2.200
1½	0.72	0.85	1.875	0.270	0.313	1.250	2.450
2	0.76	0.90	1.875	0.297	0.313	1.375	3.000
2½	1.14	1.21	1.875	0.369	0.375	1.625	3.560
3	1.20	1.30	2.000	0.405	0.375	1.750	4.250
4	1.30	1.38	2.000	0.450	0.375	2.000	5.350
6	1.44	1.50	2.000	0.504	0.500	2.125	7.625

[a]Minimum dimensions have zero negative tolorance. Bushings shall have thread lengths applicable to the corresponding sizes. The sketches and designs of fittings are illustrative only.
[b]At the manufacturer's option, the head of the plug may be hexagonal, octagonal, square or round.
[c]See thread requirements specified in note "c" of Table 17.

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3.6 Tables 17 through 19, PVC Plastic Pipe Fittings, Threaded, Schedule 80.

TABLE 19 BURST PRESSURE REQUIREMENTS FOR WATER AT 73 F

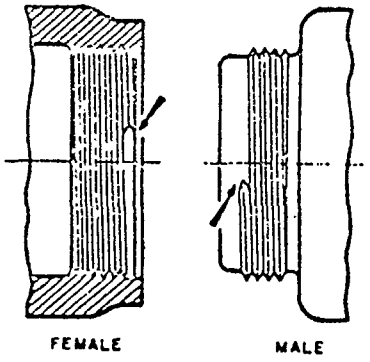
Nominal Size, in.	Minimum Burst Strength[a], psi	
	PVC Type I, Grades 1 and 2 PVC Type IV, Grade 1	PVC Type II, Grade 1
1/2	2720	2120
3/4	2200	1720
1	2020	1580
1-1/4	1660	1300
1-1/2	1510	1180
2	1290	1010
2-1/2	1360	1060
3	1200	940
4	1040	810
6	890	700

[a]This table was calculated for Schedule 80 pipe using the ISO formula and the following stress levels for materials:
PVC Type I, Grades 1 and 2; and PVC Type IV, Grade 1 . . 6400 psi
PVC Type II, Grade 1 . . . . . 5000 psi

3.7 Figures 1 and 2, PVC Plastic Fittings.

FIGURE 1

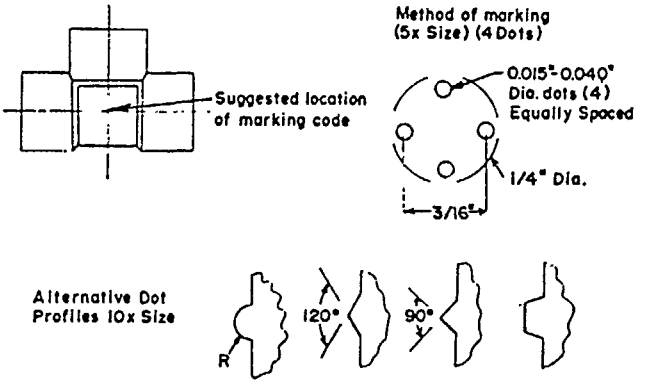
BLUNT START THREAD[a]



[a]The width of the blunt-start thread shall be 50 to 75 per cent of the full thread. The Blunt Start shall be included in the measurement of the thread length. (The Blunt Start was formerly known as the "Higbee Cut".)

FIGURE 2

ALTERNATIVE METHOD OF MARKING[a,b]



[a]Acceptable under the conditions specified in Subsection 2.4.5.2f.
[b]Signifies conformance of the fitting with the applicable ASTM fitting specification.

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4. Construction

4.1 Specifications and Drawings

4.1.1 Construction specifications and drawings should be provided for all PVC water-piping installations to be made by utility personnel. They should be of sufficient detail to assure work performance in compliance with this standard and to provide adequate direction for the proper installation of the facilities.

4.1.2 When contracting for the installation of PVC water systems, the purchaser shall provide the contractor with such specific information as detailed hereunder:

1. Standards which govern the work.

2. Drawings which cover all phases of project work and which provide:

a. The location, depth, grade and length of the new piping system.

b. The particular kind and size of PVC piping in each section of the new system.

c. The size and location of special fittings and appurtenances.

d. The location, size and depth of all existing underground-utility lines and other substructures of concern that may be known to the purchaser.

3. Specifications covering construction, hydrostatic tests, desinfection, record keeping and work performance in compliance with this standard.

4.2 Personnel

4.2.1 The utility or the contractor, whichever party is responsible for the work, shall provide qualified personnel for the supervision and construction of PVC water-piping systems.

4.2.2 For contract installations of PVC piping, purchaser should provide a qualified inspector to examine materials to be used and to inspect construction work.

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4.3 Field Inspection

4.3.1 Inspection of PVC materials and other piping-system components, their assembly and their installation shall be adequate to insure that defective and damaged materials are not used and that sound joints and connections are made.

4.3.2 All kinks, buckles and other imperfections in PVC pipe and tubing shall be removed as a cylindrical section. Patch repairs shall not be made (6.1.7).

4.3.3 Defective fittings and solvent-fusion joints shall be removed and replaced. Defects in fittings and joints shall not be repaired with filler material.

4.4 Handling, Transport and Storage. PVC materials shall be handled, transported and stockpiled with care as prescribed hereunder:

1. Pipe and tubing in straight lengths shall be stockpiled and transported to and about jobsites on horizontal surfaces which will provide adequate support and prevent pipe deformation and damage. Coiled lengths may be placed in an upright position or stacked flat one above another. Other materials shall not be stored or transported on top of plastic pipe and tubing.

2. Pipe, tubing and fittings stored indoors shall not be allowed to contact hot-water or steam lines, or other hot surfaces. When stockpiled outdoors for periods of a year or more, they shall be protected against direct exposure to sunlight by a shielding material such as black-polyethylene sheeting. Shielding material shall be installed in a manner that will provide for air circulation among the covered items to avoid excessive heat buildups.

3. Solvent-fusion materials including chemical cleaners and primers shall be stored under cover in areas free of open flames and other sources of ignition, and preferably in non-heated or cooler areas of buildings.

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4. Pipe and tubing shall be loaded, unloaded and stockpiled, and assembled piping shall be moved and installed without being tossed, dropped or subjected to other such abuse. Coiled material shall not be rolled off truck beds in a free manner or across objects which may cut, puncture or otherwise damage it. Piping shall not be pulled or pushed over sharp or rough surfaces.

4.5 PVC Joints

4.5.1 Plain-end pipe and socket fittings, and pipe with tapered-socket bells (3.4) may be joined by the solvent-fusion method.

4.5.2 Plain-end pipe may be joined also by use of plastic or metal push-on fittings with elastomeric-gasket seals (4.8.4), mechanically-tightened compression fittings and companion pipe-stiffener inserts (4.8.5), or self-restraining mechanical couplings with hydraulic-sealing gaskets (4.8.6).

4.5.3 Suitable bell-end pipe may be joined mechanically by the bell-and-spigot method using an elastomeric gasket to provide the water seal (4.8.4).

4.5.4 Threaded pipe and fitting joints may be used provided:

1. The pipe and fitting components have a wall-thickness not less than that prescribed for Schedule 80 sizes, and threads conforming with ANS B2.1 (4.8.3).

2. The pressure class of the threaded pipe and the joints is considered to be not more than 50 percent of the pressure class of like non-threaded pipe.

3. The design pressure of the system does not exceed the pressure class of the threaded pipe and joint.

4.5.5 Tubing may be joined by use of solvent-fusion, socket fittings; mechanically-tightened, compression fittings and companion stiffener inserts (4.8.5); or elastomeric-gasket, plastic or metal push-on fittings (4.8.4).

4.5.6 Metal-backup rings shall be used with PVC flanges.

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4.6 PVC Main and Service Connections

4.6.1 PVC services may be connected to PVC mains by use of solvent-fusion saddles; mechanically-tightened, full-encirclement, plastic or metal saddles with suitable gaskets (4.7.1.2); or of any other direct-connection fitting specifically designed for the purpose. Strap clamps and wrap-around saddles shall be of sufficient width to prevent deformation and damage of the plastic main (2.2.2).

4.6.2 New PVC mains may be connected to existing PVC mains by use of PVC flanges or any means prescribed in 4.5.

4.6.3 PVC pipe, tubing and fittings shall not be joined to dissimilar kinds of plastic-piping components by the solvent-fusion method.

4.7 Plastic-To-Metal Connections

4.7.1 PVC piping shall be connected to metal water mains and services by use of appropriate transition fittings and joining techniques compatible with the plastic material, in accordance with established procedures which have been demonstrated by test to produce water-tight joints that will not separate due to any foreseeable stress, and in accordance with the following provisions:

1. PVC services may be connected to metal mains by use of suitable plastic saddles; or by use of PVC flanges, PVC fittings with external threads, or any suitable compression fitting in conjunction with metal saddles, corporation stops and fittings.

2. Metal services may be connected to PVC mains by use of metal saddles, or plastic saddles and transition fittings meeting the requirements of this standard. The class (type and grade) and wall-thickness of the PVC main must be considered in the determination of the suitability of saddles and of any other fittings for making a transition connection directly to the main.

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3. The wall-thickness of threaded PVC transition fittings shall not be less than that of Schedule 80 sizes.

4. PVC fittings with internal threads shall not be used to make threaded connections to metal pipe or fittings unless the PVC fittings are reinforced externally by a fixed metallic member made of a material meeting the requirements prescribed in 2.2.2 of this standard.

5. Transition connections at meters and elsewhere in PVC water-piping systems shall be made with appropriate fittings and in compliance with all applicable requirements and provisions of this standard.

4.8 Joining Provisions and Procedures. The materials and joining techniques used in the construction of solvent-fusion, threaded, push-together, compression-fitting and self-restraining-coupling joints shall conform with the appropriate requirements prescribed in Section 2, Materials; and with the requirements and procedures specified hereunder:

4.8.1 General. PVC pipe and tubing may be cut with a hacksaw, a No. 12 carpenter saw with little or no set, or with a special pipe-cutter equipped with a thin-cutting wheel and wide rollers. All cuts shall be square with the pipe axis and slightly beveled with a knife-file or sandpaper to remove all ridges and burrs. Shavings and other loose material shall be removed before joint assembly.

4.8.2 Solvent-Fusion Joints

1. The material used to make PVC solvent-fusion joints shall conform with the requirements specified in 2.4.1 and 2.4.3 (B.5.1).

2. Solvent-fusion materials shall be used in areas free of open flames and other sources of ignition. Containers should be kept tightly closed and in shaded areas during periods of non-use.

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3. Solvent-fusion joints shall not be made in small confined areas without adequate ventilation.

4. Solvents, thinners and primers shall not be added to solvent-fusion materials. Whenever the fusion materials have changed appreciably in viscosity or appear to be gelling, they shall be discarded.

5. The engaging surfaces of joint components shall be properly prepared in accordance with manufacturer recommendations before application of solvent-fusion material. The surfaces must be clean and free of moisture. Surface dirt, oil and other impurities, and surface gloss may be removed by the appropriate use of PVC or CPVC primer specifically recommended for the purpose; or by use of abrasive paper or cloth (180 grit or finer), or clean oil-free steel wool. Chemical cleaners (solvents) shall not be used unless specifically recommended by the pipe or fitting manufacturer. Liquid cleaners shall be applied with a clean dry cloth or suitable brush. All PVC and abrasive particles must be removed after use of mechanical cleaners.

6. After surface preparation, solvent-fusion materials shall be applied to the engaging surfaces of PVC joints as quickly as possible consistent with good workmanship to prevent premature drying before joint assembly and to minimize, under high atmospheric-humidity conditions, the deposit of moist-air condensate on the joint-component surfaces. During hot-summer months, the material should be applied simultaneously to both surfaces by two men. The temperature of the engaging surfaces should not exceed 110°F at the time of material application. When the surface temperature of the joint components is above 100°F, it is usually advisable to cool the surfaces first by swabbing with clean wet rags; but, all water must be removed subsequently prior to application of the solvent-fusion materials. Natural-bristle brushes or other

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applicators specifically recommended for the purpose by manufacturers of PVC materials shall be used to apply solvent-fusion materials. Applicator width should be equal to about one-half of the nominal diameter of the pipe or tubing being used. For six-inch and larger-diameter pipe, an applicator width of two and one-half inches is usually adequate.

7. When not applied to both surfaces simultaneously, the solvent-fusion material shall be applied first to the fitting socket in a uniform thin coat which fully covers the inside surface and the contact side of the shoulder at the bottom of the socket. A coating of material shall then be applied to fully cover the leading end of the pipe or tubing and the outside surface from its end to a distance back equal to the depth of the fitting socket. It is usually advisable to apply a second thin coat of material to the fitting-socket surface, particularly during hot weather. If engagement of the coated surfaces is unduly delayed for any reason, another coat of material shall be applied to both surfaces before the joint is made.

8. The same solvent-fusion material application procedure applies to PVC bell-end pipe joints, but great care shall be taken to avoid application of excess material in the bell socket and the deposit of any in the bell-to-pipe transition area. This precaution is particularly important when bell-end pipe with a wall-thickness less than 0.125 inch is being used.

9. When a primer and a solvent-fusion material are both used to make solvent-fusion joints, and when the primer is to be applied also by one individual; it shall be applied to the component surfaces in the three-step sequence of fitting socket, pipe surface, and fitting socket. Immediately after the second application of primer to the fitting-socket surface, the solvent-fusion material shall be quickly applied first to the pipe surface, then to the fitting socket, and then again to the engaging surface of the pipe. In the first application,

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an adequate but not excessive amount of primer shall be used to uniformly coat and initiate softening (dissolvement) of the entire inside surface of the fitting socket. A more liberal amount of primer should be used on the pipe surface. A thin uniform coat of primer is usually adequate for the second fitting-socket application. Solvent-fusion-material application, other than sequence, shall conform with the requirements prescribed above in 4.8.2.7 and 4.8.2.8.

10. After application of solvent-fusion material, the PVC pipe or tubing shall be quickly aligned and inserted into the fitting until it engages the shoulder at the bottom of the socket. During engagements when possible, the pipe or fitting should be rotated about one-fourth of a full turn to uniformly distribute the solvent-fusion material. Rotation of six-inch and larger-diameter pipe during engagement is not usually practical; therefore, even greater care should be taken in the preparation for such joint assemblies to assure that the entire engagement surface of the pipe is uniformly covered with adequate solvent-fusion material. Once engaged, the joint components shall be held together momentarily to prevent voluntary separation; and then the joint shall not be disturbed for a few minutes to allow for initial set prior to handling for any purpose. Excess material expelled to the outside surface of the pipe during joint makeup shall be wiped off immediately with a clean cloth.

11. The solvent-fusion assembly of four-inch and larger-diameter PVC joints usually requires the services of three men; one to hold the pipe, another to hold the fitting, and the other to force the pipe into the fitting. Leverage may be applied by a take-up clamp or pry bar, but damage to the joint components by such action shall be prevented by the use of protective materials. Recently made solvent-fusion joints shall not be stressed by such operations.

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12. During construction hours, air shall be allowed to circulate freely through assembled PVC piping to permit escape of solvent vapors and to expedite joint cure. Metal screen or porous burlap may be used to cover open ends of piping for air circulation overnight.

13. Sufficient time shall be allowed for solvent-fusion joints to cure (set) before assembled piping is handled for placement in trenches or other locations. The manufacturer's recommendations for cure-time allowances should be observed (B.5.1.2, B.5.1.6).

4.8.3 Threaded Joints

1. PVC pipe and fitting threads shall conform with the requirements of ANS B2.1, Standard Taper Pipe Threads.

2. The threading of PVC pipe should be performed with sharp cutters in one continuous operation.

3. To prevent thread damage, the swarf at the end of new threads shall be cut before the die is removed. The die should be unscrewed about one-eighth of a turn, screwed forward again by hand until the thread end is felt, and then removed from the pipe.

4. A protective material shall be placed around the pipe section in the vice. Fine emery paper may be used to help secure the pipe in the vice without damage to it by over-tightening of the vice.

5. A slightly-tapered wooden plug of suitable size shall be inserted and lightly tapped into the pipe end to support it during the threading operation.

6. Strap wrenches shall be used to make up threaded PVC joints. A thread lubricant and sealer shall be used. Lubricants made of fluorocarbon plastics, such as Halon or Teflon for example, are generally suitable for use on plastic threads; but other lubricants shall not be used unless specifically recommended for the purpose by the pipe or fitting manufacturer. Lubricants shall conform

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with the requirements specified in 2.1.1 and 2.2.4 of this standard. Threaded joints shall be made up to not more than one-quarter to one-half of a full turn beyond hand tight.

4.8.4 Push-Together Joints. PVC joints and connections made by the use of bell-end pipe or push-on fittings, in which elastomeric gaskets under compression provide the pressure seal, shall conform with the specific installation recommendations of the manufacturer and the general requirements prescribed hereunder:

1. The qualifications of PVC bell-end pipe and of push-on fittings, and the suitability of push-on fittings for use with or without stiffener inserts in the joining of particular sizes of PVC pipe and tubing, shall be determined by the purchaser prior to use. (7.1.14; B.5.2.1)

2. The inside surface of the bell or fitting and particularly the gasket seat, the outside surface of the spigot, and the gasket shall be cleaned to remove all dirt and other foreign deposits. The engaging surfaces and the gasket may be washed with water or wiped clean with a dry cloth.

3. The spigot end of the pipe shall be square with the pipe axis, and its outside edge shall be beveled as recommended by the manufacturer.

4. The gasket shall be placed into position and lubricated or not lubricated in accordance with the specific recommendations of the manufacturer.

5. The beveled edge and outside surface of the spigot shall be lubricated before joint makeup with a material provided by the manufacturer.

6. Gaskets and lubricants shall conform with the requirements specified in 2.1 and 2.2.4 of this standard. Excessive use of lubricants shall be avoided.

7. After joint-component preparation, the spigot shall be aligned with the bell or fitting and then inserted to the depth specified by the manufacturer.

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4.8.5 Compression-Fitting Joints. The use of mechanically-tightened, compression fittings shall conform with the following requirements:

1. The fittings shall be dimensionally compatible with the PVC pipe or tubing component of the joint. They shall be designed to provide a permanent water-tight seal without damage to the PVC material, and to prevent joint separation due to possible thermal contraction or external loading of the PVC piping.

2. Pipe-stiffener inserts shall be used in conjunction with mechanically-tightened, compression fittings unless it has been established by prior tests and experience that the PVC pipe or tubing to be so joined is of sufficient rigidity to maintain a permanent water-tight seal while subjected to the compressive force exerted by the gasket after the fitting is tightened.

3. Stiffener inserts (2.2.3) shall be of adequate wall-thickness to withstand without deformation or collapse the compressive force exerted when the fitting is tightened. The tubular inserts shall be of a suitable diameter to provide a close fit. Split, loose and forced-fit inserts shall not be used. The ends, shoulders and surfaces of inserts shall be smooth, and free of rough and sharp edges. Inserts shall be of sufficient length to extend internally after joint makeup from the enclosed end of the piping to the outside face of the fitting.

4.8.6 Self-Restraining Mechanical Couplings. The use of self-restraining couplings with hydraulic-sealing gaskets shall conform with the recommendations of the specific-fitting and PVC-pipe manufacturers, and with the following general requirements:

1. Special tools specifically designed for the purpose shall be used to cut or to roll the pipe grooves required for accommodation of the housing key of such couplings.

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2. PVC pipe grooves shall be cut or rolled in strict accordance with the recommendations of the coupling manufacturer for the particular fitting and for the particular nominal size and wall-thickness of the pipe.

3. Rolled grooves shall not be made in PVC pipe with a wall-thickness less than Schedule 40 pipe.

4. Cut grooves shall not be made in PVC pipe with a wall-thickness less than Schedule 80 pipe.

5. When properly made with quality components and in compliance with the above requirements, the pressure class of self-restraining-coupling joints with rolled grooves may be considered as equal to that of the PVC pipe prior to rolling of the grooves; but the pressure class of such joints with cut grooves shall be considered to be not more than one-half of that of the PVC pipe prior to cutting of the grooves.

4.9 Installation

4.9.1 PVC water mains shall be installed to provide a minimum cover of thirty inches at all locations unless otherwise specified (4.9.3).

4.9.2 PVC water services shall be installed at least eighteen inches below grade and with sufficient cover to prevent piping damage due to gardening and other such activities on private premises. (4.9.3)

4.9.3 In cold regions, all PVC water lines shall be installed at least twelve inches below the lowest frost-depth recorded for the locality.

4.9.4 Trenches shall be wide enough to provide working space for personnel, to place the PVC pipeline properly in the trench, and to properly backfill and compact along both sides of the pipeline.

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4.9.5 PVC piping shall not be installed adjacent to underground power-transmission lines, steam lines or hot-water piping unless separated by a heat shield of suitable material. Where practicable, PVC mains should not be laid within four feet of such heat sources. Less separation without shielding may be possible depending on prevailing conditions. In special cases, the pipe manufacturer should be consulted.

4.9.6 PVC water lines within vaults and other substructures shall be cased or otherwise protected against damage.

4.9.7 PVC piping shall be cased, bridged or otherwise protected at locations where it will be subjected to heavy surface-traffic loads due to shallow burial and where it spans disturbed earth that may settle.

4.9.8 Water services shall be terminated on private premises in accordance with the requirements of the governing local code or ordinance.

4.9.9 Changes in direction of PVC water mains and services shall be made in accordance with the following provisions:

1. PVC piping may be deflected provided the radius of deflection is not less than the minimum recommended by the manufacturer for the specific kind, diameter and wall-thickness of the pipe or tubing being used, and for the temperature of the piping during deflection.

2. PVC piping shall be deflected with care to prevent kinking, buckling and other damage to the material, and especially during cold temperatures.

3. Deflected PVC piping shall contain no joints and shall not impose any stress on adjacent joints. Whenever damaged during deflection, the deflected piping shall be replaced with a new section of sufficient length to permit it to be deflected and joined to the original piping at locations where the new joints will not be subjected to any deflection stress.

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4. PVC piping shall not be heated to make it conform with a change in direction.

5. Tees, elbows, angles or other suitable fittings shall be used to make all changes in direction of PVC piping which cannot be made in compliance with the above provisions. Miter bends are not permitted.

4.9.10 PVC water lines shall be laid on trench floors free of rocks, boulders, concrete and blacktop fragments, frozen lumps and other objects of potential hazard to the plastic piping.

4.9.11 Trench floors shall provide continuous support for PVC piping. Bell holes shall be provided for flanged joints, valves and other system components which might otherwise act as a fulcrum and aid in the development of stresses detrimental to the piping.

4.9.12 PVC pipelines shall be lowered into trenches with care. Piping with solvent-fusion joints shall not be subjected to handling stresses until sufficient time has been allowed for all such joints to cure and develop the necessary strength (B.5.1.2).

4.9.13 When the temperature of PVC piping during installation is significantly different from what it will be when in service, means shall be employed during its installation to minimize the effects of subsequent longitudinal expansion or contraction of the piping due to such temperature change (B.5.3.6).

4.9.14 PVC piping shall be restrained against displacement forces as prescribed hereunder and generally in the same manner as other kinds of piping:

1. Unless otherwise desired or specified in a contract, thrust blocks are not required for PVC pipelines of two and one-half inches in diameter and smaller except when changes in direction of more than 22.5 degrees are made with push-together joints.

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2. All changes in direction of 22.5 degrees or more in three-inch and larger-diameter PVC piping that are made with fittings shall be blocked.

3. Thrust blocks shall be placed at tees when the diameter of the side opening equals or exceeds one-half of the diameter of the mainline pipe.

4. Valves shall be anchored in place by the use of metal rods and yokes. A portion of the rods shall be embedded in concrete placed beneath the valve. At least one set of rods and yoke shall be placed on each side of valves. The rods, yokes, nuts and washers shall be made of materials meeting the requirements specified in 2.2.2 of this standard.

5. Anchor blocks shall be placed at all locations where they are needed to prevent longitudinal, lateral, vertical or turning movement.

6. Poured-in-place concrete shall be used as anchorage and blocking in all such applications.

4.9.15 All trench-backfill material to a finished depth of at least six inches above the top of PVC piping shall be sand or fine-grain soil that is entirely free of rocks, cobbles, frozen lumps, pavement rubble and other objects that might damage or deform the pipe.

4.9.16 Excavations made below trench-floor level to accommodate joints, valves and other piping components, and to facilitate PVC main and service connections shall be properly backfilled with sand or fine-grain soil in a manner that will provide firm support for such system components and the connecting piping.

4.9.17 Water settlement of initial trench-backfill material should be performed with care to prevent displacement of the PVC piping which is relatively light and buoyant. Water filling of PVC piping prior to initial trench-backfill and consolidation operations is generally advisable and particularly whenever the backfill is to be consolidated by water flooding.

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4.9.18 When trench-backfill material around and over PVC piping is consolidated with water, new lifts of backfill shall not be compacted with tools until the initial backfill is firm enough to permit good compaction of the added material.

4.9.19 Old water piping used as a casing or conduit for a new PVC water main or service shall be reamed and cleaned to the extent necessary for removal of sharp metal-edges, metal projections, and abrasive material which might damage the plastic piping during or after its insertion.

4.9.20 Installations of PVC piping in metal casing or old water lines shall be performed in a manner that will prevent damage to the plastic material. PVC piping shall not be allowed to bear on the edge of metal pipe during insertion, and its leading end shall be suitably closed before insertion (B.5.3.5).

4.10 Records. Adequate construction records or other suitable means shall be provided to facilitate future location of buried PVC water lines. Records should include specific kind and size of PVC pipe used, depth of cover, and location with respect to permanent landmarks. Changes in direction should be measured and recorded. Tracer wire shall be installed with PVC piping whenever there is need to provide for future use of electronic pipe-locators (B.5.3.2).

5. Hydrostatic Tests and Disinfection

5.1 Hydrostatic Tests. PVC water-main and service piping shall be hydrostatically tested before use in accordance with the following requirements:

1. Potable water shall be used as the pressuring medium.

2. Mains and services shall be bled of air as they are being filled with water. The water shall be admitted slowly with all air-release valves open. Rapid filling may cause undue compression of residual gases and subsequent

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surge pressures of potential hazard to the PVC piping. Release valves shall not be closed for pressure testing until all air has been purged from the piping system.

3. Trenches should be partially backfilled between joints and connections in new piping systems before the systems are pressurized unless the piping is otherwise adequately restrained.

4. PVC piping with solvent-fusion joints shall not be pressure tested until the joints have cured sufficiently to withstand the pressure to be applied (B.5.1.2).

5. Short main extensions or services of normal size and length that are tested individually shall withstand a hydrostatic-test pressure equal to 1.5 times system-design pressure for a period of one hour without visible leakage, and without pressure loss other than any that may be accounted for by a decrease in test-water temperature. The test period for large-diameter and unusually-long services shall be increased proportionately to a maximum of twenty-four hours according to the judgment of utility personnel in authority, and shall be specified by the purchaser for such installations to be made by contractors. If a drop in test pressure occurs that cannot be attributed to change in water temperature, the cause shall be determined and corrected. Thereafter, the piping shall once again be subjected to the required test pressure for the full time period. Allowable pressure drop may be based on the leakage-test requirement given in the following subsection.

6. With the above exceptions, all mains and services shall be both pressure tested and leak tested in compliance with the following requirements:

a. The new piping shall be subjected first to a hydrostatic-test pressure equal to 1.5 times system-design pressure. The test pressure shall be maintained for at least six hours during which time the facilities shall be inspected for visible leaks, pipe movement, and other construction defects. All obvious defects shall be corrected before the leakage test is made.

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b. The piping shall then be subjected to a leakage test made by use of a calibrated meter while the system is pressurized. Leak-test pressure shall be maintained at a level not less than system-design pressure. Measured leakage per hour during a test period of at least two hours shall be less than the number of gallons per hour determined by the formula given below. If measured leakage is more than acceptable, the cause shall be determined and corrected; and thereafter, the piping shall once again be subjected to the leakage test.

c. Leakage formula: $L = \frac{NDP^{1/2}}{8,000}$

where: L = Leakage, gph

N = Number of joints in pipeline tested

D = Nominal diameter of pipe, in.

P = Average pressure during leakage test, psi 60

7. All joints made after completion of hydrostatic-test work for connection (tie-in) of new PVC mains and services to existing water-piping systems shall be checked also for leakage before trench backfill.

8. All leaks in PVC pipelines shall be repaired in accordance with the appropriate requirements prescribed elsewhere in this standard.

5.2 Disinfection. All PVC potable-water piping shall be disinfected before use in accordance with the following requirements:

1. Potable water shall be used in the disinfection of the facilities. It shall be admitted with or without the disinfectant in solution and at a rate both of which conform with the requirements prescribed in the AWWA Standard C601 for the disinfectant method being used.

2. When chlorine is used, it shall be introduced with the water and in solution concentrations of 40 to 50 PPM.

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3. Disinfection of valves and hydrants in the facilities being treated shall conform with requirements specified in AWWA C601.

4. New piping shall be exposed to the disinfectant for a period of at least twenty-four hours and then thoroughly flushed.

5. Coliform bacteriological tests or other tests defined in the AWWA Standard C601 shall be made before the new piping is placed in service. If the samples tested are not satisfactory, the disinfectant operation shall be repeated until satisfactory test results are obtained.

6. Contractors shall comply with all Federal, State or Provincial, and local laws and regulations applicable to the safe and effective use of disinfectants as well as the requirements specified above and in the AWWA Standard C601 for Disinfecting Water Mains.

6. Maintenance

6.1 Maintenance Requirements. Some of the common practices observed in the maintenance of non-plastic systems are not suitable for application to PVC piping systems. Work practices should be reviewed and changed as necessary. The following requirements and provisions shall be observed:

1. The location of underground PVC water lines shall not be determined by probing with steel bars.

2. Excavation work in the vicinity of PVC water lines shall be performed with care.

3. Torches and other heating equipment shall be handled with special care when used in the immediate vicinity of exposed PVC piping.

4. PVC pipelines shall be lowered, raised and otherwise handled in a manner that will prevent buckling of the pipe, over-stressing of joints and joint separations.

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5. Frozen PVC water lines may be thawed by hot-water injection, but water temperatures shall not exceed 140°F. Torches and other direct-heating devices shall not be used to thaw frozen lines.

6. All PVC-piping repairs and replacements shall be made in full compliance with the applicable construction requirements of this standard.

7. PVC pipe and tubing repairs shall be made by removal of the damaged section and replacement with a new section of like or other suitable material. If the defect is small in size, a repair clamp may be used provided it has been designed specifically for such use, and provided it is of sufficient width to prevent damage and deformation of the pipe or tubing. Patch repairs are not permitted.

8. Damaged or defective PVC fittings and solvent-fusion joints shall be removed and replaced. Fillers and packing materials shall not be used to repair leaking joints.

9. With the exception of emergencies, PVC piping shall not be squeezed shut to effect temporary interruption of water flow. When the squeeze-off method is used, the following requirements shall apply:

a. All squeeze-off work shall be performed as recommended by the manufacturer or in accordance with practices developed by the utility through research and experimentation, and by the use of trained personnel and special tools fully qualified for the job.

b. Pipe or tubing fractured or otherwise damaged during a squeeze-off operation shall be removed and replaced with a new section of like or other suitable material (6.1.6).

c. PVC piping restored to service with no visible defects after squeeze-off shall be reinforced externally with a rigid, split or two-piece PVC sleeve solvent-fused to the piping; or with a suitable plastic or metal repair clamp. The

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sleeve or clamp shall completely encase the stressed section of piping, shall be of sufficient length to extend a reasonable distance both ways from the point of squeeze-off, and shall be installed with the split or splits located circumferentially 90 degrees from the edges of the fold formed in the piping during squeeze-off. Solvent-fusion sleeves shall have a wall-thickness not less than that of the PVC piping, and they shall be further secured to the piping after solvent-fusion application by use of metal clamps (2.2.2).

7. Engineering

7.1 Design Requirements

7.1.1 The AWWA pressure class of PVC pipe or tubing used in any particular potable-water system shall be not less than the design pressure of that system.

7.1.2 The AWWA pressure class of PVC pipe and tubing of given dimensions shall be determined by use of the following equations:

1. $PC = \frac{2t}{OD-t} \times \frac{S}{F}$, or 2. $PC = \frac{2}{R-1} \times \frac{S}{F}$

where: PC = Pressure class, psi

S = Allowable long-term, hydrostatic strength; psi

t = Minimum wall-thickness, in.

OD = Average outside-diameter, in.

R = Standard-dimension-ratio number

F = Factor of safety

7.1.3 A factor of safety of 2.8 shall be used to determine the pressure class of PVC pipe and tubing to be used in potable-water applications conforming to this standard.

7.1.4 The hydrostatic-strength rating used in any pressure-class calculation shall be the value given in 2.2.1 of this standard for the specific class of PVC

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material being considered. It should be noted that the strength values given in 2.2.1 are applicable only for PVC pipe and tubing to be operated at temperatures not exceeding 73°F.

7.1.5 Whenever the working temperature of a PVC water-piping system is expected to exceed 73°F, the hydrostatic-strength rating used in the pressure-class calculation for the specific class of PVC material being considered for the application shall be a value established in accordance with the ASTM Test Methods D1598 and D2837, and a value recommended by the Plastics Pipe Institute for use of the specific PVC material at the higher operating temperature.

7.1.6 Whenever transient pressures of a magnitude greater than 20 percent of the maximum static-pressure are anticipated, the AWWA pressure class of PVC pipe or tubing used in such systems shall be not less than the sum of the maximum static-pressure plus the transient pressure. (Note: The factor of safety prescribed in 7.1.3 includes a safety allowance for transient pressures not exceeding 20 percent of the maximum static-pressure. This is considered adequate only for piping systems wherein water-flow velocities will not significantly exceed 5 fps. (B.3.1)

7.1.7 PVC pipe and tubing of a pressure class less than 55 psi for water at 73°F shall not be used for mains or services.

7.1.8 PVC pipe and tubing with a wall-thickness less than 0.062 inch shall not be used for mains or services.

7.1.9 The solvent-fusion and threaded PVC fittings used in water-piping systems shall be made of the same specific material as the PVC pipe or tubing components of such joints, or equally qualified for the service.

7.1.10 The wall-thickness of the body and of the socket of PVC fittings shall be not less than 125 percent and 100 percent respectively of the wall-thickness of the companion PVC pipe or tubing.

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7.1.11 The quick-burst strength of PVC fittings shall not be less than that of the PVC pipe or tubing with which they are used.

7.1.12 When properly made with qualified materials and joining techniques in compliance with the requirements of this standard, all PVC piping joints and connections with the exception stated in 4.5.4.2 and 4.8.6.5 may be considered as having a pressure-class rating equal to that of the PVC pipe or tubing component of such assemblies.

7.1.13 Installations of valves, hydrants, standpipes and other such appurtenances in PVC water-piping systems shall be designed and placed in a manner to prevent subjection of the connected PVC piping to torsional or shearing stresses when valves are operated, to shear stress as a result of subsequent settlement of the appurtenances, or to any other forces which might be exerted through the appurtenances, or their enclosures.

7.1.14 Use of PVC components and joining materials, and other piping materials and appurtenances in potable-water systems for which there are no product specifications prescribed or referenced in this standard is subject to the judgment and discretion of the purchaser. Each such item should be qualified prior to use by investigation, and by tests when needed, that demonstrates it is suitable and safe for the intended service and that it will be compatible with the PVC materials with which it is intended to be used. All such items shall conform with all applicable requirements prescribed in 2.1 and 2.4 of this standard, and they shall be items recommended for the intended service by the manufacturer.

7.2 External Loads. When necessary, system design shall incorporate provisions to prevent excessive deflection of PVC piping due to external loads. When judgment or calculations indicate that external loading due to trench-backfill material, surface loads, or both will cause a decrease of more than 5 percent

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in the vertical, cross-section dimension of the PVC pipe when it is installed in the usual expedient manner, suitable means shall be employed to prevent the excessive deflection; such as, trench backfilling in compliance with the recommendations given in Appendix A.1 of this standard, use of stiffer-wall pipe, use of heavier-wall pipe than that needed to comply with the pressure-class requirement applicable to system-design pressure, or any combination thereof.

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Appendix A. External Loads on Underground PVC Pipelines

This appendix is for information only and it is not a part of AWWA Standard ___?___, Poly(Vinyl Chloride) Plastic Water Mains and Services.

A.1 Installation Methods To Limit Pipe Deflection

1. Normally, superimposed loads will not cause excessive deflection of six-inch and smaller-diameter PVC pipe and tubing covered by the AWWA Standard ___?___ when the minimum-cover requirements in Subsection 4.9 have been observed. However, when judgment or calculations indicate trench-backfill material and surface loads will cause a decrease of more than 5 percent in the vertical cross-section dimension of any size of pipe, suitable backfilling techniques should be used to prevent excessive deformation. Good compaction of trench-backfill material along the sides of the pipe creates a comparatively high passive resistance in the soil which will significantly resist the development of pipe deformation by vertical loads. In special installation cases, the following recommendations may be observed:

a. Cohesionless gravel, sand, silt or mixtures thereof which will pass a one-half-inch sieve should preferably be used as trench-backfill material. However, plastic materials may be used satisfactorily provided a proper-compaction technique is employed in backfilling.

b. For pipe six inches in diameter and larger, the backfill material should be placed in the trench and worked under and around the sides of the pipe to aid in insuring proper bedding. Soil-compaction methods should be used that will attain a passive resistance in the soil great enough to significantly resist pipe deformation due to vertical loads.

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c. Various soil-compaction techniques and procedures may be observed. If the backfill material is essentially a cohesionless sand and if field conditions permit, the sand may be water flooded and then carefully compacted with a concrete vibrator. Water flooding must be performed with care to prevent floating of the PVC pipe and particularly so when the piping is not filled with water. The specific gravity of the PVC extrusion and molding materials ranges from 1.35 to 1.58. Usually, satisfactory compaction of cohesionless materials may be achieved with vibratory equipment.

d. When clayey (or plastic) soils are used as backfill materials, the desired degree of compaction may be attained by the use of impact equipment such as pneumatic tampers. Moisture content of clay soils should be near optimum for the equipment and procedures used, and the lift thicknesses must be kept small enough to achieve the desired results.

e. Mechanical-compaction equipment must be used with care to prevent distortion and damage of PVC pipelines. The impact head must not be allowed to strike the pipe. Compaction of backfill along the spring line of large-diameter pipe should be adequate but not excessive. Over compaction might cause a decrease in the horizontal cross-section dimension of the pipe. Pipe distortion and even damage can be caused by excessive compaction of backfill material above the piping with impact or heavy-rolling equipment.

f. In these special backfilling operations, judgment based on experience is most important. Additional guidance on the underground installation of thermoplastic pressure-piping is provided in ASTM D2774.

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A.2 Design Concepts

1. The load-carrying capability of piping without excessive deflection is dependent upon the inherent strength of the material, the internal pressure, and the passive soil resistance or side support. Possible deflection of large-diameter PVC pipe may be checked by one or more of the design approaches which are suggested in the publications listed below and which takes into consideration the characteristics of the soil, depth of cover, specified methods of excavation, backfill and bedding, and any surface loads which may add to the load on the pipe.

2. Spangler (1.2.3) expresses deflection as a function of pipe stiffness, pipe supports, load, side-fill pressures and pipe size. Dr. Muller (8) uses the creep modulus of elasticity along with the Marston (9) approach in his computation for the deflection of large-diameter pipe. Dr. Muller's procedure may merit investigation when large-diameter PVC pipe is to be used. The Watkins (5.6) procedure provides another method of computation wherein deflection is expressed as a function of the ratio of pipe stiffness to soil stiffness, soil pressure, soil strain and soil density. The manual of structural design and installation of buried pipelines by Clarke (7) provides a thorough discussion also on the design and installation of flexible pipe.

A.3 References

1. Spangler, M. G., "The Structural Design of Flexible Pipe Culverts", Iowa State University, Engineering Experimental Station, Bulletin 153 (1941), Page 5, Ames, Iowa.

2. Spangler, M. G., "Soil Engineering", International Textbook Company, Pages 412 and 442, 1956.

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3. Spangler, M. G., and Watkins, R. K., "Some Characteristics of The Modulus of Passive Resistance of Soil: A Study in Similitude ", Highway Research Board Proceedings, Volume 37, 1958.

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5. Watkins, R. K., and Smith, A. B., "Ring Deflection of Buried Pipe", AWWA Journal, 59:3:367, March, 1967.

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9. Marston, A., "The Theory of External Loads On Closed Conduits In Light of The Latest Experiments," Iowa State University, Engineering Experimental Station, Bulletin 96 (1930), Ames, Iowa.

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Appendix B. Poly(Vinyl Chloride) Plastic Piping Systems

This appendix is for information only and it is not a part of AWWA Standard ___?___, Poly(Vinyl Chloride) Plastic Water Mains and Services.

B.1 Purpose

B.1.1 The poly(vinly chloride) (PVC) pressure-piping materials and their use for the construction of potable-water systems are discussed hereunder to provide water-utility personnel with supplementary information and recommendations on the selection and use of these materials. A listing of reference standards and other pertinent publications is included.

B.2 Materials

B.2.1 General. The AWWA Standard ___?___ covers PVC pipe, tubing and fittings made from a number of different PVC extrusion and molding compounds. The specific compounds covered have been designed particularly for the manufacture of PVC piping products with properties generally necessary for long-term, dependable service in pressure systems. These compounds (even many of like classification) are made by different manufacturers.

B.2.2 Classification and Identification of PVC Compounds

1. PVC compounds are classified in accordance with certain mechanical-property and chemical-resistance requirements given in the ASTM Specification D1784. The pipe compounds are further distinguished by hydrostatic-strength ratings. Until recently, the various compounds belonging to the PVC family of base resins were designated as different types and grades of PVC compounds; for example, PVC Type I Grade 2 or PVC Type IV Grade 1, the latter being a chlorinated poly(vinyl chloride) (CPVC) material. These compounds are now identified on the basis of an ordered

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sequence of class numbers and suffix, such as Class 12454-B, according to a new ASTM classification system which provides a better means for material segregation and distinguishment. The order in which the digits of the class number are written corresponds to a particular order of classification factors. The first digit of the class number defines the particular base resin used to make the compound; for example, PVC or CPVC. The digits that follow designate conformance of that particular material with certain minimum property requirements, and the suffix letter further defines the material according to certain chemical-resistance requirements.

2. The ASTM and CSA standards applicable to the PVC pipe, tubing and fitting products have not been revised as yet to reflect the new identification system for PVC compounds. Therefore the PVC compounds covered by the AWWA standard are identified therein according to both the old and the new system of identification to assure proper correlation.

3. PVC compounds and the piping products made from them are commonly referred to and identified by abbreviated designations. This identification system is known as the Standard Thermoplastic Pipe Materials Designation Code. Three symbols are used to identify the materials according to the code system. The first is the abbreviation PVC for the chemical kind of plastic as given in ASTM D1600. The second is the type and grade of PVC pipe material as distinguished by properties in accordance with the old ASTM classification system for PVC compounds. The third symbol is the commercial hydrostatic-design-stress rating (long-term hydrostatic strength divided by a service factor of 2.0) of the PVC material in psi for water at 73° F divided by 100 with any decimals dropped. For example, the code designation "PVC 1120" identifies the plastic as a Poly(Vinyl Chloride), Type I Grade 1 pipe material with a hydrostatic-design-stress rating of 2,000 psi for water at 73°F. It should be noted that the commercial hydrostatic-design-stress ratings of PVC pipe and tubing are not the

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same as those determined in accordance with the AWWA standard because the service factors (factors of safety) used are different.

B.2.3 Pipe, Tubing and Fittings

1. The AWWA standard covers certain nominal sizes of different SDR (standard-dimension-ratio) series and of different schedules of PVC pipe, tubing and fittings manufactured in compliance with requirements prescribed in the standard and with applicable requirements of referenced ASTM or CSA product specifications.

2. It should be noted that the AWWA standard does not cover any piping products for which there are no product specifications prescribed or referenced in the document. The inclusion of joining or other requirements for particular products does not necessarily mean that the products themselves are covered by the standard. Use provisions for non-covered products are prescribed in Subsection 7.1.14 of the standard.

3. The SDR system of pipe sizing was developed by the plastics industry to simplify selection of different nominal sizes of pipe with equal pressure rating (pressure class). In each particular SDR series, all nominal sizes of PVC pipe or tubing will have the same AWWA pressure-class rating whenever all sizes are made from the same class of PVC compound, or from different PVC compounds with equal hydrostatic-strength ratings, provided the pressure class of all sizes is determined by use of the same factor of safety. The reason being that each particular SDR series of sizes has been designed to provide a common ratio (constant) of diameter to wall-thickness for all nominal sizes of pipe in that series. A different constant applies to each of the SDR series of pipe sizes, and its numerical value defines the SDR series. For example, consider 2 inch PVC pipe of the SDR-21 series with dimensions prescribed in Section 3 of the AWWA standard. The number "21" of the SDR-21 designation is the constant for this series of pipe sizes, and it is the approximate value obtained by dividing the outside diameter of 2 inch pipe (2.375 in.) by its prescribed minimum wall-thickness (0.113 in.). Similar computations for all other SDR-21 pipe sizes will yield the same approximate value of "21".

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4. The numbers used to designate the different SDR series of nominal pipe sizes are the American National Standards Institute (ANSI) Preferred Number Series 10 modified by +1 or -1. If the dimension ratio is based on outside diameter (OD), the modifier is +1. If it is based on inside diameter (ID), the modifier is -1. Some of the numbers are as follows:

ANSI Preferred Number Series 10	OD Control	ID Control
10.	11.	9.
12.5	13.5	11.5
16.	17.	15.
20.	21.	19.
25.	26.	24.
31.5	32.5	30.5
40.	41.	39.

5. The "schedule" system of pipe sizing does not provide a common ratio of diameter to wall-thickness for the nominal sizes of pipe in any of the different schedules of sizes. Therefore, the AWWA pressure-class ratings of the various nominal sizes of PVC pipe conforming to Schedule 40, 80 or 120 dimensions will not be the same under any conditions.

B.3 Engineering

B.3.1 Design Requirements and Recommendations

1. The AWWA standard specifies that the pressure class of PVC pipe and tubing selected for any given potable-water-system application must not be less than the design pressure of that system. This specification relates to certain pressure classes and design pressures as defined in Subsection 1.2 of the standard.

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2. The AWWA pressure-class ratings for the various specific kinds and sizes of PVC pipe and tubing covered by the standard are not necessarily the same as any other pressure-class designations which may have been used before. They are simply AWWA prescribed pressure ratings for the materials which have been determined by use of the equation given in Subsection 7.1.2 of the AWWA standard and by application of the AWWA prescribed factor of safety to the long-term, hydrostatic-strength ratings of the PVC pressure-piping materials.

3. Maximum static-pressure or operating pressure of the system, as defined in the AWWA standard and whichever is the pressure of greatest intensity, must be considered as the required minimum design-pressure of the PVC water-piping system. If maximum static pressure is used as the base for design pressure and if transient pressures are expected during operation of a magnitude that will cause system pressures in excess of maximum static pressure, then the design pressure for such PVC piping systems must be the sum of the maximum static pressure plus an allowance for transient pressures. Operating pressure is considered as a pressure which includes transient pressures experienced under system-operating conditions. In all applications, however, the pressure-class requirement for PVC pipe and tubing used does apply to the design pressure established for the intended PVC piping system even though it may be greater than both maximum static pressure and normal operating pressure.

4. The factor of safety prescribed in the AWWA standard includes a safety allowance for transient pressures in PVC water-piping systems of a magnitude not exceeding 20 percent of the maximum static pressure of the particular systems. Therefore the AWWA pressure-class ratings for PVC pipe and tubing do provide a built-in allowance for transient pressures, but this allowance is not intended to provide for transient pressures that may normally be anticipated

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in water-system operations. The built-in allowance should be considered only as a safety provision for unexpected transient pressures, and then only as a safety allowance that is adequate for systems wherein water-flow velocities will not significantly exceed 5 fps. It should be noted that the magnitude of transient pressure developed in plastic piping will be a great deal less than that developed in metal piping when pipe-size dimensions and causative conditions are the same. This is due to the relatively low elastic modulus of the plastic-piping materials.

5. Excessive transient-pressures should be prevented by system-design provisions that will permit water velocities in mains to be limited to preferably 2 to 3 fps but not more than 5 fps, that will provide the means for slow and gradual change in water-flow velocity during the operation of system valves and pumps, and that include the installation of any necessary surge-control and surge-suppression devices in the piping system.

6. Other matters of a general nature which should be considered also in the planning and the design of PVC water-piping systems are listed hereunder:

a. Operating temperature of the piping system.

b. Pressure class of PVC materials as related to operating temperature.

c. Qualified materials and methods for making PVC piping joints, and for making plastic-to-metal transition connections.

d. Construction conditions and standard practices as related to the use of PVC materials.

e. Installation requirements and recommendations of the AWWA standard.

f. Provisions of the AWWA standard applicable to installation records and system maintenance.

g. In special cases, resistance of the PVC materials to chemically-contaminated environments.

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unusual or high temperature service conditions are involved, it is advisable to obtain special use recommendations from the PVC manufacturers.

B.4.2 Temperature. The strength of all PVC materials is temperature dependent. Their mechanical strength and pressure-class rating decreases as their temperature increases. Within the normal range of water-system operating temperatures, the PVC materials exhibit the following general characteristics:

1. Increases in temperature tend to decrease the tensile, flexural and compressive strength of the materials; and to increase their ductility and impact resistance.

2. Decreases in temperature tend to increase their tensile, flexural and compressive strength; and to decrease their ductility and impact resistance.

B.4.3 Hydrostatic Strength and Pressure Class

1. The hydrostatic-strength ratings of the PVC materials covered by the AWWA standard range from 2,000 psi to 4,000 psi for water service at 73°F. The ratings have been determined individually for use of the materials at that particular operating temperature, or at lower operating temperatures, but they are not applicable for use of the materials at higher operating temperatures. Hydrostatic-strength ratings of the materials for service at 100°F, for example, have to be determined on an individual basis as well; and they will be significantly less than the ratings for use of the materials at 73°F. The procedure used to estimate the long-term, hydrostatic strength of thermoplastic-piping materials is essentially an extrapolation with respect to time of data obtained by tests made in accordance with the ASTM Method D1598, Time-To-Failure of Plastic Pipe Under Long-Term Hydrostatic Pressure. Related references are ASTM D2837 and PPI Technical Report TR-2.

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2. The AWWA pressure class of any specific kind and size of PVC pipe or tubing for water service at 73°F, or for water service at any other given higher-operating temperature, may be calculated by use of its allowable long-term, hydrostatic-strength rating for the particular use temperature in the equation given in Subsection 7.1.2 of the AWWA standard. The allowable long-term, hydrostatic strengths of the various PVC materials for water at 73°F are tabulated in Subsection 2.2.1 of the standard. Hydrostatic-strength ratings for use of the PVC materials at higher-operating temperatures may be obtained from the Plastics Pipe Institute (PPI) or the PVC manufacturers, but only ratings that are recommended by PPI should be used.

3. Pressure class is a function of and varies directly with hydrostatic-strength rating. It is for such reason that pipe made from a 2,000 psi, hydrostatic-strength-rated PVC compound will have, for example, a lower pressure-class rating than pipe of like dimensions made from a 4,000 psi, hydrostatic-strength-rated PVC compound when the same factor of safety is used; and that pipe of like nominal size and pressure-class rating will have different wall-thicknesses when they are made from PVC compounds with different hydrostatic-strength ratings for the same use temperature. The pressure-class ratings of PVC materials for service at operating temperatures above 73°F are lower, 20 percent or less at 100°F for example, but not to the same degree for all materials because some resist heat better than others.

B.4.4 Heat Resistance. This property varies among the different PVC materials. As mentioned before, some are more heat resistant than others; particularly, the CPVC (PVC 4120) materials. This difference in heat resistance is not usually a design factor in underground, water-piping applications. However, when PVC piping will unavoidably be exposed to heat sources such as hot-water or steam lines or when it is to be used for conveyance of hot water, special design data and use recommendations should be obtained from the manufacturers.

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B.4.5 Thermal Expansion and Contraction

1. The expansion and contraction characteristics of PVC materials due to pipe-temperature variations should be considered in system design regardless of which specific PVC material is to be used and particularly so for cased installations. PVC materials have higher coefficients of expansion than metals.

2. Non-restrained change in length due to temperature fluctuations varies among the PVC materials from about 1/3 to 2/3 of an inch per 100 feet of pipe for each 10°F of temperature change. Directly-buried piping is often restrained to a considerable degree by its soil environment. In fact, some soils will seize buried piping well enough to restrict change in length even when it is subjected to large changes in temperature. Cased piping is of more concern because it is free to react to temperature change. In all installations, however, joining materials and methods used must be capable of preventing joint-component separations due to thermal contraction of the PVC piping (B.5.3.5).

3. Due to a lower modulus of elasticity, the forces that develop in confined PVC piping as a result of temperature changes are less than those developed in most metal piping under similar conditions. When restrained, the PVC materials are capable of absorbing stresses developed by temperature change.

B.4.6 Cold Flow

1. When pressure class ratings are observed and when suitable methods of joining and installation are practiced, PVC piping will not cold flow to any significant extent. The cold-flow (creep) characteristic of PVC materials under sustained internal pressure and external loading has been taken into account in the determinations of the long-term, hydrostatic strengths of the materials and of the prescribed AWWA factor of safety.

2. Cold flow should be considered in the selection of mechanically-tightened, compression fittings and other such joining devices which might subject the PVC

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pipe or tubing to high levels of localized stress and which in turn might eventually adversely affect the sealing ability of the joint. In this respect, cold flow may be described as a displacement of material caused by abnormal localized stresses. When such a condition prevails, the material flows only until the stress is reduced to the extent that the material can resist it without further displacement. Cold flow can be experienced with many materials, but it is more likely to occur in plastics.

3. When necessary, design should incorporate provisions for cold flow in applications where the PVC piping will be subjected to excessive earth and traffic loads. External-loading problems may be resolved by specifying more suitable trench backfill and compaction methods, use of stiffer or heavier-wall pipe, or use of casing.

B.4.7 Impact Resistance

1. The impact resistance of the PVC materials covered by the AWWA standard should exceed all normal requirements for underground service. Although the materials exhibit some differences in this property, the differences are difficult to evaluate in terms of construction, installation and service conditions. If impact resistance is of special importance in particular applications, the manufacturer should be consulted. Special products with extremely high-impact resistance can be supplied.

2. The ductility and impact resistance of PVC materials do decrease with temperature. Therefore they should be handled, transported and installed with extra care during extremely cold weather. Extra care should be exercised also in the deflection of PVC piping during low-ambient temperatures to make changes in direction.

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B.4.8 Chemical Resistance. In the design of PVC water-piping systems, chemical resistance is not usually a factor. The PVC pressure-piping materials are not adversely affected by natural soil and water environments; they are not subject to corrosion deterioration; and they exhibit outstanding resistance to inorganic chemicals, and excellent resistance to most organic chemicals. There are differences in their resistance to some chemicals, however, which may be of significance in unusual applications; such as, installation in chemically-contaminated soils.

B.5 Construction

B.5.1 Solvent-Fusion Joints

1. When properly made with quality materials and when adequate time is allowed for cure (set) prior to handling and pressure testing, PVC solvent-fusion joints are as strong as their components. The component-preparation and assembly requirements given in Subsection 4.8.2 of the AWWA standard should be observed. Joints must not be disturbed for a short time immediately after makeup, and they must not be handled or pressure tested until they have cured sufficiently to attain the strength necessary to withstand such stresses.

2. Time requirements for joint cure prior to handling and to pressure testing depend on pipe size, depth of fitting socket, degree of component-engagement interference, ambient temperature and humidity, and on the formulation and viscosity of the solvent-fusion material used. Joint strength is a function of cure time, gradually increasing to a maximum as the joint cures. Less cure time is required for handling than for pressure testing; more cure time must be allowed for high-pressure testing than for low-pressure testing. Tables B.1 and B.2 given below are provided as a guide on cure-time allowances, but only as a guide because of the variable conditions which affect cure time.

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3. The sockets of PVC fittings for small-diameter and thin-wall pipe and tubing are designed to provide an interference fit. When the components are dry and at the same temperature, interference usually occurs when the pipe or tubing is one-third to two-thirds of the way into the fitting socket. Dry-fit tolerances of fittings for large-diameter and thicker-wall PVC pipe are of necessity more liberal to prevent makeup problems with such relatively non-roundable pipe. The ability of pipe to round out when pushed into a tapered socket has to be taken into account in the design of fit tolerances.

4. Good solvent-fusion joints are more difficult to make with excessively-loose and with abnormally-tight components. It should be noted as well that the solvent-fusion technique may not be practical when work is being performed at temperatures significantly below +20°F or when wet-working conditions prevail. Joint-cure time increases as the temperature decreases. During rain and snowfall, the work should be performed under cover. Reliable solvent-fusion joints cannot be made with wet components.

5. The amount of solvent-fusion material required to make a PVC joint depends on pipe size, dry fit of components, formulation and viscosity of the material, and on temperature and humidity conditions during application. Light, thin-bodied materials are generally suitable for interference-fit joints. Heavy-bodied materials are required to join relatively loose-fitting joint components. Under like conditions of cure, joints made with light-bodied, solvent-fusion materials will usually set in considerably less time than those made with heavy-bodied materials. Table B.3 given below is provided as a guide for estimating the quantity of solvent-fusion material required for any given project, but it is advisable to consult with manufacturers on both quantity and viscosity requirements for specific pipe sizes and application conditions.

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6. Tables:

TABLE D.1 Solvent-Fusion Joints

Guide on Cure Time Required Prior to Handling

Minimum Allowances[a]:	30 min. at 60 to 100°F
	60 min. at 40 to 60°F
	2 hrs. at 20 to 40°F
	4 hrs. at 0 to 20°F

[a]Based on temperature factor only.

TABLE D.2 Solvent-Fusion Joints

Guide on Cure Time Required Prior To Pressure Testing[a]

Temperature Range During Cure Period Degrees F	Cure Time as Related To Test Pressure and Pipe Size					
	1/2" to 1 1/4" Pipe		1 1/2" to 3" Pipe		3 1/2" to 8" Pipe	
	Up to 180 psi	Above 180 to 370 psi	Up to 180 psi	Above 180 to 315 psi	Up to 180 psi	Above 180 to 315 psi
60 to 100	1 hr.	6 hr.	2 hr.	12 hr.	6 hr.	24 hr.
40 to 60	2 hr.	12 hr.	4 hr.	24 hr.	12 hr.	48 hr.
10 to 40	8 hr.	48 hr.	16 hr.	96 hr.	48 hr.	8 days

[a]Cure time requirements based on only ambient temperature, pipe size, and required test pressure.

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TABLE B.3 Solvent-Fusion Joints

Guide for Estimating Solvent-Fusion Material Requirements

Nominal Size, Pipe or Tubing, in.	Minimum Quantity, Solvent-Fusion Material
1/2 and 3/4	1/4 pint per 30 joints
1	1/4 pint per 23 joints
1 1/4 and 1 1/2	1/4 pint per 15 joints
2 and 2 1/2	1/2 pint per 15 joints
3	1/2 pint per 12 joints
3 1/2 and 4	1/2 pint per 9 joints
5 and 6	1/2 pint per 6 joints
8	1/2 pint per 4 joints
10 and 12	1 pint per 4 joints

B.5.2 Mechanical Joints

1. The need for use of stiffener inserts with elastomeric-gasket, push-on fittings should be investigated when such fittings are being considered and evaluated for use. When stiffener inserts are not used, the wall-thickness of the PVC pipe or tubing components of such joints must be adequate to withstand the compressive force exerted by the gasket and maintain a permanent watertight seal. If the wall-thickness of the pipe or tubing being considered for use with such fittings will not of itself provide the necessary support, heavier-wall PVC pipe nipples could be used as the joint components to avoid use of stiffener inserts. Consultation with the pipe manufacturer on such matters is advisable.

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2. In Subsection 4.8.5.2 of the AWWA standard, an exception is cited to the requirement for use of stiffener inserts with mechanically-tightened, compression fittings. PVC pipe or tubing qualified for use with such fittings without being internally supported may be used also as pipe nipples to make similar joints in thin-wall PVC pipe and tubing systems.

3. Complete lines of large-diameter PVC fittings are not as yet available. Push-on, gasket-sealed mechanical fittings commonly used to join cast-iron and asbestos-cement pipe are being used also to join large-diameter PVC pipe. If need should occur for use of such fittings with PVC pipe, use should comply with the recommendations of the pipe manufacturer as well as those of the fitting manufacturer.

B.5.3 Installation

1. PVC pipelines may be installed by the "plow-in" technique or by the conventional open-trench method. The plow-in method is particularly suitable for rural-area installations where surface and subsurface obstructions are relatively few. The pipeline is either "pulled-in" or "planted-in" depending on what kind of equipment is used. The plant-in method is best suited for long-line installations, and it is generally the preferred method of plow-in because the PVC piping is subjected to less stress during its installation. The pull-in method is more often used for short-main and service installations. The plow tooth or mole used for such installations should be of suitable size and shape to provide a smooth bore for safe accommodation or passage of the PVC piping without damage to it.

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2. Tracer wire must be installed along with PVC pipelines whenever there is need to provide for future location of the facilities with an electronic pipe-locator. Plastic piping is not electrically conductive. Small-diameter, copper wire is generally used for such purpose. The wire, and all buried splices and connections should be insulated with suitable material to prevent corrosion deterioration of the metal components. To facilitate tracing of the pipeline by direct connection of the signal transmitter to the wire, the tracer circuit should be electrically continuous and terminated at accessible locations such as meter boxes. The wire should be laid above or to one side of the pipeline.

3. PVC piping may be used to replace old water mains and services by the insertion method when reduction in pipe size permits. This replacement method may be particularly useful for renewal of water lines under city streets. Installation by insertion is relatively fast when few lateral connections are involved. The requirements prescribed in Subsections 4.9.19 and 4.9.20 of the AWWA standard should be observed in all PVC insertion work to prevent damage to the material during and after its insertion.

4. Sections of PVC pipelines installed aboveground on bridges or across irrigation canals and creeks should be placed inside of suitable casing (B.5.3.5). If use of casing is not feasible or desired because of some unusual conditions, the manufacturer should be consulted about the possibility of special PVC materials for the application which would meet all pertinent requirements of the AWWA standard.

5. Materials and methods used to assemble PVC piping for installation in casing and to connect cased PVC piping to other more-restrained sections of a piping system should provide joints with adequate strength to resist any contraction force that might develop in the cased PVC piping as a result of a

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subsequent decrease in its temperature. Significant variations in the temperature of cased piping during service may be experienced in some cases, and particularly so when it is an aboveground installation exposed to sunlight and ambient temperatures. During summer construction of aboveground installations especially, the connection of cased PVC piping to underground sections of a system should be made at a time of day when its temperature is comparatively low.

6. When long runs of PVC piping are to be installed underground with pipe temperature significantly different than that at which it will subsequently operate, consideration should be given to means of providing for longitudinal expansion or contraction of the piping after installation as a result of the anticipated change in its temperature, or to means of minimizing pipe-temperature change prior to or during trench backfill. The piping may be laid in the trench with slack to provide for thermal contraction. It may be allowed to warm or cool to subsurface temperature, or to water temperature by filling, before compaction of initial-backfill material. When practical, water flooding on initial-backfill material may help to minimize pipe-temperature change after installation. It is always advisable to connect new piping to existing systems at a time when there will be the least difference between the installation and operating temperatures of the new piping.

7. During extremely cold weather, all trench-installation and backfilling operations should be performed with greater care. Frozen backfill material should be thawed before use. Compaction of backfill should be performed in a manner that will not damage the PVC piping.

B.6 Reference Standards and Other Publications

ASTM American Society For Testing and Materials
1916 Race Street
Philadelphia, Pennsylvania 19103

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ASTM

D618 Conditioning Plastics and Electrical Insulating Materials For Testing

D638 Method of Test for Tensile Properties of Plastics

D695 Method of Test for Compressive Properties of Plastics

D790 Method of Test for Flexural Properties of Plastics

D883 Standard Nomenclature Relating To Plastics

D1180 Method of Test for Bursting Strength of Round Rigid Plastic Tubing

D1598 Method of Test for Time-To-Failure of Plastic Pipe Under Long-Term Hydrostatic Pressure

D1599 Method of Test for Short-Time Rupture Strength of Plastic Pipe, Tubing and Fittings

D1600 Standard Abbreviations of Terms Relating To Plastics

D1784 Specification for rigid Poly (Vinyl Chloride) Compounds and Chlorinated Poly(Vinyl Chloride) Compounds

D1785 Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120

D2122 Method of Determining Dimensions of Thermoplastic Pipe and Fittings

D2152 Method of Test for Quality of Extruded Poly(Vinyl Chloride) Pipe By Acetone Immersion

D2153 Recommended Practice for Calculating Stress In Plastic Pipe Under Internal Pressure

D2241 Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, SDR-PR and Class-T

D2412 Method of Test for External Loading Properties of Plastic Pipe By Parallel-Plate Loading

D2444 Method of Test for Impact Resistance of Thermoplastic Pipe and Fittings By Means of A Tup (Falling Weight)

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ASTM

D2464 Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

D2466 Specification for Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40

D2467 Specification for Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

D2564 Specification for Solvent Cements For Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings

D2672 Specification for Bell-End Poly(Vinyl Chloride) (PVC) Pipe

D2740 Specification for Poly(Vinyl Chloride) (PVC) Plastic Tubing

D2749 Definitions of Terms Relating To Plastic Pipe Fittings

D2774 Recommended Practice for Underground Installation of Thermoplastic Pressure Piping

D2837 Method of Obtaining Hydrostatic Design Basis For Thermoplastic Pipe Materials

D2846 Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot-Water Distribution Systems

D2855 Recommended Practice for Making Solvent-Cemented Joints With Poly(Vinyl Chloride) (PVC) Pipe and Fittings

CSA Canadian Standards Association
178 Rexdale Boulevard
Rexdale, Ontario, Canada

B137.0 Definitions and General Requirements For Thermoplastic Piping

B137.3 Standard for Rigid Poly(Vinyl Chloride) (PVC) Pipe For Pressure Applications; Schedules 40 and 80, SDR-PR B30

ANSI American National Standards Institute, Inc.
1430 Broadway
New York, New York 10018

CAPCO JEN 0020441

ANSI

ANS A21.11 Elastomeric Seals

ANS B2.1 Standard Taper Pipe Threads

DOT-OPS Department of Transportation
Hazardous Materials Regulation Board
Office of Pipeline Safety
Washington, D. C.

Title 49, Docket OPS-3 and Amendments, Part 192: Minimum Federal Safety Standards; Transportation of Natural Gas and Other Gas By Pipeline.

NSF National Sanitation Foundation
2355 West Stadium Boulevard
P. O. Box 1468
Ann Arbor, Michigan 48106

Standard No. 14 - Thermoplastic Materials, Pipe, Fittings, Valves, Traps, and Joining Materials

Annual Listing - Manufacturers of Plastics Materials, Pipe, Fittings, and Appurtenances For Potable Water. (Authorized to use NSF product qualification seal "nsf".)

PPI Plastics Pipe Institute
Division of
The Society of The Plastics Industry, Inc.
250 Park Avenue
New York, New York 10017

Technical Reports:

TR-1 A Glossary of Plastic Piping Terms

TR-2 Recommended Method for Obtaining Hydrostatic Design Basis For Thermoplastic Pipe

CAPCO JEN 0020442

TR-3 Policies and Procedures on Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe

TR-4 Recommended Hydrostatic Strengths and Design Stresses For Thermoplastic Pipe Compounds

TR-5 List of Standards for Plastic Piping

TR-7 Recommended Method for Calculation of Nominal Weight of Plastic Pipe

TR-9 Recommended Standard Service (Design) Factors for Pressure Applications of Thermoplastic Pipe Materials

TR-10 Recommended Practice for Making Solvent-Cemented Joints with PVC Pipe and Fittings

TR-11 Resistance of Thermoplastic Piping Materials to Micro- and Micro-Biological Attack

TR-13 Poly(Vinyl Chloride) (PVC) Plastic Piping Design and Installation

TR-14 Water-Flow Characteristics of Thermoplastic Pipe

CAPCO JEN 0020443