



**American Water Works
Association**

The Authoritative Resource for Safe Drinking WaterSM

ANSI/AWWA C901-02
(Revision of ANSI/AWWA C901-96)

AWWA Standard

Polyethylene (PE) Pressure Pipe and Tubing, $\frac{1}{2}$ in. (13 mm) Through 3 in. (76 mm), for Water Service



Effective date: Jan. 1, 2003.

First edition approved by AWWA Board of Directors June 28, 1978.

This edition approved June 16, 2002.

Approved by American National Standards Institute: Oct. 11, 2002.

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Foreword

This foreword is for information only and is not a part of AWWA C901.

I. Introduction.

I.A. *Background.* This standard describes polyethylene (PE) pressure pipe and tubing for use primarily as service lines in the construction of underground water distribution systems.

This standard describes dimension ratios (DR) and inside dimension ratios (IDR) for pipe and tubing made from PE materials with standard PE code designations PE 2406, PE 3406 and PE 3408 in pressure classes of 80 psi, 100 psi, 125 psi, 160 psi, and 200 psi (559 kPa, 698 kPa, 873 kPa, 1,118 kPa, and 1,397 kPa). Pipe ranging in nominal size from $\frac{1}{2}$ in. (13 mm) through 3 in. (76 mm) conforms to the outside-diameter dimensions of iron pipe sizes (OD-based, IPS pipe) or to the inside-diameter dimensions of iron pipe sizes (ID-based, IPS pipe). Tubing ranging in size from $\frac{1}{2}$ in. (13 mm) through 2 in. (51 mm) conforms to the outside-diameter dimensions of copper tubing.

I.B. *History.* In 1966, the American Water Works Association (AWWA) appointed Committee 8350-D to study and report on the adaptability of plastic pipe for use in the water supply industry. The committee presented its report on June 6, 1967, at the AWWA Annual Conference. The report recommended that a task group be appointed to prepare standards for plastic materials. The AWWA Standards Committee on Thermoplastic Pressure Pipe was established in 1968 as a result of that recommendation.

On Jan. 28, 1978, the first edition of AWWA C901 was approved by the AWWA Board of Directors. On Aug. 9, 1982, a subcommittee of the AWWA Standards Committee on Thermoplastic Pipe was formed to review and revise the standard based on experience and advances in the state of the art since the adoption of the standard. To this end, AWWA conducted two surveys of its members to ascertain their experience with AWWA C901 products. This information was incorporated into the second edition of AWWA C901, approved by the AWWA Board of Directors on Jan. 24, 1988.

In June 1988, the Thermoplastic Pressure Pipe Committee was divided into two committees to accommodate both polyolefin and polyvinyl chloride (PVC) pipe. Thus were formed the Polyvinyl Chloride Pressure Pipe and Fittings Committee and

the Polyolefin Pressure Pipe and Fittings Committee. This edition was approved by the AWWA Board of Directors on June 16, 2002.

I.C. *Acceptance.* In May 1985, the US Environmental Protection Agency (USEPA) entered into a cooperative agreement with a consortium led by NSF International (NSF) to develop voluntary third-party consensus standards and a certification program for all direct and indirect drinking water additives. Other members of the original consortium included the American Water Works Association Research Foundation (AWWARF), and the Conference of State Health and Environmental Managers (COSHEM). The American Water Works Association (AWWA) and the Association of State Drinking Water Administrators (ASDWA) joined later.

In the United States, authority to regulate products for use in, or in contact with, drinking water rests with individual states.* Local agencies may choose to impose requirements more stringent than those required by the state. To evaluate the health effects of products and drinking water additives from such products, state and local agencies may use various references, including

1. An advisory program formerly administered by USEPA, Office of Drinking Water, discontinued on Apr. 7, 1990.
2. Specific policies of the state or local agency.
3. Two standards developed under the direction of NSF, ANSI[†]/NSF[‡] 60, Drinking Water Treatment Chemicals—Health Effects, and ANSI/NSF 61, Drinking Water System Components—Health Effects.
4. Other references, including AWWA standards, *Food Chemicals Codex*, *Water Chemicals Codex*,[§] and other standards considered appropriate by the state or local agency.

Various certification organizations may be involved in certifying products in accordance with ANSI/NSF 61. Individual states or local agencies have authority to

*Persons in Canada, Mexico, and non-North American countries should contact the appropriate authority having jurisdiction.

†American National Standards Institute, 25 W. 43rd St., Fourth Floor, New York, NY 10036-7406.

‡NSF International, 789 N. Dixboro Road, Ann Arbor, MI 48105-9723.

§Both publications available from National Academy of Sciences, 2102 Constitution Ave. N.W., Washington, DC 20418.

accept or accredit certification organizations within their jurisdiction. Accreditation of certification organizations may vary from jurisdiction to jurisdiction.

Annex A, “Toxicology Review and Evaluation Procedures,” to ANSI/NSF 61 does not stipulate a maximum allowable level (MAL) of a contaminant for substances not regulated by a USEPA final maximum contaminant level (MCL). The MALs of an unspecified list of “unregulated contaminants” are based on toxicity testing guidelines (noncarcinogens) and risk characterization methodology (carcinogens). Use of Annex A procedures may not always be identical, depending on the certifier.

ANSI/AWWA C901-02 does not address additives requirements. Thus, users of this standard should consult the appropriate state or local agency having jurisdiction in order to

1. Determine additives requirements, including applicable standards.
2. Determine the status of certifications by all parties offering to certify products for contact with, or treatment of, drinking water.
3. Determine current information on product certification.

II. Special Issues. The material presented in the foreword under Sec. II was attached to a previous edition of this standard as Appendix A, AWWA Guideline Criteria for Design and Installation of PE Water Pipe and Tubing in Sizes $\frac{1}{2}$ in. Through 3 in. These subjects are being addressed in a new AWWA Manual on Design and Installation of Polyethylene Pipe currently under development. The information has been republished here to ensure that the information is continuously available to users of this standard. After publication of the new AWWA manual, it is expected that these sections will be removed from the foreword of this standard.

II.A. *Pipe Selection.*

II.A.1. Selection of pressure class. A minimum pressure class of 160 psi (1,118 kPa) is recommended for general durability in handling and for use in typical AWWA water service installations. Lesser pressure classes may be appropriate for specific applications, but selection should be based on a detailed evaluation of factors, such as installation configuration (Sec. II.D.3), fitting type, joining methods, use of coiled or straight products, and potential for significant surge pressure.

The minimum pressure class of the pipe or tubing selected should be equal to or greater than the system working pressure. The sum of the system working pressure and surge pressure should not exceed 1.5 times the pressure class of the pipe or tubing. If surge pressures govern the selection of the pressure class, consideration

should be given to removal of the cause of surge pressures or to the incorporation of surge suppressors in the system.

II.A.2. Calculation of surge pressure. Surge pressure generated by velocity changes in a PE service line may be estimated using the formulas provided in this section. In addition, surges occurring either upstream in the mains or downstream in a user's plumbing system should be considered for their effect on the service line. The magnitude of surge pressures in mains made of material other than PE may be estimated using equations similar to those given here for PE pipe. Surge, or water hammer, problems are complex; their solution requires specialized knowledge.

The wave velocity and surge pressure that result from abrupt changes in the velocity of a column of water moving through a restrained pipe of uniform material and dimensions may be calculated using the following formulas:

$$a = \frac{A_1}{\left[1 + \frac{K(DR-2)}{E}\right]^{1/2}} = \frac{A_1}{\left[1 + \frac{K(IDR)}{E}\right]^{1/2}} \quad (\text{Eq F.1})$$

$$P_s = \frac{aV}{A_2} \quad (\text{Eq F.2})$$

Where:

- a = wave velocity, in ft/sec (m/sec)
- A_1 = 4,675 (1,433 for metric units)
- A_2 = 2.31 g for in.-lb units (1.0 for metric units)
- g = gravitational acceleration = 32.2 ft/sec² (9.81 m/s²)
- K = bulk modulus of water = 294,000 lb/in.² (2,053.5 MPa)
- R = dimension ratio, outside-diameter basis (Sec. 3(3))
- E = modulus of elasticity of pipe material, in psi (MPa)
 E varies by material used, as follows:
 - For PE 2406, E = 80,000 psi (559 MPa)
 - For PE 3406, E = 115,000 psi (803 MPa)
 - For PE 3408, E = 115,000 psi (803 MPa)
- DR = dimension ratio of pipe, inside-diameter basis (Sec. 3(6))

P_s = surge pressure, in psi, kPa gauge

V = velocity change, in ft/sec (m/sec), occurring within the critical time $2L/a$

Where:

L = pipe length, in ft (m)

Table F.1 shows surge pressures resulting from an instantaneous change in velocity of 1 ft/sec (0.3048 m/sec), as calculated from the earlier equations. The anticipated surge pressure and the instantaneous change in velocity are directly related; therefore, the surge resulting from higher velocity changes is a multiple of the values given in this table (i.e., the surge anticipated at a flow rate of 5 ft/sec (1.524 m/sec) is five times the value at 1 ft/sec (0.3048 m/sec).

II.A.3. Temperature effects. The pressure classes of pipe and tubing in ANSI/AWWA C901 are based on water temperatures of 73.4°F (23°C). Polyethylene piping intended for use where service temperatures may exceed this value for prolonged periods should have a hydrostatic design basis (HDB) established in accordance with ASTM D2837 for the specified (or higher) temperature. An elevated temperature HDB value can be obtained from the pipe manufacturer for the specific polyethylene resin being used. An elevated temperature pressure class can then be calculated using either Eq F.1 or Eq F.2 (Sec. 3[9]) with the elevated temperature HDB used as the value for HDB in the equations. An alternative method of establishing an elevated temperature pressure class (PC) for temperatures between those for which HDB values have been determined is to multiply the 73.4°F (23°C) PC value by an interpolated temperature compensation factor recommended by the pipe manufacturer.

Table F.1 Calculated surge pressures for an instantaneous change in velocity of 1 ft/sec (0.3048 m/sec) in PE pipe or tubing

Dimension Ratios		Surge Pressures	
OD-Based (DR)	ID-Based (IDR)	<i>psi</i>	<i>kPa</i>
21.0	19.0	8.9	62.0
17.0	15.0	10.0	69.6
13.5	11.5	11.4	79.2
11.0	9.0	12.8	89.1
9.0	7.0	14.5	100.5
7.3	5.3	16.5	114.5

II.B. *Design criteria.*

II.B.1. Hydrostatic design basis. Hydrostatic design basis values for a temperature of 73.4°F (23°C) for the materials covered in this standard are given in Table F.2 and are published in PPI* TR-4.

II.B.2. Hydrostatic design stress. For PE materials covered by this standard, the values of the hydrostatic design stresses (HDB multiplied by the design factor, which is 0.5 in this standard) are given in Table F.2. These values are for service temperatures of 73.4°F (23°C) and should be modified for higher service temperatures (see Sec. II.A.3).

II.B.3. Design factor. Because the strength of PE materials depends on the duration of application of loading, the effective safety factor that corresponds to a design factor of 0.5 will vary with actual end-use conditions. For the PE materials described in this standard, the effective safety factor under hydrostatic pressure ranges from at least 3 for short-term loading to approximately 2 for long-term (100,000 hr) sustained loading at the maximum recommended system working pressure and service temperature. The design factor is also intended to account for unknown local effects, such as ovaling and longitudinal bending, that occur in properly installed buried pipe.

II.C. *External Loads.*

II.C.1. Earth loads. For properly installed small-diameter conduit, the effects of distributed earth loads can usually be disregarded.

Table F.2 Hydrostatic design basis and hydrostatic design stress for PE pipe and tubing

Standard PE Code	Hydrostatic Design Basis at 73.4°F (23°C)		Hydrostatic Design Stress at 73.4°F (23°C)	
	<i>psi</i>	<i>kPa</i>	<i>psi</i>	<i>kPa</i>
PE 2406	1,250	8,618	630	4,344
PE 3406	1,250	8,618	630	4,344
PE 3408	1,600	11,032	800	5,516

*Plastics Pipe Institute, 1825 Connecticut Ave., N.W., Suite 680, Washington, DC 20009-5724.