



**American Water Works
Association**

The Authoritative Resource for Safe Drinking WaterSM

ANSI/AWWA C401-03
(Revision of ANSI/AWWA C401-93[R98])

AWWA Standard

The Selection of Asbestos–Cement Pressure Pipe, 4 in. Through 16 in. (100 mm Through 400 mm), for Water Distribution Systems



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Foreword

This foreword is for information only and is not a part of AWWA C401.

I. Introduction.

I.A. *Background.* In 1958 AWWA reactivated its Standards Committee on Asbestos–Cement Pipe, redesignating it as Committee 8340D on Asbestos–Cement Water Pipe. The committee was assigned the task of developing a new document to guide the user in the class selection and installation requirements for asbestos–cement pipe.

I.B. *History.* The standards committee developed AWWA Handbook H2, Standard Practice for the Selection of Asbestos–Cement Water Pipe, which was published in 1964. This handbook covered pipe sizes 4 in. (100 mm) through 36 in. (900 mm). Later in that same year, the standard was redesignated AWWA C401-64 and published under the same title. Subsequent editions of the standard included AWWA C401-77, Standard Practice for the Selection of Asbestos–Cement Distribution Pipe, 4 In. Through 16 In., for Water and Other Liquids; and AWWA C401-83, Standard Practice for the Selection of Asbestos–Cement Distribution Pipe, 4 In. Through 16 In. (100 mm Through 400 mm), for Water and Other Liquids. The 1983 edition was reaffirmed without revision in 1986. The standard was revised again in 1993 and reaffirmed without revision in 1998. This edition was approved by the AWWA Board of Directors on June 19, 2003.

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 consortium included the American Water Works Association Research Foundation (AWWARF), 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

*Persons outside the US should contact the appropriate authority having jurisdiction.

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 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.

AWWA C401 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.

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

†NSF International, 789 N. Dixboro Rd., Ann Arbor, MI 48105.

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

II. Special Issues.

II.A. *General.* The purpose of this standard is to provide guidance in the selection of asbestos–cement pressure pipe, manufactured in accordance with ANSI/ AWWA C400 and installed in accordance with ANSI/AWWA C603. In addition to the physical strength parameters addressed in the standard, it is recommended that the user collect site-specific data on water chemistry both for the internal water to be carried by the pipe and external groundwater conditions, and the chemistry of the soil in which the pipe is to be installed. Criteria for various water and soil chemistry parameters that affect asbestos–cement pipe are discussed.

The AWWA handbook *Work Practices for Asbestos–Cement Pipe* (1995) was developed to assist in the compliance with US federal asbestos workplace standards when shipping, receiving, handling, and assembling asbestos–cement pipe. These recommended work practices were designed to achieve safe jobsite conditions when working with asbestos–cement pipe.

III. **Use of This Standard.** It is the responsibility of the user of an AWWA standard to determine that the products described in that standard are suitable for use in the particular application being considered.

III.A. *Purchaser Options and Alternatives.* The following items should be included in the purchaser's specifications:

1. The standard used—that is, ANSI/AWWA C401, Standard for the Selection of Asbestos–Cement Pressure Pipe, 4 In. Through 16 In. (100 mm Through 400 mm), for Water Distribution Systems, of latest revision.

III.B. *Modification to Standard.* Any modification of the provisions, definitions, or terminology in this standard must be provided in the purchaser's specifications.

IV. **Major Revisions.** Major changes made to the standard include the following:

1. The format has been changed to reflect current AWWA standard style.
2. Information on determining the type of pipe to be used under various soil and water conditions has been moved from Section II of the foreword to the body of the standard (Sec. 4.8). The scope of the standard has been updated to reflect this change (Sec. 1.1). Withdrawn Sept. 23, 2008

3. Class C bedding with shaped bottom and Class D bedding have been removed, so as to show only the recommended bedding conditions (Sec. 4.4.1 and Figure 1).

V. Comments. If you have any comments or questions about this standard, please call the AWWA Volunteer and Technical Support Group, 303.794.7711, FAX 303.795.7603, or write to the group at 6666 West Quincy Avenue, Denver, CO 80235-3098, or by e-mail at standards@awwa.org.

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AWWA Standard

**The Selection of Asbestos–Cement
Pressure Pipe, 4 in. Through 16 in.
(100 mm Through 400 mm), for Water
Distribution Systems**

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard has been prepared so that the user may quickly determine the correct pressure classification of asbestos–cement pressure pipe to use under various combinations of internal pressure (working and surge) and external load (earth and superimposed live loads) in water distribution systems. Combined loading curves depicting the relationship between internal pressure and external load capabilities are included to expedite the selection of pipe class, which is defined in ANSI/AWWA C400. This standard also presents criteria for determining the type of pipe to be used under various soil and water conditions.

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NOTE: Appendix A contains a friction loss of head chart based on the Hazen–Williams formula. Appendix B is a discussion of entrapped air.

Sec. 1.2 Purpose

The purpose of this standard is to provide purchasers, manufacturers, and constructors with the minimum requirements for selecting asbestos–cement pressure pipe, 4 in. through 16 in. (100 mm through 400 mm) for water distribution systems, including design, design criteria, and loads.

Sec. 1.3 Application

This standard can be referenced in specifications for purchasing and receiving asbestos–cement pressure pipe, 4 in. through 16 in. (100 mm through 400 mm). This standard can be used as a guide for selecting this type of pipe. The stipulations of this standard apply when this document has been referenced and then only to asbestos–cement pressure pipe, 4 in. through 16 in. (100 mm through 400 mm).

SECTION 2: REFERENCES

This standard references the following documents. In their latest editions, they form a part of this standard to the extent specified herein. In any case of conflict, the requirements of this standard shall prevail.

ANSI* /AWWA C400—Asbestos–Cement Pressure Pipe, 4 In. Through 16 In. (100 mm Through 400 mm), for Water Distribution Systems.

ANSI/AWWA C403—The Selection of Asbestos–Cement Transmission Pipe, Sizes 18 In. Through 42 In. (450 mm Through 1,050 mm), for Water Supply Service.

ANSI/AWWA C603—Installation of Asbestos–Cement Pressure Pipe.

ASTM[†] C500—Standard Test Methods for Asbestos–Cement Pipe.

ASTM D698—Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ [(600 kN-m/m³)]).

ASTM D4253—Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

ASTM D4254—Standard Test Methods for Minimum Index Density of Soils and Calculation of Relative Density.

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

†American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 19428.

AASHTO* T-99—Standard Methods of Test for the Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49-kg) Rammer and 12-in. (304.8-mm) Drop.

Design and Construction of Sanitary and Storm Sewers. 1976. Manual of Engineering Practice No. 37. American Society Civil Engineers, New York.

Kerr, S.L. 1948. Practical Aspects of Water Hammer. *Jour. AWWA*, 40(6):699.

Marston, A. 1930. *The Theory of External Loads on Closed Conduits in the Light of Latest Experiments.* Bull. 96. Iowa State College Engineering Experiment Station.

Schlick, W.J. 1940. *Supporting Strengths for Cast-Iron Pipe for Water and Gas Service.* Bull. 146. Iowa State College Engineering Experiment Station.

SECTION 3: SYMBOLS, ABBREVIATIONS, AND DEFINITIONS

The following definitions, symbols, and abbreviations shall apply in this standard:

B_c = outside diameter of a pipe, in feet (meters).

B_d = width of trench measured at the top of pipe, in feet (meters).

BF = bedding factor, which is a load factor correlating three-edge V-shaped bearing test loads to field loads associated with specific bedding conditions.

B_T = maximum width of a tunnel excavation, in feet (meters).

c = coefficient of soil cohesion, in pounds per square foot (kilonewtons per square meter).

C = load coefficient dependent on construction conditions in Marston's equation.

C_c = load coefficient for the positive projecting embankment condition. It is a function of the ratio H/B_c , the projection ratio p , and the settlement ratio r_{sd} .

C_d = load coefficient for the trench condition. It is a function of the ratio H/B_d and the backfill material.

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*NOTE: AASHTO is American Association of State Highway and Transportation Officials.

C_n = load coefficient for the negative projecting embankment condition, as well as the imperfect ditch condition. It is a function of the ratio H/B_d , the projection ratio p' , and the settlement ratio r_{sd} .

C_s = load coefficient for concentrated or distributed superimposed loads. It is a function of the ratio $B_c/2H$ and the ratio $L/2H$ for concentrated loads, or the ratio $D/2H$ and the ratio $M/2H$ for distributed loads.

C_T = load coefficient for tunnel conditions. It is a function of the ratio H/B_T and the type of soil surrounding the tunnel.

d = inside diameter of a pipe, in feet (meters).

D = width of the area over which the distributed superimposed load acts, in feet (meters).

F = impact factor.

H = depth of cover, in feet (meters), for all conditions except the tunnel condition. For the tunnel condition, H is the distance from the ground surface to the top of the tunnel excavation, in feet (meters).

k = Rankine's ratio of lateral earth pressure to vertical pressure.

L = effective length of the pipe, in feet (meters). For pipe less than 3 ft (1 m), the actual length of the section should be used. For all other lengths, an effective length of 3 ft (1 m) should be used.

M = length of the area over which the distributed superimposed load acts, in feet (meters).

P = internal pressure, in pounds per square inch (kilopascals), that the pipe will withstand when no external load exists.

P_c = concentrated load, in pounds (kilonewtons*).

P_d = distributed load, in pounds per square foot (kilonewtons per square meter*).

P_o = static or operating pressure, whichever is the maximum anticipated operating pressure in pounds per square inch (kilopascals).

P_s = surge pressure or water hammer pressure change due to a sudden velocity change, in pounds per square inch (kilopascals).

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* P_c and P_d are loads measured as a mass. However, to use them in equations using SI units, the mass unit must be converted to force by multiplying by 9.807 (g , the acceleration of gravity).

- P_T = total internal pressure, in pounds per square inch (kilopascals), above which, in combination with some external load W_T applied in three-edge V-shaped bearing, the pipe will withstand.
- p = projection ratio for the positive projecting embankment condition. It is defined as the ratio of the distance that the top of the pipe projects above the original ground surface in feet (meters) to the outside diameter of the pipe in feet (meters). (See Figure 10A.)
- p' = projection ratio for the negative projecting and imperfect ditch condition. It is defined as the ratio of the vertical distance from the original ground surface down to the top of the pipe, in feet (meters), divided by the width of the trench, in feet (meters), for negative projection, and as the ratio of the vertical distance from the top of the excavated trench down to the top of the pipe, in feet (meters), divided by the diameter of the pipe, in feet (meters), for the imperfect ditch condition. (See Figure 10B and Figure 11.)
- r_{sd} = settlement ratio for positive projection, negative projection, and imperfect ditch conditions.
- RSA = ratio of the area of steel to the area at the pipe invert for reinforced concrete cradle or the area at the crown of the pipe for the concrete arch.
- SF = safety factor.
- μ = the coefficient of internal friction of backfill material.
- μ' = the coefficient of friction between backfill material and the trench wall.
- W = external load, in pounds per linear foot (kilonewtons per meter), of pipe in the three-edge V-shaped bearing test that the pipe will withstand when no hydrostatic pressure exists.
- W_E = total earth load, in pounds per linear foot (kilonewtons per meter), to which the pipe is subjected.
- W_S = total superimposed load, in pounds per linear foot (kilonewtons per meter), of pipe transmitted through the burial environment to the pipe by factors other than the earth loads.
- W_{sc} = the concentrated superimposed load, in pounds per linear foot (kilonewtons per meter), of pipe transmitted through the burial environment to the pipe by factors other than the earth loads.
- W_{sd} = distributed superimposed load, in pounds per linear foot (kilonewtons per meter), of pipe transmitted through the burial environment to the pipe by factors other than the earth loads.

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