VOID

AWWA C400–73

Reaffirmation of
AWWA C400–72

AWWA STANDARD

for

ASBESTOS–CEMENT PRESSURE PIPE FOR WATER AND OTHER LIQUIDS

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Foreword

This foreword is for information and is not a part of AWWA C400–73.

I—History of Standard

A new pipe material, consisting of an intimate mixture of portland cement and asbestos fibers, was introduced to the North American market in 1931 following a number of years of usage in other countries, particularly Italy. In the ensuing years, this type of pipe gained in popularity, and in 1949 the AWWA established a Committee on Standard Specifications for Asbestos–Cement Pipe under the chairmanship of S. M. Clarke of Greeley and Hanson, Chicago, Ill. This committee developed a "Standard for Asbestos–Cement Water Pipe," which was approved by the AWWA Board of Directors as a tentative standard, AWWA C400–53T, on May 15, 1953.

In 1958, the committee was reactivated as Committee 8340D on Asbestos-Cement Pipe under the chairmanship of Roy H. Ritter, Whitman, Requardt & Associates, Baltimore, Md., to review a number of suggested changes and to recommend revisions to the standard. The revised standard was adopted by AWWA as C400–64T on Jan. 27, 1964; it was advanced to "Standard" without revision on Jul. 2, 1965.

Early in 1968, the committee was reactivated as the Standards Committee on Asbestos–Cement Pipe to review and revise all of the AWWA standards on asbestos-cement pipe. The 1972 edition of the standard was the result of that committee's work.

In the winter of 1972–1973, the committee was reorganized and enlarged to include representation of national organizations having an interest in the scope of the committee and wishing to participate in the work. The reorganized committee reaffirmed C400–72 without revision so that it could be presented to the American National Standards Institute for designation as an American National Standard.

II—Information Regarding Use of This Standard

Flexural load tests are required (Sec. 2.2.1 and Sec. 5.2.3) for pipe sizes of 4, 6, and 8 in. to insure that the flexural strength in these sizes will be adequate to meet guaranteed loadings. In these sizes, the flexural stresses imposed by beam loads on the buried pipe rather than the crush stresses are controlling factors. In the 10-in. and larger diameters, the wall thicknesses increase to a point at which the flexural strength is not a controlling factor, and therefore routine testing is not required.

To assist the purchaser in choosing the type of pipe most suitable for his use, the following brief descriptions of Types I and II may be considered: *Type I*—for use where contact with aggressive waters and/or soils with a sulfate content is not expected; *Type II*—for use where contact with aggressive waters and/or soils with sulfate content is expected to occur.

Under the conditions of installation and operation in many water distribution systems, the pipe may be used at operating pressures equal to the class designations. However, the purchaser

should determine for himself, from AWWA C401 (formerly AWWA H2), "Standard Practice for the Selection of Asbestos–Cement Water Pipe," the proper class of pipe to be used under the installation and operating conditions that will exist on the project on which the pipe is to be used. He should also refer to AWWA C603, "Installation of Asbestos–Cement Water Pipe," for instruction in laying pipe.

When purchasing pipe to comply with the requirements of this standard, the purchaser shall provide specific information in his supplementary specifications regarding the following:

1. The standard used, that is, AWWA C400–73.
2. Affidavit of compliance (Sec. 1.3) if required.
3. Type of pipe to be furnished (Sec. 1.1 and 2.3, and second paragraph in Sec. II).
4. Class of pipe (Sec. 3.1 and third paragraph in Sec. II).
5. Nominal inside diameter (Sec. 3.2).
6. Lineal feet to be furnished in standard and random lengths (Sec. 3.3).
7. Number, size, class, lengths, and extent of machining of special short lengths (Sec. 3.3.3).
8. Whether inspection by the purchaser (Sec. 5.1) and special marking (Sec. 6.1.4) are required.

III—Major Revisions

This edition is a reaffirmation without revision of the 1972 edition, except for minor editorial changes. Therefore, the date has been changed from 1972 to 1973, and the few portions of this foreword affected by the reaffirmation and change of date have been restated as needed.

The major revisions of the 1972 edition included the following:

1. The test for uncombined calcium hydroxide was made a requirement of the standard. This test was previously included in the appendix as information for possible use by the purchaser.
2. To assist the purchaser in selecting pipe best suited to the environmental conditions in his system, two types of asbestos–cement pipe are specified as regards their content of uncombined calcium hydroxide.

AWWA C400-73

Reaffirmation of
AWWA C400-72

AWWA Standard for

Asbestos-Cement Pressure Pipe for Water and Other Liquids

Section 1—General

Sec. 1.1—Scope

This standard covers three pressure classes of Type I and Type II asbestos-cement pipe, 4 in.–36 in. in diameter, for water and other liquids, to be laid underground in public and private rights-of-way.

The pressure class designations of Class 100, Class 150, and Class 200 are the same as those used in AWWA C401 (formerly AWWA H2), "Standard Practice for the Selection of Asbestos-Cement Water Pipe."

Sec. 1.2—Definitions

Under this standard, the following definitions shall apply:

1.2.1—*Purchaser.* The person, firm, corporation, or government agency entering into a contract or agreement to purchase pipe according to this standard.

1.2.2—*Manufacturer.* The person, firm, or corporation that manufactures the pipe.

1.2.3—*Inspector.* The authorized representative of the purchaser, entrusted with the duty of inspecting pipe produced and tests performed under this standard.

1.2.4—*Inspection.* Inspection of the pipe and the tests by the inspector.

1.2.5—*Operating pressure.* The maximum hydrostatic pressure to which the pipe will be subjected in normal operation after installation, exclusive of allowance for water hammer.

1.2.6—*Lot.* Pipe of the same size, class, and type manufactured during a shift.

Sec. 1.3—Affidavit of Compliance

The purchaser's supplemental specifications may require an affidavit of compliance from the manufacturer, whether factory inspection has been required or not, to the effect that the materials furnished under the purchaser's order comply with all applicable requirements of this standard.

Section 2—Physical and Chemical Requirements

Sec. 2.1—Composition

Asbestos-cement pipe shall be composed of an intimate mixture of portland cement, or portland blast furnace slag cement, and asbestos fiber with or without silica; or portland pozzolana

cement and asbestos fiber, with or without the addition of curing agents. The mixture shall be free from organic additives and the pipe shall be formed under pressure and cured.

Sec. 2.2—Physical Requirements

2.2.1—*Flexural strength.* Each length of 4-in., 6-in., and 8-in. pipe tested in flexure by the procedure specified in this standard shall, except as otherwise provided, support the load indicated in Table 1.

TABLE 1

Flexural Test Loads

Nominal Diameter *in.*	Class 100	Class 150	Class 200
	Total Applied Load—*lb*		
4	1,200	1,460	1,860
6	2,800	3,700	4,900
8	5,330	7,600	10,130

2.2.2—*Bursting strength.* Each length of pipe and each coupling shall have sufficient strength to withstand the design internal pressures indicated for their classes in Table 2.

2.2.3—*Crushing strength.* Each length of pipe shall have sufficient strength to support the design external load indicated for its class in Table 2 when subjected to the crushing test procedure specified in this standard.

Sec. 2.3—Chemical Requirements

Pipe shall be designated as either Type I or Type II according to its content of uncombined calcium hydroxide (free lime) as determined by the test procedures in this standard for uncombined calcium hydroxide. The requirements for each type are: Type I—no limit on uncombined calcium hydroxide; Type II—1.0 per cent or less uncombined calcium hydroxide.

TABLE 2

Design Internal Pressure and Design External Load

Pipe Size *in.*	Class 100		Class 150		Class 200	
	Pressure *psi*	Load *lb/lin ft*	Pressure *psi*	Load *lb/lin ft*	Pressure *psi*	Load *lb/lin ft*
4	417	4,100	616	5,400	809	8,700
6	441	4,000	632	5,400	815	9,000
8	472	4,000	653	5,500	824	9,300
10	490	4,400	650	7,000	826	11,000
12	490	5,200	658	7,600	830	11,800
14	500	5,200	650	8,600	826	13,500
16	500	5,800	654	9,200	825	15,400
18	495	6,500	655	10,100	826	17,400
20	493	7,100	656	10.900	824	19,400
24	479	8,100	645	12,700	820	22,600
30	468	9,700	638	15,900	816	28,400
36	465	11,200	630	19,600	813	33,800

Section 3—General and Detailed Design

Sec. 3.1—Classes of Pipe

Pipe shall be made in one or more of the following classes: Class 100, Class 150, and Class 200.

Sec. 3.2—Pipe Diameters

Pipe shall be made with nominal inside diameters of 4, 6, 8, 10, 12, 14, 16, 18, 20, 24, 30, and 36 in. The average inside diameter of a standard or random pipe length shall be not less than the nominal diameter by more than 5 per cent for sizes through 16 in. and 1.5 per cent for sizes 18 in. and larger.

Sec. 3.3—Pipe Lengths

Pipe shall be produced in standard, random, and short lengths. At least 90 per cent of the total footage of pipe of any class and size, excluding short lengths, shall be furnished in standard lengths. The remaining 10 per cent may be in random lengths.

3.3.1—*Standard length* shall be 10 ft or 13 ft, plus or minus 1 in., for pipe 4 in. and 6 in. in diameter; and 13 ft, plus or minus 1 in., for pipe 8 in. in diameter and larger. Coupling areas shall be machined or otherwise rendered suitable for making a tight joint with the coupling.

3.3.2—*Random lengths* shall be cut from standard lengths and shall be not less than 7 ft. The coupling areas of all random lengths shall be machined or otherwise rendered suitable for making a tight joint with the coupling.

3.3.3—*Short lengths* for making connections to valves, fittings, or structures and for making closures shall be furnished as specified by the purchaser. They shall be properly machined at ends only or over their entire length to serve their intended purpose, as specified by the purchaser.

Sec. 3.4—Couplings

A coupling shall consist of an asbestos-cement sleeve, of the same type and composition as the pipe, and two rubber rings.

3.4.1—*One coupling* of the same size and class as the pipe shall be furnished with each standard and random length of pipe.

3.4.2—*Rubber rings* shall conform to the requirements of the latest edition of ASTM D1869, "Rubber Rings for Asbestos–Cement Pipe."

Sec. 3.5—Joints

Joints shall be capable of withstanding, without leakage, a hydrostatic pressure test as defined in Sec. 5.2.2.

Sec. 3.6—Wall Thickness

The wall thickness of the machined portion of any length of pipe shall be not less than the manufacturer's standard by an amount exceeding 0.08 in. for pipe having a design thickness of 1 in. or less, or by an amount exceeding 0.10 in. for pipe having a design thickness greater than 1 in.

Section 4—Workmanship and Finish

Sec. 4.1—Imperfections

4.1.1—*Interior surfaces.* The inside surface of each length of pipe shall be free from bulges, dents, and tears that result in a variation in diameter of more than 0.20 in. from the diameter

of adjacent unaffected portions of the surface.

4.1.2—*Coupling areas.* The coupling areas of the barrel of each length of pipe shall be free from dents and gouges that can cause leakage from the joint.

4.1.3—*Exterior surfaces.* Flaking on the exterior surface and edge of machined ends shall not extend back more than 0.500 in. from the end, have a depth of more than 0.125 in., or extend around the perimeter for more than 0.500 in. at any one location.

4.1.4—*Straightness.* Each length of pipe shall not vary in straightness by more than ½ in., measured at the midpoint of the length for lengths up to 10 ft, and not more than ⅝ in. for 13-ft lengths.

Section 5—Inspection, Testing, and Rejection

Sec. 5.1—Inspection

5.1.1—*General.* Inspection by the purchaser shall not relieve the manufacturer of the responsibility to furnish material conforming in all respects to the requirements of this standard.

5.1.2—*Notification.* If inspection is specified by the purchaser, the manufacturer shall notify the purchaser, in advance, of the date, time, and place of testing of the pipe, in order that the purchaser may be represented at the test.

5.1.3—*Access.* The inspector shall have free access to those parts of the manufacturer's plant that are involved in work performed under this standard. The manufacturer shall afford the inspector, without charge, all reasonable facilities for determining whether the pipe meets the requirements of this standard.

Sec. 5.2—Physical Test Requirements

5.2.1—*Test specimens.* All pipe and couplings tested under this standard shall be in a normal, air-dried condition when tested.

5.2.2—*Hydrostatic tests.*

5.2.2.1. Each standard, random, or short length of pipe and each coupling sleeve shall be tested under an internal hydrostatic pressure as follows: Class 100—350 psi; Class 150—525 psi; Class 200—700 psi. All air shall be expelled and the water pressure shall be increased to the test pressure at a uniform rate of not less than 100 psi/sec. The test pressure shall be maintained for at least 5 sec. Any pipe length or coupling sleeve showing leakage, sweating, or other defect shall be rejected.

5.2.2.2. From each 300 standard lengths of pipe or fraction thereof, of each size and class, one length shall be hydrostatically tested to a pressure four times the rated operating pressure for that class in the manner specified in Sec. 5.2.2.1. If inspection by the purchaser has been specified, the length of pipe to be tested may be selected by the inspector. Each length of pipe so tested shall be retested in the manner and at the pressure specified in Sec. 5.2.2.1.

5.2.3—*Flexure tests.* Each standard length of pipe and each random length of more than 9.5 ft, having a nominal diameter of 4, 6, or 8 in., shall be tested in flexure for at least 5 sec. The supports shall be 9 ft apart, except that, at the manufacturer's option, lengths

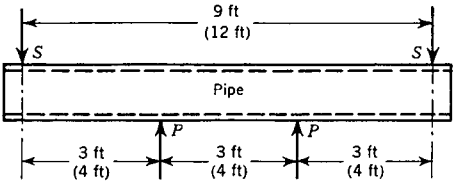

Fig. 1. Flexure Test Assembly

The numbers not in parentheses represent the distances between bearings S *and load points* P *for lengths of pipe shorter than 12.5 ft. The numbers in parentheses indicate the spacing that may be used on lengths of pipe longer than 12.5 ft. One half of the total load is applied at each point* P.

greater than 12.5 ft may be tested on supports 12 ft apart at 75 per cent of the load specified in Table 1. The total load shall be divided equally and applied at the third points of the clear span as shown in Fig. 1. Each pipe so tested shall support, without evidence of cracks or other defects, the applicable total load shown in Table 1. The load shall be applied at a minimum rate of 250 lb/sec, and the total load shall be maintained for at least 5 sec.

5.2.4—*Crushing tests.* On lots containing more than 100 lengths of each size and class, one length from each 300 lengths, or fraction thereof, shall be tested for crushing strength. If inspection by the purchaser has been specified, the length of pipe to be tested may be selected by the inspector. From each selected length, one unmachined section of pipe 1 ft long shall be cut. This section shall be tested by the crushing test method shown in Fig. 2. After 75 per cent of the specified load has been reached, the loading shall be applied at a uniform rate of approximately 2.000 lb/min. The test section shall not fail until the total load applied meets or exceeds the applicable value shown in Table 2.

For this test, the two lower bearings shall consist of two straight strips with vertical sides, each strip having its interior top edge rounded to a radius of approximately 0.5 in. The strips shall be of hardwood or metal; if metal, a piece of leather belting $\frac{3}{16}$ in. in thickness shall be laid over them. The strips shall be securely fastened to a rigid block, with the interior vertical faces parallel and at a distance apart of approximately 1 in./ft of internal pipe diameter, but in no case less than 1 in. The upper bearing shall be a rigid wooden block, straight and true from end to end. The upper and lower bearings shall extend the full length of the test section.

5.2.5—*Machines for testing.* The machine used for the hydrostatic test shall have gaskets that seal the ends of the pipe without materially counteracting the hydrostatic test pressure. The

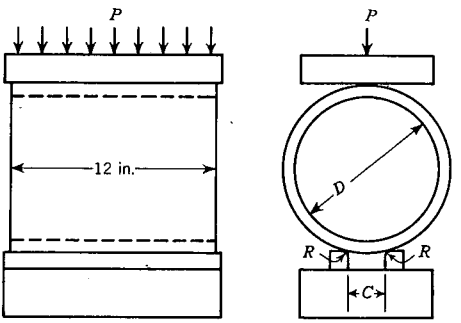

Fig. 2. Crushing Test Assembly

The diagram at the left shows a side view of the test assembly; that at the right, an end view. P *represents load;* R, *approximately 0.5 in.—the radius of the bearings;* D, *the nominal diameter of the pipe; and* C, *the clear space between supports.* C *should be approximately 1 in./ft of internal pipe diameter, but in no case less than 1 in.*

machines used for the flexure and crushing tests shall be substantial and rigid throughout, so that the distribution of the load will not be appreciably affected by the deformation or yielding of any part of the machine.

Sec. 5.3—Retests (Physical) and Rejection

The failure of any specimen tested for crushing strength to support 75 per cent of the crushing load required in Table 2 shall be cause for rejection of the entire lot of that size and class manufactured during the same shift as the test specimen. If any specimen tested for crushing strength supports more than 75 per cent but less than 100 per cent of the crushing load, two additional pipe sections of the same size and class, manufactured during the same shift, shall be subjected to the crushing test. The additional lengths may be selected by the inspector, if inspection by the purchaser has been specified. The failure of one of these additional specimens to meet the full crushing strength requirement shall be cause for rejection of the entire lot of that size and class manufactured during the same shift as the test specimen.

If any pipe subjected to the hydrostatic tests specified in Sec. 5.2.2.2 fails to withstand the specified pressure, two additional lengths of the same size and class, manufactured during the same shift, shall be subjected to the same hydrostatic test. The additional lengths may be selected by the inspector, if inspection by the purchaser has been specified. The failure of one of these additional lengths to withstand the specified pressure shall be cause for rejection of the entire lot of that size and class manufactured during the same shift as the test lengths.

Sec. 5.4—Test for Uncombined Calcium Hydroxide

The manufacturer shall perform this test as often as necessary to assure compliance with the requirements on uncombined calcium hydroxide in Type II pipe.

5.4.1—*Reagents.*

Phenolphthalein indicator. Dissolve 1.0 g of phenolphthalein in 100.0 ml of absolute ethanol.*

Glycerol-ethanol solvent. Prepare a solution consisting of glycerol and anhydrous, or absolute, ethanol,* 1:2 by volume. To each liter of this solution, add 2.0 ml phenolphthalein indicator. Adjust the solvent to slightly basic with either dilute NaOH in absolute ethanol * or standard ammonium acetate, depending on the original pH.

Strontium nitrate [$Sr(NO_3)_2$].

Standard ammonium acetate solution. Dissolve 16.0 g of dry crystalline ammonium acetate in 1 liter of absolute, or anhydrous, ethanol.*

Standardize the ammonium acetate solution by titrating against pure CaO that has been freshly prepared by calcining pure calcium carbonate or calcium oxalate to constant weight in a platinum crucible at 900 to 1,000C. When the calcined CaO has cooled in a desiccator, perform the following operations in rapid succession. Grind the CaO in an agate mortar. Then weigh out 0.05–0.06 g into a dry 250-ml Erlenmeyer flask and add 60 ml of the glycerol-ethanol solvent and 2.0 g of anhydrous strontium nitrate to the flask. Place a Teflon encapsulated magnetic stirring bar into the flask and attach a

* Specially denatured alcohol no. 30, 3a, or 2b, of the US Bureau of Internal Revenue, or alcohol consisting of 95 per cent specially denatured alcohol no. 3a plus 5 per cent isopropanol may be substituted.

reflux condenser. Adjust the heating rate and stirring speed to obtain a vigorous boiling and complete agitation. Titrate the hot solution with ammonium acetate solution every 5 min. The end point is reached when no further color appears in the solution after 10 min of boiling. Titration is to be carried out only on a hot solution. A good titration procedure is evidenced by a change in the color of the solution to pink on cooling.

Step 1. Brush representative pieces of the pipe free of dust and drill with a clean, sharp 0.25-in. carbide-tipped drill inward from the outer surface at a rate of penetration of approximately 1 ipm until the drill point emerges from the inside wall. Catch the drillings on a clean sheet of glazed paper, using a soft brush to collect all drillings. Screen through a 20-mesh screen immediately, and place in a weighing bottle.

Step 2. Place the bottle, with top removed, in a drying oven at 105C for 2 hr, and then cool to room temperature in a desiccator.

Step. 3. Weigh out 1 ± 0.010 g of the dried sample to the nearest 0.001 g and place in a dry 250-ml Erlenmeyer flask, to which a Teflon encapsulated stirring bar, 60 ml of the glycerol-ethanol solvent, and 2.0 g $Sr(NO_3)_2$ have been added. Attach the flask to a water-cooled condenser (with a standard 24/40 glass joint) and place on a hot plate with a magnetic stirrer. Boil the solution gently for 30 min, stirring slowly. Then remove the flask and filter the mixture, under vacuum, through a Buchner funnel. Bring the filtrate to a boil and titrate to a colorless end point with the standardized ammonium acetate reagent. Determine the end point by comparison with a similar mixture containing no phenolphthalein indicator.

5.4.2—*Calculations.*

$$E = \frac{W\text{CaO} \times 1.32}{V_a}$$

where

E = the weight in grams of $Ca(OH)_2$ per milliliter of standardized ammonium acetate solution

WCaO = the weight in grams of CaO in the standardized ammonium acetate solution

V_a = the volume in milliliters of ammonium acetate used in titration of the standardized solution.

$$\text{Per cent uncombined } Ca(OH)_2 = \frac{EV}{W} \times 100$$

where

V = the volume of standardized ammonium acetate solution required by the sample, in milliliters

W = the weight of the sample in grams.

Sec. 5.5—Test Records

The results of all tests shall be recorded and retained for 1 yr, and shall be available to the purchaser at the place of manufacture.

Section 6—Marking and Delivery

Sec. 6.1—Marking

6.1.1—*Standard and random lengths.* Each standard or random length of pipe shall be clearly marked on the outside surface with the trade name, nominal inside diameter, class, Type, hydro-

static test pressure, and date and shift of manufacture.

6.1.2—*Short lengths.* Each short length of pipe shall be clearly marked on the outside surface with the nominal inside diameter, the class, Type, and the letter "T" to indicate that it has been hydrostatically tested.

6.1.3—*Couplings.* All component parts of each coupling shall be clearly marked for use with the pipe for which they are intended. Each coupling sleeve shall also be marked with the letter "T" to indicate that it has been hydrostatically tested.

6.1.4—*Special markings.* If factory inspection is made by the purchaser or his authorized inspector, each pipe and each coupling sleeve shall receive an additional special marking of no more than three letters, as specified by the purchaser.

Sec. 6.2—Preparation for Shipment

All pipe and couplings, unless otherwise specified, shall be prepared for standard commercial shipment.

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