American Water Works Association
ANSI/AWWA C603-90
(Revision of AWWA C603-78)

AWWA STANDARD

FOR

INSTALLATION OF ASBESTOS-CEMENT PRESSURE PIPE

Effective date: Feb. 1, 1991.
First edition approved by AWWA Board of Directors Jan. 27, 1964.
This edition approved June 17, 1990.
Approved by American National Standards Institute, Inc., Oct. 31, 1990.

AMERICAN WATER WORKS ASSOCIATION

6666 West Quincy Avenue, Denver, Colorado 80235

AWWA Standard

This document is an American Water Works Association (AWWA) standard. It is not a specification. AWWA standards describe minimum requirements and do not contain all of the engineering and administrative information normally contained in specifications. The AWWA standards usually contain options that must be evaluated by the user of the standard. Until each optional feature is specified by the user, the product or service is not fully defined. AWWA publication of a standard does not constitute endorsement of any product or product type, nor does AWWA test, certify, or approve any product. The use of AWWA standards is entirely voluntary. AWWA standards are intended to represent a consensus of the water supply industry that the product described will provide satisfactory service. When AWWA revises or withdraws this standard, an official notice of action will be placed on the first page of the classified advertising section of *Journal AWWA*. The action becomes effective on the first day of the month following the month of *Journal AWWA* publication of the official notice.

American National Standard

An American National Standard implies a consensus of those substantially concerned with its scope and provisions. An American National Standard is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an American National Standard does not in any respect preclude anyone, whether he has approved the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standard. American National Standards are subject to periodic review, and users are cautioned to obtain the latest editions. Producers of goods made in conformity with an American National Standard are encouraged to state on their own responsibility in advertising and promotional materials or on tags or labels that the goods are produced in conformity with particular American National Standards.

CAUTION NOTICE: The American National Standards Institute (ANSI) approval date on the front cover of this standard indicates completion of the ANSI approval process. This American National Standard may be revised or withdrawn at any time. ANSI procedures require that action be taken to reaffirm, revise, or withdraw this standard no later than five years from the date of publication. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018 (212) 354-3300.

Committee Personnel

The AWWA Standards Committee on Asbestos–Cement Pressure Pipe, which reviewed and approved this standard, had the following personnel at the time of approval:

Roger C. Graff, *Chair*
Robert W. Greaves, *Vice-Chair*
B.J. Pigg, *Secretary*

Consumer Members

R.C. Graff, City of San Diego, San Diego, Calif.	(AWWA)
R.W. Greaves, American Water Works Service Company, National City, Calif.	(AWWA)
D.H. Nelson, City of Thousand Oaks, Thousand Oaks, Calif.	(AWWA)

General Interest Members

K.M. Bell, Underwriters Laboratories Inc., Northbrook, Ill.	(UL)
T.J. Brown Jr., Factory Mutual Research Corporation, Norwood, Mass.	(FMR)
B.R. Elms,* Standards Engineer Liaison, AWWA, Denver, Colo.	(AWWA)
L.A. Kinney Jr., US Bureau of Reclamation, Denver, Colo.	(USBR)
E.W. Misichko,† Underwriters Laboratories Inc., Northbrook, Ill.	(UL)
H.L. Olson, Denver, Colo.	(NEWWA)
J.S. Rego Jr., Fall River Water Department, Fall River, Mass.	(NEWWA)
E.F. Straw, ISO Commercial Risk Services, Inc., Duluth, Ga.	(ISO)

Producer Members

Marcel Cossette, Ceram-CNA, Inc., Sherbrook, Que.	(AWWA)
S.G. Leyshock, CAPCO Pipe Company, Inc., Litchfield, Ill.	(AWWA)
R.H. Novick, Certain Teed Corporation, Englewood, Colo.	(AWWA)
W.R. Perrell,† CAPCO Pipe Company, Inc., Birmingham, Ala.	(AWWA)
B.J. Pigg, Association of Asbestos–Cement Pipe Producers, Arlington, Va.	(AACPP)

*Liaison, nonvoting

†Alternate

Contents

Foreword

This foreword is for information only and is not part of AWWA C603.

I. History of Standard. In 1931, a new pipe material consisting of an intimate mixture of portland cement and asbestos fibers was introduced into the North American market following several years of use in other countries, particularly Italy.

In the ensuing years, this type of pipe gained popularity, and in 1949, the AWWA Committee on Water Works Practice established a working committee to develop standard specifications for asbestos–cement pipe under the chairmanship of S.M. Clarke of Greeley and Hanson, Chicago.

The committee developed a standard for asbestos–cement water pipe, which was approved by the AWWA Board of Directors as tentative (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 of Whitman, Requardt and Associates, Baltimore.

The committee concluded that an installation guide was needed to bring to the attention of users certain important requirements regarding the inspection, handling, installation, and field testing of asbestos–cement pressure pipe. In 1963, the committee submitted its final draft, which received approval as tentative (AWWA C603-64T) on Jan. 27, 1964. It was advanced to standard (AWWA C603-65) without revision on Aug. 9, 1965.

In early 1968, the committee was reactivated as the AWWA Standards Committee on Asbestos–Cement Pressure Pipe to review and revise all AWWA standards on asbestos–cement pipe.

The 1978 edition of AWWA C603 was approved on Jan. 28, 1978, under the new title Standard for Installation of Asbestos–Cement Pressure Pipe. Other changes in the 1978 edition included the addition of notes on trench preparation to Sec. 3.2.3 and revision of the section on pressure and leakage tests to include both asbestos–cement distribution pipe and asbestos–cement transmission pipe.

II. Information Regarding Use of This Standard.

II.A. *Advisory information on application of standard.* ANSI/AWWA C603-90, Standard for Installation of Asbestos–Cement Pressure Pipe, can be used as a reference when making extensions to existing distribution systems or when constructing new distribution systems using asbestos–cement mains. This standard is not intended to be used as a contract document, but it may be used as a reference in contract documents. The standard is based on a consensus of the committee regarding the minimum practice for the installation of asbestos–cement pipe consistent with sound, economical service under normal conditions. Under any circumstances, the provisions of the standard must be reviewed by a responsible engineer. The standard is not intended to preclude the manufacture, marketing, purchase, or the use of any product, process, or procedure.

This standard provides for the installation of asbestos–cement pipe in sizes ranging from 4 in. (100 mm) through 42 in. (1050 mm). However, current production in the United States is limited to a maximum size of 24 in. (600 mm).

Although the installation of pipe that is laid on earth mounds is included in this standard, caution should be exercised, particularly for small pipe sizes, to ensure that (1) proper clearance is maintained between the pipe or coupling and the

trench bottom, and (2) after pipe placement, the earth beneath the entire length of the pipe, including the coupling, is properly placed beneath the pipe and is compacted to a uniform density.

Effective July 21, 1986, the Occupational Safety and Health Administration (OSHA) revised its standards for workplace exposure to airborne asbestos particles. The current standard makes the employer responsible for ensuring that employee exposures to airborne asbestos-fiber concentrations do not exceed stringent exposure limits. The OSHA construction standard on asbestos, 29 CFR 1926, prescribes initial air monitoring and other compliance measures. The OSHA requirements apply to the manufacture, shipping, handling, installation, and repair of asbestos–cement pipe and appurtenances. It is recommended that users and prospective users of asbestos–cement pipe become familiar with the current OSHA asbestos work practice standards.

For additional information on recommended practices and procedures when working with asbestos–cement pipe, refer to AWWA Manual M16,* *Work Practices for Asbestos–Cement Pipe.*

II.B. *Information required for use of this standard.* The purchaser should specify special requirements and provide site-specific information in the purchaser's specifications regarding the following:

1. Standard used—that is, ANSI/AWWA C603-90, Standard for Installation of Asbestos–Cement Pressure Pipe.
2. Any exceptions to the standard that may be required.
3. Drawings, lines, and grades (Sec. 1.2.3 and Sec. 3.1).
4. Point of pipe delivery (Sec. 2.1.1 and Sec. 2.3.1).
5. Trench width(s) (Sec. 3.2.2).
6. Placement and compaction of backfill (Sec. 3.2.2).
7. Pipe bedding requirements (Sec. 3.2.3).
8. Methods and materials for trench subgrade stabilization (Sec. 3.2.4).
9. Weather conditions for laying pipe (Sec. 3.3.2.2).
10. Number and size of tie rods, if hydrants are to be tied to the main for thrust restraint (Sec. 3.5.2).
11. Concrete-curing time before testing (Sec. 4.1.2).
12. Test pressure (Sec. 4.2).
13. Visual inspection (Sec. 5.1.1 and Sec. 5.1.2).

III. Modification of 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 in this revision of the standard are as follows:

1. Metric equivalents were added to the standard.
2. Several terms in Sec. 1.2, Definitions, were redefined.
3. A new Sec. 3.3.3, Closure System, was added.
4. Sec. 3.3.4, Pipe Cutting, was completely revised.
5. Sec. 3.4.4 on poured lead joints was deleted.

V. Metrication. Metric conversions of all dimensions and physical requirements are included in this standard (see Table F.1). Metric dimensions are direct conversions of US customary units, except that nominal pipe sizes are rounded up to

**Work Practices for Asbestos–Cement Pipe,* AWWA Manual M16, AWWA, Denver (1978).

the nearest 50 mm for pipe sizes 30 in. and under and rounded up to 100 mm for pipe sizes greater than 30 in. These conversions are not those specified in International Organization for Standardization (ISO) standards.

Table F.1 Conversion Factors*

US Customary Unit	Conversion Factor	Metric Equivalent
inch (in.)	× 25.4	= millimetre (mm)
foot (ft)	× 0.3048	= metre (m)
mile (mi)	× 1.609	= kilometre (km)
gallon (gal)	× 3.785	= litre (L)
pounds per square inch (psi)	× 6.894757	= kiloPascals (kPa)
pound (lb)	× 0.4536	= kilogram (kg)
pounds per square foot (lb/ft^2)	× 0.0478803	= kiloNewtons per square metre (kN/m^2)
pounds per cubic foot (lb/ft^3)	× 16.0185	= kilograms per cubic metre (kg/m^3)

*Metric pipe inside diameter sizes are nominal and may not directly convert from the US equivalent inches.

This page intentionally blank.

American Water Works Association

ANSI/AWWA C603-90
(Revision of AWWA C603-78)

AWWA STANDARD FOR

INSTALLATION OF ASBESTOS-CEMENT PRESSURE PIPE

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard covers the installation of water pipelines constructed of asbestos–cement pressure pipe with fittings and appurtenances of asbestos–cement, cast iron, other materials, or combinations of any of these. For specific projects, a thorough review of this standard is recommended. Any special requirements not included here should be incorporated into the purchaser's contract requirements.

Sec. 1.2 Definitions

The following definitions shall apply in this standard:

1.2.1 *Compacted backfill:* Compacted backfill is job-excavated material or other such granular bedding material that is not frozen but is free from debris, organic matter, rocks, and stones, and which, in the opinion of the purchaser, is suitable for backfilling. It shall be placed in not more than 6-in. (150-mm) layers and compacted to not less than 90 percent standard density as defined in AASHTO T-99.

1.2.2 *Constructor:* The party who furnishes the work and materials for placement or installation.

1.2.3 *Drawings:* Drawings prepared by the purchaser to show the location and details for the construction of the pipeline and appurtenances (see Foreword, Sec. 2.B.3).

1.2.4 *Manufacturer:* The party who manufactures, fabricates, or produces materials or products.

1.2.5 *Purchaser:* The person, company, or organization that purchases any materials or work to be performed.

1.2.6 *Supplier:* The party who supplies material or services. A supplier may or may not be the manufacturer.

Sec. 1.3 References

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

AASHTO* T-99—Standard Methods of Test for the Moisture–Density Relation of Soils Using a 5.5 lb (2.5 kg) Rammer and a 12-in. (305 mm) Drop.

ANSI/AWWA C111/A21.11—American National Standard for Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.

ANSI/AWWA C400—Standard for Asbestos–Cement Distribution Pipe, 4 In. Through 16 In., (100 mm Through 400 mm) NPS, for Water and Other Liquids.

ANSI/AWWA C401—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.

ANSI/AWWA C402—Standard for Asbestos–Cement Transmission Pipe, 18 In. Through 42 In., (450 mm Through 1050 mm), for Potable Water and Other Liquids.

ANSI/AWWA C403—Standard Practice for the Selection of Asbestos–Cement Transmission and Feeder Main Pipe, Sizes 18 In. Through 42 In. (450 mm Through 1050 mm).

ANSI/AWWA C651—Standard for Disinfecting Water Mains.

AWWA Manual M16—Work Practices for Asbestos–Cement Pipe.

SECTION 2: MATERIAL ACCEPTANCE, STORAGE, AND HANDLING

Sec. 2.1 Acceptance

At the time of delivery, all material shall be examined for defects and damage. Any material that is defective or damaged shall be rejected and removed from the jobsite.

2.1.1 *Replacement of damaged pipe.* Material supplied by the purchaser and rejected at the point of delivery because of defects or damage shall be replaced by the purchaser. Material supplied by the constructor and rejected at the point of delivery because of defects or damage shall be replaced by the constructor. Material damaged after acceptance by the constructor shall be replaced by the constructor.

Sec. 2.2 Storage

Safe storage shall be provided for material until it has been incorporated into the completed project. The interior of all pipe, couplings, rings, fittings, and other accessories shall be kept free from dirt and other foreign matter at all times. Valves

*American Association of State Highway and Transportation Officials, 341 National Press Bldg., Washington, DC 20045.

and hydrants shall be drained and stored in a manner that will protect them from damage by freezing.

Sec. 2.3 Handling

At all times, material shall be handled with care to avoid damage. Whether moved by hand, skidways, or hoists, material shall not be dropped, bumped, or allowed to impact on itself.

2.3.1 *Rehandling.* All materials which are to be supplied by the purchaser shall be claimed at the locations designated in the purchaser's specifications and hauled to and distributed at the work site by the constructor.

2.3.2 *Unloading at work site.* When distributing the material at the work site, it shall be unloaded adjacent to or near the location where it is to be installed.

SECTION 3: GENERAL AND DETAILED WORK TO BE PERFORMED

Sec. 3.1 Alignment and Grade

All pipe shall be laid to and maintained at the lines and grades required by the purchaser (see Foreword, Sec. 2.B.3). Fittings, valves, air vents, and hydrants shall be installed at the required locations with joints centered, spigots home, and valve and hydrant stems plumb. No deviation shall be made from the required line or grade without the approval of the purchaser or the purchaser's agent.

Sec. 3.2 Excavation and Preparation of Trench

The trench shall be excavated to the required alignment and depth shown on the purchaser's drawings or as subsequently approved in writing by the purchaser, and only so far in advance of pipe laying as permitted by the purchaser's specifications.

3.2.1 *Excavation methods.* When necessary to prevent caving, trench excavations shall be sheeted and braced or sloped according to applicable laws and ordinances. When sheeting and bracing are used, the trench width shall not be less than that specified in Sec. 3.2.2. As backfill is placed and sheeting is withdrawn, it shall be withdrawn vertically in increments of not more than 1 ft (0.3 m), and the void left by the withdrawn sheeting shall be filled and compacted before withdrawing the next increment. All excavated material shall be piled in a manner that will not endanger the work or obstruct sidewalks and driveways. Gutters shall be kept clear or other provisions made for surface drainage.

3.2.2 *Trench width.* The trench width shall be ample to permit the pipe to be laid and jointed properly and the backfill to be placed and compacted as specified by the purchaser. Trenches shall be of such extra width, when required, to permit the convenient placing of timber supports and sheeting and bracing, as well as the handling of specials.

3.2.3 *Trench preparation.* The trench shall be prepared for the direct placement of the pipe. This preparation includes digging coupling holes in the trench bottom or bedding, or placing properly prepared mounds as specified by the

purchaser. (Illustrations of the various bedding conditions are presented in ANSI/AWWA C401 and ANSI/AWWA C403.)

3.2.4 *Excavation in poor soil and refilling to grade.* Any part of the trench excavated below grade shall be backfilled to grade with thoroughly compacted material approved by the purchaser. When an unstable subgrade condition is encountered and, in the opinion of the purchaser, it cannot support the pipe, an additional depth shall be excavated and refilled to pipe foundation grade with crushed stone or other suitable material as required by the purchaser to achieve a satisfactory trench bottom.

3.2.5 *Pipe laid on trench bottom or bedding.* Before the pipe is lowered into the trench, the constructor shall:

1. Excavate a coupling hole having sufficient length, width, and depth to permit assembly and provide a minimum clearance of 2 in. (50 mm) below the coupling, and

2. Provide the pipe with continuous support between coupling holes.

NOTE: Use of granular material for bedding is recommended as a preferred method of preparing the trench bottom for pipe installation.

3.2.6 *Pipe laid on earth mounds.* Pipe shall be laid on earth mounds of backfill material compacted firmly in place and of a size adequate to hold the pipe in alignment and to maintain a 2-in. (50-mm) minimum clearance from coupling to trench bottom. Each pipe shall be laid on two mounds with the center of each mound placed approximately one fifth of the pipe length from each end. The trench shall be excavated a minimum of 2 in. (50 mm) below the grade of the bottom of the outside diameter of the coupling, and high spots between couplings shall be leveled in order to maintain a minimum of 2 in. (50 mm) under the pipe barrel. The clearance between the trench bottom and the bottom of the coupling and pipe shall be backfilled properly, using material approved by the purchaser. The material shall be compacted using appropriate equipment to provide a firm and uniform bedding along the entire length of the pipe.

NOTE: Earth mounds have been used in some areas with success. However, if this method is to be used, particularly for small pipe sizes, caution should be exercised to ensure that (1) proper clearance is maintained between the pipe or coupling and the trench bottom, and (2) after pipe placement, the earth beneath the entire length of the pipe including the coupling is properly placed beneath the pipe and is compacted to a uniform density specified by the purchaser.

Sec. 3.3 Laying of Pipe

3.3.1 *Lowering of pipe and accessories into trench.* Pipe shall not be lowered into the trench until the pipe bed has been brought to grade. All pipe and accessories shall be inspected for defects. Dirt and other foreign matter shall be removed from the interior and the machined ends before lowering into the trench. Pipe and accessories shall be lowered carefully into the trench by hand or with suitable equipment in a manner that will prevent damage to pipe and fittings or injury to the installers. The sealing surfaces of all materials shall be kept clean during installation.

3.3.2 *Pipe joints.* The machined ends of pipe to be jointed, coupling grooves, and rubber rings shall be cleaned immediately before assembly, and assembly shall be made as recommended by the manufacturer. Care shall be taken not to reverse

the gasket when placing it in the coupling. Each pipe joint shall be sealed with a coupling consisting of an asbestos–cement sleeve and two rubber rings or an equivalent coupling or joint of equivalent strength and performance. The pipe joint shall not be deflected either vertically or horizontally beyond the limits recommended by the manufacturer.

3.3.2.1 When pipe-laying is not in progress, the open ends of installed pipe shall be closed to prevent entrance of trench water into the line.

3.3.2.2 Whenever water is in the pipe trench, enough backfill shall be placed on the pipe to prevent it from floating. Any pipe that has floated shall be removed from the trench and the bedding corrected to conform to Sec. 3.2.3. No pipe shall be laid when the weather is unsuitable for proper installation as determined by the purchaser.

3.3.3 *Closure system.* Closure lengths and closure couplings should be used for tying in asbestos–cement pipe. Closure lengths and closure couplings can span closure distances up to 13 ft (3.96 m) without any field cutting. They eliminate any possible airborne asbestos fiber exposure, which may result from the field cutting of pipe.

3.3.4. *Pipe cutting.* Since the introduction of the closure system, pipe cutting is no longer required in the field. If pipe cutting is done, methods that produce a smooth square cut end, without damage to the pipe, and that do not produce airborne particles, shall be employed. Abrasive discs are prohibited unless they are equipped with local exhaust ventilation and a high efficiency particulate air (HEPA) filter dust collection system.

3.3.5 *End preparation.* Whenever it is necessary to cut a length of pipe in the field, the end shall be prepared as follows:

3.3.5.1 The pipe end of random lengths shall be machined by commercially available field lathes designed for this purpose to ensure that the diameter, profile, and roundness meet the pipe manufacturer's specifications. The machined surface on which the compression ring seals shall be smooth and cylindrical to ensure joint integrity.

3.3.5.2 The pipe end of machined overall lengths shall be beveled according to the pipe manufacturer's specifications.

3.3.6 *Length of pipe at fittings and rigid structures.* Where rigid joints are formed by caulked materials or by bolts with rubber-ring seals, such as at fittings, the length of 8-in. (200-mm) diameter and smaller pipe fitted into the bell of the fittings shall not exceed 3 ft 3 in. (1.0 m), and the length of 10-in. (250-mm) diameter and larger pipe shall not exceed 6 ft 6 in. (2.0 m). At least one flexible joint shall be used between two adjacent rigid joints. A coupling shall be cast in the wall of rigid structures at the point of entry of pipelines to provide flexibility at the wall. To provide additional flexibility, the pipe at the point of entry shall have a laying length of not more than 6 ft 6 in. (2.0 m).

Sec. 3.4 Jointing of Pipe to Valves, Hydrants, and Fittings

3.4.1 *General.* Each valve, hydrant, or fitting connected to asbestos–cement pipe shall have a profile that permits a seal to be made between the machined pipe and the bell of the fitting with a continuous rubber-ring gasket.

3.4.1.1 Before valves, hydrants, or fittings are laid, all lumps, blisters, and excess coating shall be removed from the bell. The inside of the bell shall then be

wire-brushed, and both the inside of the bell and the spigot end of the pipe shall be wiped clean and dry. All surfaces to be jointed shall be kept clean until the joints are made.

3.4.2 *Push-on joint.* The push-on joint is a single rubber-gasket joint. It shall be assembled by positioning a continuous rubber-ring gasket in the annular groove of the fitting bell and pulling the machined pipe end into the bell. A lubricant approved by the pipe manufacturer must be used. Care should be taken to ensure that the correct size of gasket for the fitting bell is used with the correct size of asbestos–cement pipe.

3.4.3 *Mechanical joint.* The mechanical joint is a bolted joint of the stuffing-box type. In some sizes and classes, an adaptor is required between the asbestos–cement pipe and the mechanical joint. The joints shall conform to the current revision of ANSI/AWWA C111/A21.11 and shall be assembled as required in appendix A, Notes on Installation of Mechanical Joints, of that standard.

Sec. 3.5 Setting of Hydrants, Valves, and Fittings

3.5.1 *General.* Hydrants, valves, and fittings shall be provided and installed as shown on the drawings or as specified in the purchaser's specifications. They shall be inspected carefully and cleaned as required in Sec. 3.4.1.1 before lowering into the trench.

3.5.2 *Reaction or thrust blocking.* A reaction or thrust block shall be provided at each hydrant, valve, bend, and tee and at reducers or fittings where changes in pipe diameter occur. Each block shall be centered on the longitudinal axis and extended to solid undisturbed ground. Hydrants may be tied to the water main with rods. The size and shape of thrust blocks and the number and size of the tie rods shall be as shown on the drawings or as specified in the purchaser's specifications.

Sec. 3.6 Plugging Dead Ends

Plugs shall be inserted into the bells of all dead-end fittings. Spigot ends of fittings and plain ends of pipe shall be capped. A reaction or thrust block shall be provided at all dead ends of pipe that are capped or plugged. Capped or plugged outlets to fittings shall be tied to the fittings and shall be restrained according to the fitting manufacturer's recommendations.

SECTION 4: PRESSURE AND LEAKAGE TESTS

Sec. 4.1 General

The field pressure and leakage tests should be conducted on each section of pipeline as soon as possible after the following requirements have been met:

4.1.1 *Backfilling.* Backfill sufficient to prevent the lifting of the pipe shall be placed before filling the pipe with water and field testing. When local conditions require that the trenches be backfilled immediately after the pipe has been laid, then the testing may be conducted after backfilling has been completed and before placement of a permanent surface.

4.1.2 *Concrete-curing time.* Before testing, or as specified by the purchaser, at least 36 h shall elapse after the last concrete thrust or reaction blocking has been cast with high-early-strength cement, and at least 7 days shall elapse after the last concrete thrust or reaction blocking has been cast with standard cement.

Sec. 4.2 Test Pressure

Unless otherwise specified by the purchaser, the test pressure for distribution pipe (ANSI/AWWA C400, sizes 4 in. [100 mm] through 16 in. [400 mm]) shall be double the operating pressure at the lowest elevation of the system, or it shall be the class designation of the pipe plus 50 psi (345 kPa), whichever is less. The test pressure for transmission pipe (ANSI/AWWA C402, sizes 18 in. [450 mm] through 42 in. [1050 mm]) shall be the operating pressure plus 50 psi (345 kPa), but not to exceed the design pressure (operating pressure plus surge).

Sec. 4.3 Procedure

The following procedure is based on the assumption that the pressure and leakage tests will be performed at the same time. The total time for the combined pressure and leakage tests for each section of the pipeline being tested shall be a minimum of 2 h, unless otherwise specified. If separate tests are made, the pressure test shall be made first. The duration of the pressure test shall be a minimum of 1 h. The duration of the leakage test shall be a minimum of 4 h. The pressure of the leakage test may be reduced to 150 percent of the maximum working pressure that will occur on that portion of the line or shall equal the test pressure (Sec. 4.2), whichever is less.

4.3.1 *Filling.* After the pipeline has been laid, it shall be filled with water for a minimum of 24 h before being subjected to the hydrostatic pressure test. Each section of the pipeline shall be filled slowly with water and all air expelled by means of taps at points of highest elevation.

4.3.2 *Pressurization.* The specified test pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the purchaser. The test pressure shall be maintained for the specified time during which all exposed pipe, couplings, fittings, valves, and hydrants shall be examined carefully.

4.3.3 *Cracked or defective elements.* All cracked or defective elements shall be removed and replaced and the test repeated until all visible leakage has been stopped and the requirements of Sec. 4.4 have been met.

Sec. 4.4 Allowable Leakage

No pipe installation will be accepted if the leakage for the section of line that is tested is more than the rate of leakage specified in Table 1 (Table 1M). The data contained in Tables 1 and 1M are based on a leakage allowance of 30 gpd/mi of pipe per inch of pipe diameter (2.78 L/day/km of pipe/per millimetre of pipe diameter) when tested at 150 psi (1034 kPa). In determining the number of couplings, consideration should be given to allowing for the additional number of joints if the pipe length furnished is less than 13 ft (3.96 m). If the test leakage in any section is greater than permitted, the leakage shall be located and repaired and the test performed until the leakage is within the permitted allowance.

SECTION 5: BACKFILLING

Sec. 5.1 Backfill Procedure Before Tests

Backfill material approved by the purchaser shall be free of any frozen lumps, rock that is 1½ in. (38 mm) or larger in size, and lumps of clay, large stones,

Table 1 Allowable Leakage per 100 Couplings

Pipe Diameter, *in.*	Average Test Pressure at Lowest Point in Line—*psi*								
	50	75	100	125	150	175	200	225	250
	Leakage—*gal/h*								
4	0.71	0.87	1.00	1.12	1.23	1.32	1.42	1.51	1.58
6	1.06	1.29	1.51	1.68	1.84	1.98	2.12	2.25	2.37
8	1.42	1.72	2.00	2.24	2.45	2.64	2.84	3.00	3.16
10	1.77	2.15	2.50	2.79	3.07	3.40	3.54	3.75	3.95
12	2.12	2.58	3.00	3.35	3.68	3.96	4.24	4.52	4.74
14	2.48	3.01	3.50	3.91	4.28	4.62	4.96	5.26	5.50
16	2.83	3.44	4.01	4.47	4.89	5.27	5.68	6.00	6.32
18	3.18	3.87	4.52	5.02	5.52	5.93	6.37	6.75	7.11
20	3.54	4.30	5.00	5.58	6.12	6.58	7.08	7.51	7.90
21	3.73	4.54	5.24	5.88	6.40	6.92	7.42	7.86	8.28
24	4.24	5.16	6.00	6.69	7.34	7.91	8.50	9.01	9.47
27	4.77	5.83	6.74	7.56	8.23	8.90	9.54	10.12	10.66
30	5.30	6.45	7.51	8.37	9.18	9.88	10.62	11.26	11.84
33	5.83	7.13	8.24	9.25	10.06	10.88	11.67	12.36	13.02
36	6.37	7.75	9.01	10.07	11.02	11.88	12.74	13.50	14.22
39	6.88	8.42	9.74	10.83	11.90	12.96	13.79	14.61	15.40
42	7.42	9.08	10.48	11.78	12.82	13.85	14.86	15.74	16.58

boulders, or other unsuitable substances, such as debris. The backfill shall be deposited in the trench up to the horizontal diameter of the pipeline in 6-in. (150-mm) thick compacted layers and shall be sufficiently damp to permit thorough compaction under and on each side of the pipe to provide support that is free from voids.

5.1.1 *Visual inspection not required.* If visual inspection during the hydrostatic tests is not required, then the pipe and joints shall be backfilled as specified previously and a cushion of material shall be hand-placed over the pipe and joints to an average depth of 12 in. (300 mm) for all sizes of pipe.

5.1.2 *Visual inspection required.* If the joints are to be exposed during the test, additional backfill material shall be hand-placed between the joints in order to hold the line securely during the test. The average depth of material in this instance shall be 12 in. (300 mm) over the top of 8-in. (200-mm) diameter and smaller pipe, and 24 in. (600 mm) over larger pipe. In no case shall material with a diameter in excess of 1½ in. (38 mm) be placed in the trench in the first 12 in. (300 mm) above the pipe.

Sec. 5.2 Backfill Procedure After Tests

Upon completion of pressure and leakage tests, exposed couplings shall be covered, and backfill shall be hand-placed to a depth of 12 in. (300 mm) above the top of the pipe and couplings. The balance of backfill shall not contain stones that are more than 6 in. (150 mm) in their largest dimension, and the backfill mixture

Table 1M Allowable Leakage per 100 Couplings (Metric)

Pipe Diameter, *mm*	Average Test Pressure at Lowest Point in Line—*kPa*								
	345	517	689	862	1034	1207	1379	1551	1724
	Leakage—*L/h*								
100	2.69	3.29	3.78	4.24	4.66	5.00	5.37	5.72	5.98
150	4.01	4.88	5.72	6.36	6.96	7.49	8.02	8.52	8.97
200	5.37	6.51	7.57	8.48	9.27	9.99	10.75	11.36	11.96
250	6.70	8.14	9.46	10.56	11.62	12.87	13.40	14.19	14.95
300	8.02	9.77	11.36	12.68	13.93	14.99	16.05	17.11	17.94
350	9.39	11.39	13.25	14.78	16.20	17.49	18.77	19.91	20.82
400	10.71	13.02	15.18	16.92	18.51	19.95	21.50	22.71	23.92
450	12.04	14.65	17.11	19.00	20.89	22.44	24.11	25.55	26.91
500	13.40	16.28	18.92	21.12	23.16	24.90	26.80	28.43	29.90
525	14.12	17.18	19.83	22.26	24.22	26.19	28.08	29.75	31.34
600	16.05	19.53	22.71	25.32	27.78	29.94	32.17	34.10	35.84
675	18.05	22.07	25.51	28.61	31.15	33.69	36.11	38.30	40.35
750	20.06	24.41	28.43	31.68	34.75	37.40	40.20	42.62	44.81
825	22.07	26.99	31.19	35.01	38.07	41.18	44.17	46.78	49.28
900	24.11	29.33	34.10	38.11	41.71	44.97	48.22	51.10	53.82
975	26.04	31.87	36.87	40.99	45.04	49.05	52.20	55.30	58.29
1050	28.08	34.37	39.67	44.59	48.52	52.42	56.24	59.58	62.76

shall not be used for disposal of refuse. Trenches under pavements and sidewalks shall be backfilled to a compaction density of 90 percent as determined by the American Association of State Highway and Transportation Officials Method T-99 for compaction and density of soils. The balance of the backfill for other trenches and those trenches not in a right-of-way may be backfilled by machine without compaction unless otherwise specified in the purchaser's specifications. Additional backfill material shall be supplied, if needed, to completely backfill the trenches or to fill depressions caused by subsequent settlement.

SECTION 6: DISINFECTION

Before the pipeline is placed into service, all new water systems, extensions to existing systems, valved sections of extensions, replacements in the existing system, and any exposed section of the existing system shall be disinfected according to ANSI/AWWA C651.

This page intentionally blank.

This page intentionally blank.

2P-5C-43603-7/96-MG

Printed on recycled paper.