ANSI/AWWA C602-17
(Revision of ANSI/AWWA C602-11)

American Water Works Association

Dedicated to the World's Most Important Resource®

AWWA Standard

Cement–Mortar Lining of Water Pipelines in Place—4 In. (100 mm) and Larger

Effective date: May 1, 2017.
First edition approved by AWWA Board of Directors June 17, 1955.
This edition approved Jan. 14, 2017.
Approved by American National Standards Institute Jan. 24, 2017.

American Water Works Association | STANDARD | *Since 1881*

Approved American National Standard ANSI

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. This standard does not supersede or take precedence over or displace any applicable law, regulation, or code of any governmental authority. AWWA standards are intended to represent a consensus of the water 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 Official Notice section of *Journal – American Water Works Association*. The action becomes effective on the first day of the month following the month of *Journal – American Water Works Association* 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 that person 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, 25 West 43rd Street, Fourth Floor, New York, NY 10036; 212.642.4900; or emailing info@ansi.org.

ISBN-13, print: 978-1-62576-216-0 eISBN-13, electronic: 978-1-61300-416-6

DOI: http://dx.doi.org/10.12999/AWWA.C602.17

Committee Personnel

The Steel Water Pipe Manufacturers Technical Advisory Committee (SWPMTAC) Task Group for C602, which developed this standard, had the following personnel at the time:

Christopher Walsh, *Chair*
Bruce J. Britton, *Vice-Chair*

H.H. Bardakjian, Manufacturers Consultant, Glendale, Calif.	(AWWA)
B.J. Britton, W. Walsh Company, Attleboro, Mass.	(AWWA)
R.J. Card, Manufacturers Consultant, Sugar Hill, Ga.	(AWWA)
D.P. Ebner, Heitkamp Inc., Watertown, Conn.	(AWWA)
J.E. Hohider, Heitkamp Inc., Watertown, Conn.	(AWWA)
B.D. Keil, Northwest Pipe Company, Draper, Utah	(AWWA)
J.L. Luka, American SpiralWeld Pipe Company, Columbia, S.C.	(AWWA)
C.J. Walsh, W. Walsh Company, Attleboro, Mass.	(AWWA)

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

John H. Bambei Jr., *Chair*
Dennis [illegible]nt, *Vice-Chair*
John [illegible] Luka, *Secretary*

General Interest Members

J.H. Bambei Jr., Bambei Engineering Services, Arvada, Colo.	(AWWA)
W.R. Brunzell, Brunzell Associates Ltd., Skokie, Ill.	(AWWA)
R.J. Card, Lockwood, Andrews & Newnam Inc., Houston, Texas	(AWWA)
R.L. Coffey, HDR Engineering Inc., Omaha, Neb.	(AWWA)
S.N. Foellmi, Black & Veatch Corporation, Irvine, Calif.	(AWWA)
R.L. Gibson, Freese and Nichols Inc., Fort Worth, Texas	(AWWA)
M.D. Gossett,* HDR Engineering Inc., Denver, Colo.	(AWWA)
M.B. Horsley,* Horsley Engineering LLC, Overland Park, Kan.	(AWWA)
T. Issa,* AECOM, McKinney, Texas	(AWWA)
R.A. Kufaas, Norske Corrosion & Inspection Services Ltd., Surrey, B.C., Canada	(AWWA)
J.L. Mattson, Corrosion Control Technologies, Sandy, Utah	(AWWA)

* Alternate

A. Murdock, CH2M, Salt Lake City, Utah (AWWA)
R. Ortega,* Lockwood, Andrews & Newnam Inc., Houston, Texas (AWWA)
E.S. Ralph,† Standards Engineer Liaison, AWWA, Denver, Colo. (AWWA)
A.E. Romer, AECOM, Orange, Calif. (AWWA)
J.R. Snow, MWH Americas, Denver, Colo. (AWWA)
W.R. Whidden, Woolpert, Winter Park, Fla. (AWWA)

Producer Members

D.W. Angell,† Standards Council Liaison, American Flow Control, Birmingham, Ala. (AWWA)
S.A. Arnaout, Forterra Pressure Pipe, Dallas, Texas (AWWA)
H.H. Bardakjian, Consultant, Glendale, Calif. (AWWA)
D. Dechant, Dechant Infrastructure Service, Aurora, Colo. (AWWA)
V. DeGrande,* Ameron Water Transmission Group, Rancho Cucamonga, Calif. (AWWA)
W.B. Geyer, Steel Plate Fabricators Associates, Lake Zurich, Ill. (AWWA)
B.D. Keil, Northwest Pipe Company, Draper, Utah (AWWA)
J.L. Luka, American SpiralWeld Pipe Company, Columbia, S.C. (AWWA)
R.D. Mielke,* Northwest Pipe Company, Raleigh, N.C. (AWWA)
J. Olmos, Ameron International, Rancho Cucamonga, Calif. (AWWA)
G.F. Ruchti,* Consultant, Punta Gorda, Fla. (AWWA)
B.P. Simpson,* American Cast Iron Pipe Company, Birmingham, Ala. (AWWA)
C.C. Sundberg, Victaulic, Issaquah, Wash. (AWWA)
D. Walker, Avid Protective Products LTD/Trenmac Company, Oakville, Ont., Canada (AWWA)
J.A. Wise, Canus International Sales Inc., Surrey, B.C., Canada (AWWA)

User Members

L. Adams, US Bureau of Reclamation, Denver, Colo. (AWWA)
G.A. Andersen, New York City Bureau of Water Supply, Little Neck, N.Y. (AWWA)
B. Cheng, Metro Vancouver, Burnaby, B.C., Canada (AWWA)
M.E. Conner, San Diego County Water Authority, San Diego, Calif. (AWWA)
S. Hattan, Tarrant Regional Water District, Fort Worth, Texas (AWWA)
T.J. Jordan,* Metropolitan Water District of Southern California, LaVerne, Calif. (AWWA)
P.K. Karn, Tacoma Water, Tacoma, Wash. (AWWA)
M. McReynolds, Metropolitan Water District of Southern California, Oak Park, Calif. (AWWA)
K.K. Parbhoo, Los Angeles Department of Water and Power, Los Angeles, Calif. (AWWA)
M. Turney,* Denver Water, Denver, Colo. (AWWA)

* Alternate
† Liaison, nonvoting

Contents

All AWWA standards follow the general format indicated subsequently. Some variations from this format may be found in a particular standard.

This page intentionally blank.

Foreword

This foreword is for information only and is not part of ANSI/AWWA C602.*

I. Introduction.

I.A. *Background.* Cement–mortar lining provides the interior of a ferrous-metal pipe with a smooth finish that protects it from corrosion and tuberculation. The lining can significantly retard the recurrence of these problems in previously used pipe if the pipe has been properly cleaned and repaired before application of the lining. Furthermore, the lining can increase the pipeline's carrying capacity because of the reduction in friction resulting from streamlining surface irregularities.

The use of cement mortar as a protective lining for water mains was reported by the French Academy of Science in 1836. Fourteen years later, cement-lined, coated sheet-metal pipe was introduced in the United States. Some of the early pipelines were in use for the better part of a century, but it was not until the 1930s that a practical method was developed for lining pipe in place.

The first field trial of in-place cement–mortar lining (of pipe that had been in service) was conducted in Jersey City, N.J., in 1933. The pipe was a short section 72 in. (1,830 mm) in diameter. The favorable outcome of the trial led to the cleaning and lining of more than 27,000 ft (8,230 m) of aged 48-in. (1,220-mm) riveted-steel pipe supplying Newark, N.J. The lining stopped all leakage and, as a result of streamlining the surface over large rivets, also increased the Hazen-Williams flow coefficient by 14 points (estimated by the engineer).

For many years, the smallest-diameter pipe that could be reconditioned by the centrifugal process was 24 in. (600 mm) because a man was required to ride the lining machine through the pipe. In 1950, a remote-control centrifugal-lining machine was introduced that made in-place lining of progressively smaller-diameter pipe possible. Presently, pipelines ranging from 4 in. (100 mm) to 28 ft (9.2 m) in diameter can be cleaned and cement–mortar lined in place.

I.B. *History.* The first American Water Works Association (AWWA) standard for cement–mortar lining of pipe in place was published in 1939 as part of AWWA C205-41 (formerly 7A-7-41), Standard for Cement–Mortar Protective Lining and Coating for Steel Water Pipe. That standard was primarily concerned with in-plant lining and coating, a completely different process from in-place lining. Therefore, in

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

1951 the in-place lining portion was withdrawn and expanded into a separate standard under the direction of the late H.A. Price, who authored most of the new document. That standard, AWWA C602, Cement–Mortar Lining of Water Pipelines in Place—Sizes 16 In. and Larger, was approved as tentative in 1954 and made standard in 1955.

In 1962, Price suggested to the AWWA Steel Water Pipe Manufacturers Technical Advisory Committee (SWPMTAC) that AWWA C602-55 should be revised in view of the extended competence of the centrifugal-lining process, which at that time included pipe as small as 4 in. (100 mm) in diameter. The assignment was given to SWPMTAC Subcommittee 8 and resulted in the revision of the standard adopted and published in 1967.

In 1972, the standard was again considered for revision to reflect the state of the art of in-place cement–mortar lining. The more frequent use of in-place cement–mortar lining in new large-diameter steel pipelines prompted the committee to note some of the standard procedures used in this application. The standard was revised in 1976, 1983, 1988, 1995, 2000, 2006, and 2011. This edition was approved on Jan. 14, 2017.

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 direct and indirect drinking water additives. Other members of the original consortium included the Water Research Foundation (formerly 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. Specific policies of the state or local agency.
2. Two standards developed under the direction of NSF:† NSF/ANSI 60, Drinking Water Treatment Chemicals—Health Effects, and NSF/ANSI 61, Drinking Water System Components—Health Effects.

* Persons outside the United States should contact the appropriate authority having jurisdiction.
† NSF International, 789 North Dixboro Road, Ann Arbor, MI 48105.

3. 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 NSF/ANSI 61. Individual states or local agencies have authority to accept or accredit certification organizations within their jurisdictions. Accreditation of certification organizations may vary from jurisdiction to jurisdiction.

Annex A, "Toxicology Review and Evaluation Procedures," to NSF/ANSI 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 C602 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 parties offering to certify products for contact with, or treatment of, drinking water.
3. Determine current information on product certification.

II. Special Issues. This standard has no applicable information for this section.

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 information should be provided by the purchaser:

1. Standard used—that is, ANSI/AWWA C602, Cement–Mortar Lining of Water Pipelines in Place—4 In. (100 mm) and Larger, of latest revision.
2. Project. Diameter, length, and location of pipeline, including plan and profile drawings when available; limits of pipeline shutdowns, if service requirements make these limits necessary; location of access manholes; location, type, and size of valves; location of interconnecting pipelines, hydrant branches, and service pipes; location of

* Both publications available from National Academy of Sciences, 500 Fifth Street, NW, Washington, DC 20001.

fittings and restrictions that could interfere with cleaning and lining operations; location, diameter, and connections of temporary bypass, if required; and other details of the pipe within the scope of the contract between the purchaser and the constructor.

3. Thickness of cement–mortar lining. Nominal thickness of cement–mortar lining required (Sec. 4.4.5).

4. Services provided by purchaser. Description of services or field operations to be performed by the purchaser, such as locating the main to be cleaned and lined; removal and replacement of line valves; operation of valves; tagging valves that separate the main to be cleaned and lined from the water system to prevent accidental opening; shutting off inflow of water from connecting pipelines; locating and operating blowoffs; connecting and disconnecting temporary bypasses to customer services; obtaining permits required for the work; handling customer contacts; disinfection; and conducting flow tests.

5. Additional work to be performed by constructor. Description of work, including repairs to deteriorated pipe; extra thickness of lining over the rivet heads and lockbar seams; excavation, backfill, and resurfacing work at access excavations; method of opening and closing access openings in the pipeline; supplying, laying, and removing temporary bypass pipe; and operation of main-line or blowoff valves.

NOTE: When it is necessary to repair deteriorated pipe before lining, the pipe will be repaired by the purchaser or under provisions of the contract between the purchaser and the constructor.

6. Water for cleaning and lining operations. Location of water sources, method of supplying, quantity available, and pressure information.

7. Disposal of cleaning water and debris. Requirements for the disposal of cleaning water, old lining and other debris; instructions regarding permits from the responsible authorities.

8. Permissible cement–mortar materials. Preference for, or any restrictions on, type of portland cement or admixtures to be used in lining mortar.

9. Purchaser options. Options that may be specified by the purchaser after reviewing the following items in the sections noted:

a. Whether compliance with NSF/ANSI 61, Drinking Water System Components—Health Effects, is required.

b. Details of other federal, state or provincial, and local requirements (Sec. 4.3.1).

c. Portland cement (Sec. 4.3.2).

d. Use of admixtures (Sec. 4.3.3, 4.4.1, and 4.4.2).

e. Mortar lining thickness (Sec. 4.4.5).