

ANSI/AWWA **C104/A21.4-22**  
(Revision of ANSI/AWWA C104/A21.4-16)

AWWA Standard

# Cement–Mortar Lining for Ductile-Iron Pipe and Fittings

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American Water Works  
Association



## AWWA Standard

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# Foreword

*This foreword is for information only and is not a part of ANSI\*/AWWA C104/A21.4.*

## **I. Introduction.**

I.A. *Background.* The first cast-iron water mains were not lined but were installed in the same condition in which they came from the molds following cleaning. After many years, it became evident that the interior of the pipe could be affected by certain types of water. The first lining used to combat aggressive waters was a hot dip bituminous lining that protected the pipe satisfactorily, except in areas where water penetrated the pinholes in the bituminous lining, wherein tuberculation ensued. The need for a better lining to combat tuberculation led to experiments with cement mortar as a lining material.

Cement–mortar linings prevent tuberculation by creating a high pH at the pipe wall and ultimately by providing a physical barrier to the water. Cement–mortar linings are also smooth, which results in high flow coefficients.

In 1922, the first cement–mortar-lined cast-iron pipe was installed in the water distribution system of Charleston, S.C. The pipe was lined in the field using a projectile drawn through the pipe. Since this initial installation, many improvements have been made in the production of cement–mortar-lined pipe. Cement–mortar-lined pipes are now centrifugally lined at the foundry to ensure that quality control is maintained and that a uniform thickness of mortar is distributed throughout the length of the pipe.

I.B. *History.* From 1922 to 1929, many installations of cement–mortar-lined cast-iron pipe were made under various manufacturers' specifications. In 1929, the American Standards Association (ASA) [now the American National Standards Institute (ANSI)] Committee A21 on Cast-Iron Pipe and Fittings issued a tentative standard for cement–mortar linings, which was published by AWWA as a tentative standard in 1932. After many revisions and refinements, the standard was officially adopted by ASA in 1939 under the designation A21.4, American Standard Specifications for Cement–Mortar Lining for Cast-Iron Pipe and Fittings.

From 1940 to 1952, considerable research was done to improve the quality of the cement–mortar lining. The centrifugal process of lining was improved to provide the controls and techniques necessary to ensure uniformity of lining thickness throughout the length of the pipe. Methods of curing cement mortar were investigated, resulting

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

in the recognition that seal-coat materials could be used as a substitute for the moist-curing process. As a result of this research, a revised edition of the 1939 standard was approved and issued in 1953.

In 1958, Committee A21 was reorganized, and subcommittees were established to study each group of standards in accordance with ASA's review and revision policy. Subcommittee 4, Coatings and Linings for Cast-Iron Pipe, was organized to examine the existing ASA A21.4-53, American National Standard Specifications for Cement-Mortar Lining for Cast-Iron Pipe and Fittings. The subcommittee completed its study of A21.4-53 and submitted a proposed revision to Committee A21 in 1963. The revised third edition was approved and issued in 1964 and included a reduction in the minimum permissible thickness of lining. This reduction was based on more than 20 years of research by the Cast Iron Pipe Research Association (CIPRA) [now the Ductile Iron Pipe Research Association (DIPRA)] on experimental test lines having cement-mortar linings ranging from 1/32 to 1/4 in. (0.79 to 6.35 mm) in thickness and the assurance of uniformity of lining thickness using the centrifugal lining process. The 1964 revision also required the cement to meet the requirements of ASTM<sup>†</sup> C150, Specification for Portland Cement.

The next revision was issued in 1971. This revision incorporated a standard test for toxicity of the seal-coat material. The standard was again revised in 1974, and major changes to the section on lining quality were incorporated into that revision.

The 1980 revision to the standard included further changes to the section on lining quality, clarifying problems with some initial interpretations. Metric conversions of all dimensions and physical requirements were also included, and the projection method was added as an allowable means of lining pipe and fittings.

In the 1985 edition of the standard, all references to gray cast-iron pipe were deleted because gray cast-iron pipe was no longer being produced in the United States.

The 1990 revision of the standard included no major changes.

In 1995 the section on cement was expanded to include types of cement other than Portland, and the size range covered by the standard was expanded to include 3-in. through 64-in. (76-mm through 1,600-mm) sizes. Additionally, the section on seal-coat was revised to allow the manufacturer the option of providing the cement-mortar lining with or without a seal coat unless otherwise specified; the option of using seal-coat materials other than asphaltic was deleted.

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<sup>†</sup> ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428.

In 2003, the format was changed to the current AWWA standard style. Sec. 4.7 on the thickness of lining and Sec. 4.8 on determination of thickness were revised to delete the requirement that the thickness shall be determined while the mortar is wet.

The next edition of ANSI/AWWA C104 was approved by the AWWA Board of Directors on June 8, 2008. In 2008, wastewater and reclaimed water applications were added; water contact surfaces were allowed to be qualified for the limit of toxic substances in accordance with NSF/ANSI 61; and delivery requirements were added for Notice of Nonconformance and Affidavit of Compliance.

In 2013, raw water applications were added; testing to NSF/ANSI 61 or Food and Drug Administration (FDA) Section 175.300 of Title 21 *Code of Federal Regulations* (CFR) Resinous and Polymeric Coatings for products in contact with potable water was added; and a provision for blending other cements with ASTM C150 cement was added.

The last edition was approved on Jan. 16, 2016, and this edition was approved on Oct. 24, 2022.

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). 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.<sup>‡</sup> 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<sup>§</sup>: NSF/ANSI/CAN<sup>¶</sup> 60, Drinking Water Treatment Chemicals—Health Effects, and NSF/ANSI/CAN 61, Drinking Water System Components—Health Effects.

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<sup>‡</sup> Persons outside the United States should contact the appropriate authority having jurisdiction.

<sup>§</sup> NSF International, 789 North Dixboro Road, Ann Arbor, MI 48106.

<sup>¶</sup> Standards Council of Canada, 55 Metcalfe Street, Suite 600, Ottawa, ON K1P 6L5 Canada.

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/CAN 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/CAN 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 C104 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.**

II.A. *Use of Seal Coat.* Cement–mortar linings may be provided with or without a seal coat (Sec. 4.12.1). The purchaser of cement–mortar-lined pipe or fittings for use with water that is corrosive to cement, such as very soft water, should determine, by using the appropriate test, that a lining without a seal coat will not impart objectionable hardness or alkalinity to the water. The procedure outlined in Sec. 5.2.2.2, modified by the substitution of the water with which the pipe is to be used, is recommended. The concentration of leachates increases with the aggressiveness of the water and its residual time in the pipe and is indirectly proportional to the diameter of the pipe.

II.B. *Lining of Pipelines in Place.* This standard does not include provisions for cement–mortar lining of pipelines in place. Field lining of pipes is addressed in ANSI/AWWA C602.

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\*\* Both publications available from National Academies Press, 500 Fifth Street, NW, Washington, DC 20001.

**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 provided by the purchaser:

1. Standard used—that is, ANSI/AWWA C104, Standard for Cement–Mortar Lining for Ductile-Iron Pipe and Fittings, of latest revision.
2. Details of federal, state, provincial, and local requirements (Sec. 4.1).
3. For applications other than potable water, whether compliance with NSF/ANSI/CAN 61, Drinking Water System Components—Health Effects, or alternatively FDA Section 175.300 of Title 21 CFR, is required (Sec. 4.1.2).
4. Type of cement (Sec. 4.2).
5. Thickness of lining (Sec. 4.8). Two thicknesses of lining are available, and purchasers who require a lining thickness twice the standard thickness have the option of so specifying.
6. Seal-coat requirements (Sec. 4.12). The purchaser has the option of specifying if the cement–mortar lining is to be provided with or without a seal coat.
7. Notice of nonconformance (Sec. 6.1).
8. Request for an affidavit of compliance (Sec. 6.2).

III.B. *Modification to Standard.* Any modifications to the provisions, definitions, or terminology in this standard must be provided by the purchaser.

**IV. Major Revisions.** Major revisions made to the standard in this edition include the following:

1. Clarification to acceptable water use in Sec. 4.4.
2. Clarification to test record requirements in Sec. 5.1.5.
3. Clarification to notice of nonconformance in Sec. 6.1.

**V. Comments.** If you have any comments or questions about this standard, please call AWWA Engineering and Technical Services at 303.794.7711; FAX at 303.795.7603; write to the department at 6666 West Quincy Avenue, Denver, CO 80235-3098; or email at [standards@awwa.org](mailto:standards@awwa.org).

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# Cement–Mortar Lining for Ductile-Iron Pipe and Fittings

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## SECTION 1: GENERAL

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### **Sec. 1.1 Scope**

This standard describes shop-applied cement–mortar linings specified in the ANSI\*/AWWA C100/A21 series of standards for ductile-iron pipe and ductile-iron and gray-iron fittings for potable water, raw water, wastewater, and reclaimed water systems and is intended to be used as a supplement to those standards.

### **Sec. 1.2 Purpose**

The purpose of this standard is to provide the minimum requirements for shop-applied cement–mortar linings for ductile-iron pipe and ductile-iron and gray-iron fittings for potable water, raw water, wastewater, and reclaimed water systems, including requirements for cement, sand, water, and mortar; surface of pipe and fittings for lining; method and thickness of lining; and curing.

### **Sec. 1.3 Application**

This standard can be referenced in purchase documents for shop-applied cement–mortar linings for ductile-iron pipe and fittings for potable water, raw water, wastewater, and reclaimed water systems. The stipulations of this standard apply when this document has been referenced and only to shop-applied

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