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ANSI A21.4–1974
(AWWA C104–74)

Revision of
A21.4–1971
(AWWA C104–71)

AMERICAN NATIONAL STANDARD

for

CEMENT-MORTAR LINING FOR CAST-IRON AND DUCTILE-IRON PIPE AND FITTINGS FOR WATER

ADMINISTRATIVE SECRETARIAT
AMERICAN WATER WORKS ASSOCIATION

CO-SECRETARIATS
AMERICAN GAS ASSOCIATION
NEW ENGLAND WATER WORKS ASSOCIATION

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Foreword

This foreword is for information and is not a part of ANSI A21.4–1974 (AWWA C104–74).

I—History of Standard

The first recorded installation of cement-mortar linings in cast-iron pipe was in 1922 at Charleston, S.C., under the supervision of J. E. Gibson.

From 1922 to 1929, many installations were made under various manufacturers' specifications. In 1929, ASA (now ANSI) Sectional Committee A21 issued a tentative standard for cement-mortar linings. This was published as a tentative standard by AWWA in 1932. After many revisions and refinements, it was finally adopted by ASA in 1939 under the designation A21.4—Specifications for Cement-Mortar Lining for Cast-Iron Pipe and Fittings.

During the period 1940–52, much research was done on various types of cement, methods of manufacture, and methods of curing cement mortar to improve the quality of cement-mortar linings. As a result of this research, a revised edition of the 1939 standard was approved and issued in 1953.

The centrifugal process for lining was further developed during the 1940–52 period to provide the controls and techniques necessary for assurance of uniformity of thickness throughout the length of a pipe. Another major revision recognized the ability of cure-assist bituminous materials to provide controlled curing of the mortar. The use of this method was permitted as a substitute for the moist-curing process.

In 1958, Sectional 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 A21.4–1953, "Standard for Cement-Mortar Lining for Cast-Iron Pipe and Fittings." This subcommittee completed its study of A21.4–53 and submitted a proposed revision to Sectional Committee A21 in 1963. The revised third edition was approved and issued in 1964.

The 1964 standard reduced the minimum permissible thickness of the lining. This reduction was based on more than 20 years of Cast Iron Pipe Research Association (CIPRA) studies of experimental test lines having cement-mortar linings varying from $\frac{1}{32}$ in. to $\frac{1}{4}$ in. in thickness, on field tests of linings of these thicknesses that had been in service for more than 30 years, and on the assurance of uniformity of thickness afforded by improvements in the centrifugal lining process.

Two thicknesses of lining were made available, and purchasers who required a lining thickness twice the standard thickness had the option of so specifying.

The cement linings were specified for use in water lines only. This qualification was made to avoid the use of cement-mortar linings in pipe carrying aggressive liquids, which would react with the lining to produce undesirable results.

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The purchaser of cement-mortar-lined pipe or fittings for use with a water that is corrosive to calcium carbonate, such as a very soft water, is advised, before specifying the omission of the seal coat, to satisfy himself by appropriate test that such a lining will not impart objectionable hardness or alkalinity to the water. The procedure outlined in Sec. 4–14.4, modified by the substitution of the water with which the pipe is to be used for distilled water, is suggested as a convenient form of test.

The 1971 revision incorporated a standard test for toxicity of the seal coat material.

This standard does not include provisions for cement-mortar lining of pipelines in place.

II—Major Revision

The title of Sec. 4–13 has been changed from Finished Lining to Lining Quality, and the entire section has been rewritten to provide new requirements of acceptable lining.

III—Options

This standard includes certain options, which, if desired, *must* be specified. These are:

1. *Thickness of lining.* Two thicknesses of lining are available, and purchasers who require a lining thickness twice the standard thickness have the option of so specifying (Sec. 4–10).

2. *Seal coat.* As other seal coats than bituminous ones are available, this standard makes provision for their use (Sec. 4–14).

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Revision of
A21.4–1971
(AWWA C104–71)

American National Standard for

Cement-Mortar Lining for Cast-Iron and Ductile-Iron Pipe and Fittings for Water

Sec. 4–1—Scope

This standard covers cement-mortar linings specified in the A21 series of ANSI Standards for Cast-Iron and Ductile-Iron Pipe and Fittings for Water and is intended for use as a supplement to those standards.

Sec. 4–2—Cement

The cement shall meet the requirements of "Standard Specifications for Portland Cement," ASTM Designation C150–73–a. The analysis and physical test records of each shipment shall be kept for reference for 1 year.

The type of cement selected shall be left to the option of the pipe and fittings manufacturer.

Sec. 4–3—Sand

4–3.1. *Type of sand.* The sand shall be well graded, from fine to coarse, and consist of inert granular material having hard, strong, durable, uncoated grains and meet the test requirements of Sec. 4–3.2.

4–3.2. *Testing of sand.* The sand shall be tested in accordance with the requirements of these sections:

4–3.2.1. *Sampling.* The sand to be tested shall be sampled according to Sections 14 and 15 of ASTM D75–71, "Standard Methods of Sampling Aggregates."

4–3.2.2. *Sieve tests.* The sand shall be tested with standard sieves, as defined in ASTM Designation E11–70, "Standard Specification for Wire-Cloth Sieves for Testing Purposes," and shall meet the requirements listed in Table 1. One sieve analysis shall be performed on each carload of sand delivered. For sand delivered by other means, one sieve analysis shall be made for each 50 tons.

4–3.2.3. *Colorimetric test.* The test for impurities shall be in accordance with ASTM C40–73, "Standard Method of Test for Organic Impurities in Sands for Concrete."

TABLE 1

Requirements for Sand Tested With Standard Sieves

Min. Thickness of Lining *in.*	Sieve Requirement*	
	100 Per Cent of Sand Shall Pass (Sieve No.)	75 Per Cent of Sand Shall Pass (Sieve No.)
$\frac{1}{16}$	12	20
$\frac{3}{32}$	12	16
$\frac{1}{8}$	12	†
$\frac{3}{16}$	8	†
$\frac{1}{4}$	6	†

* Not more than 10 per cent, by weight, of any sand shall pass through sieve No. 100.
† Not applicable.

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Under this test, the sand shall not produce a color darker than required in the standard. The sand shall be acceptable, however, if it is shown by adequate test that the impurities causing the color are not harmful to the strength or other specified properties of the finished lining.

The colorimetric tests of sand from an established source of supply shall be made once each 6 months. For sand from a new source, these tests shall be made not less than once a month for a period of 6 months.

4–3.2.4. *Decantation test.* The sand shall be tested according to ASTM C117–69, "Standard Method of Test for Materials Finer Than No. 200 (75-μm) Sieve in Mineral Aggregates by Washing."

At the option of the manufacturer, the clay content and sand grain fineness may be determined by using the American Foundrymen's Society procedure, described in the *Foundry Sand Handbook*, Seventh Edition, Section 5. By this latter method, the total percentage finer than No. 200 sieve, as defined in ASTM Designation C119–71, is equal to the AFS percentage of clay plus the percentage passing through the No. 200 sieve.

No more than 2 per cent shall be lost in the decantation test.

The decantation tests of sand from an established source of supply shall be made once each 6 months. For sand from a new source, these tests shall be made not less than once a month for a period of 6 months.

4–3.2.5. *Test records.* The requirements of Sec. 4–3.2.2, 4–3.2.3, and 4–3.2.4 shall be met, and the records shall be filed for reference for 1 year.

Sec. 4–4—Water

The water used for tempering the mortar shall meet the requirements of the United States Public Health Service Drinking Water Standards 1962.

Sec. 4–5—Mortar

Mortar for the lining shall be composed of cement, sand, and water. The mortar shall be well mixed and of proper consistency to produce a dense, homogeneous lining that will adhere firmly to the pipe or fitting surface. Admixtures may be used, provided the linings meet all the requirements of this standard. The cement mortar shall contain not less than one part of cement to two parts of sand, by volume.

Sec. 4–6—Preparation of Pipe and Fittings for Lining

The surface to be lined shall be free from foreign material, which would adversely affect the lining adhesion or cause inclusions, blisters, or voids in the lining. The surface shall be free from projections of iron which may protrude through the lining.

Sec. 4–7—Method of Lining

4–7.1. *Lining of pipe and fittings.* Pipe shall be lined by the centrifugal process. Fittings shall be lined by a process that will produce linings meeting the requirements of this standard.

4–7.2. *Mortar.* The waterway surfaces of pipe and fittings shall be completely covered with the specified mortar. The mortar shall be entirely free from holidays or visible bubbles of air and shall be thoroughly compacted throughout. The consistency of the mortar and the time and speed of spinning of the pipe shall be so adjusted as to minimize the segregation of the sand from the cement and to deliver the finished lining substantially free of laitance.

4–7.3. *Repair of defective or damaged areas of linings.* Defective or

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damaged areas of linings may be patched by cutting out the defective or damaged lining to the metal so that the edges of the lining not removed are perpendicular or slightly undercut. A stiff mortar shall be prepared in accordance with Sec. 4–5. The cut-out area and the adjoining lining shall be thoroughly wetted, and the mortar applied and troweled smooth with the adjoining lining. After any surface water has evaporated, but while the patch is still moist, it shall be cured as specified in Sec. 4–12.

Sec. 4–8—Socket

The socket shall be free of mortar.

Sec. 4–9—Protection of Work

The lined pipe and fittings shall be protected from extreme heat due to direct rays of the sun, from impact of rainfall, and from freezing temperatures until the linings have cured sufficiently to withstand these conditions.

Sec. 4–10—Thickness of Lining

4–10.1. *Standard thickness.* The thickness of linings for pipe and fittings, as determined in Sec. 4–11, shall be not less than $\frac{1}{16}$ in. for 3–12 in. pipe, $\frac{3}{32}$ in. for 14–24 in. pipe, and $\frac{1}{8}$ in. for 30–54 in. pipe.

4–10.2. *Double thickness.* Linings with thicknesses twice those specified in Sec. 4–10.1 shall be furnished if specified by the purchaser.

4–10.3. *Taper of linings.* Lining thickness may taper to less than the specified minimum thickness at the ends of the pipe or fitting. The length of the taper shall be as short as practicable and shall not exceed 2 in.

4–10.4. *Permitted tolerances.* A thickness tolerance of $+\frac{1}{8}$ in. shall be permitted on pipe and $+\frac{1}{4}$ in. on fittings.

Sec. 4–11—Determination of Thickness

Lining thickness shall be determined at intervals frequent enough to assure compliance. Thickness of lining may be determined by means of spear measurement, with a hardened-steel point not larger than $\frac{1}{16}$ in. in diameter. The inspector shall pierce the lining immediately after it is placed in the pipe or fitting and before the mortar has set. The lining shall be pierced at four equidistant points on two cross sections of the barrel at each end of the pipe or fitting. The first set shall be not more than 4 in. from the respective ends of the pipe or fitting. The second set shall be made as far into the interior of the pipe or fitting as can be readily reached without injuring the lining.

Sec. 4–12—Curing

The lining shall be cured in such a manner as to produce a properly hydrated mortar lining that is hard and durable and will otherwise meet the requirements of Sec. 4–13. The cure may be effected by the application of a seal coat to the still-moist lining.

Sec. 4–13—Lining Quality

The lining shall be free from voids, ridges, or corrugations that reduce the thickness of lining to less than the specified thickness.

Unbonded areas of cement lining in a pipe or fitting are acceptable if the dimension of any single area does not exceed the nominal diameter in the circumferential direction and in longitudinal direction does not exceed the nominal diameter or 12 in., whichever is greater.

Longitudinal cracks less than 9 in. in length or less than the nominal diameter, whichever is greater, are accept-

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able. Circumferential cracks of any length are acceptable. Surface crazing is acceptable.

Repair of any unacceptable condition is permitted in the field, in accordance with Sec. 4–7.3.

Sec. 4–14—Seal Coat

4–14.1. *General.* Unless otherwise specified, the cement lining shall be given a seal coat of bituminous material. Other seal coat materials may be used, but they shall be agreed upon at the time of purchase and shall be specified on the purchase order.

4–14.2. *Seal coat characteristics.* The seal coat shall be continuous and shall adhere to the mortar lining at all points. The seal coat, after drying for at least 48 hr, shall have no deleterious effect upon the quality, color, taste, or odor of potable water.

4–14.3. *Limit of toxic substances.*

4–14.3.1. *Requirements.* The seal coat material shall not yield chloroform–soluble extractives, corrected for zinc extractives as zinc oleate, in excess of 18 mg per sq in. of surface exposed or of 50 ppm by weight of the water capacity of the test container.

4–14.3.2. *Frequency of test.* The seal coat material shall be tested at sufficiently frequent intervals to determine that it meets the requirements prescribed in Sec. 4–14.3.1.

4–14.3.3. *Method of testing.* The procedure used in the determination of the amount of toxic substances shall be in accordance with the FDA "Method of Testing for Toxicity of Coating Material Intended for Use in Transporting or Holding Food or Potable Water," as described in *Food Additives Amendment and Code of Federal Regulations,* pp. 13.0 through 13.8, April 16, 1963, Food and Drug Administration, US Department of Health, Education and Welfare. The seal coat material shall be extracted with distilled or demineralized water at 120F for 24 hr.

4–14.4. *Leaching resistance.*

4–14.4.1. *Requirements.* The seal-coated pipe shall impart to the water during any 24-hr test period no more than 25 ppm of hardness or 25 ppm of total alkalinity, and shall impart no caustic alkalinity.

4–14.4.2. *Frequency of test and records.* Leaching tests shall be made at sufficiently frequent intervals to assure compliance. The results of one test each month shall be filed for reference for 1 year.

4–14.4.3. *Method of testing.* The seal-coated pipe shall be tested as follows:

The test specimen shall be at least 6 in. in length, either cut or isolated by suitable closure pieces. When a cut section is used, it shall be bedded on end in a shallow pan of molten paraffin. After the paraffin has cooled, the cut section shall be filled nearly to the top with distilled or demineralized water at laboratory temperature. The top shall be covered with a glass plate and sealed with petroleum jelly. If an isolated section is used, it shall be filled through a tap in the closure device with distilled or demineralized water at laboratory temperature.

In either case, the water in the specimen shall be changed and tested after 24-hr contact on each of 3 successive days. The methods and procedures used in the determination of hardness and alkalinity shall be those prescribed in *Standard Methods for the Examination of Water and Wastewater,* APHA, AWWA, and WPCF, thirteenth edition, 1971.

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