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AWWA Standard

Ductile-Iron and Gray-Iron Fittings

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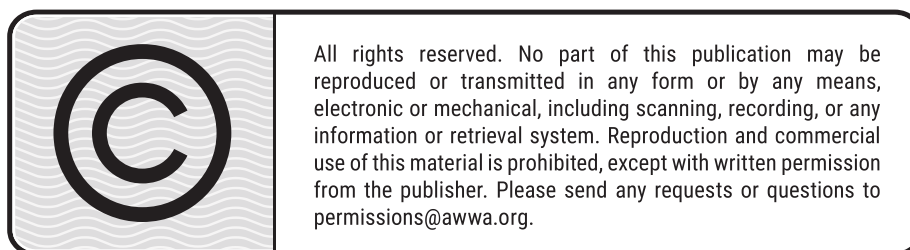
AWWA Standard

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Foreword

This foreword is for information only and is not a part of ANSI/AWWA C110/A21.10.*

I. Introduction.

I.A. *Background.* American National Standards Committee A21 on Cast-Iron Pipe and Fittings was organized in 1926 under the sponsorship of the American Gas Association (AGA), the ASTM International (ASTM), the American Water Works Association (AWWA), and the New England Water Works Association (NEWWA). Between 1972 and 1984, the co-secretariats were AGA, AWWA, and NEWWA, with AWWA serving as administrative secretariat. In 1984, the committee became an AWWA committee with the name AWWA Standards Committee A21 on Ductile Iron Pipe and Fittings. In 1988, NEWWA withdrew as a separate secretariat; however, it continues to maintain its representation on the A21 Committee. In 1997, AGA withdrew as co-secretariat.

The present scope of Committee A21 activity is the development of standards and manuals addressing ductile-iron pressure pipe for water and ductile-iron and gray-iron fittings for use with such pipe. These standards and manuals include topics such as design, dimensions, materials, coatings, linings, joints, accessories, methods of inspection and testing, and installation.

The work of Committee A21 is conducted by subcommittees. The scope of Subcommittee 3, Fittings, includes the periodic review of current A21 standards for fittings and the preparation of revisions and new standards, when needed, for fittings to be used with cast-iron and ductile-iron pressure pipe included in A21 standards.

I.B. *History.* The evolution of AWWA and ANSI standards for fittings is presented in this foreword to provide information relating to systems having aged cast-iron pipe and fittings still in service.

The earliest record of an AWWA standard for cast-iron pipe is contained in the Report of Proceedings of the Tenth Annual Meeting of the American Water Works Association (1890). In 1902, NEWWA adopted a more detailed standard titled “Standard Specification for Cast Iron Pipe and Special Castings.”

The next AWWA standard for pipe and fittings, AWWA 7C.1-1908, was approved May 12, 1908. A second edition, AWWA C100-52T, was approved by AWWA Dec. 31, 1952, and by NEWWA Jan. 23, 1953. The third edition, AWWA C100-54T, was approved by AWWA Oct. 25, 1954, and finally issued as AWWA C100-55, having been

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

advanced from tentative to standard without change June 17, 1955. AWWA C100-55 covered fittings in the size range 4 to 60 in. (100 to 1,500 mm). The fittings were bell and spigot (caulked joint) of the so-called long-radius design. The outside diameter (OD) for spigots varied with wall thicknesses, which were designated classes A, B, C, and D. Fittings 4 to 12 in. (100 to 300 mm) were made to class D patterns, having only one OD and pressure rating. Fittings 14 to 24 in. (350 to 600 mm) in size were provided in classes B and D, and fittings 30 to 60 in. (750 to 1,500 mm) in size were provided in classes A, B, C, and D. Fittings made in accordance with AWWA 7C.1-1908 and C100-55 had the class identification cast on the fitting.

ASA[†] A21.10-1952 (AWWA C110-52) was approved by ASA Sept. 30, 1952, following approval by AWWA May 4, 1951. The standard described 3- to 12-in. (80- to 300-mm) fittings of the so-called short-body design, which were the subject of extensive research and tests by Committee A21. The rated pressure given by the standard was 250 psi (1,724 kPa) plus water hammer. The standard provided a safety factor of 2.5 plus water hammer based on burst tests. Hydraulic losses were determined and compared with those found with long-radius fittings manufactured in accordance with AWWA Standards. The minimum grade of cast iron in the standard was 25,000 psi (172.4 MPa) tensile strength.

ASA A21.10-1964 (AWWA C110-64) was approved by ASA Jan. 9, 1964. The revision described 2- to 48-in. (50- to 1,200-mm) fittings. The design of the 14- to 48-in. (350- to 1,200-mm) fittings in the revision was based on an exhaustive series of burst tests. The minimum grade of cast iron (25,000 psi [172.4 MPa] tensile strength) was retained, and higher grades up to 35,000 psi (241.3 MPa) tensile strength were used to secure higher pressure ratings without radically changing the thicknesses. Ductile iron, grade 80-60-03, was also added in the 14- to 48-in. (350- to 1,200-mm) sizes with a rated working pressure of 250 psi (1,724 kPa), having the same wall thicknesses as 150-psi (1,034-kPa) rated gray-iron fittings. The minimum safety factor based on burst tests of representative fittings of the weakest type was three times the rated working pressure. Tables for flanged fittings and mechanical-joint fittings were added for the first time.

ANSI A21.10-1971 (AWWA C110-71) was approved by ANSI July 14, 1971. Ductile-iron fittings were added in sizes 3 to 12 in. (80 to 300 mm) and were rated for 350 psi (2,413 kPa) working pressure. The grade of ductile iron was changed to 70-50-05 to provide greater toughness. The safety factor against bursting was three

[†] American Standards Association (ASA) is the former name of the American National Standards Institute.

times the rated working pressure. If required by the purchaser on special order, fittings were required to withstand a hydrostatic proof test not to exceed one-and-one-half times the rated working pressure without leaks or permanent distortions.

ANSI A21.10a-1972 (AWWA C110a-72) was approved Dec. 17, 1972, as a supplement to ANSI A21.10-1971. The pressure rating for 14- to 24-in. (350- to 600-mm) ductile-iron fittings was increased to 350 psi (2,413 kPa).

ANSI/AWWA C110-77 (ANSI A21.10) was approved by ANSI Apr. 7, 1977. The major change in this revision was the discontinuance of bell-and-spigot fittings (caulked joints) and 2- and 2¼-in. (50- and 56-mm) fittings in the standard. These actions were taken because the use of caulked joints had steadily declined until their use had become a rarity and the 2- and 2¼-in. (50- and 56-mm) sizes were no longer manufactured in the United States. (Bell-and-spigot fittings are still available from some foundries on special order.) With the elimination of 2- and 2¼-in. (50- and 56-mm) sizes, the standard included 3- to 48-in. (80- to 1,200-mm) mechanical-joint and flanged fittings only.

Another change made in the 1977 edition was in bolt lengths for flanged fittings to comply with ANSI/AWWA C115/A21.15-75, Standard for Flanged Cast-Iron and Ductile-Iron Pipe with Threaded Flanges. Appendix A was added to the standard to cover bolts, gaskets, and the installation of flanged fittings. Appendix B was added as a listing of available special fittings that are not a part of the standard. These include reducing bends, Y-branches, blind flanges, reducing tees, bullhead tees, flared fittings, side-outlet tees and elbows, and wall pipe.

The following note introduced in the 1977 edition cautioned about using mechanical-joint fittings with aged existing cast-iron pipe:

NOTE: Care should be used when connecting mechanical-joint fittings to aged existing cast-iron pipe. The outside diameter of aged pipe should be measured prior to cutting since some of the older pipe was manufactured to a larger diameter than is presently specified in A21 standards. Mechanical-joint sleeves or bell-and-spigot (caulked-joint) sleeves are available to provide transition from existing cast-iron pipe; however, they must be specified on the purchase order. Center to bottom-of-socket dimensions (dimension A in Table 3 and dimension J in Table 4 of this standard) for A21.10 mechanical-joint fittings are the same as the center to bottom-of-socket dimensions for bell-and-spigot (caulked-joint) fittings specified in the 1971 and previous editions of A21.10. The following standards contain reference dimensions useful in classifying existing cast-iron pipe:

AWWA 7C.1-1908 (AWWA C100-55), Standard Specifications for Cast Iron Pressure Fittings, Table 1.

ASA A21.2-1953 (AWWA C102-53), American Standard for Cast Iron Pit Cast Pipe for Water or Other Liquids, Tables 2.1 and 2.2.

ANSI A21.6-1975 (AWWA C106-75), American National Standard for Cast-Iron Pipe Centrifugally Cast in Metal Molds for Water or Other Liquids, Tables 6.4, 6.5, and 6.6.

ANSI A21.8-1975 (AWWA C108-75), American National Standard for Cast Iron Pipe Centrifugally Cast in Sand-Lined Molds for Water or Other Liquids, Tables 8.4, 8.5, and 8.6.

ANSI/AWWA C110/A21.10-82, as approved by ANSI Aug. 24, 1982, introduced no major revisions.

ANSI/AWWA C153/A21.53-84 (First Edition), American National Standard for Ductile-Iron Compact Fittings, 3 In. through 12 In. (80 mm through 300 mm), for Water and Other Liquids, was approved by ANSI Feb. 4, 1985. This standard, developed by Standards Committee A21, Subcommittee 3, Fittings, presents compact fittings designed to use the attendant strength of ductile iron.

ANSI/AWWA C151/A21.51-86, American National Standard for Ductile Iron Pipe Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids, Tables 51.4 and 51.5.

ANSI/AWWA C110/A21.10-87 was approved by ANSI Oct. 30, 1987. The major revisions included new sections on rejection of fittings and determination of rejection, and ductile-iron grade 60-42-10 was added. Cast marking of the country where cast was added; Sec. 10-4.3, Joint Accessories, was added; and 14 through 48-in. (350 through 1,200-mm) solid sleeves made with B-pattern equipment were added.

ANSI/AWWA C110/A21.10-93 was approved by ANSI Aug. 10, 1993. Major revisions in this edition of the standard included the addition of a section on health effects and permeation, allowance for reduced metal-section thicknesses for ductile-iron glands, addition of a precautionary note on the use of flange gaskets thinner than $\frac{1}{8}$ in. (3.2 mm) in appendix A, addition of flanged-joint bolt tightening sequence to appendix A, and the addition of a section on ring gaskets in appendix A.

ANSI/AWWA C110/A21.10-98 was approved by ANSI September 10, 1998. Major revisions included limiting the scope to water service, noting the possibility of 350 psi (2,413 kPa) rating for 12 in. (300 mm) and smaller flanged fittings with the use of special gaskets, and the optional status of seal coat on cement–mortar linings. Table 1 was revised to include plus tolerances on the K1, K2, and L dimensions; longer

bolt lengths for 42- and 48-in. (1,050- and 1,200-mm) sizes; and the footnote on ductile-iron glands. Tables 16 through 19 were revised to show 3- through 12-in. (80- through 300-mm) flanged ductile-iron fittings with the same dimensions as gray-iron fittings.

ANSI/AWWA C110/A21.10-03 was approved by ANSI on October 7, 2003. Major revisions included recognition of the current scope of the A21 Committee. The scope of the standard was amended and Tables 12 and 15 through 19 were footnoted to recognize that 24-in. (600-mm) and smaller flanged fittings may be rated for 350 psi (2,413 kPa) with the use of specially designed gaskets, either ring or full-face, using annular rings molded into the gasket to improve performance as recommended by the manufacturer.

The scope of the standard was additionally revised to include a surge allowance. Sec. 4.3.1 was revised to reference ANSI/AWWA C111/A21.11 for the details of mechanical joint bell, plain end, and accessories. The figure and table providing details of the mechanical joint were deleted. Sec. 4.4.4 was revised to include fusion-bonded epoxy coating systems as a manufacturer's option.

ANSI/AWWA C110/A21.10-08 was approved by the AWWA Board of Directors on Jan. 27, 2008. Major revisions included expansion of the scope and purpose to include wastewater and reclaimed water and additional requirements for materials.

The 2012 edition was approved on Jan. 22, 2012.

This edition was approved on Oct. 25, 2021.

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 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

[‡] Persons outside the United States should contact the appropriate authority having jurisdiction.

1. Specific policies of the state or local agency.
2. Two standards developed under the direction of NSF, NSF[§]/ANSI/CAN 60, Drinking Water Treatment Chemicals—Health Effects, and NSF/ANSI/CAN 61, Drinking Water System Components—Health Effects.
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 jurisdiction. 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 C110/A21.10 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. *Advisory Information on Product Application.* Unless otherwise provided in the purchaser’s documents, all fittings and accessories shall comply with this standard.

II.B. *Chlorine and Chloramine Degradation of Elastomers.* The selection of materials is critical for water service and distribution piping in locations where there is a possibility that elastomers will be in contact with chlorine or chloramines. Documented research has shown that elastomers such as gaskets, seals, valve seats, and encapsulations may be degraded when exposed to chlorine or chloramines. The impact of degradation is a function of the type of elastomeric material, chemical concentration,

[§] NSF International, 789 North Dixboro Road, Ann Arbor, MI 48105.

[¶] Both publications available from National Academy of Sciences, 500 Fifth Street NW, Washington, DC 20418.

contact surface area, elastomer cross section, environmental conditions as well as temperature. Careful selection of and specifications for elastomeric materials and the specifics of their application for each water system component should be considered to provide long term usefulness and minimum degradation (swelling, loss of elasticity or softening) of the elastomer specified.

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 C110, Ductile-Iron and Gray-Iron Fittings, of latest revision.
2. Size, joint type, pressure rating (Sec. 1.1 and tables).
3. Details of federal, state, or provincial, and local requirements (Sec. 4.1.1).
4. For applications other than potable water, whether compliance with NSF/ANSI 61, Drinking Water System Components—Health Effects, is required (Sec. 4.1.2).
5. Permeation (Sec. 4.2).
6. Joint requirements (Sec. 4.3.1 and Sec. 4.3.2).
7. Joint accessory requirements (Sec. 4.3.3).
8. Type of iron required, gray or ductile (Sec. 4.3.4).
9. End combinations for nonstandard fittings (Sec. 4.3.5).
10. Type of coating and lining required: asphaltic coating, cement–mortar lining, or fusion bonded epoxy lining (Sec. 4.4.1). If cement–mortar lining is required, identify if asphaltic seal coat is required or not (Sec. 4.4.3).
11. Elimination of lining (either cement–mortar lining or fusion bonded epoxy) and if eliminated, identify whether to apply asphaltic lining or not (Sec. 4.4.5). Experience has indicated that the petroleum asphaltic inside coating is not complete protection against loss in pipe capacity caused by tuberculation. Cement–mortar linings are recommended for most waters.
12. Special coatings and linings requirements (Sec. 4.4.5 and Sec. 4.4.6).
13. Special flange bolt-hole orientation (Sec. 4.5.3.2).
14. Requirement for certification by manufacturer (Sec. 5.1.3).
15. Inspection by purchaser (Sec. 5.2).
16. Acceptance tests requirements transverse or tensile (Sec. 5.4.1.1).
17. Special tests requirements (Sec. 5.6).

III.B. *Special Service Requirements.* The following special service requirements should be noted:

1. The fittings for which this standard is intended are those normally used for potable water, wastewater, and reclaimed water. The 120°F (49°C) temperature maximum (Sec. 1.1) reflects immersion temperature limitations of most epoxies. Seal-coated cement–mortar lining and bare cement–mortar linings have higher temperature limitations. Consult the manufacturer for service requirements above 120°F (49°C).

2. The method of installation of fittings depends on the type of joint and should be made in accordance with applicable parts of ANSI/AWWA C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; ANSI/AWWA C600, Installation of Ductile-Iron Mains and Their Appurtenances; and recommendations of manufacturers regarding their product.

3. Attention is directed to an apparent conflict between this standard and ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings, with regard to pressure ratings for flanged fittings.

In ANSI/AWWA C110/A21.10, flanged joint fittings are rated for 150- or 250-psi (1,034- or 1,724-kPa) working pressure, depending on the material, that is, gray iron or ductile iron; the wall thickness of gray iron; and the size of the fitting. The ratings of these fittings were established on the basis of hydrostatic testing of fittings to bursting and provide for a factor of safety of at least 3.0 at the rated working pressure and at ambient temperature. ANSI/AWWA C110/A21.10 flanges that are adequate for water service of 250-psi (1,724-kPa) working pressure have facing and drilling identical to ASME B16.1 class 125 flanges and match class 125 B16.1 flanges that for service at –20 to 150°F (–28.9 to 65.6°C) are rated for only 150 to 200 psi (1,034 to 1,724 kPa), depending on the flange size and the class or grade of iron.

ASME B16.1 describes both separate flanges and flanged fittings of gray iron for service at both ambient and elevated temperatures. The pressure-temperature ratings of these flanges, as stated in ASME B16.1 and stated on the flyleaf of that standard, are not based on burst strength, but have evolved over an extended period of time of satisfactory performance in a wide range of general service conditions. These ratings encompass pressure combined with elevated temperature, stresses imposed by piping, thermal stresses caused by temperature variations, and many other conditions causing stress in the flange or fitting.

ASME B16.1 also contains the design of a class 250 flange, which is much heavier, has a larger bolt circle, and uses larger-sized bolts than the B16.1 class 125 flange and the flanges described in ANSI/AWWA C115/A21.15 and in this standard. ASME B16.1

class 250 flanges will not connect to the B16.1 class 125 flange, the ANSI/AWWA C115/A21.15 flange, or the ANSI/AWWA C110/A21.10 flange.

4. Although this standard does not detail the orientation of bolt holes in the flanges of the mechanical joint, it is at times convenient or necessary to have the bolt holes specially oriented. The normal but not universal practice is to have the bolt holes straddle the vertical centerline of the fittings, valves, and hydrants. (The vertical centerline of a fitting is determined when the fitting is in the position to change the direction of fluid flowing in a horizontal plane. With standard base bends and standard base tees, the vertical centerline is determined when the fitting is in a position to change the fluid flowing in a vertical plane.) If special orientation is known to be necessary, it should be stated on the purchase order.

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

IV. Major Revisions. The major revisions made to this standard in this edition are as follows:

1. An advisory statement was added in the Foreword (Sec. II.B) regarding chlorine and chloramine degradation of elastomers.
2. Removed requirement that fittings shall be capable of withstanding, without bursting, hydrostatic tests of 2.5 times the rated working water pressure from Sec. 4.3.4, Type of iron, since it is now covered in new Sec. 5.7, Performance Requirements.
3. Manufacturer certifications requirements were updated and moved from Sec. 5.1.3, *Certification by manufacturer*, to Sec. 5.7 Performance Requirements.
4. Sec. 5.4.2.1 was modified to add 65-45-12 as a standard grade of iron.
5. Fittings having proprietary joints shall be marked with the proprietary name or trademark of the joint was added to Sec. 6.1, Marking.
6. Tables were updated. 150 psi rated fittings have been deleted for 42-in. and 48-in. sizes.
7. Appendix A, Sec. A.1: Bolts and Nuts, was revised.

V. Comments. If you have any comments or questions about this standard, please call AWWA Engineering and Technical Services at 303.794.7711, write to the department at 6666 West Quincy Avenue, Denver, CO 80235-3098, or e-mail at standards@awwa.org.

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ANSI/AWWA C110-21/A21.10-21
(Revision of ANSI/AWWA C110/A21.10-12)

AWWA Standard

Ductile-Iron and Gray-Iron Fittings

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes 3- to 48-in. (80- to 1,200-mm)* gray-iron or ductile-iron fittings to be used with ductile-iron pipe for potable water, wastewater, and reclaimed water for a temperature range of 33–120° F (0.6–49°C). Requirements for fittings with mechanical joints and flanged joints are listed in Tables 3 through 21 at the end of this standard. This standard may also be used for fittings with push-on joints or such other joints as may be agreed on at the time of purchase.

For the 3- to 24-in. (80- to 600-mm) size range, ductile-iron mechanical-joint fittings and ductile-iron push-on-joint fittings are rated for 350-psi (2,413-kPa) working pressure. Ductile-iron flange-joint fittings are rated for 250-psi (1,724-kPa) working pressure; however, 24-in. (600-mm) and smaller sizes may be rated for 350 psi (2,413 kPa) with the use of special gaskets. Gray-iron fittings having all types of joints described in this standard are rated for 150- or 250-psi (1,034- or 1,724-kPa) working pressures, as shown in the tables.

For the 30- to 48-in. (750- to 1,200-mm) size range, fittings with all types of joints described in this standard are shown in the tables with rated working

* Metric identifiers in this standard are nominal sizes and are not those specified in International Organization for Standardization (ISO) standards.

pressures of 150 or 250 psi (1,034 or 1,724 kPa), depending on the type of iron, as shown in the tables.

Fittings are adequate for the rated working pressure plus a surge allowance of 100 psi (689 kPa) or a surge allowance of half the rated working pressure, whichever is less.

Sec. 1.2 Purpose

The purpose of this standard is to provide the minimum requirements for ductile-iron and gray-iron fittings, 3 through 48 in. (80 through 1,200 mm), for potable water, wastewater, and reclaimed water.

Sec. 1.3 Application

This standard can be referenced in specifications for ductile-iron and gray-iron fittings, 3 through 48 in. (80 through 1,200 mm), for potable water, wastewater, and reclaimed water. The stipulations of this standard apply when this document has been referenced and then only to ductile-iron and gray-iron fittings, 3 through 48 in. (80 through 1,200 mm), for potable water, wastewater, and reclaimed water.

SECTION 2: REFERENCES

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

ANSI*/AWWA C104/A21.4—Cement–Mortar Lining for Ductile-Iron Pipe and Fittings.

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

ANSI/AWWA C116/A21.16—Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings.

ANSI/AWWA C153/A21.53—Ductile-Iron Compact Fittings.

ANSI/AWWA C600—Installation of Ductile-Iron Mains and Their Appurtenances.

ASME[†] B16.1—Cast Iron Pipe Flanges and Flanged Fittings.

ASTM[‡] A48—Standard Specification for Gray Iron Castings.

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

† ASME International, Three Park Avenue, New York, NY 10016.

‡ ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

ASTM A438—Standard Test Method for Transverse Testing of Gray Cast Iron (Withdrawn 2003).

ASTM A536—Standard Specification for Ductile Iron Castings.

NSF[§]/ANSI/CAN 61—Drinking Water System Components—Health Effects.

SECTION 3: DEFINITIONS

The following definitions shall apply in this standard:

1. *Ductile iron*: A cast ferrous material in which a major part of the carbon content occurs as free graphite in a substantially nodular or spheroidal form.
2. *Flange joint*: The flanged and bolted joint as detailed in Figure 13 and Table 15.
3. *Gray iron*: The cast ferrous material in which a major part of the carbon content occurs as free graphite in the form of flakes interspersed throughout the metal.
4. *Manufacturer*: The party that manufactures, fabricates, or produces materials or products marked with their brand name.
5. *Mechanical joint*: The gasketed and bolted joint as detailed in ANSI/AWWA C111/A21.11.
6. *Potable water*: Water that is safe and satisfactory for drinking and cooking.
7. *Purchaser*: The person, company, or organization that purchases any materials or work to be performed.
8. *Push-on joint*: The single rubber-gasket joint as stated in ANSI/AWWA C111/A21.11.
9. *Reclaimed water*: Wastewater that becomes suitable for beneficial use as a result of treatment.
10. *Supplier*: The party that supplies material or services. A supplier may or may not be the manufacturer.
11. *Wastewater*: A combination of the liquid and water-carried waste from residences, commercial buildings, industrial plants, and institutions, together with any groundwater, surface water, and stormwater that may be present.

[§] NSF International, P.O. Box 130140, 789 North Dixboro Road, Ann Arbor, MI 48105.

SECTION 4: REQUIREMENTS

Sec. 4.1 Materials

4.1.1 *Materials.* Materials shall comply with the requirements of the Safe Drinking Water Act and federal regulations for potable water, wastewater, and reclaimed water systems as applicable.

4.1.2 *Certification.* Products intended for contact with potable water shall be certified to the requirements of NSF/ANSI 61. Certification shall be accomplished by a certification organization accredited by the American National Standards Institute (ANSI).

Sec. 4.2 Permeation

The selection of materials is critical for potable water, wastewater, and reclaimed water service and distribution piping in locations where there is likelihood the pipe will be exposed to significant concentrations of pollutants composed of low-molecular-weight petroleum products or organic solvents or their vapors. Documented research has shown that pipe materials (such as polyethylene and polyvinyl chloride) and elastomers, such as used in jointing gaskets and packing glands, are subject to permeation by low-molecular-weight organic solvents or petroleum products. If a potable water, wastewater, and reclaimed water pipe must pass through such a contaminated area or an area subject to contamination, consult with the manufacturer regarding permeation of pipe walls, jointing materials, and so on, before selecting materials for use in that area.

Sec. 4.3 General Requirements

4.3.1 *Mechanical joint and flange joint.* Fittings with mechanical joints and flange joints shall conform to the dimensions and weights shown in the tables in this standard unless otherwise agreed on at the time of purchase. The mechanical joint bells, plain ends, and accessories shall conform to ANSI/AWWA C111/A21.11. Either ductile-iron or gray-iron glands may be used unless otherwise specified by the purchaser.

Split glands and glands in segments and other variations shall be allowed, provided they meet the performance requirements of ANSI/AWWA C111/A21.11.

4.3.2 *Push-on joint.* Fittings with push-on joints shall have weights and dimensions of the bell, socket, and plain end in accordance with the manufacturer's standard design. The manufacturer shall provide drawings of the joint and gasket if requested by the purchaser. Performance requirements and special requirements for

push-on joints shall conform to the requirements for the push-on joint in ANSI/AWWA C111/A21.11.

4.3.3 *Joint accessories.* Inclusion of joint accessories shall be specified by the purchaser. Accessories include products such as gaskets and lubricants for push-on joints; gaskets, glands, and bolts for mechanical joints; and gaskets and bolts for flange joints.

4.3.4 *Type of iron.* Fittings shall be cast from gray iron or ductile iron and have pressure ratings as shown in the tables. When both materials are shown in the tables, either may be provided at the manufacturer's option unless otherwise specified by the purchaser.

4.3.5 *Other joint designs or dimensions.* Standard fittings shall be provided with the end combinations shown in the tables. When fittings of other designs or dimensions are purchased under this standard, the purchaser must specify the fitting design. Plain ends of mechanical-joint fittings may be provided with bevels for assembly with push-on joint bells.

NOTE: Bell fittings without plain ends are most readily available.

Sec. 4.4 Coatings and Linings

4.4.1 *General.* The manufacturer may supply either asphaltic coating with cement–mortar lining or fusion bonded epoxy inside and out unless otherwise specified by the purchaser.

4.4.2 *Asphaltic outside coating.* The outside coating shall be a petroleum asphaltic coating approximately 1 mil (25 μm) thick applied to the outside of the fittings. The finished coating shall be continuous, smooth, neither brittle when cold nor sticky when exposed to the sun, and strongly adherent to the fitting.

4.4.3 *Cement–mortar linings.* Cement–mortar linings shall be in accordance with the latest revision of ANSI/AWWA C104/A21.4. At the manufacturer's option, moist cement–mortar linings can be given a seal coat of asphaltic material for curing the cement mortar. Cement–mortar linings are not normally supplied in caps, plugs, or sleeves.

4.4.4 *Fusion-bonded epoxy coating.* Fusion-bonded epoxy coatings shall be in accordance with ANSI/AWWA C116/A21.16 and shall be applied to interior and exterior surfaces.

4.4.5 *Inside coating.* When specified by the purchaser, the inside of fittings that are not cement–mortar or epoxy lined shall be an asphaltic material as thick as practicable (at least 1 mil [25 μm]). This coating shall conform to appropriate requirements for seal coat in ANSI/AWWA C104/A21.4.

4.4.6 *Special coatings and linings.* For special conditions, other types of coatings and linings may be available. Such special coatings and linings shall be specified by the purchaser.

Sec. 4.5 Special Requirements for Flanged Fittings

4.5.1 *Flanges.* Flanges shall conform to dimensions shown in Table 15, which are adequate for the pressure ratings given in Sec. 4.3.2 of ANSI/AWWA C111/A21.11.

NOTE: The bolt circle and bolt holes of these flanges match those of ASME B16.1 and can be joined with these class 125 flanges. Flanges of ANSI/AWWA C110/A21.10 fittings cannot be joined with class 250 B16.1 flanges.

4.5.2 *Facing.* Flanges shall be flat-faced without projection or raised-face and shall be smooth or with shallow serrations. Flanges may be back-faced or spot-faced for compliance with the flange thickness tolerance stated in this standard. Bearing surfaces for bolting shall be parallel to the flange face within 3°.

4.5.3 *Bolt holes.* Bolt holes shall be in accordance with the dimensions shown in Table 15. Bolt holes shall be equally spaced and shall straddle the centerlines of the flange as shown in Figure 13.

4.5.3.1 *Misalignment.* Misalignment of corresponding bolt holes of two opposing flanges shall not exceed 0.12 in. (3.0 mm).

4.5.3.2 *Orientation.* If bolt-hole orientation other than provided for in this standard is required by the purchaser, the special orientation shall be specified in the purchaser's specification.

4.5.4 *Laying-length dimensions.* Face-to-face dimensions shall conform to a tolerance of ± 0.06 in. (± 1.5 mm) for sizes 3 to 10 in. (80 to 250 mm) and ± 0.12 in. (± 3.0 mm) for sizes 12 to 48 in. (300 to 1,200 mm). Center-to-face tolerances shall be one half those of face-to-face tolerances. The largest opening shall govern the tolerance for all openings.

SECTION 5: VERIFICATION

Sec. 5.1 Inspection by Manufacturer

5.1.1 *Quality control and inspection practice.* The manufacturer shall establish the necessary quality control and inspection practice to ensure compliance with this standard. Test frequencies shall be a function of production and quality

control systems of the manufacturer. Fittings shall be clean and sound without defects that could impair their service.

5.1.2 *Repairs of defects.* Repairing defects by welding or other methods shall not be allowed if such repairs could adversely affect the serviceability of the fitting or its capability to meet the strength requirements of this standard.

5.1.3 *Manufacturer's records.* The results of the specified tests (Sec. 5.4, Sec. 5.5, Sec. 5.6, and Sec. 5.9, if applicable) shall be recorded and retained for one year and shall be available to the purchaser at the manufacturer's plant.

Sec. 5.2 Inspection by Purchaser

5.2.1 *Purchaser's obligations.* If the purchaser desires to inspect fittings at the manufacturer's plant, it shall be stated in the purchaser's documents and the conditions described under which the inspection shall be made (such as time and extent of the inspection).

5.2.2 *Manufacturer's obligations.* The purchaser's representative shall have free access to those areas of the manufacturer's plant as are necessary to determine compliance with this standard. The manufacturer shall make available for use by the purchaser's representative such gauges as are necessary for inspection. The manufacturer shall provide the purchaser's representative with assistance as necessary for the handling of fittings.

Sec. 5.3 Tolerances or Permitted Variations

5.3.1 *Dimensions.* Fittings shall be measured with suitable gauges each production run and at sufficiently frequent intervals to ensure that the dimensions comply with the requirements of this standard. The smallest inside diameter (ID) of the sockets and the outside diameter (OD) of the plain ends shall be tested with circular gauges. Other socket dimensions shall be measured as appropriate.

5.3.2 *Thickness.* Minus tolerances for metal thicknesses shall not exceed 0.10 in. (2.5 mm) for 3-6 in. (80-150 mm) sizes, 0.12 in. (3.0 mm) for 8-20 in. (200-500 mm) sizes, and 0.15 in. (3.8 mm) for 24-48 in. (600-1,200 mm) sizes.

An additional tolerance shall be permitted over areas not exceeding 8 in. (200 mm) in any direction as follows: for 3- to 12-in. (80- to 300-mm) fittings, 0.02 in. (0.5 mm); for 14- to 48-in. (350- to 1,200-mm) fittings, 0.03 in. (0.8 mm).

5.3.3 *Weight.* The weight of any fitting shall not be less than the nominal tabulated weight by more than 10 percent for fittings 12 in. (300 mm) or smaller in diameter or by more than 8 percent for fittings larger than 12 in. (300 mm) in diameter. The nominal tabulated weight is the weight of the fitting before the application of any lining or coating other than the standard coatings.

Sec. 5.4 Acceptance Tests

5.4.1 *Physical test—gray-iron fittings.* The standard acceptance test for the physical characteristics of gray-iron fittings shall be one of the following:

1. Transverse test conducted in accordance with ASTM A438.
2. Tensile test conducted in accordance with ASTM A48.

3. Transverse or tensile tests conducted on coupons obtained from a part of the castings' runner-bar system or the casting. The diameter of the runner bar or the thickness of the casting where the test coupon or bar is selected must be similar to that required of ASTM A438 or A48 test bars.

5.4.1.1 Choice of test. Unless specified by the purchaser, selection of the test bar coupon and test method (either the transverse test or tensile test, as the acceptance test) shall be at the option of the manufacturer. The acceptance values for tensile and transverse tests shall be as shown in Table 1.

For 20-in. (500-mm) and 24-in. (600-mm) fittings with a body thickness greater than 1 in. (25.4 mm), a 2-in. (50.8-mm) test bar shall be used.

5.4.2 *Physical test—ductile-iron fittings.* The standard conformance test for the physical characteristics of ductile-iron fittings shall be a tensile test on coupons cast from the same iron as the fittings.

Except as otherwise provided in this standard, coupons shall be cast and the test made in accordance with ASTM A536. The test coupon shall be obtained, at the manufacturer's option, from one of the following: (1) the ASTM A536 keel block, modified keel block, or Y-block separately cast coupon; (2) the castings' runner-bar system, provided that the diameter of the runner bar at the location where the coupon is selected is similar to the respective ASTM A536 coupon; or (3) the casting.

Table 1 Gray-iron test specimens and acceptance values

Iron Strength		Fitting Size	Bar Diam.		Span [†]		Min. Breaking Load		Min. Tensile Strength [‡]	
<i>psi (1,000s)</i>	<i>(MPa)</i>	<i>in.*</i>	<i>in.</i>	<i>(mm)</i>	<i>in.</i>	<i>(mm)</i>	<i>lb</i>	<i>(kg)</i>	<i>psi (1,000s)</i>	<i>(MPa)</i>
25	(172)	3–14	1.20	(30.5)	18	(457)	2,000	(907)	25	(172)
30	(207)	14–24	1.20	(30.5)	18	(457)	2,200	(998)	30	(207)
30	(207)	20–48	2.00	(50.8)	24	(610)	7,600	(3,447)	30	(207)
35	(241)	16–24	1.20	(30.5)	18	(457)	2,400	(1,089)	35	(241)
35	(241)	20–36	2.00	(50.8)	24	(610)	8,300	(3,765)	35	(241)

* Metric conversion for dimension: in. × 25.4 mm.

[†] ASTM A438.

[‡] ASTM A48.

5.4.2.1 Conformance values. The standard grade of iron shall be 70-50-05 or 65-45-12. Conformance values for 70-50-05 are: minimum tensile strength, 70,000 psi (483 MPa); minimum yield strength, 50,000 psi (345 MPa); minimum elongation, 5 percent. Conformance values for 65-45-12 are: minimum tensile strength, 65,000 psi (448 MPa); minimum yield strength, 45,000 psi (310 MPa); minimum elongation, 12 percent.

5.4.2.1.1 Other grades of iron. For 60-42-10 grade of iron, conformance values are as follows: minimum tensile strength, 60,000 psi (414 MPa); minimum yield strength, 42,000 psi (290 MPa); minimum elongation, 10 percent. The manufacturer of fittings produced from this grade must be able to provide records to demonstrate that these fittings meet the performance test requirements of this standard.

5.4.3 Sampling. At least one sample shall be taken during each period of approximately 3 hr, while the melting unit is operated continuously.

Sec. 5.5 Chemical Limitations

5.5.1 *Gray-iron fittings.* Analyses of the iron in gray-iron fittings shall be made on every melt and at sufficiently frequent intervals to ensure compliance with the following limits: phosphorus, 0.90 percent maximum; sulfur, 0.15 percent maximum.

Control of the other chemical constituents shall be maintained to meet the physical property requirements of this standard. Samples for chemical analyses shall be representative and shall be obtained from either acceptance-test specimens or specimens cast for this purpose.

5.5.2 *Ductile-iron fittings.* Analyses of the iron shall be made on every melt and at sufficiently frequent intervals to ensure compliance with the following limit: phosphorus, 0.08 percent maximum. Control of other chemical constituents shall be maintained to meet the physical property requirements of this standard.

Samples for chemical analyses shall be representative and shall be obtained from either an acceptance-test specimen or specimens cast for this purpose.

Sec. 5.6 Additional Tests Required by the Purchaser

If tests other than those provided in this standard are required by the purchaser, such tests shall be specified by the purchaser. Although it is not customary to make hydrostatic proof tests of fittings at the foundry, such tests may be made if specified by the purchaser. If proof tests at the foundry are required by the purchaser for an order of fittings, the fittings shall withstand, without leaks or permanent distortion,

hydrostatic test pressures not to exceed one-and-one-half times the rated water working pressures.

Sec. 5.7 Performance Requirements

The manufacturer shall qualify the design of the product by performing pressure tests on 90° bends and crosses of each size to demonstrate a minimum safety factor of 2.5 times the rated working pressure and shall have records to show the results of the tests. Tests of equal opening tees shall be substituted for tests of crosses if the manufacturer produces tees but not crosses.

Sec. 5.8 Defective Specimens and Retests

When any physical test specimen shows defective machining or lack of continuity of metal, it shall be discarded and replaced by another specimen cast in the same sampling period as the specimen that failed.

Sec. 5.9 Rejection of Fittings

If the test results of any sound specimen fail to meet the applicable requirements of Sec. 5.4, or the chemical analyses do not conform to the limitations of Sec. 5.5 where applicable, the fittings represented by these tests or analyses shall be rejected, except as provided in Sec. 5.9.

Sec. 5.10 Determining Rejection

The manufacturer may limit the amount of rejection by making additional acceptance tests until the rejected lot is bracketed, in order of manufacture, by an acceptable test at each end of the interval in question.

SECTION 6: DELIVERY

Sec. 6.1 Marking

Fittings shall have distinctly cast on them the pressure rating, nominal diameters of openings, manufacturer's identification, country where cast, and the number of degrees or fraction of the circle on all bends. Ductile-iron fittings shall have the letters "DI" or "Ductile" cast on them. Fittings having proprietary joints shall be marked with the proprietary name or trademark of the joint. Cast letters and figures shall be on the outside body of the fitting and shall have dimensions no smaller than the dimensions in Table 2.