

American Water Works Association
ANSI/AWWA C110/A21.10-98
(Revision of ANSI/AWWA C110/A21.10-93)



AMERICAN NATIONAL STANDARD
FOR
DUCTILE-IRON AND GRAY-IRON FITTINGS,
3 IN. THROUGH 48 IN.
(76 mm THROUGH 1,219 mm),
FOR WATER



Administrative Secretariat
AMERICAN WATER WORKS ASSOCIATION

Effective date: Dec. 1, 1998.

First edition approved by AWWA Board of Directors May 4, 1951.

This edition approved June 21, 1998.

Approved by American National Standards Institute Sept. 10, 1998.

AMERICAN WATER WORKS ASSOCIATION

6666 West Quincy Avenue, Denver, Colorado 80235

AWWA Standard

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

American National Standard

An American National Standard implies a consensus of those substantially concerned with its scope and provisions. An American National Standard is intended as a guide to aid the manufacturer, the consumer, and the general public. The existence of an American National Standard does not in any respect preclude anyone, whether 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, 11 W. 42nd St., New York, NY 10036; (212) 642-4900.

All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any information or retrieval system, except in the form of brief excerpts or quotations for review purposes, without the written permission of the publisher.

Copyright © 1999 American Water Works Association
Printed in USA

Committee Personnel

Subcommittee 3, Fittings, which reviewed this standard, had the following personnel at the time:

Larry R. Dunn, *Chair*
C.M. Luna, *Vice-Chair*

Consumer Members

K.A. Alms, St. Louis County Water Company, St. Louis, Mo.	(AWWA)
T.E. Coughran, City of Santa Ana, Santa Ana, Calif.	(AWWA)
R.R. Goold, Johnson County Water District No. 1, Kansas City, Kan.	(AWWA)
R.D. Zwygart, Tampa Water Department, Tampa, Fla.	(AWWA)

General Interest Members

M.G. Hoover, HYA Consulting Engineers, Pasadena, Calif.	(AWWA)
Harold Kennedy Jr., Suiken & Kennedy LLP, Morrisville, N.C.	(AWWA)
P.I. McGrath Jr., Birmingham, Ala.	(AWWA)
W.H. Smith, Flora, Ill.	(AWWA)
R.D. Wilroy, Catlin Engineers & Scientists, Columbia, S.C.	(AWWA)

Producer Members

Siddharth Bhattacharji, Sigma Corporation, Cream Ridge, N.J.	(AWWA)
Bill Bliss, Tyler Pipe, Tyler, Texas	(DIPRA)
E.C. Bradley Jr., EBBA Iron, Inc., Eastland, Texas	(AWWA)
L.R. Dunn, US Pipe & Foundry Company, Birmingham, Ala.	(AWWA)
M.B. Harrington, Harrington Corporation, Lynchburg, Va.	(AWWA)
T.M. Kiley, Victaulic Company of America, Easton, Pa.	(AWWA)
C.M. Luna, McWane Cast Iron Pipe Company, Birmingham, Ala.	(AWWA)
D.W. McCutcheon, Star Pipe Products Inc., Houston, Texas	(AWWA)
P.A. Selig, American Cast Iron Pipe Company, Birmingham, Ala.	(AWWA)
T.F. Stroud, Ductile Iron Pipe Research Association, Birmingham, Ala.	(AWWA)
C.L. Walton, Russell Pipe & Foundry Company, Alexander City, Ala.	(AWWA)

AWWA Standards Committee A21, Ductile-Iron Pipe and Fittings, which reviewed and approved this standard, had the following personnel at the time of approval:

Edward T. Knudsen Jr., *Chair*

Philip A. Selig, *Vice-Chair*

John H. Wilber, *Secretary*

Consumer Members

T.E. Coughran, City of Santa Ana, Santa Ana, Calif.	(AWWA)
A.J. DeBoy, Indiana–American Water Company, Greenwood, Ind.	(AWWA)
R.R. Goold, Johnson County Water District, Kansas City, Kan.	(AWWA)
E.T. Knudsen Jr., St. Petersburg Engineering, St. Petersburg, Fla.	(AWWA)
J.D. Larson, St. Louis County Water Company, St. Louis, Mo.	(AWWA)
G.L. Meyer, City of Sioux Falls, Sioux Falls, S.D.	(AWWA)
T.C. Moreno, Bexar Metropolitan Water District, San Antonio, Texas	(AWWA)
C.R. Schwenker, Fairfax County Water Authority, Merrifield, Va.	(AWWA)
R.D. Zwygart, Tampa Water Department, Tampa, Fla.	(AWWA)

General Interest Members

K.M. Bell, Underwriters Laboratories Inc., Northbrook, Ill.	(UL)
Vance Forsgren, Forsgren Associates Inc., Rexburg, Idaho	(AWWA)
Joseph Goss,* Delon, Hampton & Associates, Rockville, Md.	(AWWA)
K.W. Henderson, Malcolm Pirnie Inc., White Plains, N.Y.	(AWWA)
M.G. Hoover, HYA Consulting Engineers, Pasadena, Calif.	(AWWA)
M.B. Horsley, Black & Veatch Engineers, Overland Park, Mo.	(AWWA)
W.B. Jeffcoat, CH2M Hill, Montgomery, Ala.	(AWWA)
Harold Kennedy Jr., Harold Kennedy & Associates, Morrisville, N.C.	(AWWA)
J.L. Lane,† Council Liaison, Missouri Department of Natural Resources, Jefferson City, Mo.	(AWWA)
E.W. Misichko,* Underwriters Laboratories Inc., Northbrook, Ill.	(UL)
R.L. Scarpa, Metcalf & Eddy, Dripping Spring, Texas	(AWWA)
W.H. Smith, Flora, Ill.	(AWWA)
J.H. Wilber,† Standards Engineer Liaison, AWWA, Denver, Colo.	(AWWA)
L.C. Yates, McGoodwin Williams & Yates, Fayetteville, Ark.	(AWWA)

Producer Members

L.R. Dunn, US Pipe & Foundry Company, Birmingham, Ala.	(DIPRA)
Steven Farkas, Griffin Pipe Products Company, Lynchburg, Va.	(DIPRA)
B.C. Helton,* American Cast Iron Pipe Company, Birmingham, Ala.	(DIPRA)
C.M. Luna, McWane Cast Iron Pipe Company, Birmingham, Ala.	(DIPRA)
C.W. McCauley, Griffin Pipe Products Company, Lynchburg, Va.	(AWWA)
P.I. McGrath Jr.,* US Pipe & Foundry Company, Birmingham, Ala.	(DIPRA)
P.L. Robertson, Specification Rubber Products, Alabaster, Ala.	(AWWA)
P.A. Selig, American Cast Iron Pipe Company, Birmingham, Ala.	(DIPRA)
Dennis Shumard, EBAA Iron Inc., Eastland, Texas	(AWWA)
T.F. Stroud, Ductile Iron Pipe Research Association, Birmingham, Ala.	(DIPRA)

*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.

SEC.	PAGE	SEC.	PAGE
Foreword			
I	Introduction.....	vii	
I.A	Background.....	vii	
I.B	History	vii	
I.C	Acceptance	ix	
II	Special Issues	x	
II.A	Advisory Information on Product Application.....	x	
III	Use of This Standard.....	xi	
III.A	Purchaser Options and Alternatives	xi	
III.B	Special Service Requirements.....	xi	
III.C	Modification to Standard.....	xii	
IV	Major Revisions.....	xii	
V	Comments	xiii	
Standard			
1	General		
1.1	Scope	1	
1.2	Purpose	2	
1.3	Application.....	2	
2	Definitions	2	
3	References	2	
4	Requirements		
4.1	Permeation	3	
4.2	General Requirements.....	3	
4.3	Coatings and Linings.....	4	
4.4	Special Requirements for Flanged Fittings	4	
5	Verification		
5.1	Inspection and Certification by Manufacturer	5	
5.2	Inspection by Purchaser	5	
5.3	Tolerances or Permitted Variations.....	5	
5.4	Acceptance Tests	6	
5.5	Chemical Limitations	7	
5.6	Additional Tests Required by the Purchaser.....	7	
5.7	Defective Specimens and Retests.....	8	
5.8	Rejection of Fittings	8	
5.9	Determining Rejection	8	
6	Delivery		
6.1	Marking.....	8	
6.2	Packing and Shipping	8	
6.3	Affidavit of Compliance.....	8	
Appendixes			
A	Flanged Fittings—Bolts, Gaskets, and Installation	45	
A.1	Bolts and Nuts.....	45	
A.2	Gaskets.....	45	
A.3	Installation.....	46	
B	Special Fittings	47	
Figures			
1	Mechanical-Joint Dimensions for Sizes 3 to 48 in. (76 to 1,219 mm)	9	
2	Mechanical-Joint Plain-End Dimensions and Tolerances.....	11	
3	Mechanical-Joint Bends	12	
4	Mechanical-Joint Tees and Crosses.....	17	
5	Mechanical-Joint Base Bends.....	23	
6	Mechanical-Joint Base Tees	24	
7	Mechanical-Joint Reducers	25	
8	Mechanical-Joint Tapped Tees.....	28	
9	Mechanical-Joint Offsets	29	
10	Mechanical-Joint Sleeves.....	30	
10a	Mechanical-Joint Split Sleeves.....	30	
11	Mechanical-Joint Caps and Plugs.....	31	
12	Mechanical-Joint Connecting Pieces.....	32	
13	Connecting Pieces, One-End Flanged	33	
14	Flange Details.....	34	
15	Base Drilling Details.....	35	
16	Flanged Bends	36	

SEC.		PAGE	SEC.		PAGE
17	Flanged Tees and Crosses.....	37	8	Mechanical-Joint Tapped Tees.....	28
18	Flanged Base Bends	41	9	Mechanical-Joint Offsets	29
19	Flanged Base Tees	42	10	Mechanical-Joint Sleeves.....	30
20	Flanged Reducers.....	43	11	Mechanical-Joint Caps and Plugs.....	31
			12	Mechanical-Joint Connecting Pieces.....	32
Tables			13	Connecting Pieces, One-End Flanged	33
1	Mechanical-Joint Dimensions—in.	10	14	Flange Details.....	34
2	Plain-End Dimensions and Tolerances for Mechanical- Joint Fittings	11	15	Base Drilling Details.....	35
3	Mechanical-Joint Bends	13	16	Flanged Bends	36
4	Mechanical-Joint Tees and Crosses	17	17	Flanged Tees and Crosses	37
5	Mechanical-Joint Base Bends	23	18	Flanged Base Bends	41
6	Mechanical-Joint Base Tees.....	24	19	Flanged Base Tees.....	42
7	Mechanical-Joint Reducers	25	20	Flanged Reducers	43
			A.1	Flange Gasket Details.....	46

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 (A.G.A.), the American Society for Testing and Materials (ASTM), the American Water Works Association (AWWA), and the New England Water Works Association (NEWWA). Between 1972 and 1984, the cosecretariats were A.G.A., 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, A.G.A. withdrew as cosecretariat.

The present scope of Committee A21 activity is the preparation of standards for cast-iron and ductile-iron pressure pipe for gas, water, and other liquids, and fittings for use with such pipe. These standards include design, dimensions, materials, coatings, linings, joints, accessories, and methods of inspection and testing.

The work of Committee A21 is conducted by subcommittees. The scope of Subcommittee 3, Fittings, includes the periodic review of all 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 advanced from tentative to standard without change June 17, 1955. AWWA C100-55 covered fittings in the size range 4 to 60 in. (102 to 1,500 mm).^{*} The fittings were all 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. (102 to 305 mm) were made to class D patterns, having only one OD and pressure rating. Fittings 14 to 24 in. (356 to 610 mm) in size were furnished in classes B and D, and fittings 30 to 60 in. (762 to 1,500 mm) in size were furnished in classes A, B, C, and D. All fittings made in accordance with AWWA 7C.1-1908 and C100-55 had the class identification cast on the fitting.

^{*}Metric conversions given in this standard are direct conversions of US customary units and are not those specified in the International Organization for Standardization (ISO) standards.

ASA* A21.10-1952 (AWWA C110-52) was approved by ASA Sept. 30, 1952, following approval by AWWA May 4, 1951. The standard covered 3- to 12-in. (76- to 305-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 covered 2- to 48-in. (50- to 1,219-mm) fittings. The design of the 14- to 48-in. (356- to 1,219-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. (356- to 1,219-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. (76 to 305 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 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. (356- to 610-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. (76- to 1,219-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

*American Standards Association (ASA) is the former name of the American National Standards Institute.

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 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 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/A21.10-82, 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. (76 mm through 305 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 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-in. through 48-in. (356-mm through 1,219-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.

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 all direct and indirect drinking water additives. Other

members of the original consortium included the American Water Works Association Research Foundation (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. An advisory program formerly administered by USEPA, Office of Drinking Water, discontinued on Apr. 7, 1990.
2. Specific policies of the state or local agency.
3. Two standards developed under the direction of NSF, ANSI[†]/NSF[‡] 60, Drinking Water Treatment Chemicals—Health Effects, and ANSI/NSF 61, Drinking Water System Components—Health Effects.
4. 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 ANSI/NSF 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.

Appendix A, “Toxicology Review and Evaluation Procedures,” to ANSI/NSF 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 Appendix 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 all 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 specifications, all fittings and accessories shall comply with this standard. Fittings and accessories not complying with this standard shall be replaced by the manufacturer at the agreed point of delivery. The manufacturer shall not be liable for shortages or damaged fittings after the fitting is accepted at the agreed

*Persons in Canada, Mexico, and non-North American countries should contact the appropriate authority having jurisdiction.

[†]American National Standards Institute, 11 W. 42nd St., New York, NY 10036.

[‡]NSF International, 3475 Plymouth Rd., Ann Arbor, MI 48106.

[§]Both publications available from National Academy of Sciences, 2102 Constitution Ave. N.W., Washington, DC 20418.

point of delivery, except as recorded on the delivery receipt or similar document by the carrier's agent.

III. Use of This Standard.

AWWA has no responsibility for the suitability or compatibility of the provisions of this standard to any intended application by any user. Accordingly, each user of this standard is responsible for determining that the standard's provisions are suitable for and compatible with that user's intended application.

III.A. *Purchaser Options and Alternatives.* This standard includes certain options that, if desired, must be specified in the purchaser's specifications. It is also necessary that such options be included on the purchase order. Also, a number of items must be specified to describe completely the fittings required. The following list summarizes the details and available options, and references the sections of the standard where they are found.

1. Size, joint type, pressure rating (Sec. 1.1 and tables).
2. Joint requirements (Sec. 4.2.1 and 4.2.2).
3. Type of iron (Sec. 4.2.4).
4. End combinations (Sec. 4.2.5).
5. Certification by manufacturer (Sec. 5.1.3).
6. Inspection by purchaser (Sec. 5.2).
7. Elimination of cement-mortar lining (Sec. 4.3.2). 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.
8. Special coatings and linings (Sec. 4.3.3).
9. Acceptance tests (Sec. 5.4).
10. Special tests (Sec. 5.6).
11. Special flange bolt-hole orientation (Sec. 4.4.3).

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 water. Fittings for other services may require special consideration by the purchaser.
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 and Gray-Iron Pressure Pipe and Fittings; ANSI/AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances; and recommendations of manufacturers regarding their product.
3. Attention is directed to an apparent conflict between this standard and ASME/ANSI 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/ANSI 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/ANSI B16.1 covers 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 set forth in ASME/ANSI 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 due to temperature variations, and many other conditions causing stress in the flange or fitting.

ASME/ANSI 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 covered in ANSI/AWWA C115/A21.15 and this standard. ASME/ANSI 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 in the purchaser's specifications.

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

1. The format has been changed to AWWA standard style.
2. Section I.A, Background, was revised to recognize the withdrawal of the American Gas Association as cosecretariat of the A21 Committee.
3. The acceptance clause (Sec. I.C) has been revised to approved wording.
4. The advisory information paragraph (Sec. II.A) was revised and moved from the body of the standard into the foreword.
5. The scope of the standard has been limited to water service and all references to gas and other liquids have been eliminated.
6. The scope was amended to recognize 350-psi (2,413-kPa) ratings for 12-in. (305-mm) and smaller flanged ductile-iron fittings when used with special gaskets.
7. Cement-mortar linings (Sec. 4.3.2) was revised to reflect the optional status of seal coat in the latest revision of ANSI/AWWA C104/A21.4.
8. Special coatings and linings (Sec. 4.3.3) was revised to include asphaltic material as a special lining.
9. Table 1 was revised in accordance with the 1995 revision of ANSI/AWWA C111/A21.11. Revisions include plus tolerances on the K_1 , K_2 , and L dimensions; longer bolt lengths for the 42- and 48-in. (1,067- and 1,219-mm) sizes; and the footnote on ductile-iron glands.
10. Tables 16 through 19 on flanged fittings were revised to show the use of ductile iron for 3- to 12-in. (76- to 305-mm) flanged fittings with the same dimensions as gray-iron fittings. Explanatory footnotes were also added.
11. The gaskets section of appendix A was revised to describe the rubber material as being synthetic.

V. Comments. If you have any comments or questions about this standard, please call the AWWA Volunteer and Technical Support Group, (303) 794-7711 ext. 6283, FAX (303) 795-1440, or write to the department at 6666 W. Quincy Ave., Denver, CO 80235.

This page intentionally blank.



AMERICAN NATIONAL STANDARD FOR DUCTILE-IRON AND GRAY-IRON FITTINGS, 3 IN. THROUGH 48 IN. (76 mm THROUGH 1,219 mm), FOR WATER

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard covers 3- to 48-in. (76- to 1,219-mm) gray-iron and/or ductile-iron fittings to be used with ductile-iron pipe for water. Requirements for fittings with mechanical joints and flanged joints are listed in Tables 1 through 20 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. (76- to 610-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, 12-in. (305-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 covered by 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. (762- to 1,219-mm) size range, fittings with all types of joints covered by this standard are shown in the tables with rated working pressures of 150 or 250 psi (1,034 or 1,724 kPa), depending on the type of iron as shown in the tables.

Sec. 1.2 Purpose

The main purpose of this standard is to provide the minimum requirements for ductile-iron and gray-iron fittings, 3 in. through 48 in. (76 mm through 1,219 mm), for water.

Sec. 1.3 Application

This standard can be referenced in specifications for ductile-iron and gray-iron fittings, 3 in. through 48 in. (76 mm through 1,219 mm), for water. The stipulations of this standard apply when this document has been referenced and then only to ductile-iron and gray-iron fittings, 3 in. through 48 in. (76 mm through 1,219 mm), for water.

SECTION 2: 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 14 and Table 14.
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.
5. *Mechanical joint*: The gasketed and bolted joint as detailed in the latest revision of ANSI/AWWA C111/A21.11.
6. *Purchaser*: The person, company, or organization that purchases any materials or work to be performed.
7. *Push-on joint*: The single rubber-gasket joint as set forth in the latest revision of ANSI/AWWA C111/A21.11.

SECTION 3: 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.

ASME^{*}/ANSI[†] B16.1—Cast Iron Pipe Flanges and Flanged Fittings.

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

^{*}American Society of Mechanical Engineers, United Engineering Center, 345 E. 47th St., New York, NY 10017.

[†]American National Standards Institute, 11 W. 42nd St., New York, NY 10036.

[‡]American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959.

ASTM A438—Standard Test Method for Transverse Testing of Gray Cast Iron.

ASTM A536—Standard Specification for Ductile Iron Castings.

ANSI/AWWA C104/A21.4—American National Standard for Cement-Mortar Lining for Ductile-Iron Pressure Pipe and Fittings for Water.

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

ANSI/AWWA C153/A21.53—American National Standard for Ductile-Iron Compact Fittings, 3 In. Through 24 In. (76 mm Through 610 mm) and 54 In. Through 64 In. (1,400 mm Through 1,600 mm), for Water Service.

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

SECTION 4: REQUIREMENTS

Sec. 4.1 Permeation

The selection of materials is critical for 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. Research has documented that pipe materials such as polyethylene, polybutylene, polyvinyl chloride, and asbestos cement, and elastomers, such as used in jointing gaskets and packing glands, may be subject to permeation by lower molecular weight organic solvents or petroleum products. If a 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 forth, *before* selecting materials for use in that area.

Sec. 4.2 General Requirements

4.2.1 *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 shall also 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.

4.2.2 *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 furnish 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.

4.2.3 *Joint accessories.* Unless otherwise specified by the purchaser, gaskets, glands, bolts, and nuts shall be furnished with mechanical joints; and gaskets and lubricant shall be furnished with push-on joints; all in sufficient quantity for assembly of each joint.

4.2.4 *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 furnished at the manufacturer's option unless otherwise

specified by the purchaser. All fittings shall be capable of withstanding, without bursting, hydrostatic tests of three times the rated water working pressure.

4.2.5 *Other joint designs or dimensions.* Standard fittings shall be furnished 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 furnished with bevels for assembly with push-on joint bells.

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

Sec. 4.3 Coatings and Linings

4.3.1 *Outside coating.* The outside coating shall be a petroleum asphaltic coating approximately 1 mil (25 μ m) thick. The coating shall be applied to the outside of all fittings unless otherwise specified by the purchaser. The finished coating shall be continuous, smooth, neither brittle when cold nor sticky when exposed to the sun, and strongly adherent to the fitting.

4.3.2 *Cement-mortar linings.* The lining for use under normal conditions shall be a cement-mortar lining in accordance with the latest revision of ANSI/AWWA C104/A21.4, unless otherwise specified.* Cement-mortar linings are not normally furnished in sleeves, plugs, or caps.

4.3.3 *Special coatings and linings.* For special conditions, other types of coatings and linings may be available. Special coatings and linings shall be specified by the purchaser. One special lining for fittings that are not cement-mortar lined is an asphaltic material as thick as practicable, at least 1 mil (25 μ m), that conforms to all appropriate requirements for seal coat, as described in the latest revision of ANSI/AWWA C104/A21.4.

Sec. 4.4 Special Requirements for Flanged Fittings

4.4.1 *Flanges.* Flanges shall conform to the dimensions shown in Table 14, which are adequate for the pressure ratings given in Sec. 4.2.2 of ANSI/AWWA C111/A21.11.

NOTE: The bolt circle and bolt holes of these flanges match those of ASME/ANSI 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.

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

4.4.3 *Bolt holes.* Bolt holes shall be in accordance with the dimensions shown in Table 14. Bolt holes shall be equally spaced and shall straddle the centerlines of the flange as shown in Figure 14.

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

4.4.3.2. 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.

*Experience indicates 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.

4.4.4 *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. (76 to 254 mm) and ± 0.12 in. (± 3.0 mm) for sizes 12 to 48 in. (305 to 1,219 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 and Certification 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. All 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 *Certification by manufacturer.* If required by the purchaser, the manufacturer shall furnish a sworn statement that the inspection and all the specified tests have been made and the results thereof comply with the requirements of this standard.

5.1.4 *Manufacturer's records.* The results of the specified tests (Sec. 5.4, 5.5, 5.6, and 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 specifications 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 the 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 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, except those shown in Tables 1 and 2, shall not exceed the following:

Fitting Size [*] <i>in.</i>	Minus Tolerance	
	<i>in.</i>	<i>(mm)</i>
3–6	0.10	(2.5)
8–20	0.12	(3.0)
24–48	0.15	(3.8)

*Metric conversion for dimension: in. $\times$ 25.4 = mm.

An additional tolerance shall be permitted over areas not exceeding 8 in. (200 mm) in any direction as follows: for 3- to 12-in. (76- to 305-mm) fittings, 0.02 in. (0.5 mm); for 14- to 48-in. (356- to 1,219-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. (305 mm) or smaller in diameter or by more than 8 percent for fittings larger than 12 in. (305 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 the following table.

Iron Strength		Fitting Size <i>in.</i> [*]	Bar Diam.		Span [†]		Min. Breaking Load		Min. Tensile Strength [‡]	
<i>psi</i> (1,000s)	(MPa)		<i>in.</i>	<i>(mm)</i>	<i>in.</i>	<i>(mm)</i>	<i>lb</i>	<i>(kg)</i>	<i>psi</i> (1,000s)	(MPa)
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. $\times$ 25.4 = mm.

†ASTM A438.

‡ASTM A48.

For 20-in. (508-mm) and 24-in. (610-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 acceptance 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 herein, 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 the coupon is selected is similar to the respective ASTM A536 coupon; or (3) the casting.

5.4.2.1 Acceptance value. The standard grade of iron shall be 70-50-05, with acceptance values as follows: minimum tensile strength, 70,000 psi (483 MPa); minimum yield strength, 50,000 psi (345 MPa); minimum elongation, 5 percent.

Another permissible acceptance value shall be the 60-42-10 grade of iron, with acceptance values as follows: minimum tensile strength, 60,000 psi (414 MPa); minimum yield strength, 42,000 psi (290 MPa); and minimum elongation, 10 percent; provided the manufacturer of fittings produced from this grade can furnish records to demonstrate that such 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 h, 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 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 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 on special order at additional cost. 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.