



**American Water Works  
Association**

The Authoritative Resource for Safe Water®

ANSI/AWWA C110/A21.10-08  
(Revision of ANSI/AWWA C110/A21.10-03)

---

---

*AWWA Standard*

---

---

# Ductile-Iron and Gray-Iron Fittings



Effective date: Sept. 1, 2008.

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

This edition approved Jan. 27, 2008.

Approved by American National Standards Institute May 22, 2008.

---

---

6666 West Quincy Avenue  
Denver, CO 80235-3098  
T 800.926.7337  
[www.awwa.org](http://www.awwa.org)

Advocacy  
Communications  
Conferences  
Education and Training  
Science and Technology  
Sections

**AVA** Documents  
Document Sharing Hub

## **AWWA Standard**

This document is an American Water Works Association (AWWA) standard. It is not a specification. AWWA standards describe minimum requirements and do not contain all of the engineering and administrative information normally contained in specifications. The AWWA standards usually contain options that must be evaluated by the user of the standard. Until each optional feature is specified by the user, the product or service is not fully defined. AWWA publication of a standard does not constitute endorsement of any product or product type, nor does AWWA test, certify, or approve any product. The use of AWWA standards is entirely voluntary. This standard does not supersede or take precedence over or displace any applicable law, regulation, or codes of any governmental authority. 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, 25 West 43rd Street, Fourth Floor, 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 © 2008 by 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*

### *General Interest Members*

|                                                |        |
|------------------------------------------------|--------|
| P.I. McGrath Jr., Consultant, Birmingham, Ala. | (AWWA) |
| P.A. Selig, Birmingham, Ala.                   | (AWWA) |
| W.H. Smith, Flora, Ill.                        | (AWWA) |

### *Producer Members*

|                                                                      |        |
|----------------------------------------------------------------------|--------|
| S. Bhattacharji, Sigma Corporation, Cream Ridge, N.J.                | (AWWA) |
| R.W. Bonds, Ductile Iron Pipe Research Association, Birmingham, Ala. | (AWWA) |
| M. Bowsher, Star Pipe Products Inc., Houston, Texas                  | (AWWA) |
| L.R. Dunn, U.S. Pipe & Foundry Company, Birmingham, Ala.             | (AWWA) |
| G.A. Fox Russell Pipe, Alexander City, Fla.                          | (AWWA) |
| M.D. Gaston, American Cast Iron Pipe Company, Birmingham, Ala.       | (AWWA) |
| M.B. Harrington, Harrington Corporation, Lynchburg, Va.              | (AWWA) |
| J. Jones, Houston, Texas                                             | (AWWA) |
| H. Kennedy Jr., Harold Kennedy and Associates, Cary, N.C.            | (AWWA) |
| T.M. Kiley, Victaulic Company of America, Easton, Pa.                | (AWWA) |
| B. Leider, Golden, Colo.                                             | (AWWA) |
| T.J. Muntz, Fab Pipe Inc., Rogers, Minn.                             | (AWWA) |
| W. Stout., Griffin Pipe Products Company, Lynchburg, Va.             | (AWWA) |

### *User Members*

|                                                                   |        |
|-------------------------------------------------------------------|--------|
| T.E. Coughran, City of Santa Ana, Santa Ana, Calif.               | (AWWA) |
| R.R. Goold, Kansas City Water Department, Kansas City, Mo.        | (AWWA) |
| D.D. Montgomery, Independence Water Department, Independence, Mo. | (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:

John R. Plattsmier, *Chair*  
Larry R. Dunn, *Vice-Chair*

*General Interest Members*

|                                                                                                  |         |
|--------------------------------------------------------------------------------------------------|---------|
| H.E. Holcomb, Jordan Jones and Goulding Inc., Norcross, Ga.                                      | (AWWA)  |
| M.B. Horsley, Black and Veatch Corp., Kansas City, Mo.                                           | (AWWA)  |
| D.H. Kroon, Corpro Companies Inc., Houston, Texas                                                | (AWWA)  |
| D.D. Lary, <sup>*</sup> Wright-Pierce, Topsham, Maine                                            | (AWWA)  |
| G.E. Laverick, Underwriters Laboratories Inc., Northbrook, Ill.                                  | (AWWA)  |
| T.J. McCandless, <sup>†</sup> Standards Engineer Liaison, AWWA, Denver, Colo.                    | (AWWA)  |
| C.L. McLain, <sup>†</sup> Standards Council Liaison, Moorhead Public Service,<br>Moorhead, Minn. | (AWWA)  |
| P.I. McGrath Jr., Consultant, Birmingham, Ala.                                                   | (AWWA)  |
| T.C. Moreno, Bexar Metropolitan Water District, San Antonio, Texas                               | (AWWA)  |
| P.J. Mourt, Hatch Mott MacDonald, Millburn, N.J.                                                 | (AWWA)  |
| J.R. Plattsmier, HDR Engineering Inc., Denver, Colo.                                             | (AWWA)  |
| C.R. Schwenker, Malcolm Pirnie Inc., Arlington, Va.                                              | (AWWA)  |
| W.H. Smith, Flora, Ill.                                                                          | (AWWA)  |
| T.M. Stinson, New England Water Works Association, Holliston, Mass.                              | (NEWWA) |
| L.C. Yates, McGoodwin Williams & Yates, Fayetteville, Ark.                                       | (AWWA)  |
| K. Zastrow, <sup>*</sup> Underwriters Laboratories Inc., Northbrook, Ill.                        | (UL)    |

*Producer Members*

|                                                                      |         |
|----------------------------------------------------------------------|---------|
| R.W. Bonds, Ductile Iron Pipe Research Association, Birmingham, Ala. | (AWWA)  |
| L.R. Dunn, U.S. Pipe & Foundry Company, Birmingham, Ala.             | (DIPRA) |
| J.H. Eddings, McWane Cast Iron Pipe Company, Birmingham, Ala.        | (DIPRA) |

---

<sup>\*</sup>Alternate

<sup>†</sup>Liaison, nonvoting

|                                                                |         |
|----------------------------------------------------------------|---------|
| M.D. Gaston, American Cast Iron Pipe Company, Birmingham, Ala. | (DIPRA) |
| H. Kennedy Jr., Harold Kennedy and Associates, Cary, N.C.      | (AWWA)  |
| M. Lundstrom, EBAA Iron, Eastland, Texas                       | (AWWA)  |
| T.J. Muntz, Fab Pipe Inc., Rogers, Minn.                       | (AWWA)  |
| G. Oliver,* American Cast Iron Pipe Company, Birmingham, Ala.  | (AWWA)  |
| W.A. Stout, Griffin Pipe Products Company, Downers Grove, Ill. | (AWWA)  |

#### *User Members*

|                                                                   |        |
|-------------------------------------------------------------------|--------|
| D.T. Bradley, Oak Lodge Water District, Portland, Ore.            | (AWWA) |
| T.E. Coughran, City of Santa Ana, Santa Ana, Calif.               | (AWWA) |
| A.J. DeBoy, Indiana–American Water Company, Greenwood, Ind.       | (AWWA) |
| R.R. Goold, Kansas City Water Department, Kansas City, Mo.        | (AWWA) |
| J.M. Kennedy, Tampa Bay Water, Clearwater, Fla.                   | (AWWA) |
| D.D. Montgomery, Independence Water Department, Independence, Mo. | (AWWA) |
| C.J. Patla, Connecticut Water Company, Clinton, Conn.             | (AWWA) |
| R.L. Worden, Sequin, Texas                                        | (AWWA) |

---

\* Alternate

This page intentionally blank.

# 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                                                             |
|-----------------|------------------------------------------------------|-------------------|------------------------------------------------------------------|
| <b>Foreword</b> |                                                      | 4.2               | Permeation..... 4                                                |
| I               | Introduction..... ix                                 | 4.3               | General Requirements..... 4                                      |
| I.A             | Background..... ix                                   | 4.4               | Coatings and Linings ..... 5                                     |
| I.B             | History..... ix                                      | 4.5               | Special Requirements for Flanged Fittings..... 6                 |
| I.C             | Acceptance ..... xiii                                |                   |                                                                  |
| II              | Special Issues..... xv                               | <b>5</b>          | <b>Verification</b>                                              |
| II.A            | Advisory Information on Product Application ..... xv | 5.1               | Inspection and Certification by Manufacturer ..... 6             |
| III             | Use of This Standard ..... xv                        | 5.2               | Inspection by Purchaser ..... 7                                  |
| III.A           | Purchaser Options and Alternatives ..... xv          | 5.3               | Tolerances or Permitted Variations.... 7                         |
| III.B           | Special Service Requirements ..... xv                | 5.4               | Acceptance Tests..... 8                                          |
| III.C           | Modification to Standard..... xvii                   | 5.5               | Chemical Limitations..... 9                                      |
| IV              | Major Revisions ..... xvii                           | 5.6               | Additional Tests Required by the Purchaser ..... 10              |
| V               | Comments ..... xvii                                  | 5.7               | Defective Specimens and Retests ..... 10                         |
|                 |                                                      | 5.8               | Rejection of Fittings ..... 10                                   |
|                 |                                                      | 5.9               | Determining Rejection..... 10                                    |
| <b>Standard</b> |                                                      | <b>6</b>          | <b>Delivery</b>                                                  |
| <b>1</b>        | <b>General</b>                                       | 6.1               | Marking..... 10                                                  |
| 1.1             | Scope ..... 1                                        | 6.2               | Notice of Nonconformance ..... 11                                |
| 1.2             | Purpose ..... 2                                      | 6.3               | Affidavit of Compliance..... 11                                  |
| 1.3             | Application ..... 2                                  |                   |                                                                  |
| <b>2</b>        | <b>References</b> ..... 2                            | <b>Appendixes</b> |                                                                  |
| <b>3</b>        | <b>Definitions</b> ..... 3                           | <b>A</b>          | <b>Flanged Fittings—Bolts, Gaskets, and Installation..... 51</b> |
| <b>4</b>        | <b>Requirements</b>                                  |                   |                                                                  |
| 4.1             | Materials ..... 4                                    |                   |                                                                  |

| SEC.           | PAGE                                                            | SEC.          | PAGE                                                                         |
|----------------|-----------------------------------------------------------------|---------------|------------------------------------------------------------------------------|
| <b>B</b>       | <b>Special Fittings .....</b>                                   | <b>Tables</b> |                                                                              |
|                |                                                                 | 1             | Gray-Iron Test Specimens and<br>Acceptance Values..... 8                     |
|                |                                                                 | 2             | Minimum Dimensional Requirements<br>for Cast Markings..... 11                |
|                |                                                                 | 3             | Plain-End Dimensions and Tolerances<br>for Mechanical-Joint Fittings .....12 |
|                |                                                                 | 4             | Mechanical-Joint Bends..... 14                                               |
|                |                                                                 | 5             | Mechanical-Joint Tees and<br>Crosses..... 18                                 |
|                |                                                                 | 6             | Mechanical-Joint Base Bends..... 25                                          |
|                |                                                                 | 7             | Mechanical-Joint Base Tees ..... 26                                          |
|                |                                                                 | 8             | Mechanical-Joint Reducers ..... 27                                           |
|                |                                                                 | 9             | Mechanical-Joint Tapped Tees ..... 31                                        |
|                |                                                                 | 10            | Mechanical-Joint Offsets..... 32                                             |
|                |                                                                 | 11            | Mechanical-Joint Sleeves..... 33                                             |
|                |                                                                 | 12            | Mechanical-Joint Caps and Plugs .... 34                                      |
|                |                                                                 | 13            | Mechanical-Joint Connecting<br>Pieces ..... 35                               |
|                |                                                                 | 14            | Connecting Pieces, One-End<br>Flanged ..... 36                               |
|                |                                                                 | 15            | Flange Details ..... 37                                                      |
|                |                                                                 | 16            | Base Drilling Details..... 38                                                |
|                |                                                                 | 17            | Flanged Bends..... 39                                                        |
|                |                                                                 | 18            | Flanged Tees and Crosses ..... 40                                            |
|                |                                                                 | 19            | Flanged Base Bends ..... 46                                                  |
|                |                                                                 | 20            | Flanged Base Tees..... 47                                                    |
|                |                                                                 | 21            | Flanged Reducers..... 48                                                     |
|                |                                                                 | A.1           | Flange Gasket Details ..... 53                                               |
| <b>Figures</b> |                                                                 |               |                                                                              |
| 1              | Mechanical-Joint Plain-End<br>Dimensions and Tolerances..... 12 |               |                                                                              |
| 2              | Mechanical-Joint Bends..... 13                                  |               |                                                                              |
| 3              | Mechanical-Joint Tees and<br>Crosses..... 18                    |               |                                                                              |
| 4              | Mechanical-Joint Base Bends..... 25                             |               |                                                                              |
| 5              | Mechanical-Joint Base Tees ..... 26                             |               |                                                                              |
| 6              | Mechanical-Joint Reducers ..... 27                              |               |                                                                              |
| 7              | Mechanical-Joint Tapped Tees ..... 31                           |               |                                                                              |
| 8              | Mechanical-Joint Offsets..... 32                                |               |                                                                              |
| 9a             | Mechanical-Joint Sleeves..... 33                                |               |                                                                              |
| 9b             | Mechanical-Joint Split Sleeves ..... 33                         |               |                                                                              |
| 10             | Mechanical-Joint Caps<br>and Plugs ..... 34                     |               |                                                                              |
| 11             | Mechanical-Joint Connecting<br>Pieces ..... 35                  |               |                                                                              |
| 12             | Connecting Pieces, One-End<br>Flanged ..... 36                  |               |                                                                              |
| 13             | Flange Details ..... 37                                         |               |                                                                              |
| 14             | Base Drilling Details..... 38                                   |               |                                                                              |
| 15             | Flanged Bends..... 39                                           |               |                                                                              |
| 16             | Flanged Tees and Crosses ..... 40                               |               |                                                                              |
| 17             | Flanged Base Bends ..... 46                                     |               |                                                                              |
| 18             | Flanged Base Tees..... 47                                       |               |                                                                              |
| 19             | Flanged Reducers..... 48                                        |               |                                                                              |

# 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 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 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 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).<sup>\*</sup> 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. (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 provided in classes B and D, and fittings 30 to 60 in. (762 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<sup>†</sup> 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. (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 described 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.

---

<sup>\*</sup>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.

<sup>†</sup>American Standards Association (ASA) is the former name of the American National Standards Institute.

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 2<sup>1</sup>/<sub>4</sub>-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 2<sup>1</sup>/<sub>4</sub>-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 2<sup>1</sup>/<sub>4</sub>-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 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.

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 rating for 12 in. 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. sizes; and the footnote on ductile-iron glands. Tables 16 through 19 were revised to show 3- through 12-in. 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. (610-mm) and smaller flanged fittings may be rated for 350 psi 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.

This edition of ANSI/AWWA C110 was approved by the AWWA Board of Directors on Jan. 27, 2008.

*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 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

---

\*Persons outside the United States should contact the appropriate authority having jurisdiction.

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.

Annex 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 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.

---

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

†NSF International, 789 N. Dixboro Road, Ann Arbor, MI 48105.

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

## 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.

## 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 for Water, of latest revision.
2. Size, joint type, pressure rating (Sec. 1.1 and tables).
3. Details of other federal, state or provincial, and local requirements (Sec. 4.1)
4. Permeation (Sec. 4.2)
5. Joint requirements (Sec. 4.3.1 and 4.3.2).
6. Joint accessory requirements (Sec. 4.3.3).
7. Type of iron required gray or ductile (Sec. 4.3.4).
8. End combinations for nonstandard fittings (Sec. 4.3.5).
9. Type of coating and lining required, asphaltic cement mortar or fusion bonded (Sec. 4.4.1).
10. Elimination of cement–mortar lining (Sec. 4.4.3 and 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.
11. Special coatings and linings requirements (Sec. 4.4.5 and 4.4.6).
12. Special flange bolt-hole orientation (Sec. 4.5.3.2).
13. Requirement for certification by manufacturer (Sec. 5.1.3).
14. Inspection by purchaser (Sec. 5.2).
15. Acceptance tests requirements transverse or tensile (Sec. 5.4.1.1).
16. 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.

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 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 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  $-20^{\circ}$  to  $150^{\circ}\text{F}$  ( $-28.9^{\circ}$  to  $65.6^{\circ}\text{C}$ ) 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. The Scope and Purpose of the standard were expanded to include wastewater and reclaimed water.
2. Addition of Requirements Sec. 4.1 Materials.
3. The table numbers were revised.

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

This page intentionally blank.



---

---

## *AWWA Standard*

---

---

# Ductile-Iron and Gray-Iron Fittings

---

## SECTION 1: GENERAL

---

### Sec. 1.1 Scope

This standard describes 3- to 48-in. (76- to 1,219-mm) gray-iron or ductile-iron fittings to be used with ductile-iron pipe for water, wastewater, and reclaimed water. 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. (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, 24-in. (610-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. (762- to 1,219-mm) size range, fittings with all types of joints described in 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.

Fittings are adequate for the rated working pressure plus a surge allowance of 100 psi 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 in. through 48 in. (76 mm through 1,219 mm), for water, wastewater, and reclaimed 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: 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<sup>\*</sup>/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 C116/A21.16—American National Standard for Protective Fusion Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.

ANSI/AWWA C153/A21.53—American National Standard for Ductile-Iron Compact Fittings for Water Service.

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

ASME<sup>†</sup> B16.1—Cast Iron Pipe Flanges and Flanged Fittings.

---

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

<sup>†</sup>ASME International, Three Park Avenue, New York, NY 10016.

ASTM\* A48—Standard Specification for Gray Iron Casting.

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

ASTM A536—Standard Specification for Ductile Iron Castings.

NSF†/ANSI 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.
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 stated in the latest revision of ANSI/AWWA C111/A21.11.
8. *Reclaimed water:* Wastewater that becomes suitable for beneficial use as a result of treatment.
9. *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.

---

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

†NSF International, 789 N. Dixboro Road, Ann Arbor, MI 48105.

---

## SECTION 4: REQUIREMENTS

---

### Sec. 4.1 Materials

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

### 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. 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 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 forth, *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. Fittings shall be capable of withstanding, without bursting, hydrostatic tests of three times the rated water working pressure.

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 the 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  $\pm 0.06$  in. ( $\pm 1.5$  mm) for sizes 3 in. to 10 in. (76 mm to 254 mm) and  $\pm 0.12$  in. ( $\pm 3.0$  mm) for sizes 12 in. to 48 in. (305 mm 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