



**American Water Works
Association**

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ANSI/AWWA C207-18
(Revision of ANSI/AWWA C207-13)

AWWA Standard

**Steel Pipe Flanges
for Waterworks
Service, Sizes 4 In.
Through 144 In.
(100 mm Through
3,600 mm)**

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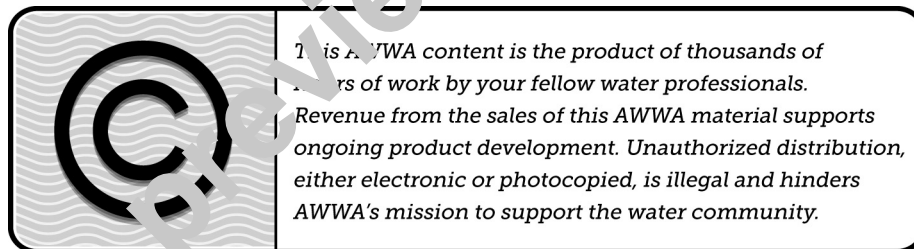
AWWA Standard

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Foreword

This foreword is for information only and is not a part of ANSI/AWWA C207.*

I. Introduction.

I.A. *Background.* Steel flanges have been used with steel pipe in the waterworks field since the first riveted steel water-supply lines were installed with flanges attached by riveting. Flanges manufactured according to unofficial flange standards, such as the riveted-pipe manufacturer's standards, were in common use for 50 years or more before the advent of ANSI/AWWA C207. Steel-plate ring flanges and rolled-angle flanges, to match the drilling of existing cast valves and cast fittings, were also used extensively.

The greatly increased usage of steel pipe for waterworks service during the 1930s made standardization of flanges desirable. The first step toward standardization was taken in 1942 when a paper[†] proposing standards for slip-on steel flanges for welding to steel water pipe was presented at the annual conference of the American Water Works Association (AWWA).

In 1945, at the request of the American Society of Mechanical Engineers (ASME), a committee having representatives from both ASME and AWWA was formed. The ASME/AWWA committee was charged with establishing standards for steel flanges having dimensions and pressure ratings commonly used in waterworks service. The standards were necessary because the lowest pressure ratings for steel flanges at that time were those having cold-water pressure ratings of 275 psi (1,896 kPa) (ASME[‡] B16.5, Pipe Flanges and Flanged Fittings). The ratings were far higher than those ordinarily needed for water service (50 psi [1,034-kPa]) primary pressure rating.

Generally accepted practice for the design of bolted flanged connections considers all fields of usage and a wide range of pressure and temperature applications. In waterworks practice, it is not necessary, within the scope of this standard, to deal with temperatures greater than the atmospheric range, and it is possible to limit the scope of consideration to gaskets contained in this standard and to flanges that are flat faced. The designs were prepared in conformity with these limitations.

The ASME/AWWA committee gave careful consideration to the following: (1) the effect of new standards on existing equipment; (2) the fact that cast valves and fittings will always have flanges of large outside diameter, which cannot be reduced because of

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

† Hill, H.O., et al. 1944. Fabricated Steel Ring Flanges for Water Pipe Service for Low Pressure and Low Temperatures. *Journal AWWA*, 36:9:968.

‡ ASME International, 3 Park Avenue, New York, NY 10016.

the wall thickness of this equipment; (3) the need for interchangeability of equipment through the use of common drilling patterns; and (4) the fact that standards could be based on the successful usage and good service records of existing installations.

A survey of water utility users indicated that it was desirable to maintain the outside diameter and drilling of flanged fittings and valves given in ANSI/AWWA C500, Gate Valves for Water and Sewage Systems, and ANSI/ASME B16.1, Cast Iron Pipe Flanges and Flanged Fittings (for Classes 25, 125, 250, and 800). The committee decided to follow this practice for sizes 6–48 in. (150–1,200 mm).

In its extensive deliberations, the ASME/AWWA committee had available the results of special research and testing conducted by Armco Steel Corporation, Bethlehem Steel Company, and Taylor Forge and Pipe Works. The various design methods and test results were given in “Steel Ring Flanges for Steel Pipe,” *ARMCO Bulletin 47-A* (1947), from the American Rolling Mill Company, Middletown, Ohio. The design of flanges for waterworks service, with the results of the preceding report, was published in *Journal AWWA* in October 1950, pp. 931–944. A discussion in the paper by Taylor Forge, participants in the ASME/AWWA conference, states the reasons why a waterworks flange is not an ASME/Taylor Forge flange. Concern about high secondary stresses at the attachment, e.g., thick material to thin wall pipe, is covered here along with the published “Design of Wye Branches” (*Journal AWWA*, June 1955, appendix C, pp. 581–630).

Beginning in 2006, a special flange task group investigated the development history of the flange dimensions found in the standard. After 5 years of research, the task group reached the following conclusions:

1. There is no one exact stress-based design method that could reproduce the thickness values in the tables. However, it appears the ring flange thicknesses in this standard are based on using the LaTour–Barnard design procedure (*ARMCO Bulletin 47-A*, 1947) for ring flanges, which is based on ASME integral flange design procedures.

2. A current design analysis was performed based on the LaTour–Barnard proposed design method (which was based on physical tests on pipes with steel-ring flanges) that demonstrated comparable results. The original LaTour–Barnard design procedure was a bending-stress design methodology.

3. It has been established that flange thickness design based solely on a stress-based design procedure is incorrect. In Barnard’s October 1950 *Journal AWWA* paper, he writes:

“When the test results were analyzed, it became obvious that the design formulas used in establishing American Standard flange dimensions predicted

fantastically high localized stresses even when the joint assembly performed satisfactorily. Since a method of designing by test was being sought, a reconciliation of the apparent contradictions between theory and test results had to be explored. To find the answer, attention was turned to the behavior under load of the steel being tested in pipe wall and flange. Also, the stress factors in the formulas were further examined to discover whether or not a different concept of design would compose the apparent differences between theory and test results. It was found that theory fits the data when the concept of calculated stress level design is displaced by a concept of limiting-strain design. Then there was good correlation between theory, the test results, and past field experience and practice.”

Simply put, the design of flange thickness was performed as a limiting-strain type of design procedure and not based on stress. The limiting strain was 5,000 $\mu\text{in./in.}$ as determined by the 0.5 percent load extension method.

4. Many steel-ring flanges have been supplied with thicknesses and dimensions that match the tables herein since these initial investigations were performed in the 1940s and 1950s by the ASME/AWWA committees leading up to the first edition of AWWA C207. As written by Barnard in 1950, “the primary aim in flange design should be to prevent joint leakage since steel flange joints do not fail by fracture.” The current flange task group has found this to be true over the past 60 years as there have been no reported occurrences of steel flanges fracturing when servicing the pressure that they were supplied to meet.

5. The determination of the steel-cylinder thickness at the flange attachment to be used in this standard is based on the design procedures for internal pressures shown in AWWA Manual M11, *Steel Pipe—A Guide for Design and Installation*. This practice is deemed acceptable based on empirical data of successful performance dating back to the early 1950s.

Tables 2 through 5 are based on historical dimensions and are presented without additional calculations.

I.B. *History.* The report of the ASME/AWWA committee was approved in 1951, and the first edition of this standard, designated AWWA C207-52T, was published in 1952 under the title *Tentative Standard Specifications for Steel Pipe Flanges*. That edition covered diameters from 6 to 48 in. (from 150 to 1,200 mm) and pressures through 150 psi (1,034 kPa). In 1954, a committee composed of Taylor Forge, Armco, Bethlehem Steel, and consulting engineers revised the existing standard to include diameters through 96 in. (2,400 mm) and pressures upto 275 psi (1,896 kPa). This

revision was published under designation AWWA C207-55, Standard Specifications/Standard for Steel Pipe Flanges. The standard was further revised and the next edition published in 1978 as ANSI/AWWA C207, Steel Pipe Flanges for Waterworks Service—Sizes 4 In. Through 144 In. The next edition, designated C207 with the same title, was published in 1986. It revised the maximum test pressure to 125 percent of the flange rating and added segmentation of flanges, blind flanges, Class E ring flanges, Class F ring and hub flanges, and tolerances for flange draft or layback. Subsequent editions were approved by the AWWA Board of Directors on June 17, 2001 and Jan. 21, 2007.

The 2013 edition of C207, approved on Jan. 20, 2013, deleted the use of ASTM A307 Grade B bolting requirements from Sec. 4.1.4, Bolting Materials. However, the design basis for the flange minimum thickness in Table 5, AWWA Blind-Flange Thickness, is 7,000-psi allowable bolt stress for Classes B and D flanges. The 2013 edition also removed hub flanges from the body of the standard, and the tables for steel-hub flanges for Classes D and E have been included in a new appendix B for information purposes only. This edition was approved on Jan. 20, 2018.

I.C. *Acceptance.* In May 1985, the US Environmental Protection Agency (USEPA) entered into a cooperative agreement with a consortium led by NSF International (NSF) to develop voluntary third-party consensus standards and a certification program for direct and indirect drinking water additives. Other members of the original consortium included the Water Research Foundation (formerly AwwaRF) and the Conference of State Health and Environmental Managers (COSHEM). The American Water Works Association (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. Specific policies of the state or local agency.
2. Two standards developed under the direction of NSF[†], NSF/ANSI[‡] 60, Drinking Water Treatment Chemicals—Health Effects, and NSF/ANSI 61, Drinking Water System Components—Health Effects.

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

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

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

3. Other references, including AWWA standards, *Food Chemicals Codex*, *Water Chemicals Codex*,* and other standards considered appropriate by the state or local agency.

Various certification organizations may be involved in certifying products in accordance with NSF/ANSI 61. Individual states or local agencies have authority to accept or accredit certification organizations within their jurisdictions. Accreditation of certification organizations may vary from jurisdiction to jurisdiction.

Annex A, “Toxicology Review and Evaluation Procedures,” to NSF/ANSI 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 C207 does not address additives requirements. Users of this standard should consult the appropriate state or local agency having jurisdiction in order to

1. Determine additives requirements, including applicable standards.
2. Determine the status of certifications by parties offering to certify products for contact with, or treatment of, drinking water.
3. Determine current information on product certification.

II. Special Issues.

II.A. *Thickness and Dimensional Design.* Thickness and dimensional design of ring flanges have been based on references given in the background section of this Foreword, as well as on industry standards and other empirical data. Thickness design of the blind flanges has been based on the ASME Code Design Method. For hub-flange applications, refer to ASME B16.47 and ASME B16.5.

Because of potential corrosion issues and differences in material strengths between stainless and carbon steel, stainless-steel fasteners are not covered in ANSI/AWWA C207.

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

* Both publications are available from National Academy of Sciences, 500 Fifth Street, NW, Washington, DC 20001.

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

II.C. *Gasket Degradation Study.* A pipe gasket having the hardness of a compressed elastomer with a large mass relative to the small exposed surfaced area experiences minimal degradation. This was validated in a research paper reported in the *Journal AWWA*,* where the pipe gasket degradation in a 110-mg/L chloramine solution was found to degrade just the exposed surface.

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.* When purchasing steel flanges for steel water pipe, the purchaser shall specify the following:

1. Standard used—that is, ANSI/AWWA C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm), of latest revision.
2. Whether compliance with NSF/ANSI 61, Drinking Water System Components—Health Effects, is required.
3. Type of flanges required—ring or blind type (Sec. 1.1).
4. Details of other federal, state or provincial, and local requirements (Sec. 4.1.1).
5. Gaskets—elastomeric (rubber), compressed fiber, or polytetrafluoroethylene (PTFE) based (Sec. 4.1.5).
6. Coating selection (Sec. 4.4).
7. Working pressure limit required (Tables 2 through 5).
8. Class of flange required (Tables 2 through 5).
9. Inside diameter of flanges (Tables 2 through 4).
10. Affidavit of compliance, if required (Sec. 6.2).

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

* Bonds, R.W. 2004. Effect of Chloramines on Ductile-Iron Pipe Gaskets of Various Elastomer Compounds. *Journal AWWA*, 96:4:153–160.

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

1. An advisory statement was added in the Foreword (Sec. II.B and II.C) regarding chlorine and chloramine degradation of elastomers.

2. Section 2, References, was updated.

3. Sec. 4.1.4.2, under Sec. 4.1.4, Bolting Materials, was revised to clarify the use of studs with one nut versus two nuts.

4. Sec. 4.1.5, Gaskets, was revised to replace the term *rubber* with *elastomeric*; the reference to ASTM D1330 was removed; the maximum gasket seating stress for compressed fiber was revised; and a requirement for gaskets used for electrical isolation was added.

5. Table 1 was updated; the option of rubber gaskets for Class B and Class D flanges larger than 24 in. (600 mm) and for Class E flanges sizes 4 in. (100 mm) to 24 in. (600 mm) was deleted because of concerns of overcompressing the gasket; the term *rubber* was replaced with *elastomeric*; and Note 2 of Table 1 regarding insulation/isolation requirements was revised and the information was moved to Sec. 4.1.5.

6. The term *roughness average* (Ra) and a reference to ASME B46.1 were added to Sec. 4.2.2, Facing, for clarity.

7. Sec. 4.2.2.1 was rewritten to more clearly specify that a removable corrosion inhibitor is permitted on flange faces prior to installation.

8. A sentence was added to Sec. 4.2.3, Drilling, to require the use of washers for oversized bolt holes.

9. Sec. 4.2.4, Segmentation of Flanges, was revised to clarify that segments must be of approximate equal size.

10. In Sec. 4.2.4.2, the term *100 percent* was added to clarify that radiographic or ultrasonic testing is 100 percent required for all welds.

11. Sec. 4.3.1, Welding, was revised to reflect changes in Figure 1 where t has been revised to T_f and T_y was added for the pipe cylinder thickness to clarify that for ¼-in. (6.4-mm) wall or smaller the weld size cannot be smaller than the cylinder wall.

12. The variable designations in Figure 1, Attachment of Flange, were revised to reflect the changes made to Sec. 4.3.1.

13. Sec. 4.3.2, Welding Procedure and Qualification, was revised.

14. Sec. 4.3.3, Draft or Layback Tolerance, was revised to reflect the tolerance for total draft or layback for a single flange.

15. The notation within Figure 2, Draft or Layback Measurement, was revised to be consistent with the change made in Sec. 4.3.3.

16. A new Figure 3, Negative Draft or Layback, was added to illustrate this issue.

17. Sec. 4.4, Protective Coating, was updated to reflect only those protective coatings allowed on flanges or flange joints.

V. Comments. If you have any comments or questions about this standard, please call AWWA Engineering and Technical Services at 303.794.7711, FAX at 303.795.7603, write to the department at 6666 West Quincy Avenue, Denver, CO 80235-3098, or e-mail at standards@awwa.org.



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Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes ring-type slip-on flanges and blind flanges. The flange pressure limits and the tables that describe them are

1. Ring-type, slip-on flanges (see Tables 2, 3, and 4).
2. Blind flanges (see Table 5).

Unless otherwise specified by the purchaser, the manufacturer shall select the type to be used.

Sec. 1.2 Purpose

The purpose of this standard is to provide minimum requirements and dimensions for a variety of steel flanges for attachment to steel water pipe and fittings.

Sec. 1.3 Application

1.3.1 *Intended use.* Flanges in this standard are intended for use with steel pipe, fittings, or appurtenances meeting the requirements of ANSI/AWWA C200, ANSI/AWWA C208, or other equivalent standards. It is intended that flanges be attached by welding in accordance with Sec. 4.3 of this standard.