American Water Works Association
ANSI/AWWA C207-94
(Revision of ANSI/AWWA C207-86)

AWWA STANDARD

FOR

STEEL PIPE FLANGES FOR WATERWORKS SERVICE — SIZES 4 IN. THROUGH 144 IN. (100 mm THROUGH 3,600 mm)

Effective date: Nov. 1, 1994.
First edition approved by AWWA Board of Directors June 17, 1955.
This edition approved Jan. 30, 1994.
Approved by American National Standards Institute Aug. 18, 1994.

AMERICAN WATER WORKS ASSOCIATION

6666 West Quincy Avenue, Denver, Colorado 80235

AWWA Standard

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Contents

All AWWA standards follow the general format indicated subsequently. Some variations from this format may be found in a particular standard.

Foreword

This foreword is for information only and is not a part of 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 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-ring flanges for welding to steel water pipe was presented at the annual conference of the American Water Works Association.

In 1945, at the request of the American Society of Mechanical Engineers (ASME), a committee having representatives from both ASME and the American Water Works Association (AWWA) was formed. The ASME/AWWA committee was charged with establishing standards for steel flanges having dimensions and pressure ratings commensurate with the pressures 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) (ANSI†/ASME‡ B16.5, Pipe Flanges and Flanged Fittings) (150-psi [1,034-kPa] primary pressure rating). The ratings were far higher than those ordinarily needed for water service.

The generally accepted rules for the design of bolted, flanged connections embraced 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 restrict consideration to joints with softer gaskets 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 the wall thickness of such equipment; (3) the need for interchangeability of equipment through the medium of common drilling templates; 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, Standard for Gate Valves for Water and Sewage Systems; and ANSI/ASME

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

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

‡American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017.

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 in. (150 mm) through 48 in. (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 are given in "Steel Ring Flanges for Steel Pipe," 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 committee, 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." (See *Journal AWWA,* June 1955, Appendix C, pp. 581–630.)

I.B. *History of Standard.* The report of the ASME/AWWA committee was approved in 1951, and the first edition of this standard, designated C207-52T, was published under the title "Tentative Standard Specifications For Steel Pipe Flanges" in 1952. That edition covered diameters from 6 in. to 48 in. (150 mm to 1,200 mm) and pressures through 150 psi (1,034 kPa). In 1954, a committee composed of Taylor Forge, Armco, Bethlehem, and consulting engineers revised the existing standard to include diameters through 96 in. (2,400 mm) and pressures to 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 AWWA C207-78, Standard For Steel Pipe Flanges For Waterworks Service — Sizes 4 In. Through 144 In. The next edition, designated AWWA C207-86 with the same title, was published in 1986 and revised the maximum test pressure to 125 percent of the flange rating, added segmentation of flanges, blind flanges, class E ring flanges, class F ring and hub flanges, and tolerances for flange draft or layback.

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 consortium included the American Water Works Association Research Foundation (AWWARF), the Conference of State Health and Environmental Managers (COSHEM), the American Water Works Association (AWWA), and the Association of State Drinking Water Administrators (ASDWA). The consortium is responsible for the cooperative effort of manufacturers, regulators, product users, and other interested parties that develop and maintain the NSF standards.

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

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

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.

AWWA C207-94 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. It should be noted that thickness and dimensional designs of ring and hub flanges have been based on references given in the background section of this foreword, as well as industry standard and other empirical data. Thickness design of the blind flanges has been based on the ASME Code Design Method.

III. Use of 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 make specific statements in the specifications regarding the following:

1. Standard used — that is, AWWA C207-94, Standard for Steel Pipe Flanges for Waterworks Service — Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).

2. Type of flanges required — ring or hub type (Sec. 1.1).

3. Pressure rating required (Tables 2 through 7).

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*American National Standards Institute, 11 W. 42nd St., New York, NY 10036.

†NSF International, 3475 Plymouth Rd., Ann Arbor, MI 48106.

‡Both publications available fron National Academy of Sciences, 2102 Constitution Ave. N.W., Washington, DC 20418.

4. Class of flange required (Tables 2 through 7).

5. Inside diameter of flanges (Tables 2 through 7).

6. Gaskets — rubber or nonasbestos (Sec. 4.1.3) and gasket thickness for diameters up to and including 24 in. (610 mm)

III.B. *Modification to Standard.* Any modification of the provisions, definitions, or terminology in this standard must be provided in the purchaser's specifications.

IV. Major Revisions. Major changes made in this edition of the standard are as follows:

1. The standard was edited and reformatted throughout.

2. Sec. 4.1.1.2, Steel plate or bar (old Sec. 2.1.2), was revised to add carbon restrictions and the minimum yield strength was increased to 32,000 psi (220.6 MPa), representative of materials commonly used today.

3. Sec. 4.1.2, Bolting (old Sec. 2.2), was revised to delete ASTM* A307 grade A for class B and D flanges and add ASTM A193 grade B7 for class E and F flanges.

4. Sec. 4.1.3, Gaskets (old Sec. 2.3), was revised and new Table 1, Flange Gasket Materials, Type and Thickness, was added.

5. Sec. 4.2.5, Blind Flanges (old Sec. 3.5), was revised, reducing the maximum size of flat-plate blind flanges from 60 in. to 48 in. (1,500 mm to 1,200 mm).

6. Tables previously numbered 1–5 were renumbered Tables 2–6, respectively.

7. Bolt diameters for class B flanges in Tables 2 and 3 (new) were revised to match class D bolts.

8. Thicknesses of some flanges were changed in Tables 2 and 6 (new).

9. A tolerance on the diameter of the flange bore was added to Tables 2 and 3 (new) to prevent overboring hub flanges.

10. Hub flanges greater than 96 in. (2,400 mm) were deleted from Tables 3 and 4 (new).

11. Old Table 6, AWWA Standard Steel Hub Flanges, Class F (300 psi [2,068 kPa]), was deleted since these flanges are identical to ANSI/ASME B16.5, and new Table 7, AWWA Blind-Flange Thickness, was added.

V. Comments. If you have any comments or questions about this standard, please call the AWWA Standards Department, (303) 794-7711 ext. 2201, FAX (303) 795-1440, or write to the department at 6666 W. Quincy Ave., Denver, CO 80235.

*American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

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AWWA STANDARD FOR

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 covers two types of slip-on flanges, ring type and hub type, that may be used interchangeably if the dimensions given in the standard are used. The standard also covers blind flanges. The flange types and the tables that describe them are

1. Ring-type, slip-on flanges (see Tables 2, 5, and 6).
2. Hub-type, slip-on flanges (see Tables 3 and 4).
3. Blind flanges (see Table 7).

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

Sec. 1.2 Purpose

The purpose of this standard is to provide purchasers and manufacturers minimum material 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, ASTM† A134, ASTM A139, or other equivalent standards. It is intended that flanges be attached by welding in accordance with Sec. 4.3 of this standard.

1.3.2 *Pressure ratings*. The following pressure ratings apply to flanges covered by this standard:

1.3.2.1 Class B flanges are suitable for pressure ratings up to and including 86 psi (593 kPa). This rating is identical to that for class B cast-iron fittings for a 200-ft (60.96-m) head of water.

1.3.2.2 Class D flanges are suitable for pressure ratings as follows:

1. Sizes 4–12 in. (100–300 mm): 175 psi (1,207 kPa).
2. Sizes greater than 12 in. (300 mm): 150 psi (1,034 kPa).

1.3.2.3 Class E flanges are suitable for pressure ratings up to and including 275 psi (1,896 kPa). Dimensions of Table 4 flanges are identical to ANSI/ASME‡ B16.5 class 150 flanges up to 24 in. (600 mm) (without raised face), and ANSI/ASME B16.1 class 125, large-diameter flanges above 24 in. (600 mm) (without raised face), except they shall be faced in accordance with Sec. 4.2.2 of this standard.

1.3.2.4 Class F flanges are suitable for water pressures up to and including 300 psi (2,068 kPa). Flange outside diameter (OD) and bolt-circle dimensions conform to ANSI/ASME B16.1, class 250 through 48 in. (1,200 mm), ANSI/ASME B16.5 class 300 through 24 in. (600 mm), and ANSI/ASME B16.47 class 300 for 26–30 in. (650–750 mm).

1.3.2.5 Pressure ratings are for conditions and temperatures customary in water utility service. The pressure ratings for the flange should be based on the design of the maximum operating pressure plus the anticipated surge pressure. Test pressures should not exceed 125 percent of the ratings.

1.3.2.6 Flange design is based on pressure considerations, not for stresses induced by external moments when pipe acts as a beam.

SECTION 2: REFERENCES

This standard references the following documents. They form a part of this standard to the extent specified herein. In any case of conflict, the requirements of this standard shall prevail.

ANSI/ASME B1.1 — Unified Inch Screw Threads (UN and UNR Thread Form).
ANSI/ASME B16.1 — Cast Iron Pipe Flanges and Flanged Fittings.
ANSI/ASME B16.5 — Pipe Flanges and Flanged Fittings.
ANSI/ASME B16.47 — Large Diameter Steel Flanges: NPS 26 through NPS 60.
ANSI/ASME B18.2.1 — Square and Hex Bolts and Screws (Inch Series).
ANSI/ASME B18.2.2 — Square and Hex Nuts (Inch Series).

*American National Standards Institute, 11 W. 42nd St., New York, NY 10036.

†American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103.

‡American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017.

ANSI/ASME B36.10 — Welded and Seamless Wrought Steel Pipe.

ASME — Boiler and Pressure Vessel Codes — Section VIII, Pressure Vessels and Section IX, Welding Operator Qualification.

ASTM A36 — Standard Specification for Structural Steel.

ASTM A105 — Standard Specification for Forgings, Carbon Steel, for Piping Components.

ASTM A134 — Standard Specification for Pipe, Steel, Electric-Fusion (Arc)-Welded (Sizes NPS 16 and Over).

ASTM A139 — Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over).

ASTM A181 — Standard Specification for Forgings, Carbon Steel, for General-Purpose Piping.

ASTM A193 — Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.

ASTM A307 — Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

ASTM A516 — Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service.

ASTM D1330 — Standard Specification for Rubber-Sheet Gaskets.

ANSI/AWS* D1.1 — Structural Welding Code — Steel.

ANSI/AWWA C200 — Standard for Steel Water Pipe — 6 In. (150 mm) and Larger.

ANSI/AWWA C203 — Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipelines — Enamel and Tape — Hot-Applied.

ANSI/AWWA C205 — Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe — 4 In. and Larger — Shop Applied.

ANSI/AWWA C206 — Standard for Field Welding of Steel Water Pipe.

ANSI/AWWA C208 — Standard for Dimensions for Fabricated Steel Water Pipe Fittings.

ANSI/AWWA C209 — Standard for Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.

ANSI/AWWA C210 — Standard for Liquid Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

ANSI/AWWA C213 — Standard for Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.

ANSI/AWWA C214 — Standard for Tape Coatings Systems for the Exterior of Steel Water Pipelines.

ANSI/AWWA C215 — Standard for Extruded Polyolefin Coatings for the Exterior of Steel Water Pipelines.

ANSI/AWWA C216 — Standard for Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.

ANSI/AWWA C217 — Standard for Cold-Applied Petrolatum Tape and Petroleum Wax Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Buried Steel Water Pipelines.

ANSI/AWWA C218 — Standard for Coating the Exterior of Aboveground Steel Water Pipelines and Fittings.

*American Welding Society Inc., 550 N.W. LeJeune Rd., Miami, FL 33135.

SECTION 3: DEFINITIONS

In this standard, the following definitions shall apply:

1. *Manufacturer:* The party that manufactures, fabricates, or produces materials or products.

2. *Purchaser:* The person, company, or organization that purchases any materials or work to be performed.

SECTION 4: REQUIREMENTS

Sec. 4.1 Material

4.1.1 *Flanges.* Flanges shall be made from seamless forgings, cut from plate as a single piece, welded bar rings, or segmented and welded plates.

4.1.1.1 Forgings. Forgings shall meet the minimum requirements of ASTM A105 or ASTM A181.

4.1.1.2 Steel plate or bar. Steel plate or bar used in the manufacture of flanges shall meet the following requirements:

1. Tensile strength = 50,000 psi (345 MPa) (min.).
2. Yield strength = 32,000 psi (221 MPa) (min.).
3. Carbon (max.) = 0.29 percent.
4. Phosphorus (max.) = 0.04 percent.
5. Sulfur (max.) = 0.05 percent.

The following plate designations will meet the previously listed requirements:

1. ASTM A36.
2. ASTM A516, grade 60, 65, or 70.

4.1.1.3 Mill test reports. The manufacturer shall furnish mill test reports showing conformance to the physical and chemical requirements on request.

4.1.2 *Bolting.* Bolts and nuts shall be carbon steel, ASTM A307 grade B for class B and D flanges. Bolts for class E and F flanges shall be ASTM A193 grade B7. Bolts shall have regular unfinished square or hexagonal heads, and nuts shall have regular square or hexagonal dimensions, all in accordance with ANSI/ASME B18.2.1 for wrench head bolts and nuts and wrench openings. All bolts and nuts shall be threaded in accordance with ANSI/ASME B1.1 for screw threads, coarse-threaded series, class 2A and 2B fit (8-series, 1-in. [25-mm] diameter and above).

Minimum bolt lengths shall be the sum of the mating flange maximum thicknesses, the gasket, and the depth of the nut plus ⅛ in. (3.2 mm) minimum before torquing. If threaded rods are used, they shall be the same length as the bolts determined previously, plus the depth of the nuts, plus ⅛ in. (3.2 mm).

4.1.3 *Gaskets.* This standard is predicated on gaskets of the type, thickness, and material shown in Table l for the class of flange, working pressure, and diameter listed.

Rubber gaskets shall be red rubber (SBR) hardness (Shore A) 80 ± 5, suitable for water service temperature to 200°F (93.3°C) with gasket yield pressure of 200 psi (1,379 kPa) minimum to 1,200 psi (8,274 kPa) maximum, conforming to ASTM D1330 grades I and II.

Nonasbestos gaskets shall be a blend of synthetic fibers, fillers, and elastomeric binders suitable for potable water service and temperatures to 700°F (371.1°C).

Table 1 Flange gasket materials, type and thickness

Flange Class	Working Pressure		Nominal Pipe Diameter		Thickness			
	psi	*(kPa)*	*in.*	*(mm)*	Material	Type	*in.*	*(mm)*
B	86	(593)	4–24	(100–600)	Rubber	FF*	1/16 or 1/8	(1.59 or 3.18)
B	86	(593)	26–144	(650–3,600)	Rubber	Ring	1/8	(3.18)
D	175	(1,207)	4–12	(100–300)	Rubber	FF	1/16 or 1/8	(1.59 or 3.18)
D	150	(1,034)	14–24	(350–600)	Rubber	FF	1/16 or 1/8	(1.59 or 3.18)
D	150	(1,034)	26–144	(650–3,600)	Rubber	Ring	1/8	(3.18)
E	175	(1,207)	4–12	(100–300)	Rubber	FF	1/16	(1.59)
E	150	(1,034)	14–24	(350–600)	Rubber	FF	1/16	(1.59)
E	275	(1,896)	4–24	(100–600)	Nonasbestos	Ring	1/16	(1.59)
E	275	(1,896)	26–144	(650–3,600)	Nonasbestos	Ring	1/8	(3.18)
F	300	(2,068)	4–24	(100–600)	Nonasbestos	Ring	1/16	(1.59)
F	300	(2,068)	26–48	(650–1,200)	Nonasbestos	Ring	1/8	(3.18)

*Full faced.

Gasket yield pressure shall be 3,600 psi (24.82 MPa) minimum for gaskets 1/16-in. (1.6-mm) thick and 4,800 psi (33.09 MPa) minimum for gaskets 1/8-in. (3.2-mm) thick. Gaskets shall be suitable for a maximum seating pressure of 15,000 psi (103.42 MPa).

Ring-gasket diameter shall be as follows:
inside diameter (ID) = flange ID
outside diameter (OD) = ID of bolt-hole circle less 1/16 in. (1.6 mm).

Sec. 4.2 Fabrication

4.2.1 *Tolerances.* The dimensions listed in Tables 2 through 7 (following Sec. 6.1) shall apply prior to attachment and are subject to the following tolerances:

4.2.1.1 Inside diameter of flange +1/16 in. (1.6 mm), –0
4.2.1.2 Outside diameter of flange ± 1/8 in. (3.2 mm)
4.2.1.3 Thickness of flanges
18 in. (450 mm) and smaller +1/8 in. (3.2 mm), –0
4.2.1.4 Thickness of flanges
20 in. (500 mm) and larger +3/16 in. (4.8 mm), –0
4.2.1.5 Length through hub
18 in. (450 mm) and smaller +1/8 in. (3.2 mm), –1/32 in. (0.79 mm)
4.2.1.6 Length through hub
20 in. (500 mm) and larger +3/16 in. (4.8 mm), –1/16 in. (1.6 mm)
4.2.1.7 Bolt-circle diameter ± 1/16 in. (1.6 mm)
4.2.1.8 Bolt-hole spacing ± 1/32 in. (0.79 mm)

4.2.2 *Facing.* Flanges of all classes shall be flat faced — that is, without projection or raised face. Either a serrated concentric or serrated spiral finish having from 24 to 40 grooves/in. (0.94 to 1.57 grooves/mm) shall be used. The cutting tool employed shall have an approximate 0.06-in. (1.52-mm) or larger radius. The resultant surface finish shall have a 250- to 500-μm (6.35- to 12.7-μm) roughness.

4.2.3 *Drilling.* Drilling templates are in multiples of four so that fittings can be made to face any quarter. Bolt holes shall straddle the center line, except where

special mating conditions exist, and shall be drilled ⅛ in. (3.2 mm) larger in diameter than the nominal diameter of the bolt, except for flanges larger than 84 in. (2,100 mm) in diameter, bolt holes shall be drilled 3⁄16 in. (4.8 mm) larger than the nominal bolt diameter. Bolt holes may be overdrilled by an additional ⅛ in. (3.2 mm) to accommodate insulators or to facilitate alignment with the mating flange.

4.2.4 *Segmentation of flanges.* Construction of flanges by welding segments together will be necessary when the OD of a flange exceeds the width of available plate material (approximately 78-in. [1,950-mm] ID and larger). A maximum of four segments are allowed in a single flange.

4.2.4.1 Welding of the segments shall be performed in accordance with Sec. 4.3.2 of this standard.

4.2.4.2 Radiographic or ultrasonic testing of all welds is required and shall be performed in accordance with the governing welding code selected in Sec. 4.3.2.

4.2.4.3 If any specimen tested in accordance with the approved procedure fails to meet the requirements, it shall be repaired using the approved repair procedure and radiographically or ultrasonically tested for conformance. If the retest fails to conform to the requirements, the flange shall be rejected.

4.2.4.4 Segmented flanges shall be stress-relieved by a method acceptable to the purchaser. Stress relieving shall be done after welding and before machining.

4.2.5 *Blind flanges.* Blind-flange thicknesses shall be as set forth in Table 7. For blind flanges over 48-in. (1,200-mm) nominal diameter, it is recommended that a combination of a ring flange and a flanged and dished head, suitable for the pressure and design conditions, be used. Blind flanges shall be machine faced to match the mating flange. The thickness shown in Table 7 is after machining.

Sec. 4.3 Method of Attachment of Flanges

4.3.1 *Welding.* Flanges shall be attached to pipe, fittings, or other appurtenances by means of two fillet welds of the size shown in Figure 1. Whenever attachment by this means is not practical, the flanges may be attached by welds similar to those described in Section VIII of the ASME Boiler and Pressure Vessel Code.

4.3.2 *Welding procedure and qualification.* All welds performed in the attachment of flanges, welding of segments of flanges, and the repair of welding defects shall conform to a written procedure developed by the manufacturer. This procedure shall be available on request to the purchaser for review, approval, or modification.

The procedure used shall be based on a current, applicable welding code, such as ANSI/AWS D1.1 or ASME Boiler and Pressure Vessel Code, Section IX.

4.3.2.1 Welder and welding operator qualification. Welders and welding operators shall be qualified under Section IX, Part A, of the ASME Boiler and Pressure Vessel Code; applicable parts of Section 3, ANSI/AWS D1.1; or other approved procedure.

4.3.3 *Draft or layback tolerance.* After welding of the flange has been completed, a draft or layback of the flange face may occur as shown in Figure 2. Total draft or layback shall not exceed 1½° between two mating flanges. Negative draft will not be permitted.

4.3.4 *Welding technique.* Care shall be taken during the welding process to avoid warping the flange face, particularly when attaching class B flanges.

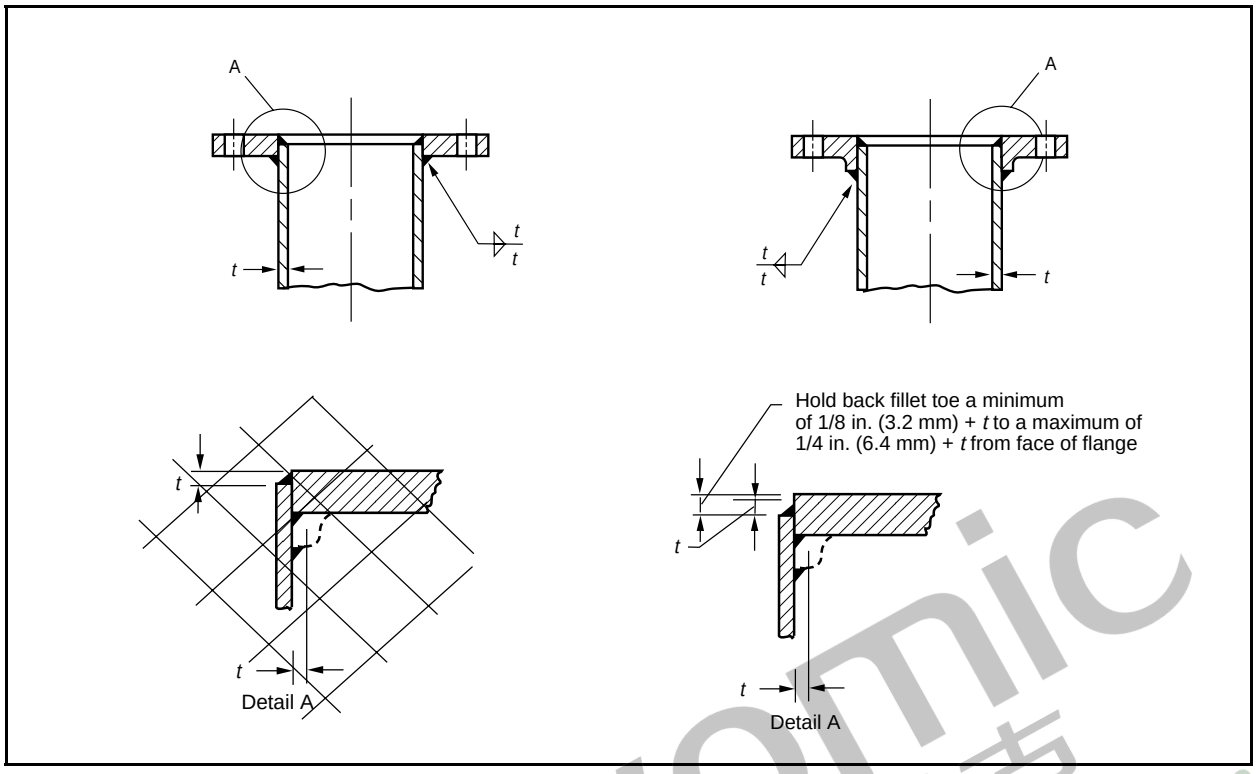

Figure 1 Attachment of flange

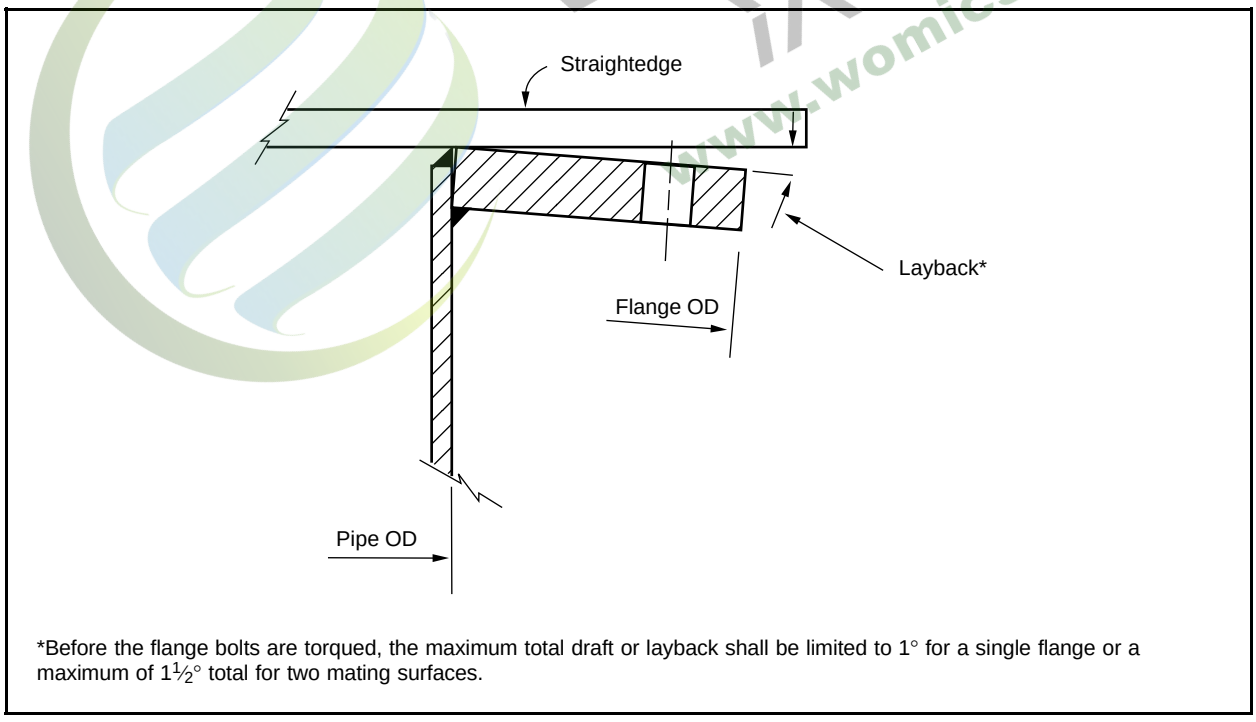

Figure 2 Draft or layback measurement

Sec. 4.4 Protective Coating

If specified by the purchaser, the flanges and/or flanged joints shall be given a protective coating conforming to ANSI/AWWA C203, ANSI/AWWA C205, ANSI/AWWA C209, ANSI/AWWA C210, ANSI/AWWA C213, ANSI/AWWA C214, ANSI/AWWA C215, ANSI/AWWA C216, ANSI/AWWA C217, ANSI/AWWA C218, or some combination of these coatings.

SECTION 5: VERIFICATION

Sec. 5.1 Inspection by the Purchaser

5.1.1 *Optional inspection.* At the purchaser's option, flange dimensions and attachment to pipe by welding may be inspected by the purchaser. Such inspection shall not relieve the manufacturer of the responsibility to furnish material and perform work in accordance with this standard.

5.1.2 *Access and facilities.* The purchaser shall have access at all reasonable times to those parts of the manufacturer's plant involved in the manufacture of the material ordered while the work contracted is being performed. The manufacturer shall provide the purchaser with the facilities necessary to determine that the material is being furnished in accordance with this standard. Inspections shall be made at the place of manufacture prior to shipment.

5.1.3 *Rejection.* The purchaser may reject any flanges that do not conform to the requirements of this standard and the purchaser's specifications.

Sec. 5.2 Mill Test Reports

Mill test reports may be requested as set forth in Sec. 4.1.1.3.

SECTION 6: DELIVERY

Sec. 6.1 Markings

Flanges shall be stamped with the size and name or trademark of the manufacturer and with the AWWA class as defined in Sec. 1.3.2.

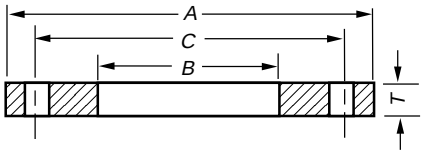

Table 2 AWWA standard steel-ring flanges, class B* (86 psi) and class D† (175–150 psi)

Nominal Pipe Size *in.*	OD of Flange (*A*) *in.*	ID of Flange (*B*‡) *in.*	Number of Bolts	Diam. of Bolt Circle (*C*) *in.*	Diam. of Bolts§ *in.*	Thickness of Flange — *in.*	
						Class B (*T*)	Class D (*T*)
4	9.00	4.57	8	7.50	0.625	0.625	0.625
5	10.00	5.66	8	8.50	0.750	0.625	0.625
6	11.00	6.72	8	9.50	0.750	0.688	0.688
8	13.50	8.72	8	11.75	0.750	0.688	0.688
10	16.00	10.88	12	14.25	0.875	0.688	0.688
12	19.00	12.88	12	17.00	0.875	0.688	0.812
14	21.00	14.19	12	18.75	1.000	0.688	0.938
16	23.50	16.19	16	21.25	1.000	0.688	1.000
18	25.00	18.19	16	22.75	1.125	0.688	1.062
20	27.50	20.19	20	25.00	1.125	0.688	1.125
22	29.50	22.19	20	27.25	1.250	0.750	1.188
24	32.00	24.19	20	29.50	1.250	0.750	1.250
26	34.25		24	31.75	1.250	0.812	1.312
28	36.50		28	34.00	1.250	0.875	1.312
30	38.75		28	36.00	1.250	0.875	1.375
32	41.75		28	38.50	1.500	0.938	1.500
34	43.75		32	40.50	1.500	0.938	1.500
36	46.00		32	42.75	1.500	1.000	1.625
38	48.75		32	45.25	1.500	1.000	1.625
40	50.75		36	47.25	1.500	1.000	1.625
42	53.00		36	49.50	1.500	1.125	1.750
44	55.25		40	51.75	1.500	1.125	1.750
46	57.25		40	53.75	1.500	1.125	1.750
48	59.50		44	56.00	1.500	1.250	1.875
50	61.75		44	58.25	1.750	1.250	2.000
52	64.00		44	60.50	1.750	1.250	2.000
54	66.25		44	62.75	1.750	1.375	2.125
60	73.00		52	69.25	1.750	1.500	2.250
66	80.00		52	76.00	1.750	1.625	2.500
72	86.50		60	82.50	1.750	1.750	2.625
78	93.00		64	89.00	2.000	2.000	2.750
84	99.75		64	95.50	2.000	2.000	2.875
90	106.50		68	102.00	2.250	2.250	3.000
96	113.25		68	108.50	2.250	2.250	3.250
102	120.00		72	114.50	2.500	2.500	3.250
108	126.75		72	120.75	2.500	2.500	3.375
114	133.50		76	126.75	2.750	2.750	3.500
120	140.25		76	132.75	2.750	2.750	3.500
126	147.00		80	139.25	3.000	3.000	3.750
132	153.75		80	145.75	3.000	3.000	3.875
138	160.50		84	152.00	3.250	3.250	4.000
144	167.25		84	158.25	3.250	3.250	4.125

NOTES:

1. Ring flanges may be overbored or counterbored to accommodate larger-outside-diameter pipe than that shown as nominal. This is done to allow a clear inside diameter after cement–mortar lining. Wrench clearance between the pipe OD and bolt circle must be maintained as well as sufficient gasket seating area.

2. Metric conversion: nominal pipe size: in. × 25 = mm; dimensions: in. × 25.4 = mm; psi × 6.895 = kPa.

*Pressure rating at atmospheric temperature is 86 psi. These flanges have the same OD and drilling as class 125 cast-iron flanges (ANSI/ASME B16.1). In sizes 24 in. and smaller, they also match ANSI/ASME B16.5 150-psi drilling for steel flanges.

†Pressure rating at atmospheric temperature: sizes 4–12 in. inclusive, 175 psi; sizes larger than 12 in., 150 psi. These flanges have the same diameter and drilling as class 125 cast-iron flanges (ANSI/ASME B16.1). In sizes 24 in. and smaller, they also match ANSI/ASME B16.5 150-psi standard for steel flanges.

‡The purchaser shall specify the ID of the flange, dimension *B,* for nominal pipe sizes 26 in. and larger. The diameter of the flange bore shall not exceed the pipe OD by more than 0.19 in.

§Bolt holes shall be drilled $\frac{1}{8}$ in. larger in diameter than the nominal diameter of the bolt except as stated in Sec. 4.2.3.

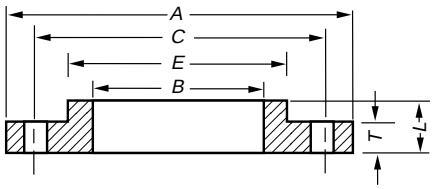

Table 3 AWWA standard steel-hub flanges, class B* (86 psi) and class D† (175- 150 psi)

Nominal Pipe Size *in.*	OD of Flange (*A*) *in.*	ID of Flange (*B*) *in.*	Number of Bolts	Diam. of Bolt Circle (*C*) *in.*	Diam. of Bolts‡ *in.*	Flange Dimensions — *in.*		
						(*T*)	(*L*)	(*E*)
4	9.00	4.57	8	7.50	0.625	0.500	0.875	5.312
5	10.00	5.66	8	8.50	0.750	0.562	1.250	6.312
6	11.00	6.72	8	9.50	0.750	0.562	1.250	7.562
8	13.50	8.72	8	11.75	0.750	0.562	1.250	9.688
10	16.00	10.88	12	14.25	0.875	0.688	1.250	12.000
12	19.00	12.88	12	17.00	0.875	0.688	1.250	14.375
14	21.00	14.19	12	18.75	1.000	0.750	1.250	15.750
16	23.50	16.19	16	21.25	1.000	0.750	1.250	18.000
18	25.00	18.19	16	22.75	1.125	0.750	1.250	19.875
20	27.50	20.19	20	25.00	1.125	0.750	1.250	22.000
22	29.50	22.19	20	27.25	1.250	1.000	1.750	24.250
24	32.00	24.19	20	29.50	1.250	1.000	1.750	26.125
26	34.25	26.19	24	31.75	1.250	1.000	1.750	28.500
28	36.50	28.19	28	34.00	1.250	1.000	1.750	30.500
30	38.75	30.19	28	36.00	1.250	1.000	1.750	32.500
32	41.75	32.19	28	38.50	1.500	1.125	1.750	34.750
34	43.75	34.19	32	40.50	1.500	1.125	1.750	36.750
36	46.00	36.19	32	42.75	1.500	1.125	1.750	38.750
38	48.75	38.19	32	45.25	1.500	1.125	1.750	40.750
40	50.75	40.19	36	47.25	1.500	1.125	1.750	43.000
42	53.00	42.19	36	49.50	1.500	1.250	1.750	45.000
44	55.25	44.19	40	51.75	1.500	1.250	2.250	47.000
46	57.25	46.19	40	53.75	1.500	1.250	2.250	49.000
48	59.50	48.19	44	56.00	1.500	1.375	2.500	51.000
50	61.75	50.19	44	58.25	1.750	1.375	2.500	53.000
52	64.00	52.19	44	60.50	1.750	1.375	2.500	55.000
54	66.25	54.19	44	62.75	1.750	1.375	2.500	57.000
60	73.00	60.19	52	69.25	1.750	1.500	2.750	63.000
66	80.00	66.19	52	76.00	1.750	1.500	2.750	69.000
72	86.50	72.19	60	82.50	1.750	1.500	2.750	75.000
78	93.00	78.19	64	89.00	2.000	1.750	3.000	81.250
84	99.75	84.19	64	95.50	2.000	1.750	3.000	87.500
90	106.50	90.19	68	102.00	2.250	2.000	3.250	93.750
96	113.25	96.19	68	108.50	2.250	2.000	3.250	100.000

NOTES:

1. Hub flanges are to be used on pipe that has an OD equal to the nominal pipe size in the first column.
2. Metric conversion: nominal pipe size: in. × 25 = mm; dimensions: in. × 25.4 = mm; psi × 6.895 = kPa.

*Pressure rating at atmospheric temperature is 86 psi. These flanges have the same OD and drilling as class 125 cast-iron flanges (ANSI/ASME B16.1). In sizes 24 in. and smaller, they also match ANSI/ASME B16.5 150-psi drilling for steel flanges.

†Pressure rating at atmospheric temperature: sizes 4–12 in. inclusive, 175 psi; sizes larger than 12 in., 150 psi. These flanges have the same diameter and drilling as class 125 cast-iron flanges (ANSI/ASME B16.1). In sizes 24 in. and smaller, they also match ANSI/ASME B16.5 150-psi standard for steel flanges.

‡Bolt holes shall be drilled $\frac{1}{8}$-in. larger in diameter than the nominal diameter of the bolt as stated in Sec. 4.2.3.

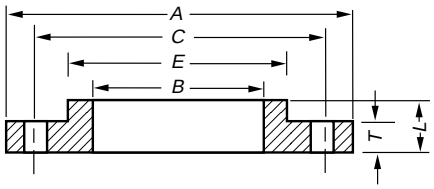

Table 4 AWWA standard steel-hub flanges, class E* (275 psi)

Nominal. Pipe Size *in.*	OD of Flange (*A*) *in.*	ID of Flange (*B*†) *in.*	Number of Bolts	Diam. of Bolt Circle (*C*) *in.*	Diam. of of Bolts‡ *in.*	Flange Dimensions — *in.*		
						(*T*)§	(*L*)	(*E*)
4	9.00	4.57	8	7.50	0.625	0.938	1.312	5.312
5	10.00	5.66	8	8.50	0.750	0.938	1.438	6.438
6	11.00	6.72	8	9.50	0.750	1.000	1.562	7.562
8	13.50	8.72	8	11.75	0.750	1.125	1.750	9.688
10	16.00	10.88	12	14.25	0.875	1.188	1.938	12.000
12	19.00	12.88	12	17.00	0.875	1.250	2.188	14.375
14	21.00	14.19	12	18.75	1.000	1.375	2.250	15.750
16	23.50	16.19	16	21.25	1.000	1.438	2.500	18.000
18	25.00	18.19	16	22.75	1.125	1.562	2.688	19.875
20	27.50	20.19	20	25.00	1.125	1.688	2.875	22.000
22	29.50	22.19	20	27.25	1.250	1.812	3.125	24.000
24	32.00	24.19	20	29.50	1.250	1.875	3.250	26.125
26	34.25	26.19	24	31.75	1.250	2.000	3.375	28.500
28	36.50	28.19	28	34.00	1.250	2.062	3.438	30.750
30	38.75	30.19	28	36.00	1.250	2.125	3.500	32.750
32	41.75	32.19	28	38.50	1.500	2.250	3.625	35.000
34	43.75	34.19	32	40.50	1.500	2.312	3.688	37.000
36	46.00	36.19	32	42.75	1.500	2.375	3.750	39.250
38	48.75	38.19	32	45.25	1.500	2.375	3.750	41.750
40	50.75	40.19	36	47.25	1.500	2.500	3.875	43.750
42	53.00	42.19	36	49.50	1.500	2.625	4.000	46.000
44	55.25	44.19	40	51.75	1.500	2.625	4.000	48.000
46	57.25	46.19	40	53.75	1.500	2.688	4.062	50.000
48	59.50	48.19	44	56.00	1.500	2.750	4.125	52.250
50	61.75	50.19	44	58.25	1.750	2.750	4.125	54.250
52	64.00	52.19	44	60.50	1.750	2.875	4.250	56.500
54	66.25	54.19	44	62.75	1.750	3.000	4.375	58.750
60	73.00	60.19	52	69.25	1.750	3.125	4.500	65.250
66	80.00	66.19	52	76.00	1.750	3.375	4.875	71.500
72	86.50	72.19	60	82.50	1.750	3.500	5.000	78.500
78	93.00	78.19	64	89.00	2.000	3.875	5.375	84.500
84	99.75	84.19	64	95.50	2.000	3.875	5.375	90.500
90	106.50	90.19	68	102.00	2.250	4.250	5.750	96.750
96	113.25	96.19	68	108.50	2.250	4.250	5.750	102.750

NOTES:

1. Hub flanges are to be used on pipe that has an OD equal to the nominal pipe size in the first column.
2. Metric conversion: nominal pipe size: in. × 25 = mm; dimensions: in. × 25.4 = mm; psi × 6.895 = kPa.

*Pressure rating at atmospheric temperature is 275 psi. These flanges have the same diameter and drilling as ANSI/ASME B16.1 class 125 cast-iron flanges. In sizes 24 in. and smaller they also match ANSI/ASME B16.5 150-psi standard for steel flanges.

†Welding neck flanges may be used at the purchaser's option.

‡Bolt holes shall be drilled $\frac{1}{8}$ in. larger in diameter than the nominal diameter of the bolt as stated in Sec. 4.2.3.

§The thickness of a 150-psi flange from which the raised face has been removed shall be no less than dimension *T* minus 0.06 in.

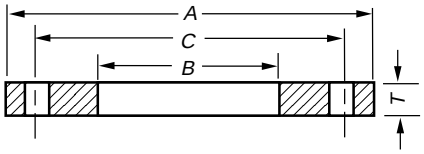

Table 5 AWWA standard steel-ring flanges, class E* (275 psi)

Nominal Pipe Size *in.*	OD of Flange (*A*) *in.*	ID of Flange (*B*†) *in.*	Number of Bolts	Diam. of Bolt Circle (*C*) *in.*	Diam. of Bolts‡ *in.*	Thickness of Flange (*T*) *in.*
4	9.00	4.57	8	7.50	0.625	1.125
5	10.00	5.66	8	8.50	0.750	1.188
6	11.00	6.72	8	9.50	0.750	1.313
8	13.50	8.72	8	11.75	0.750	1.500
10	16.00	10.88	12	14.25	0.875	1.563
12	19.00	12.88	12	17.00	0.875	1.750
14	21.00	14.19	12	18.75	1.000	1.875
16	23.50	16.19	16	21.25	1.000	2.000
18	25.00	18.19	16	22.75	1.125	2.125
20	27.50	20.19	20	25.00	1.125	2.375
22	29.50	22.19	20	27.25	1.250	2.500
24	32.00	24.19	20	29.50	1.250	2.625
26	34.25		24	31.75	1.250	2.750
28	36.50		28	34.00	1.250	2.750
30	38.75		28	36.00	1.250	2.875
32	41.75		28	38.50	1.500	3.000
34	43.75		32	40.50	1.500	3.000
36	46.00		32	42.75	1.500	3.125
38	48.75		32	45.25	1.500	3.125
40	50.75		36	47.25	1.500	3.250
42	53.00		36	49.50	1.500	3.375
44	55.25		40	51.75	1.500	3.375
46	57.25		40	53.75	1.500	3.438
48	59.50		44	56.00	1.500	3.500
50	61.75		44	58.25	1.750	3.500
52	64.00		44	60.50	1.750	3.625
54	66.25		44	62.75	1.750	3.750
60	73.00		52	69.25	1.750	3.875
66	80.00		52	76.00	1.750	4.250
72	86.50		60	82.50	1.750	4.375
78	93.00		64	89.00	2.000	4.750
84	99.75		64	95.50	2.000	4.750
90	106.50		68	102.00	2.250	5.125
96	113.25		68	108.50	2.250	5.125
102	120.00		72	114.50	2.500	5.500
108	126.75		72	120.75	2.500	5.500
114	133.50		76	126.75	2.750	5.875
120	140.25		76	132.75	2.750	5.875
126	147.00		80	139.25	3.000	6.250
132	153.75		80	145.75	3.000	6.250
138	160.50		84	152.00	3.250	6.750
144	167.25		84	158.25	3.250	6.750

NOTES:

1. Ring flanges may be overbored or counterbored to accommodate larger-outside-diameter pipe than that shown as nominal. This is done to allow a clear inside diameter after cement–mortar lining. Wrench clearance between the pipe OD and bolt circle must be maintained as well as sufficient gasket seating area.

2. Metric conversion: nominal pipe size: in. × 25 = mm; dimensions: in. × 25.4 = mm; psi × 6.895 = kPa.

*Pressure rating at atmospheric temperature is 275 psi. These flanges have the same diameter and drilling as ANSI/ASME B16.1 class 125 cast-iron flanges. In sizes 24 in. and smaller they also match ANSI/ASME B16.5 150-psi standard for steel flanges.

†The purchaser shall specify the ID of the flange, dimension *B*, for nominal pipe sizes 26 in. and larger. It is recommended that this dimension be $\frac{3}{16}$ in. larger in diameter than the nominal OD of the pipe.

‡Bolt holes shall be drilled $\frac{1}{8}$ in. larger in diameter than the nominal diameter of the bolt as stated in Sec. 4.2.3.

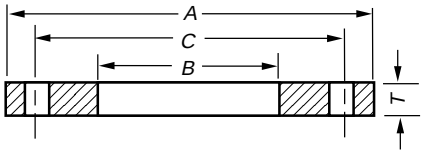

Table 6 AWWA standard steel-ring flanges, class F* (300 psi)

Nominal Pipe Size *in.*	OD of Flange (*A*) *in.*	ID of Flange (*B*) *in.*	Number of Bolts	Diam. of Bolt Circle (*C*) *in.*	Diam. of Bolts† *in.*	Thickness of Flange (*T*) *in.*
4	10.00	4.57	8	7.88	0.750	1.13
5	11.00	5.66	8	9.25	0.750	1.21
6	12.50	6.73	12	10.62	0.750	1.31
8	15.00	8.73	12	13.00	0.875	1.31
10	17.50	10.88	16	15.25	1.000	1.50
12	20.50	12.88	16	17.75	1.125	1.63
14	23.00	14.19	20	20.25	1.125	1.94
16	25.50	16.19	20	22.50	1.250	2.14
18	28.00	18.19	24	24.75	1.250	2.25
20	30.50	20.19	24	27.00	1.250	2.33
22	33.00	22.19	24	29.25	1.250	2.50
24	36.00	24.19	24	32.00	1.500	2.69
26	38.25	26.25	28	34.50	1.750	3.00
28	40.75	28.25	28	37.00	1.750	3.13
30	43.00	30.25	28	39.25	1.750	3.15
32	45.25	32.25	28	41.50	1.750	3.25
34	47.50	34.25	28	43.50	1.750	3.38
36	50.00	36.25	32	46.00	2.000	3.46
38	52.25	38.25	32	48.00	2.000	3.50
40	54.25	40.25	36	50.25	2.000	3.63
42	57.00	42.25	36	52.75	2.000	3.81
44	59.25	44.25	36	55.00	2.000	4.00
46	61.50	46.25	40	57.25	2.000	4.13
48	65.00	48.25	40	60.75	2.000	4.50

NOTES:

1. Ring flanges may be overbored or counterbored to accommodate larger-outside-diameter pipe than that shown as nominal. This is done to allow a clear inside diameter after cement–mortar lining. Wrench clearance between the pipe OD and bolt circle must be maintained as well as sufficient gasket seating area.

2. Metric conversion: nominal pipe size: in. × 25 = mm; dimensions: in. × 25.4 = mm; psi × 6.895 = kPa.

*Pressure rating at atmospheric temperature is 300 psi. These flanges have the same diameter and drilling as ANSI/ASME B16.2 class 250 cast-iron pipe and flanged fittings.

†Bolt holes shall be drilled $\frac{1}{8}$ in. larger in diameter than the nominal diameter of the bolt as stated in Sec. 4.2.3.

Table 7 AWWA blind-flange thickness

Nominal Pipe Size		Minimum Thickness*							
		Class B 86 psi (593 kPa)		Class D†		Class E 275 psi (1,896 kPa)		Class F 300 psi (2,068 kPa)	
in.	*(mm)*	*in.*	*(mm)*	*in.*	*(mm)*	*in.*	*(mm)*	*in.*	*(mm)*
4	(100)	.625	(15.88)	.625	(15.88)	1.125	(28.58)	1.125	(28.58)
6	(150)	.688	(17.48)	.692	(17.58)	1.313	(33.35)	1.316	(33.43)
8	(200)	.688	(17.48)	.805	(20.45)	1.500	(38.10)	1.316	(33.43)
10	(250)	.688	(17.48)	.947	(24.05)	1.563	(39.70)	1.534	(38.96)
12	(300)	.752	(19.10)	1.110	(28.19)	1.750	(44.45)	1.730	(43.94)
14	(350)	.835	(21.21)	1.127	(28.63)	1.875	(47.62)	1.938	(49.23)
16	(400)	.941	(23.90)	1.258	(31.95)	2.000	(50.80)	2.139	(54.33)
18	(450)	1.013	(25.73)	1.326	(33.68)	2.125	(53.98)	2.294	(58.27)
20	(500)	1.108	(28.14)	1.442	(36.63)	2.375	(60.32)	2.401	(60.99)
24	(600)	1.275	(32.38)	1.657	(42.09)	2.625	(66.68)	2.799	(71.09)
30	(750)	1.530	(38.86)	2.003	(50.88)	2.875	(73.02)	3.419	(86.84)
36	(900)	1.834	(46.58)	2.369	(60.17)	3.344	(84.93)	4.017	(102.03)
42	(1,050)	2.084	(52.93)	2.725	(69.21)	3.789	(96.24)	4.450	(113.03)
48	(1,200)	2.341	(59.46)	3.067	(77.90)	4.246	(107.85)	4.991	(126.77)
54	(1,350)	2.634	(66.90)	3.431	(87.15)	4.776	(121.31)		
60	(1,500)	2.892	(73.46)	3.774	(95.86)	5.236	(132.99)		
66	(1,650)	3.139	(79.73)	4.132	(104.95)	5.674	(144.12)		
72	(1,800)	3.399	(86.33)	4.476	(113.69)	6.137	(155.88)		

NOTES:

1. Mating flange ID dimensions are as shown in tables through 20 in. OD and $\frac{1}{8}$ in. over pipe OD using the following ODs for pipe 24 in. and larger (25.375 in., 31.375 in., 37.50 in., 43.50 in., 49.50 in., 55.625 in., 61.625 in., 67.750 in., and 73.750 in.).
2. All flanges are flat faced.
3. ASTM A-36 steel used (16,000 psi allowable stress).
4. ASTM A-307, grade B bolts (7,000 psi allowable stress) used for class B and D.
5. ASTM A193, grade B7 bolts (25,000 psi allowable stress) used for class E and F.
6. For diameters over 48 in., designers should consider using dished heads welded to a standard flange.

*Design Method: ASME Boiler & Pressure Vessel Code, Sec. VIII, Div. 1.

†Class D flanges are rated at 175 psi (1,207 kPa) for nominal pipe sizes ≤12 in. (600 mm) and 150 psi (1,034 kPa) for nominal pipe sizes >12 in. (600 mm).

APPENDIX A
Bibliography

The following references are not listed in AWWA C207 but are provided in this appendix as sources of additional information:

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3P-5C-43207-7/98-RM