ANSI/AWWA C228-08
(First Edition)

American Water Works Association

The Authoritative Resource for Safe Water®

AWWA Standard

Stainless-Steel Pipe Flanges for Water Service—Sizes 2 In. Through 72 In. (50 mm Through 1,800 mm)

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AWWA Standard

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The Steel Water Pipe Manufacturers Technical Advisory Committee (SWPMTAC) Task Group on C228, which developed this standard, had the following personnel at the time:

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*Liaison, nonvoting

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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.

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Foreword

This foreword is for information only and is not a part of ANSI/AWWA C228.

I. Introduction.

I.A. *Background.* Stainless steel is a standard material used to construct piping and flanges. It offers very low corrosion rates, which makes it suitable for the handling of potable water while maintaining purity and quality.

I.B. *History.* 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 commensurate with the pressures commonly used in water 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) or 150-psi (1,034-kPa) primary pressure ratings. 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. It is not 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 for carbon steel and first adopted in 1952. In 1999, AWWA developed a new standard for stainless-steel pipe, which then required a new standard for stainless-steel flanges.

In 1999, the AWWA Standards Council directed the Standards Committee on Steel Pipe to develop a standard for stainless-steel flanges used in water treatment and conveying facilities. In 2003, Standards Council approved the formation of the Standards Committee on Stainless Steel Pipe, which assumed responsibility for the development of this standard. This is the first edition of this standard. It was approved by the AWWA Board of Directors on Jan. 27, 2008.

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

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 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, NSF/ANSI 60, Drinking Water Treatment Chemicals—Health Effects, and NSF/ANSI 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 NSF/ANSI 61. Individual states or local agencies have authority to accept or accredit certification organizations within their jurisdiction. Accreditation of certification organizations may vary from jurisdiction to jurisdiction.

Annex A, "Toxicology Review and Evaluation Procedures," to NSF/ANSI 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

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

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

‡Both publications available from National Academy of Sciences, 500 Fifth Street, N.W., Washington, DC 20001.

(noncarcinogens) and risk characterization methodology (carcinogens). Use of Annex A procedures may not always be identical, depending on the certifier.

ANSI/AWWA C228 does not address additives requirements. Thus, users of this standard should consult the appropriate state or local agency having jurisdiction in order to

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

II. Special Issues. Ring flanges included in this standard are for integral use on stainless-steel pipe only, and not for use as a loose backup flange. The thicknesses shown in the ring flange tables are based on the LaTour Barnard Analysis as presented in the *Steel Ring Flanges for Steel Pipe—Armco Bulletin 47A* (1947), and have been used successfully in the waterworks industry for more than 50 years. The flange thickness design using the LaTour Barnard Analysis is based on limiting flange stress to 22,500 psi (155 MPa) at the rated pressure. Thickness design of blind flanges has been based on the ASME Boiler and Pressure Vessel Code Design Method in Section VIII, Division 1, UG-34.

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, Stainless-Steel Pipe Flanges for Water Service—Sizes 2 In. through 72 In. (50 mm Through 1,800 mm), of latest edition.
2. Whether compliance with NSF/ANSI 61 Drinking Water System Components—Health Effects, is required.
3. Details of other federal, state or provincial, and local requirements.
4. Mill test certification (Sec. 4.1.2.4).
5. Class of flange required (Tables 2, 3, and 4).
6. Inside diameter of flanges (Tables 2 and 3).
7. Gaskets—rubber or nonasbestos (Sec. 4.1.4) and gasket thickness.

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

IV. Major Revisions. This is the first edition of this standard.

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

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AWWA Standard

Stainless-Steel Pipe Flanges for Water Service—Sizes 2 In. Through 72 In. (50 mm Through 1,800 mm)

SECTION 1: GENERAL

Sec. 1.1 Scope

This standard describes stainless-steel ring-type slip-on flanges and blind flanges for use in conjunction with stainless-steel pipe used in facilities of waterworks service.

Sec. 1.2 Purpose

The purpose of this standard is to provide minimum material requirements and dimensions for a variety of stainless-steel flanges for attachment to stainless-steel piping systems.

Sec. 1.3 Application

1.3.1 *Intended use.* Flanges in this standard are described in the following tables:

1. Table 2 and Table 3, ring-type slip-on flanges.
2. Table 4, blind flanges.

Flanges covered in this standard are intended for use with stainless-steel pipe or appurtenances meeting the requirements of ANSI/AWWA C220, ANSI/AWWA C226, or other equivalent standards. It is intended that flanges be attached 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. Class SA stainless-steel flanges are suitable for design pressures up to and including 50 psi (345 kPa).

2. Class SB stainless-steel flanges are suitable for design pressures up to and including 86 psi (593 kPa).

3. Class SD stainless-steel flanges are suitable for design pressures as follows:

   a. Sizes 2 in.–12 in. (50 mm–300 mm) = 175 psi (1,206 kPa)

   b. Sizes greater than 12 in. (300 mm) = 150 psi (1,034 kPa).

4. Class SE stainless-steel flanges are suitable for design pressures up to and including 275 psi (1,896 kPa).

5. Class SF stainless-steel flanges are suitable for design pressures up to and including 300 psi (2,068 kPa).

6. Pressure ratings are based on conditions and temperatures customarily found in water and wastewater applications. Maximum sustained operating pressure, plus any anticipated surge/transient pressures, should not exceed flange pressure ratings. Test pressure should not exceed 125 percent of the design pressure.

7. Flange design is based on pressure considerations, not for stresses induced by external moments when pipe acts as a beam. The tables in this standard have been developed using a design stress of 22,500 psi (155 MPa) for the design pressure.

SECTION 2: REFERENCES

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

ANSI*/AWWA C220—Stainless-Steel Pipe, 1/2 in. and Larger.

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

ANSI/AWWA C226—Stainless-Steel Fittings for Wateworks Service, Sizes 1/2 In. Through 72 In.

ASME* B16.1—Cast Iron Pipe Flanges and Flanged Fittings.

ASME B16.5—Pipe Flanges and Flanged Fittings.

ASME B18.2.1—Square and Hex Bolts and Screws.

ASME B18.2.2—Square and Hex Nuts.

ASME Section VIII Division 1—Boiler and Pressure Vessel Codes.

ASTM† A182—Standard Specification for Forgings, Stainless-Steel.

ASTM A240/A240M—Standard Specification for Plate, Stainless-Steel.

ASTM A276—Standard Specification for Stainless-Steel Bars and Shapes.

ASTM A351/351M—Standard Specification for Castings, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts.

ASTM A380-Standard Practice for Cleaning, Descaling, and Passivation of Stainless-Steel Parts, Equipment, and Systems.

ASTM D1330—Standard Specification for Rubber-Sheet Gaskets.

ASTM F593—Standard Specification for Stainless-Steel Bolts, Hex Cap Screws, and Studs.

ASTM F594—Standard Specification for Stainless-Steel Nuts.

AWS‡ B2.1—Standard for Welding Procedure and Performance Qualifications.

AWS D1.6—Standard Structural Welding Code—Stainless-Steel.

AWS QC.1—Standard for AWS Certification of Welding Inspectors.

SECTION 3: DEFINITIONS

The following definitions shall apply in this standard:

1. *Design pressure:* The various internal pressures that a system must be designed to withstand. This is usually a combination of working pressure and surge pressure.

2. *Dual certification:* Low-carbon stainless-steel, suitable for welding, with nitrogen additions to provide and meet the minimum mechanical properties offered by standard grades of stainless-steel.

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

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

‡American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

3. *Intergranular attack (IGA):* IGA corrosion occurs when carbon combines with chromium in the grain boundaries to form chrome carbides, resulting in reduced corrosion in the grain boundary due to reduced chromium levels. The grain boundary area may become susceptible to oxidizing acid attack, unless the carbon level is held to a maximum of 0.03 percent carbon or stabilized with titanium (321) or columbium (347). The dual-certified grades of stainless-steel will meet this criteria.

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

5. *Operating pressure:* Synonymous with working pressure.

6. *Pressure:* An internal force applied by a fluid to the inside of a conduit.

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

8. *Rated pressure:* Synonymous with design pressure.

9. *Surge pressure:* A transient pressure increase induced upon a system that results in rapid change in flow velocity with corresponding pressure rise.

10. *Test pressure:* A pressure, shop or field, which is utilized to verify the integrity and soundness of a system. The test pressure may be lower or higher than the working pressure.

11. *Working pressure:* The maximum sustained pressure under which a system operates.

SECTION 4: REQUIREMENTS

Sec. 4.1 Material

4.1.1 *Permeation.* The selection of materials is critical for water service and distribution piping in locations where there is likelihood the pipe will be exposed to significant concentrations of pollutants comprised 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, are subject to permeation by lower molecular weight organic solvents or petroleum products. If a water pipe must pass through such a contaminated area or an area

subject to contamination, consult with the manufacturer regarding permeation of pipe walls, jointing materials, etc., *before* selecting materials for use in that area.

The purchaser shall specify the materials to be used.

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

4.1.2.1 Castings. Cast stainless-steel flanges shall meet the minimum requirements of ASTM A351/351M.

4.1.2.2 Forgings. Forgings shall meet the minimum requirements of ASTM A182 certified stainless-steel material.

4.1.2.3 Stainless-steel plate or bar. Stainless-steel plate or bar shall meet the minimum requirements of ASTM A240 or ASTM A276 certified stainless-steel material.

Minimum tensile strength = 75,000 psi (515 MPa)

Minimum yield strength = 30,000 psi (205 MPa)

The following material designations will meet the previously listed requirements:

1. ASTM A240 grades 304, 304N, 304H, 316, 316N, 316H, 317, 317LMN, 321, Alloy 2205, and Type 2304.

2. ASTM A182 grades 304, 304N, 304H, 316, 316N, 316H, 317, 317LMN, and 321.

3. Dual-certified stainless-steels such as ASTM A240 304/304L and 316/316L will also meet minimum tensile and yield-strength requirements.

4. Special service conditions may require grades other than those listed. Other grades meeting or exceeding tensile and yield strengths specified above are acceptable.

4.1.2.4 Certification. The manufacturer shall provide mill test reports showing conformance to physical and chemical requirements on request.

4.1.3 *Fasteners.* At a minimum, stainless-steel bolts and threaded rods shall be in accordance with ASTM F593 and with a minimum yield of 75,000 psi (515 MPa); nuts shall be stainless-steel in accordance with ASTM F594. Bolts shall have regular, unfinished square or hexagonal heads, in accordance with ASME B18.2.1, and nuts shall have regular square or hexagonal dimensions, in accordance with ASME B18.2.2.

Minimum bolt lengths shall be the sum of the mating flange maximum thicknesses, the gasket, the depth of the nut and washer(s), plus 1/8 in. (3.2 mm) minimum before torquing. If threaded rods (studs) are used, they shall be the same

Table 1 Flange gasket materials, types, and thicknesses

Flange Class	Rated Pressure		Nominal Pipe Diameter		Thickness			
	psi	*(kPa)*	*in.*	*(mm)*	Material	Type	*in.*	*(mm)*
SA	50	(345)	2–24	(50–600)	Rubber	FF*	1/16 or 1/8	(1.59 or 3.18)
SA	50	(345)	26–72	(650–1,800)	Rubber	Ring	1/8	(3.18)
SB	75	(517)	2–24	(50–600)	Rubber	FF	1/16 or 1/8	(1.59 or 3.18)
SB	75	(517)	26–72	(650–1,800)	Rubber	Ring	1/8	(3.18)
SD	150	(1,034)	2–24	(50–600)	Rubber	FF	1/16 or 1/8	(1.59 or 3.18)
SD	150	(1,034)	26–72	(650–1,800)	Rubber	Ring	1/8	(3.18)
SE	275	(1,896)	2–24	(50–600)	Nonasbestos	Ring	1/16	(1.59)
SE	275	(1,896)	26–72	(650–1,800)	Nonasbestos	Ring	1/8	(3.18)
SF	300	(2,068)	2–24	(50–600)	Nonasbestos	Ring	1/16	(1.59)
SF	300	(2,068)	26–48	(650–1,200)	Nonasbestos	Ring	1/8	(3.18)

*Full faced.

length as the bolts determined previously, plus the depth of the nuts and the washer(s), plus 1/4 in. (6.4 mm) minimum before torquing.

4.1.4 *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) with hardness (Shore A) 80 ± 5, suitable for water service temperature to 200°F (93°C) with gasket yield pressure of 200 psi (1,400 kPa) minimum to 1,200 psi (8,300 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. Gasket yield pressure shall be 3,000 psi (21 MPa) minimum for gaskets 1/16-in. (1.6-mm) thick and 4,800 psi (33 MPa) minimum for gasket 1/8-in. (3.2 mm) thick. Gaskets shall be suitable for a maximum seating pressure of 15,000 psi (103 MPa).

Ring-gasket diameters shall be as follows:

Inside diameter (ID) = flange ID.

Outside diameter (OD) = ID of bolt-hole circle less 1/16 in. (1.6 mm).

Full-face gasket diameters shall be as follows:

Inside diameter (ID) = flange ID.

Outside diameter (OD) = OD of flange.

Sec. 4.2 Fabrication

4.2.1 *Tolerances.* The dimensions listed in Tables 2 and 3 shall apply prior to attachment and are subject to the following tolerances:

1. Inside diameter of flange = + 1/16 in. (1.6 mm), –0.
2. Outside diameter of flange = ± 1/8 in. (3.2 mm).
3. Thickness of flanges 18 in. (450 mm) and smaller = + 1/8 in. (3.2 mm), –0.
4. Thickness of flanges 20 in. (500 mm) and larger = + 3/16 in. (4.8 mm), –0.
5. Bolt-circle diameter = ± 1/16 in. (1.6 mm).
6. Bolt-hole spacing maximum variation = ± 1/32 in. (0.79 mm).

4.2.2 *Facing.* Flanges of all classes shall be flat-faced without projection or raised face. Either a serrated concentric or serrated spiral finish having from 24 grooves per in. to 55 grooves per in. (0.94 grooves per mm to 1.57 grooves per mm) shall be used. The cutting tool employed shall have an approximately 0.06-in. (1.52-mm) or larger radius. The resultant surface finish shall have a 250- to 500-RMS (6.35-µm 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 1/8 in. (3.2 mm) larger in diameter than the nominal diameter of the bolt. Bolt holes may be overdrilled by an additional 1/8 in. (3.2 mm) to accommodate insulators or to facilitate alignment with the mating flange.

4.2.4 *Segmentation of flanges.* Flanges may be constructed by welding segments together. A maximum of four segments are allowed in a single flange.

1. Welding of the segments shall be performed in accordance with Sec. 4.3.2 and 4.3.3 of this standard.

2. 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.

Table 2 AWWA standard stainless-steel ring flanges, Class SA (50 psi), Class SB (86 psi), Class SD (150 psi), and Class SE (275 psi)* †

Nominal Pipe Size *in.*	OD of Flange (A) *in.*	ID of Flange (B) *in.*‡		Number of Bolts	Dia. of Bolt Circle (C) *in.*	Dia. of Bolts§ *in.*	Thickness of Flange *in.*			
		Pipe	Tube				Class SA 50 psi	Class SB 86 psi	Class SD 150 psi	Class SE 275 psi
2.0	6.00	2.44	2.03	4	4.75	0.625	0.500	0.625	0.625	1.125
2.5	7.00	2.94	2.53	4	5.50	0.625	0.500	0.625	0.625	1.125
3.0	7.50	3.57	3.03	4	6.00	0.625	0.500	0.625	0.625	1.125
4.0	9.00	4.57	4.03	8	7.50	0.625	0.500	0.625	0.625	1.125
5.0	10.00	5.66	5.03	8	8.50	0.750	0.500	0.625	0.625	1.188
6.0	11.00	6.72	6.03	8	9.50	0.750	0.500	0.688	0.688	1.313
8.0	13.50	8.72	8.03	8	11.75	0.750	0.500	0.688	0.688	1.500
10.0	16.00	10.88	10.03	12	14.25	0.875	0.625	0.688	0.688	1.563
12.0	19.00	12.88	12.06	12	17.00	0.875	0.625	0.688	0.812	1.750
14.0	21.00	14.19	14.19	12	18.75	1.000	0.625	0.688	0.938	1.875
16.0	23.50	16.19	16.19	16	21.25	1.000	Use class SB	0.688	1.000	2.000
18.0	25.00	18.19	18.19	16	22.75	1.125	Use class SB	0.688	1.062	2.125
20.0	27.50	20.19	20.19	20	25.00	1.125	Use class SB	0.688	1.125	2.375
22.0	29.50	22.19	—	20	27.25	1.250	Use class SB	0.750	1.188	2.500
24.0	32.00	24.19	24.19	20	29.50	1.250	Use class SB	0.750	1.250	2.625
26.0	34.25	26.25	—	24	31.75	1.250	Use class SB	0.812	1.312	2.750
28.0	36.50	28.25	—	28	34.00	1.250	Use class SB	0.875	1.312	2.750
30.0	38.75	30.25	30.25	28	36.00	1.250	Use class SB	0.875	1.375	2.875
32.0	41.75	32.25	—	28	38.50	1.500	Use class SB	0.938	1.500	3.000
34.0	43.75	34.25	—	32	40.50	1.500	Use class SB	0.938	1.500	3.000
36.0	46.00	36.25	36.25	32	42.75	1.500	Use class SB	1.000	1.625	3.125
38.0	48.75	38.25		32	45.25	1.500	Use class SB	1.000	1.625	3.125
40.0	50.75	40.25		36	47.25	1.500	Use class SB	1.000	1.625	3.250
42.0	53.00	42.25		36	49.50	1.500	Use class SB	1.125	1.750	3.375
44.0	55.25	44.25		40	51.75	1.500	Use class SB	1.125	1.750	3.375
46.0	57.25	46.25		40	53.75	1.500	Use class SB	1.125	1.750	3.438
48.0	59.50	48.25		44	56.00	1.500	Use class SB	1.250	1.875	3.500
50.0	61.75	50.25		44	58.25	1.750	Use class SB	1.250	2.000	3.500
52.0	64.00	52.25		44	60.50	1.750	Use class SB	1.250	2.000	3.625
54.0	66.25	54.25		44	62.75	1.750	Use class SB	1.375	2.125	3.750
60.0	73.00	60.25		52	69.25	1.750	Use class SB	1.500	2.250	3.875
66.0	80.00	66.25		52	76.00	1.750	Use class SB	1.625	2.500	4.250
72.0	86.50	72.25		60	82.50	1.750	Use class SB	1.750	2.625	4.375

NOTES:

1. Ring flanges may be overbored or counterbored to accommodate larger-outside-diameter pipe than shown as nominal. 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

*Class SA flanges 50 psi; Class SB flanges 86 psi; Class SD flanges 2 in.–12 in., 175 psi; 14 in. and larger, 150 psi; Class SE flanges 275 psi. These flanges have the same diameter and drilling as AWWA D flanges and Class 125 cast-iron flanges (ASME B16.1). In sizes 24 in. and smaller, they also match ASME B16.5 150-psi standard for steel flanges.

†Pressure rating at atmospheric temperature.

‡The purchaser shall specify the ID of the flange if dimension B is required to be other than the dimension shown above.

§Bolt holes shall be drilled 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 stainless-steel ring flanges, Class SF (300 psi)* †

Nominal Pipe Size *in.*	OD of Flange (A), *in.*	ID of Flange (B), *in.*‡		Number of Bolts	Diameter of Bolt Circle (C) *in.*	Diameter of Bolts§ *in.*	Thickness of Flange (T) *in.* Class SF 300 psi
		Pipe	Tube				
4	10.00	4.57	4.03	8	7.88	0.750	1.13
5	11.00	5.66	5.03	8	9.25	0.750	1.21
6	12.50	6.72	6.03	12	10.62	0.750	1.31
8	15.00	8.72	8.03	12	13.00	0.875	1.31
10	17.50	10.88	10.03	16	15.25	1.000	1.50
12	20.50	12.88	12.06	16	17.75	1.125	1.63
14	23.00	14.19	14.19	20	20.25	1.125	1.94
16	25.50	16.19	16.19	20	22.50	1.250	2.14
18	28.00	18.19	18.19	24	24.75	1.250	2.25
20	30.50	20.19	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	24.19	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	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	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 shown as nominal. 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

*Class SF flanges 300 psi. These flanges have the same diameter and drilling as AWWA F flanges and Class 250 cast-iron flanges (ASME B16.1). In sizes 24 in. and smaller, they also match ASME B16.5 300-psi standard for steel flanges.

†Pressure rating at atmospheric temperature.

‡The purchaser shall specify the ID of the flange if dimension B is required to be other than the dimension shown above.

§Bolt holes shall be drilled 1/8 in. (3.2 mm) larger in diameter than the nominal diameter of the bolt except as stated in Sec. 4.2.3.

4.2.5 *Blind flanges.* Blind flange thicknesses shall be as set forth in Table 4. For blind flanges larger than 48-in. (1,200-mm) nominal diameter, it is recommended that a combination of a ring flange and a dished head suitable for the pressure and design conditions be used. Blind flanges shall have machined, serrated faces to match the mating flange. The thickness shown in Table 4 is after machining.

Table 4 AWWA standard stainless-steel blind flanges, Class SA (50 psi), Class SB (86 psi), Class SD (150 psi), Class SE (275 psi), and Class SF (300 psi)

Nominal Pipe Size *in.*	Class SA 50 psi *in.*	Class SB 86 psi *in.*	Class SD 150 psi *in.*	Class SE 275 psi *in.*	Class SF 300 psi *in.*
2.0	0.50	NA	NA	NA	NA
2.5	0.50	NA	NA	NA	NA
3.0	0.50	NA	NA	NA	NA
4.0	0.50	0.625	0.6250	1.125	1.130
5.0	0.50	0.625	0.6500	1.188	1.210
6.0	0.50	0.688	0.6930	1.313	1.310
8.0	0.50	0.688	0.8125	1.500	1.310
10.0	Use Class SB	0.688	0.9530	1.563	1.500
12.0	Use Class SB	0.719	1.117	1.750	1.630
14.0	Use Class SB	0.791	1.133	1.875	1.940
16.0	Use Class SB	0.892	1.265	2.000	2.140
18.0	Use Class SB	0.950	1.331	2.125	2.250
20.0	Use Class SB	1.040	1.448	2.375	2.330
22.0	Use Class SB	1.132	1.568	2.500	2.500
24.0	Use Class SB	1.216	1.661	2.625	2.690
26.0	Use Class SB	1.307	1.786	2.750	3.000
28.0	Use Class SB	1.398	1.906	2.750	3.130
30.0	Use Class SB	1.477	2.008	2.875	3.166
32.0	Use Class SB	1.581	2.150	3.000	3.332
34.0	Use Class SB	1.661	2.252	3.050	3.475
36.0	Use Class SB	1.751	2.370	3.209	3.671
38.0	Use Class SB	1.853	2.506	3.394	3.815
40.0	Use Class SB	1.933	2.609	3.533	3.982
42.0	Use Class SB	2.023	2.729	3.695	4.171
44.0	Use Class SB	2.114	2.849	3.857	4.338
46.0	Use Class SB	2.194	2.952	3.997	4.505
48.0	Use Class SB	2.285	3.072	4.159	4.781
50.0	Use Class SB	2.377	3.196	4.327	
52.0	Use Class SB	2.468	3.315	4.489	
54.0	Use Class SB	2.559	3.435	4.651	
60.0	Use Class SB	2.820	3.779	5.116	
66.0	Use Class SB	3.092	4.136	5.601	
72.0	Use Class SB	3.353	4.480	6.066	

NOTES:

1. All flanges are flat-faced.
2. Metric conversion: nominal pipe size: in. × 25 = mm; dimensions: in. × 25.4 = mm; psi × 6.895 = kPa
3. Minimum 30,000-yield stainless-steel material used (allowable stress 22,500 psi).
4. Design Method: ASME Boiler and Pressure Vessel Code, Sec. VIII, Div. 1, UG-34.

4.2.6 *Manufacturing and handling.* During manufacturing and handling, proper care must be taken to avoid contact or contamination with any ordinary carbon-steel or low-melting point metals. In all cases, marking ink and identification crayons should be free of zinc, lead, copper, and sulfur.

4.2.7 *Cleaning.* Flanges shall be cleaned as specified by the purchaser.

Sec. 4.3 Method of Attachment of Flanges

Except for blind flanges, the flanges in this standard must be integral, welded to a pipe, meter, or valve, etc. It is recommended that the low carbon or dual-certified Type 304/304L and Type 316/316L, Type 321, or duplex stainless-steel be specified when welding.

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, Division 1, 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 to the purchaser on request for review, approval, or modification.

The procedure used shall be based on a current, applicable welding code, AWS D1.6 or ASME Boiler and Pressure Vessel Code, Section IX.

4.3.3 *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; or AWS D1.6; or other approved procedure

4.3.4 *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 1.5 degrees between two mating flanges. Negative draft will not be permitted.

4.3.5 *Welding technique.* Care shall be taken during the welding process to avoid warping the flange face.

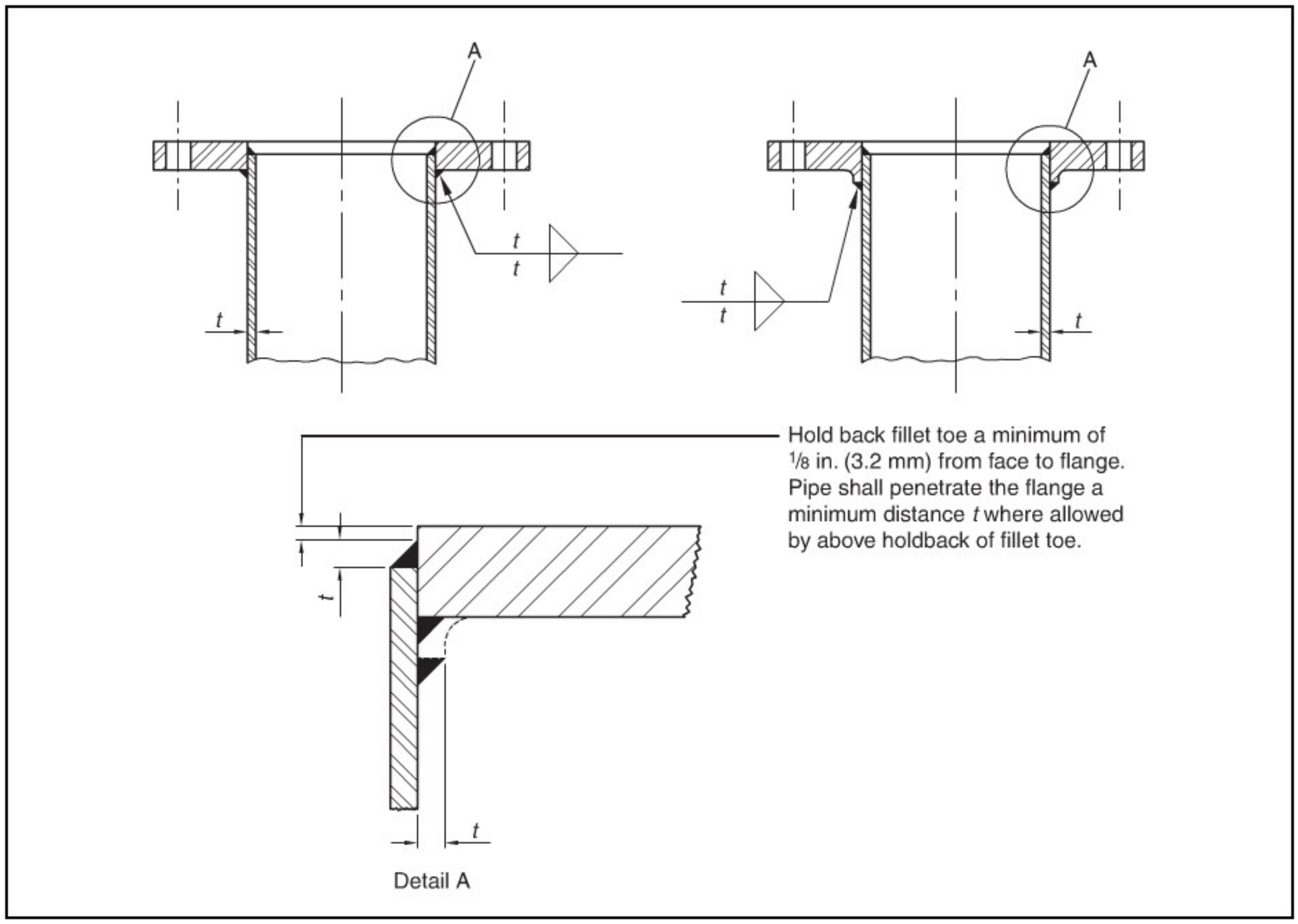

Figure 1 Attachment of flange

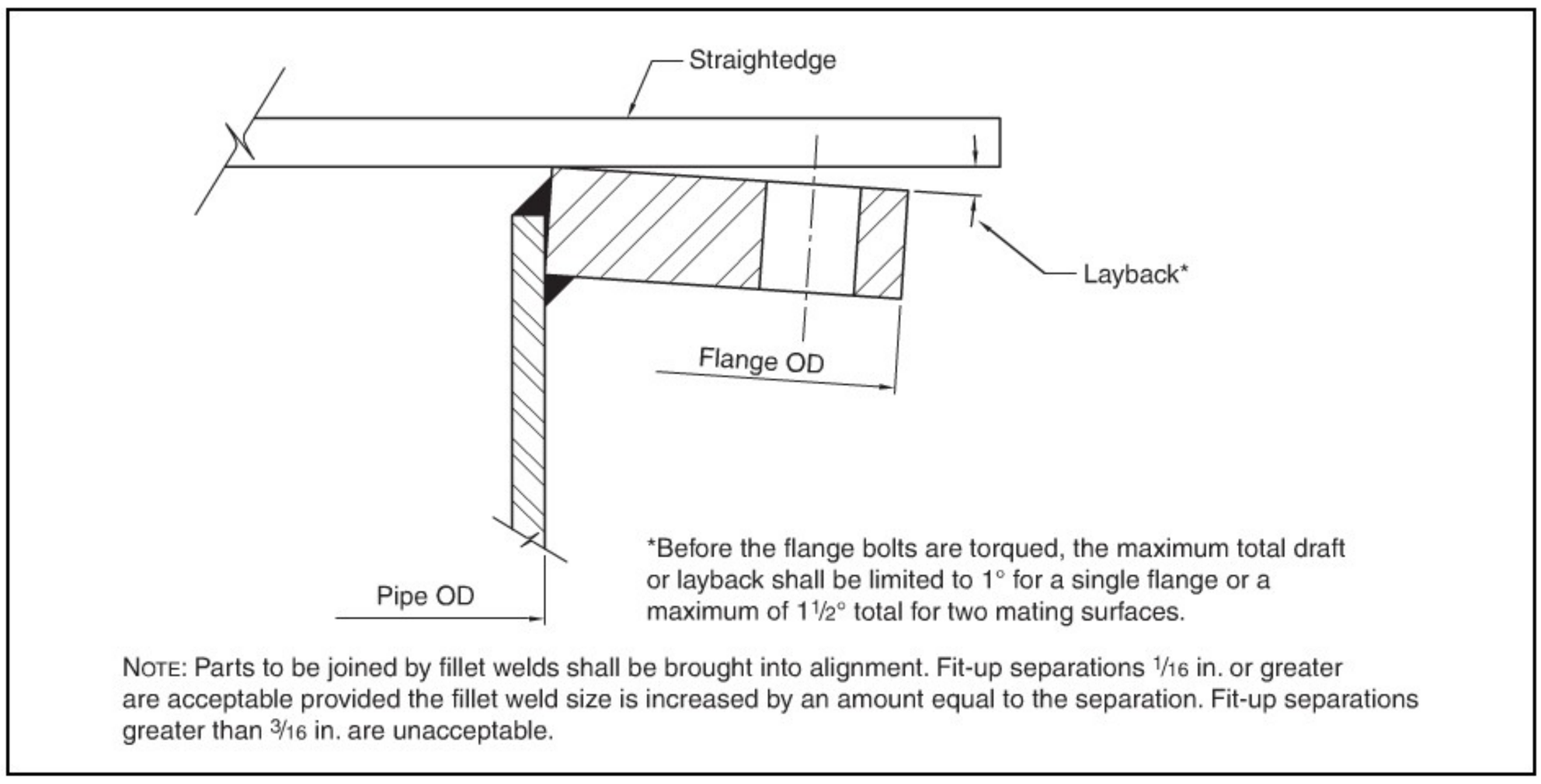

Figure 2 Draft or layback measurement

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 provided 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.

Sec. 5.2 Certification

Mill test reports may be requested as set forth in Sec. 4.1.2.4.

Sec. 5.3 Quality Assurance

5.3.1 *Quality assurance.* The manufacturer shall maintain a quality assurance program to ensure minimum standards are met. It shall include a certified welding inspector (AWS QC.1) to verify that welders and welding procedures are qualified, procedures are being followed within the limitations of testing, and quality-assurance functions are being implemented.

5.3.2 *Contaminants.* Stainless-steel flanges shall be free of contaminating iron particles. All contaminating particles shall be removed by pickling in accordance with ASTM A380 or other methods acceptable to the purchaser.

SECTION 6: DELIVERY

Sec. 6.1 Markings

Flanges shall be impression-stamped on a nonsealing surface with the size, name, or trademark of the manufacturer; heat number; material type; and AWWA class as defined in Sec. 1.3.2.

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