



Designation: D4024 – 22

Standard Specification for Machine Made “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Flanges¹

This standard is issued under the fixed designation D4024; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers reinforced-thermosetting resin flanges other than contact-molded flanges. Included are requirements for materials, workmanship, performance, and dimensions.

1.2 Flanges may be produced integrally with a pipe or fitting, may be produced with a socket for adhesive bonding to a pipe or fitting, or may be of the type used in conjunction with either a metallic or nonmetallic backup ring.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values in parentheses are given for information only. In cases where materials, products, or equipment are available only in SI units, inch-pound units are omitted.

1.4 The following precautionary caveat pertains only to the test methods portion, Section 10, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

NOTE 1—Contact molded flanges are covered in Specification D5421 and referenced in Specification D5685.

NOTE 2—There is no known ISO equivalent to this standard.

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

¹ This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.23 on Reinforced Thermosetting Resin Piping Systems and Chemical Equipment.

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2. Referenced Documents

2.1 ASTM Standards:²

D618 Practice for Conditioning Plastics for Testing

D883 Terminology Relating to Plastics

D1599 Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings

D1600 Terminology for Abbreviated Terms Relating to Plastics

D5421 Specification for Contact Molded “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Flanges

D5685 Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings

F412 Terminology Relating to Plastic Piping Systems

2.2 ANSI Standards:³

B 16.1 Cast Iron Pipe Flanges and Flanged Fittings

B 16.5 Pipe Flanges and Flanged Fittings

3. Terminology

3.1 Definitions:

3.1.1 *General*—Definitions are in accordance with Terminology D883 or Terminology F412. Abbreviations are in accordance with Terminology D1600, unless otherwise indicated. The abbreviation for reinforced-thermosetting-resin pipe is RTRP.

4. Classification

4.1 *General*—This specification covers machine-made reinforced-thermosetting-resin flanges defined by type (method of manufacture), grade (generic type of resin), class (configuration of joining system), and pressure rating. Flanges complying with this specification are also given numerical classifications relating to burst pressure, sealing test pressure, and bolt torque limit.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

³ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

*A Summary of Changes section appears at the end of this standard

TABLE 1 Pressure Categories

Designation	Pressure Rating	
	psi	MPa
A	25	0.17
B	50	0.35
C	75	0.52
D	100	0.69
E	125	0.86
F	150	1.04
G	175	1.21
H	200	1.38
I	225	1.55
J	250	1.73
K	275	1.89
L	300	2.07
M	350	2.41
N	400	2.76
O	450	3.10
P	500	3.45
Q	550	3.79
R	600	4.13
S	650	4.48
T	700	4.82
U	750	5.17
V	800	5.51
W	850	5.86
X	900	6.20
Y	950	6.55
Z	1000	6.89

4.1.1 Types:

4.1.1.1 *Type 1*—Filament-wound flanges manufactured by winding continuous fibrous glass strand roving or roving tape, either preimpregnated or impregnated during winding, onto flange tooling under controlled tension.

4.1.1.2 *Type 2*—Compression-molded flanges made by applying external pressure and heat to a molding compound that is confined within a closed mold.

4.1.1.3 *Type 3*—Resin-transfer-molded flanges manufactured by pumping a thermosetting resin into glass reinforcements that have been cut to size and clamped between matched molds.

4.1.1.4 *Type 4*—Centrifugally-cast flanges are made by applying resin and reinforcement to the inside of a mold that is rotated and heated, subsequently polymerizing the resin system.

4.1.2 Grades:

4.1.2.1 *Grade 1*—Epoxy resin.

4.1.2.2 *Grade 2*—Polyester resin.

4.1.2.3 *Grade 3*—Phenolic resin.

4.1.2.4 *Grade 4*—Vinylester resin.

4.1.2.5 *Grade 7*—Furan resin.

4.1.3 Classes:

4.1.3.1 *Class 1*—Integrally-molded flange manufactured directly on a pipe section, pipe stub, or fitting.

4.1.3.2 *Class 2*—Taper to taper adhesive joint flange manufactured with a tapered socket to be used in conjunction with a pipe or fitting with a tapered spigot section and a suitable adhesive. This joining method provides an interference fit over the entire length of the bond line.

4.1.3.3 *Class 3*—Straight-taper adhesive joint flange manufactured with a tapered socket to be used with a pipe or fitting with an untapered spigot section and a suitable adhesive. This joining method provides an interference fit at the bottom of the socket.

4.1.3.4 *Class 4*—Straight adhesive joint flange manufactured with an untapered socket for use with a pipe or fitting with an untapered spigot and a suitable adhesive. This joint provides a pipe stop and may have an interference fit at the bottom of the socket.

4.1.4 *Pressure Rating*—Pressure rating shall be categorized by a single letter designation. Pressure designations are shown in **Table 1**.

4.1.5 Burst pressure, sealing test pressure, and bolt torque limit shall be categorized by single capital letter designations as indicated by the cell classification system of **Table 2**.

4.2 *Designation Code*—The flange designation code shall consist of the abbreviation RTR, followed by the type, grade, and class in Arabic numerals, the pressure rating category as a capital letter, and three capital letters identifying the cell classification designations of the burst pressure, sealing test pressure, and the bolt torque limit, respectively. Thus, a complete flange designation code shall consist of three letters, three numerals and one letter, and three letters.

4.2.1 *Example*—RTR-112F-FFI. This designation describes a filament-wound, glass fiber-reinforced epoxy resin flange with a taper to taper adhesive joining system. The flange has a 150 psi (1.40 MPa) pressure rating, a burst pressure in excess

of 600 psi (4.1 MPa), a sealing test pressure of 225 psi (1.6 MPa), and a bolt torque limit greater than 75 lbf-ft (102 N-m).

NOTE 3—Flanges with identical classification from different manufacturers may not be interchangeable due to nonstandardization of pipe or socket diameter, socket length, taper angle, or combination thereof.

5. Materials and Manufacture

5.1 Flanges manufactured in accordance with this specification shall be composed of reinforcement imbedded in or surrounded by cured thermosetting resin. The composite structure may contain granular or platelet fillers, thixotropic agents, pigments, or dyes.

5.2 The resins, reinforcements, and other materials, when combined as composite structure, shall produce a flange that will meet the performance requirements of this specification.

6. Performance Requirements

6.1 The following performance requirements are intended to provide classification and performance criteria for the purpose of qualification testing and rating of prototype constructions and periodic reevaluation of the manufacturer's stated ratings. They are not intended as routine quality assurance requirements for production runs of rated flanges.

6.2 Flanges shall meet the following performance requirements when joined for testing according to the manufacturer's recommended practice for field installation:

6.2.1 *Sealing*—Flanges shall withstand a pressure of at least 1.5 times the rated design pressure without leakage when tested in accordance with **10.4**.

6.2.2 *Short-Term Rupture Strength*—Flanges shall withstand a hydrostatic load of at least four times their rated design pressure without damage to the flange when tested in accordance with **10.5**.

TABLE 2 Burst Pressure, Sealing Test Pressure, and Bolt Torque Limit

Property	A	B	C	D	E	F	G	H	J	K
Burst pressure, psi	100	200	300	400	500	600	700	800	900	1000
(MPa)	0.69	1.38	2.07	2.76	3.45	4.13	4.82	5.51	6.20	6.89
Sealing test pressure, psi	37.5	75	113	150	188	225	263	300	338	375
(MPa)	0.26	0.52	0.78	1.03	1.29	1.55	1.81	2.07	2.33	2.58
Bolt torque limit, lbf-ft.	15	22.5	30	37.5	45	52.5	60	67.5	75	90
(N-m)	20.3	30.5	40.7	50.8	61.0	71.2	81.3	91.5	102	122

Property	K	L	M	N	O	P	Q	R	S	T
Burst pressure, psi	1100	1200	1400	1600	1800	2000	2200	2400	2600	2800
(MPa)	7.58	8.27	9.65	11.02	12.40	13.78	15.16	16.54	17.91	19.29
Sealing test pressure, psi	413	450	525	600	675	750	825	900	975	1050
(MPa)	2.84	3.10	3.62	4.13	4.65	5.17	5.68	6.20	6.72	7.23
Bolt torque limit, lbf-ft.	105	120	135	150	165	180	195	210	225	263
(N-m)	142	163	183	203	224	244	264	285	305	356

Property	U	V	W	X	Y	Z
Burst pressure, psi	3000	3200	3400	3600	3800	4000
(MPa)	20.67	22.05	23.43	24.80	26.18	27.56
Sealing test pressure, psi	1125	1200	1275	1350	1425	1500
(MPa)	7.75	8.27	8.78	9.30	9.82	10.34
Bolt torque limit, lbf-ft.	300	338	375	413	450	488
(N-m)	407	458	508	559	610	661

6.2.3 *Bolt Torque*—Flanges shall withstand, without visible sign of damage, a bolt torque of at least 1.5 times that recommended by the manufacturer for sealing of the flange at its rated pressure when tested in accordance with 10.6.

7. Content Requirements

7.1 *Recycled or Reprocessed Thermosetting Plastics*—Flanges shall not contain any recycled or reprocessed thermosetting plastics which might otherwise be added as fillers.

8. Dimensions

8.1 Dimensions and Tolerances:

8.1.1 *Flange and Bolt Dimensions*—Flanges of 24 in. (610 mm) or smaller diameter shall conform to the values given in Table 3A or 3B for bolt circle, number and size of bolt holes, and outside diameter. Flanges larger than 24 in. (610 mm) in diameter shall conform to the values for bolt circle, number and size of bolt holes, and outside diameter for Class 125 cast

TABLE 3 A Flange Dimensions, in. (mm)^A

Nominal Pipe, Size ^B	Outside Diameter of Flange	Drilling			
		Diameter of Bolt Circle	Diameter of Bolt Holes	Number of Bolts	Diameter of Bolts
1/2	3.50 (88.9)	2.38 (60.5)	0.62 (15.75)	4	1/2 (12.70)
3/4	3.88 (98.6)	2.75 (69.9)	0.62 (15.75)	4	1/2 (12.70)
1	4.25 (107.9)	3.12 (79.2)	0.62 (15.75)	4	1/2 (12.70)
1 1/4	4.62 (117.3)	3.50 (88.9)	0.62 (15.75)	4	1/2 (12.70)
1 1/2	5.00 (127.0)	3.88 (98.6)	0.62 (15.75)	4	1/2 (12.70)
2	6.00 (152.4)	4.75 (120.6)	0.75 (19.0)	4	5/8 (15.9)
2 1/2	7.00 (177.8)	5.50 (139.7)	0.75 (19.0)	4	5/8 (15.9)
3	7.50 (190.5)	6.00 (152.4)	0.75 (19.0)	4	5/8 (15.9)
3 1/2	8.50 (215.9)	7.00 (177.8)	0.75 (19.0)	8	5/8 (15.9)
4	9.00 (228.6)	7.50 (190.5)	0.75 (19.0)	8	5/8 (15.9)
5	10.00 (254.0)	8.50 (215.9)	0.88 (22.4)	8	3/4 (19.0)
6	11.00 (279.4)	9.50 (241.3)	0.88 (22.4)	8	3/4 (19.0)
8	13.50 (342.9)	11.75 (298.4)	0.88 (22.4)	8	3/4 (19.0)
10	16.00 (406.4)	14.25 (361.9)	1.00 (25.4)	12	7/8 (22.2)
12	19.00 (482.6)	17.00 (431.8)	1.00 (25.4)	12	7/8 (22.2)
14	21.00 (533.4)	18.75 (476.2)	1.12 (28.4)	12	1 (25.4)
16	23.50 (596.9)	21.25 (539.8)	1.12 (28.4)	16	1 (25.4)
18	25.00 (635.0)	22.75 (577.8)	1.25 (31.7)	16	1 1/8 (28.6)
20	27.50 (698.5)	25.00 (635.0)	1.25 (31.7)	20	1 1/8 (28.6)
24	32.00 (812.8)	29.50 (749.3)	1.38 (35.1)	20	1 1/4 (31.7)

^ADimensions conform to ANSI B16.5 for Class 150 steel flanges.

^BFor larger sizes, see 8.1.1.

TABLE 3 B Flange Dimensions, in. (mm)^A (continued)

Nominal Pipe Size	Outside Diameter of Flange	Diameter of Bolt Circle	Diameter of Bolt Holes	Number of Bolts	Diameter of Bolts
1/2	3.75 (95.3)	2.62 (66.5)	0.62 (15.75)	4	1/2 (12)
3/4	4.62 (117.3)	3.25 (82.6)	0.75 (19.0)	4	5/8 (16)
1	4.88 (124.0)	3.50 (88.9)	0.75 (19.0)	4	5/8 (16)
1 1/4	5.25 (133.4)	3.88 (98.6)	0.75 (19.0)	4	5/8 (16)
1 1/2	6.12 (155.4)	4.50 (114.3)	0.88 (22.4)	4	3/4 (18)
2	6.50 (165.1)	5.00 (127.0)	0.75 (19.0)	8	5/8 (16)
2 1/2	7.50 (190.5)	5.88 (149.4)	0.88 (22.4)	8	3/4 (18)
3	8.25 (209.6)	6.62 (168.1)	0.88 (22.4)	8	3/4 (18)
3 1/2	9.00 (228.6)	7.25 (184.2)	0.88 (22.4)	8	3/4 (18)
4	10.00 (254.0)	7.88 (200.2)	0.88 (22.4)	8	3/4 (18)
5	11.00 (279.4)	9.25 (235.0)	0.88 (22.4)	8	3/4 (18)
6	12.50 (317.5)	10.62 (269.7)	0.88 (22.4)	12	3/4 (18)
8	15.00 (381.0)	13.00 (330.2)	1.00 (25.4)	12	7/8 (22)
10	17.50 (444.5)	15.25 (387.4)	1.12 (28.4)	16	1 (24)
12	20.50 (520.7)	17.75 (450.9)	1.25 (31.7)	16	1 1/8 (24)
14	23.00 (584.2)	20.25 (514.4)	1.25 (31.7)	20	1 1/8 (24)
16	25.50 (647.7)	22.50 (571.5)	1.38 (35.1)	20	1 1/4 (30)
18	28.00 (711.2)	24.75 (628.7)	1.38 (35.1)	24	1 1/4 (30)
20	30.50 (774.7)	27.00 (685.8)	1.38 (35.1)	24	1 1/4 (30)
24	36.00 (914.4)	32.00 (812.8)	1.62 (41.1)	24	1 1/2 (36)

^ADimensions conform to ANSI B16.5 for Class 300 steel flanges.

iron flanges in ANSI B 16.1 or Class 150 flanges in ANSI B16.47. The tolerances for the flange dimensions provided in Table 3A and 3B shall be the same as those contained in ANSI B 16.5. For all size flanges other flange and bolt dimensions which meet internationally recognized standards such as ISO, DIN, JIS, BS, or GB can be used as long as they are agreed to by the buyer and seller.

8.1.2 *Flange Face*—The flange face shall be perpendicular to the axis of the fitting within 1/2°. The sealing surface of flat face or serrated face flanges shall be flat to ±1/32 in. (1 mm) for sizes up to and including 18 in. (457 mm) diameter and ±1/16 in. (2 mm) for larger diameters.

8.1.3 *Washer Bearing Surface*—Washer bearing surface shall be flat and parallel to the flange face within ±1°.

8.2 *Pipe Stop*—Each adhesive joined flange shall provide sufficient taper or a diametric constriction to act as a stop during adhesive joining so that the pipe stub cannot project beyond the face of the flange.

9. Workmanship, Finish, and Appearance

9.1 Flanges shall be free as commercially practical of defects, including indentations, delaminations, bubbles, pinholes, foreign inclusions, and resin-starved areas, which, due to their nature, degree, or extent, detrimentally affect the strength and serviceability of the flange. The flange shall be as uniform as commercially practicable in color, opacity, and other physical properties.

10. Test Methods

10.1 *Conditioning*—When conditioning is required, and in all cases of disagreement, condition the test specimens at 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 10 % relative humidity for not less than 40 h prior to test, in accordance with Procedure A of Practice D618.

10.2 *Test Conditions*—The tests may be conducted at ambient temperature and humidity conditions. When controlled environment testing is specified, tests shall be conducted in the Standard Laboratory Atmosphere of 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 10 % relative humidity. When elevated temperature testing is specified, the tests shall be conducted at the design operating temperature ±5.4°F (3°C).

10.3 *Dimensions and Tolerances*—Flange dimensions shall be measured with a micrometer or vernier calipers, or other suitable measuring devices accurate to within ±0.001 in. (±0.02 mm). Diameters shall be determined by averaging a minimum of four measurements, equally spaced circumferentially.

10.4 *Sealing*—Flanged components in general arrangement with Fig. 1 shall be bolted together using the gasket and bolt torque recommended for standard field installation by the flange manufacturer. The assembly shall then be pressure

- (A) - END PLATE, END CAP OR QUICK CLOSURE WITH COUPLING FOR PRESSURE SOURCE/VENT LINE.
- (B) - REINFORCED THERMOSETTING RESIN PIPE (RTRP).
- (C) - TEST FLANGE SET.
- (D) - END PLATE, END CAP OR QUICK CLOSURE.

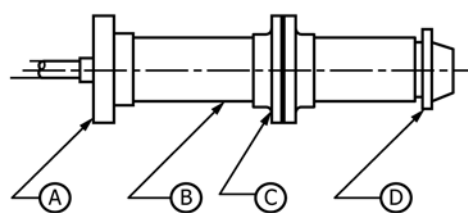


FIG. 1 Test Assembly Configuration