Designation: D4024 – 15

An American National Standard

Standard Specification for Machine Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges[1]

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 and health 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.

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.

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, into a flange cavity 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.

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

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[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**

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-112E-EED. 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.

TABLE 1 Pressure Categories

Designation	Pressure Rating	
	psi	MPa
A	50	0.35
B	75	0.52
C	100	0.69
D	125	0.86
E	150	1.04
F	175	1.21
G	200	1.38
H	225	1.55
J	250	1.73
K	300	2.07
L	350	2.42
M	400	2.76
N	450	3.11
P	500	3.45
R	550	3.80
S	600	4.14
T	650	4.49
U	700	4.83
V	750	5.18
W	800	5.52

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.

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 recylced 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,

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

Property	X[A]	A	B	C	D	E	F	G	H	J	K
Burst pressure, psi		200	300	400	500	600	700	800	900	1000	1200
(MPa)		1.38	2.07	2.76	3.45	4.14	4.83	5.52	6.21	6.90	8.27
Sealing test pressure, psi		75	115	150	190	225	265	300	340	375	450
(MPa)		0.52	0.79	1.03	1.31	1.55	1.83	2.07	2.34	2.59	3.10
Bolt torque limit, lbf·ft.		20	30	50	75	100	125	150	175	200	225
(N·m)		27.1	40.7	67.8	101.7	135.6	169.5	203.4	237.3	271.2	305.1

Property	L	M	N	P	R	S	T	U	V	W
Burst pressure, psi	1400	1600	1800	2000	2200	2400	2600	2800	3000	3200
(MPa)	9.65	11.03	12.41	13.79	15.17	16.55	17.93	19.31	20.69	22.06
Sealing test pressure, psi	525	600	675	750	825	900	975	1050	1125	1200
(MPa)	3.62	4.14	4.65	5.17	5.69	6.21	6.72	7.24	7.76	8.27
Bolt torque limit, lbf·ft.	250	275	300							
(N·m)	339.0	372.9	406.8							

[A] X = unspecified

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
½	3.50 (88.9)	2.38 (60.5)	0.62 (15.75)	4	½ (12.70)
¾	3.88 (98.6)	2.75 (69.9)	0.62 (15.75)	4	½ (12.70)
1	4.25 (107.9)	3.12 (79.2)	0.62 (15.75)	4	½ (12.70)
1¼	4.62 (117.3)	3.50 (88.9)	0.62 (15.75)	4	½ (12.70)
1½	5.00 (127.0)	3.88 (98.6)	0.62 (15.75)	4	½ (12.70)
2	6.00 (152.4)	4.75 (120.6)	0.75 (19.0)	4	⅝ (15.9)
2½	7.00 (177.8)	5.50 (139.7)	0.75 (19.0)	4	⅝ (15.9)
3	7.50 (190.5)	6.00 (152.4)	0.75 (19.0)	4	⅝ (15.9)
3½	8.50 (215.9)	7.00 (177.8)	0.75 (19.0)	8	⅝ (15.9)
4	9.00 (228.6)	7.50 (190.5)	0.75 (19.0)	8	⅝ (15.9)
5	10.00 (254.0)	8.50 (215.9)	0.88 (22.4)	8	¾ (19.0)
6	11.00 (279.4)	9.50 (241.3)	0.88 (22.4)	8	¾ (19.0)
8	13.50 (342.9)	11.75 (298.4)	0.88 (22.4)	8	¾ (19.0)
10	16.00 (406.4)	14.25 (361.9)	1.00 (25.4)	12	⅞ (22.2)
12	19.00 (482.6)	17.00 (431.8)	1.00 (25.4)	12	⅞ (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	1⅛ (28.6)
20	27.50 (698.5)	25.00 (635.0)	1.25 (31.7)	20	1⅛ (28.6)
24	32.00 (812.8)	29.50 (749.3)	1.38 (35.1)	20	1¼ (31.7)

[A] Dimensions conform to ANSI B16.5 for Class 150 steel flanges.
[B] For larger sizes, see 8.1.1.

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 iron flanges in ANSI B 16.1. 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 ½ °. 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.

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)

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
½	3.75 (95.3)	2.62 (66.5)	0.62 (15.75)	4	½ (12)
¾	4.62 (117.3)	3.25 (82.6)	0.75 (19.0)	4	⅝ (16)
1	4.88 (124.0)	3.50 (88.9)	0.75 (19.0)	4	⅝ (16)
1¼	5.25 (133.4)	3.88 (98.6)	0.75 (19.0)	4	⅝ (16)
1½	6.12 (155.4)	4.50 (114.3)	0.88 (22.4)	4	¾ (18)
2	6.50 (165.1)	5.00 (127.0)	0.75 (19.0)	8	⅝ (16)
2½	7.50 (190.5)	5.88 (149.4)	0.88 (22.4)	8	¾ (18)
3	8.25 (209.6)	6.62 (168.1)	0.88 (22.4)	8	¾ (18)
3½	9.00 (228.6)	7.25 (184.2)	0.88 (22.4)	8	¾ (18)
4	10.00 (254.0)	7.88 (200.2)	0.88 (22.4)	8	¾ (18)
5	11.00 (279.4)	9.25 (235.0)	0.88 (22.4)	8	¾ (18)
6	12.50 (317.5)	10.62 (269.7)	0.88 (22.4)	12	¾ (18)
8	15.00 (381.0)	13.00 (330.2)	1.00 (25.4)	12	⅞ (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	1⅛ (24)
14	23.00 (584.2)	20.25 (514.4)	1.25 (31.7)	20	1⅛ (24)
16	25.50 (647.7)	22.50 (571.5)	1.38 (35.1)	20	1¼ (30)
18	28.00 (711.2)	24.75 (628.7)	1.38 (35.1)	24	1¼ (30)
20	30.50 (774.7)	27.00 (685.8)	1.38 (35.1)	24	1¼ (30)
24	36.00 (914.4)	32.00 (812.8)	1.62 (41.1)	24	1½ (36)

[A]Dimensions conform to ANSI B16.5 for Class 300 steel flanges.

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 of 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 tested and be required to hold the test pressure for a period of 168 hours without leakage. Retorque to the manufacturer's specified level after initial pressurization is permitted.

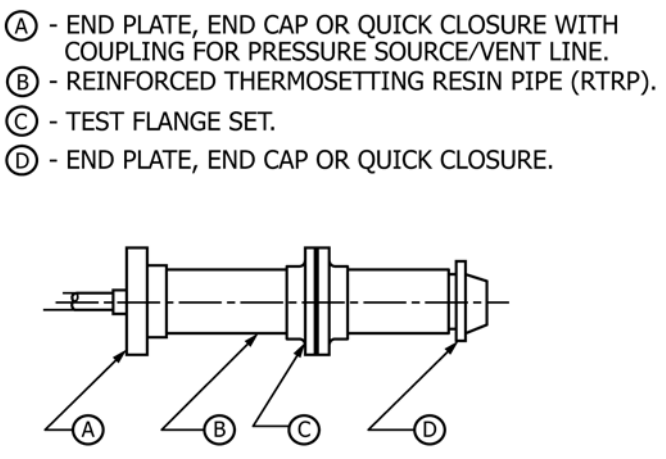

FIG. 1 Test Assembly Configuration

10.5 *Short-Term Rupture Strength*—Flanged components shall be tested in accordance with Test Method D1599 with free-end closure except as herein noted. The pressure in the specimen shall be increased until failure of the flange occurs. Pressure testing in an atmospheric environment is permissible. Minimum failure time shall be 60 s; no restriction shall be placed on maximum time-to-failure. Leaking past the gasket interface is permissible during this test. Bolt torque may be increased as necessary during the test in order to minimize gasket leaking and to achieve the pressure necessary to cause flange failure. The assembly used for the test in 10.4 may be used for this test. (**Warning—**Do not test with any pressurized gas.)

10.6 *Maximum Bolt Torque*—Using the gasket and hardware recommended by the flange manufacturer, bolt the flange against a flat face steel flange. Tighten the nuts by hand until they are snug. Prior to fit-up, the nuts, bolts, and washers should be well lubricated, using a nonfluid thread lubricant. Establish uniform pressure over the flange face by tightening bolts in 5 lbf·ft (7 N·m) increments according to the sequence shown in Fig. 2. For flanges with more than 20 bolts, similar alternating bolt tightening sequences shall be used. Increase the bolt torque uniformly until flange failure occurs or until all bolts have been torqued to five times the level recommended by the manufacturer for field installation practice to establish the bolt torque cell classification of the flange. Any sign of flange damage (crumbling, flaking, cracking, or other breaking) shall constitute failure.

NOTE 4—The torque limits determined by 10.6 apply only to flanges bolted up against a flat sealing surface. Significantly lower bolt torque value will normally be obtained when RTR flanges are bolted up against raised-faced flanges. When RTR flanges must be used against raised steel flange face, the RTR flange manufacturer should be contacted for his torque and installation recommendations.

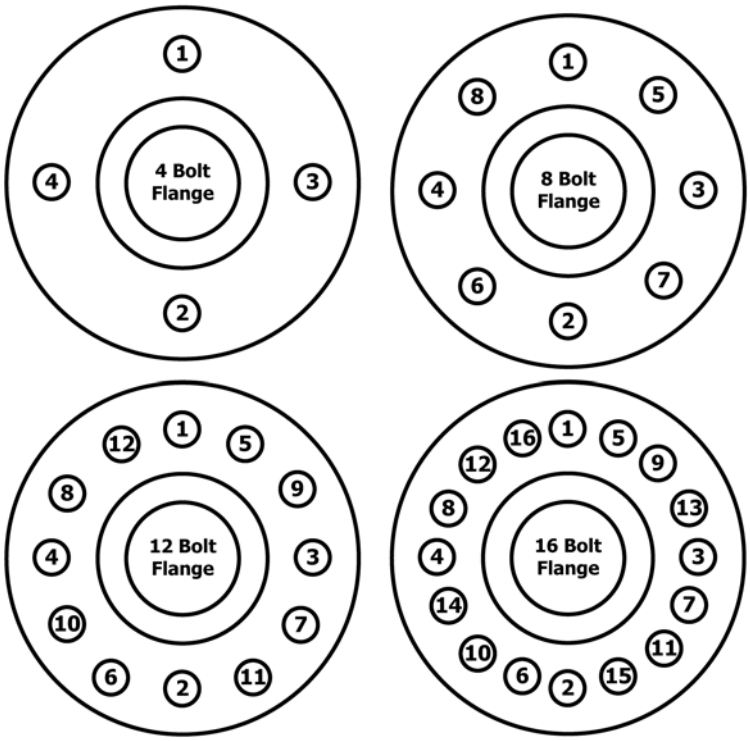

FIG. 2 Bolt Torquing Sequence

11. Product Marking

11.1 Each flange shall be marked with the following information:

11.1.1 The designation "ASTM D4024" indicating compliance with this specification,

11.1.2 Identification of the flange in accordance with the designation code in 4.2,

11.1.3 Nominal flange size, and

11.1.4 Manufacturer's name (or trademark) and product designation.

11.2 All required markings shall be legible and so applied as to remain legible under normal handling and installation practices.

12. Precision and Bias

12.1 No precision and bias statement can be made for this test method, since controlled round robin test programs have not been run.

NOTE 5—The wide variation in raw materials and constructions allowed in this specification make round robin testing difficult to apply.

13. Keywords

13.1 centrifugally-cast; compression-molded; filament-wound; furan; machine-made; phenolic; polyester; resin-transfer; vinyl ester

SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue (D4024 - 12) that may impact the use of this standard. (May 1, 2015)

(1) Corrected bolt tightening sequence on 8-bolt flange diagram (Fig. 2).