Designation: D3982 – 21

Standard Specification for Contact Molded "Fiberglass" (Glass Fiber Reinforced Thermosetting Resin) Ducts [1]

This standard is issued under the fixed designation D3982; 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 ducts fabricated by contact molding intended for use in handling corrosive fumes and process gases. Special attention is given to equipment that operates at temperatures over 180°F (82.2°C) with regard to strength and corrosion resistance.

1.2 The material of construction shall be "fiberglass" consisting of a polyester, vinyl ester, or other qualified resin-matrix systems with fiber reinforcement in accordance with Specification C582.

1.3 This specification is not intended to cover selection of resins and reinforcements for specific chemical environments.

1.4 This specification covers ducts up to a design pressure of ±5 psig (34.5 Pa).

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.6 *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—There is no known ISO equivalent to this standard.

1.7 *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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C581 Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service

C582 Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment

D883 Terminology Relating to Plastics

D2583 Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor (Withdrawn 2022)[3]

D2584 Test Method for Ignition Loss of Cured Reinforced Resins

F412 Terminology Relating to Plastic Piping Systems

F436 Specification for Hardened Steel Washers (Metric) F0436_F0436M

2.2 *NFPA Standard:*

NFPA 91 Installation of Blower and Exhaust Systems for Duct, Stack and Vapor Removal or Conveying[4]

3. Terminology

3.1 *Definitions:*

3.1.1 The definitions used in this specification are in accordance with definitions in Terminologies D883 and F412, unless otherwise specified.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calculated thickness*—this description is in accordance with the standard laminate composition tables for Types I and II in Specification C582.

3.2.2 *contact molding*—includes the "hand layup" and the "spray up" methods of manufacture.

[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] 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] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.

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

3.2.3 *flange cant*—the angle that an entire branch is off from being perpendicular to the main run centerline (see Fig. 1).

3.2.4 *flange flatness*—maximum deviation, (see Fig. 2) from the actual flange face not including warpage or perpendicularity.

3.2.5 *flange offset*—the amount that an entire branch is off the main run centerline (see Fig. 3).

3.2.6 *flange perpendicularity*—maximum angle that the plane (see Fig. 2) of the flange inside diameter makes with the perpendicular plane to the duct's centerline.

3.2.7 *flange warpage*—the amount that a flange outside diameter pulls back from the plane of the inside diameter during the cure of the material (see Fig. 2).

3.2.8 *hand layup*—application of glass plies in sheet form by hand. Resin can be applied by either brushing, rolling, or spraying.

3.2.9 *minimum thickness*—take six thickness readings. The average of the six readings shall be a minimum of 85 % of the calculated thickness. This must contain the required layers of glass.

3.2.10 *spray up*—fiberglass roving is chopped and blown onto the mold in conjunction with resin and catalyst.

3.3 *Symbols:*

3.3.1 M = 1½ oz/ft^2 chopped-strand mat.

3.3.2 R = 24 oz/yd^2 woven-roving with a 5 by 4 weave.

3.3.3 V = glass or synthetic veil, 0.010 in. (0.25 mm) calculated thickness.

3.3.4 For additional symbols and abbreviations specific to design requirements, see 6.2.1.

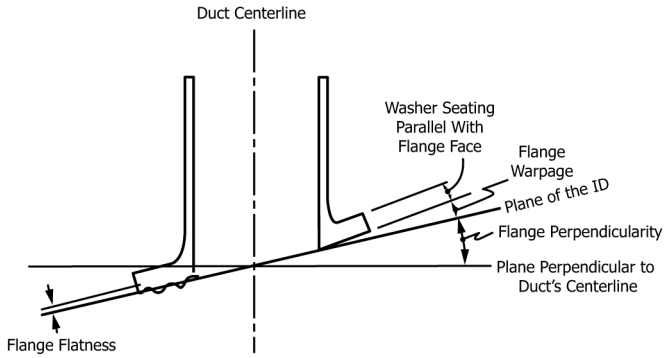


FIG. 2 Flange Tolerance Description

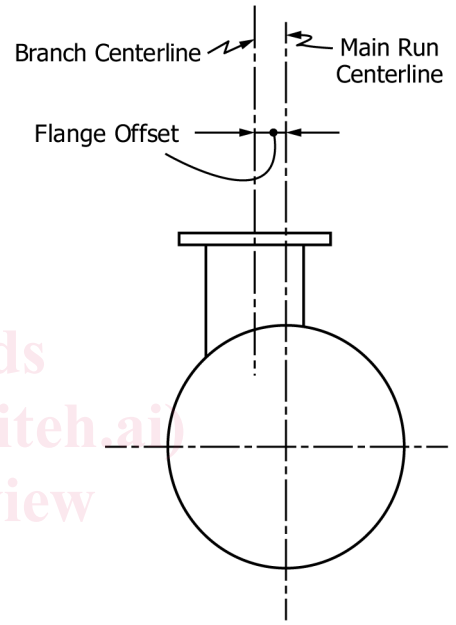


FIG. 3 Flange Offset

4. Materials and Manufacture

4.1 *Resin*—The resin used shall be a commercial-grade thermoset that has either been evaluated in a laminate by test in accordance with Practice C581 or that has been determined by previous documented service to be acceptable for service conditions. Where service conditions have not been evaluated a suitable resin shall be selected by agreement between the manufacturer and the end user.

4.1.1 The use of resin containing fillers or pigments in accordance with Specification C582 shall be allowed.

4.1.2 A thixotropic agent is allowed up to 5 % by weight of resin.

NOTE 2—The addition of a thixotropic agent may reduce the resistance of many resin systems to certain corrosive chemical environments. It is the responsibility of the fabricator, using a thixotropic agent in the resin to ascertain its compatibility with the corrosive environment when this has been reported to him by the purchaser.

4.1.3 Fire-retardant additives are allowed to be added to resins if required to reduce flame spread.

NOTE 3—The addition of fire-retardant agents may interfere with the visual inspection of laminate quality. Use in the inner surface and interior layer should consider this, and the need for fire retardance should outweigh any potential visual inspection difficulties. In some cases, fire-retardant agents can also affect the chemical resistance of the resin. If this is suspected, then chemical resistance testing of the resin should be conducted with fire-retardant additives included. Again, the need for fire

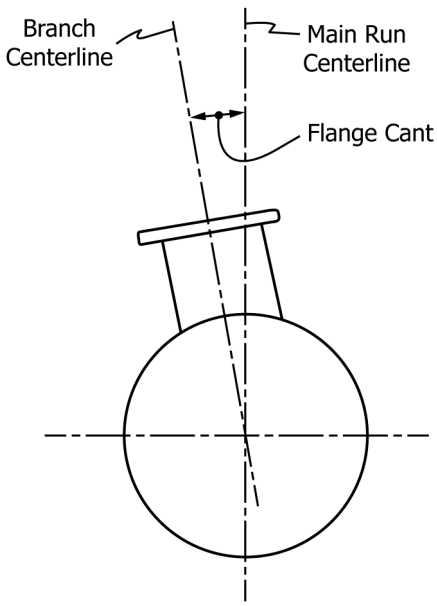


FIG. 1 Flange Cant

resistance should be balanced with chemical resistance.

4.2 *Reinforcement*—Glass reinforcing material with a binder and sizing compatible with the resin to be used. Fiber reinforcements shall be in accordance with, and meet the requirements of, Specification C582 including composition requirements for Type I and Type II laminates.

4.2.1 *Corrosion Barrier*—Consists of the inner surface followed by the interior layer. The corrosion barrier has a minimum total calculated thickness of 0.096 in. (2.4 mm).

4.2.1.1 *Inner Surface*—Surfacing veil with approximately 90 % resin and 0.010 to 0.020-in. (0.25 to 0.50-mm) calculated thickness.

4.2.1.2 *Interior Layer*—A minimum of two plies of 1½ oz/ft^2 chopped-strand mat or chopped roving equivalent with a compatible sizing system with approximately 75 % resin and 0.086-in. (2.2-mm) calculated thickness minimum. Fiber length shall be ½ in. (12.7 mm) minimum to 2 in. (50.8 mm) maximum.

4.2.2 *Structural Layer*—Shall consist of chopped-strand mat plies of nominally 1½ oz/ft^2 and have a ½ in. (12.7 mm) minimum to 2 in. (50.8 mm) maximum fiber length, or shall consist of a chopped roving equivalent in the spray-up method. When necessary, woven-roving plies shall be used and shall consist of 24 oz/yd^2 with a five by four weave or a suitable equivalent agreed on by the end user and the fabricator. Woven-roving shall be applied alternately with a minimum of a 1½ oz/yd^2 mat or chopped roving equivalent, finishing with a mat layer.

4.2.3 *Outer Surface*—Shall be coated with a resin-rich layer and containing 0.2 to 0.6 % paraffin wax with a melting point of 122 to 126°F (50.0 to 52.2°C), except when other means are used to prevent air inhibition.

5. Physical Properties

5.1 Minimum wall of (*V, M, M, M*) shall be maintained under any circumstances.

5.2 Laminates or portions of laminates comprised only of chopped-strand mat or chopped roving equivalent shall have a 20 to 35 % glass content by weight when tested by Test Method D2584.

5.3 Minimum mechanical properties of standard laminates shall be in accordance with Specification C582.

6. Design Requirements

6.1 *Design Limitations:*

6.1.1 *Safety Factor*—Use four for external pressure, use six for internal pressure and all other design calculations except secondary bonding stresses.

6.1.2 *Maximum Permissible Deflection Under Design Load*—Use L/240 for duct spans. Deflection limit for panel deflection shall be 1.5 %.

6.1.3 *Secondary Bond Strength*—When the load is along the surface, use 2000 psi (13.79 MPa) ultimate shear stress for the bonding surface area. Use a safety factor of ten when calculating allowable secondary bonding stresses.

6.1.4 When an extra corrosion barrier is specified, do not include this thickness in the design calculations.

6.1.5 Increase all calculated wall thicknesses to the nearest standard wall thickness. Treat these standard wall thicknesses as minimum dimensions.

6.2 *Cylinder Wall Design:*

6.2.1 *Symbols and Abbreviations:*

6.2.1.1 *P*—Actual design pressure, psi (MPa).

6.2.1.2 *PA*—Allowable pressure, psi (MPa).

6.2.1.3 D_o—Outside diameter of cylinder, in. (mm).

6.2.1.4 *D*—Inside diameter of cylinder, in. (mm).

6.2.1.5 *S*—Ultimate tensile strength, psi (MPa).

6.2.1.6 *F*—Safety factor (see 6.1.1).

6.2.1.7 *T*—Cylinder wall thickness, in. (mm).

6.2.1.8 *E*—Tensile modulus of elasticity, psi (MPa).

6.2.1.9 *L*—Cylinder length between joints or elements that qualify as a stiffener, in. (mm).

6.2.1.10 *I*—Required moment of inertia for an element to qualify as a stiffener, in.^{3} (mm^3).

6.2.2 *Internal Pressure:*

$$T = \frac{PDF}{2S}$$

6.2.3 *External Pressure (Internal Vacuum):* Calculate:

$$1.73\left(\frac{D_o}{T}\right)^{0.5}$$

If result:

$$< \frac{L}{D_o}$$

Then use:

$$P = \frac{2.2E}{F}\left(\frac{T}{D_o}\right)^3$$

If result:

$$\geq \frac{L}{D_o}$$

Then use:

$$P = \frac{\frac{2.6E}{F}\left(\frac{T}{D_o}\right)^{2.5}}{\frac{L}{D_o} - 0.45\left(\frac{T}{D_o}\right)^{0.5}}$$

6.2.4 *Stiffeners to Withstand External Pressure:*

6.2.4.1 *Required Moment of Inertia:*

$$I = \frac{PL\,(D_o)^3\,F}{24E}$$

6.2.4.2 It is permitted to include material used to attach ring stiffener to cylinder wall when calculating the actual moment of inertia of the stiffener as well as the portion of the cylinder wall beneath the stiffener and attachment material up to a width of 2*x* (stiffener width).

6.3 *Rectangular Duct:*

6.3.1 The largest flat panel shall be designed to withstand the loading conditions and not exceed the design limitations (see 6.1.2). This can be accomplished with a sufficient wall

thickness alone or by the incorporation of stiffening ribs to reduce the required wall thickness.

6.3.2 Appropriate calculations shall be performed for wall thickness and stiffening ribs as determined by the manufacturer and the purchaser. Minimum wall thickness in all cases for rectangular duct shall be as in Table 1, substituting the longer side for the diameter.

6.3.3 The radial sides of a rectangular elbow shall be designed as a round cylinder with the same radius.

6.4 Follow the requirements of NFPA 91Bulletin, Section 510 when it is required by law or the engineer.

6.5 *Shop Drawings and Design Calculations*—The fabricated structure shall be in accordance with the design and construction details shown on shop drawings and design calculations prepared by the manufacturer and approved by the purchaser. Details to be covered include, but are not limited to, the following:

6.5.1 Materials, including a definition of the fiber-resin system, in accordance with types of resins and reinforcing materials of Specification C582,

6.5.2 Dimensions,

6.5.3 Size and location of stiffening ribs, (if used),

6.5.4 Location of field joints and flanges, and

6.5.5 Type and location of supports, if supplied by the manufacturer.

6.6 All stiffeners, access openings, lifting devices or other appurtenances shall be included as part of the duct design.

6.7 Where static electricity has been determined to be a problem by the engineer, the inner surface of the ductwork shall be grounded with a maximum resistance to ground of $10^6\ \Omega$. The grounding method shall be determined by the manufacturer and the purchaser.

7. Dimensions

7.1 Standard duct and fitting dimensions are shown on Fig. 4 and are based on inside dimensions.

7.2 Standard elbows shall have a centerline radius of 1½ times the duct diameter for over 3-in. (76.2-mm) diameter and two times the duct diameter for 3-in. diameter and under.

7.3 Mitered joints on all elbows 24-in. (609.6-mm) diameter and under are not permitted except when more room is required for bolting or when a diameter is chosen that is not shown on Table 1.

7.4 Standard duct flange thickness, drilling patterns, and minimum wall thickness are shown in Table 1.

7.4.1 Vent connections from tanks and fans are normally different from this pattern. Appropriate adjustments to flange dimensions need to be taken to effect transition.

7.5 To determine minimum information for rectangular duct, use the longest side and increase to the nearest standard round-duct inside diameter. This diameter can be used to determine the flange thickness, minimum wall thickness and bolt-hole diameter, or tolerances.

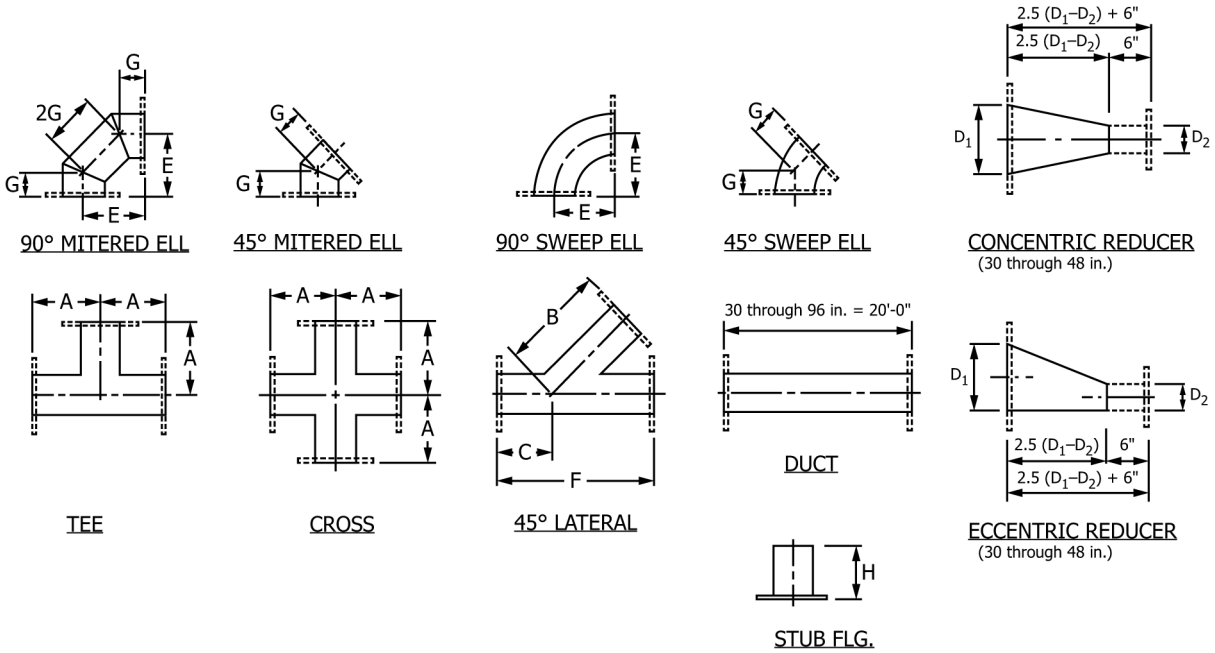
TABLE 1 Typical Flange Dimensions

NOTE 1—1 in. = 25.4 mm
1 lb/ft = 1.488164 kg/m.

Inside Diameter, in.	Wall Thickness, min, in.[A]	Flange[B] Thickness, min, in.	Flange Outside Diameter, in.	Flange Bolt Circle, in.	Bolt Hole Diameter, in.	Number Bolt Holes	Recommended Bolt Torque, ft/lb	Maximum Bolt Torque, ft/lb
1	0.14	3/8	5 3/8	4	7/16	4	20	30
1 1/4	0.14	3/8	5 5/8	4 1/4	7/16	4	20	30
1 1/2	0.14	3/8	5 7/8	4 1/2	7/16	4	20	30
2	0.14	1/2	6 3/8	5	7/16	4	25	40
2 1/2	0.14	1/2	6 7/8	5 1/2	7/16	4	25	40
3	0.14	1/2	7 3/8	6	7/16	4	25	40
4	0.14	1/2	8 3/8	7	7/16	4	25	40
6	0.14	1/2	10 3/8	9	7/16	8	25	40
8	0.14	1/2	12 3/8	11	7/16	8	25	40
10	0.14	1/2	14 3/8	13	7/16	12	25	40
12	0.14	1/2	16 3/8	15	7/16	12	25	40
14	0.14	1/2	18 3/8	17	7/16	12	25	40
16	0.14	1/2	20 3/8	19	7/16	16	25	40
18	0.14	1/2	22 3/8	21	7/16	16	25	40
20	0.14	1/2	24 3/8	23	7/16	20	25	40
24	0.18	1/2	28 3/8	27	7/16	20	25	40
30	0.18	5/8	34 3/8	33	7/16	28	35	50
36	0.18	5/8	40 3/8	39	7/16	32	35	50
42	0.22	5/8	46 3/8	45	7/16	36	35	50
48	0.22	5/8	54 3/8	52	9/16	44	35	50
54	0.22	5/8	60 3/8	58	9/16	44	35	50
60	0.30	5/8	66 3/8	64	9/16	52	35	50
72	0.30	3/4	78 3/8	76	9/16	60	40	60
84	0.30	3/4	90 3/8	88	9/16	72	40	60
96	0.30	3/4	102 3/8	100	9/16	80	40	60

[A] Based on 10 ft (3.0 m) between stiffeners for 5-in. (127.0 mm) H_2O vacuum service. See Specification C582 for wall construction.

[B] The flange thicknesses are based on practical experience to resist maximum bolt torquing since these thicknesses are sufficient to resist process conditions. Minimum flange thickness shall be measured in the spot-faced area.



NOTE 1—FLGs are optional.

NOTE 2—FLG bolt holes straddle major centerlines.

NOTE 3—FLG backs flat for SAE washers unless otherwise specified by purchaser.

NOTE 4—All units are in inches, unless otherwise specified.

Dimensions for Installation

Size ID[A]	A	B	C	F	E	G	H
1	6	10	6	16	–	–	6
1¼	6	10	6	16	–	–	6
1½	6	10	6	16	–	–	6
2	6	10	6	16	4	1⅝	6
2½	7	12	6	18	6	2½	6
3	7	12	6	18	6	2½	6
4	8	14	6	20	6	2½	6
6	10	16	8	24	9	3¾	8
8	12	20	10	30	12	5	8
10	14	24	10	34	15	6¼	10
12	16	26	12	38	18	7½	10
14	18	30	12	42	21	8¾	12
16	20	32	14	46	24	10	12
18	21	36	14	50	27	11¼	12
20	22	38	16	54	30	12½	12
24	24	42	18	60	36	15	12
30	30	52	20	72	45	18⅝	15
36	33	62	22	84	54	22½	15
42	36	72	24	96	63	26⅛	15
48	39	81	26	107	72	29⅞	15
54	42	91	26	117	81	33½	15
60	45	99	28	127	90	37¼	15
72	54	117	34	151	72	29⅞	18
84	60	136	36	172	84	34¾	18
96	66	154	38	192	96	39¾	18

[A] All units measured in inches.

FIG. 4 Standard Duct Dimensions