Designation: D 3982 – ~~98~~03

An American National Standard

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

This standard is issued under the fixed designation D 3982; 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 and hoods 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 C 582.

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

1.4 All descriptions and limitations in this specification are to include both ducts and hoods, where applicable.

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

1.6 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

1.7 *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—There is no similar or equivalent ISO standard.

[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. Referenced Documents

2.1 *ASTM Standards:* [2]

C 581 Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures, Intended for Liquid Service

C 582 Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment

D 883 Terminology Relating to Plastics

D 2583 Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor

D 2584 Test Method for Ignition Loss of Cured Reinforced Resins

F 412 Terminology Relating to Plastic Piping Systems

F 436 Specification for Hardened Steel Washers

2.2 *NFPA Standard:*

NFPA 91 Installation of Blower and Exhaust Systems for Duct, Stack and Vapor Removal or Conveying[3]

3. Terminology

3.1 *Definitions:*

3.1.1 The definitions used in this specification are in accordance with definitions in Terminologies D 883 and F 412, 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 C 582.

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

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.

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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, ~~Vol 08.04.~~ volume information, refer to the standard’s Document Summary page on the ASTM website.
~~*Annual Book of ASTM Standards,* Vol 08.01.~~

[3] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02269-9101.

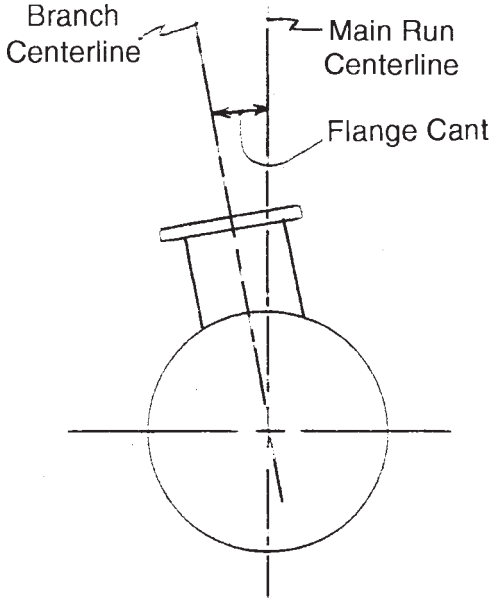


FIG. 1 Flange Cant

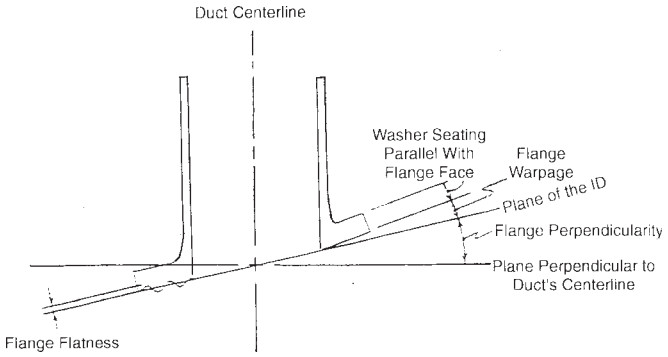


FIG. 2 Flange Tolerance Description

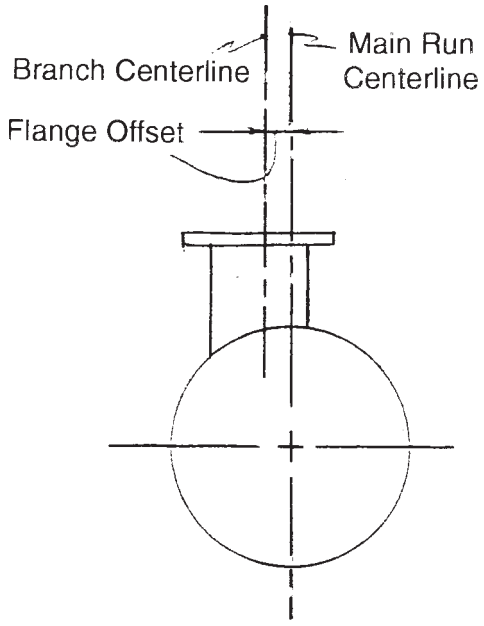


FIG. 3 Flange Offset

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

3.3 *Abbreviations:~~Symbols and Abbreviations:~~ 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.

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 C 581 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 may be selected by agreement between the manufacturer and the end user.

4.1.1 The resin may contain fillers or pigments in accordance with Specification C 582.

4.1.2 A thixotropic agent may be added up to 5 % by weight of resin.

NOTE ~~1~~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 may be added to resins if required to reduce flame spread.

NOTE ~~2—Because the~~ 3—The addition of fire-retardant agents may interfere with the visual inspection of laminate ~~quality, they should not be used~~ quality. Use in the inner surface ~~or~~ and interior layer ~~unless their functional advantages would outweigh~~ should consider this, and the ~~loss of~~ need for fire retardance should out weigh any potential visual ~~inspection.~~

~~4.1.4 Where static electricity has been determined to be a problem by~~ inspection difficulties. In some cases fire-retardant agents

can also affect the ~~engineer,~~ the ~~inner surface~~ chemical resistance of the ~~ductwork shall be grounded with a maximum~~ resin. If this is suspected, then chemical resistance ~~to ground~~ testing of ~~10^6 Ω. The grounding method shall~~ the resin should be conducted with fire-~~r~~retardant additives included ~~by~~. Again the ~~manufacturer and the purchaser.~~ need for fire 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 C 582 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 which~~ 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 ~~not required as determined by the engineer.~~ 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 shall have a 25 to 30 % glass content by weight when tested by Test Method D 2584.

5.3 Minimum mechanical properties of standard laminates shall be in accordance with Specification C 582.

6. Design Requirements

6.1 *Design Limitations*:

6.1.1 *Safety Factor*—Use five for external pressure, use ten for internal pressure and all other design calculations.

6.1.2 *Maximum Permissible Deflection Under Design Load* —Use 1 % of the span for laminates not exposed to a chemical environment and use ½ % of the span for allowable deflection when a chemical environment will be in contact with the laminate.

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 Material used to attach ring stiffener to cylinder wall may be included 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 ~~run~~ 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 Bulletin 91, 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 C 582,

6.5.2 Dimensions,

6.5.3 Size and location of stiffening ribs,

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 Ω. 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) diam-eter 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

TABLE 1 Typical Flange Dimensions and Hanger Spacing

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

Inside Diameter, in.	Calculated[A] Wall Thickness, in.	Cylinder[A] Wall Construction	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	Maximum[CD] Hanger Spacing, ft
1	0.14	Type I	⅜	5⅜	4	7/16	4	20	30	8.0
1¼	0.14	Type I	⅜	5⅝	4¼	7/16	4	20	30	8.0
1½	0.14	Type I	⅜	5⅞	4½	7/16	4	20	30	8.5
2	0.14	Type I	½	6⅜	5	7/16	4	25	40	8.5
2½	0.14	Type I	½	6⅞	5½	7/16	4	25	40	9.0
3	0.14	Type I	½	7⅜	6	7/16	4	25	40	9.5
4	0.14	Type I	½	8⅜	7	7/16	4	25	40	10.0
6	0.14	Type I	½	10⅜	9	7/16	8	25	40	10.5
8	0.14	Type I	½	12⅜	11	7/16	8	25	40	11.0
10	0.14	Type I	½	14⅜	13	7/16	12	25	40	11.5
12	0.14	Type I	½	16⅜	15	7/16	12	25	40	11.5
14	0.14	Type I	½	18⅜	17	7/16	12	25	40	12.0
16	0.14	Type I	½	20⅜	19	7/16	16	25	40	12.5
18	0.14	Type I	½	22⅜	21	7/16	16	25	40	12.5
20	0.14	Type I	½	24⅜	23	7/16	20	25	40	13.0
24	0.18	Type I	½	28⅜	27	7/16	20	25	40	15.0
30	0.18	Type I	⅝	34⅜	33	7/16	28	35	50	15.5
36	0.18	Type I	⅝	40⅜	39	7/16	32	35	50	16.0
42	0.22	Type II	⅝	46⅜	45	7/16	36	35	50	19.0
48	0.22	Type II	⅝	54⅜	52	9/16	44	35	50	19.5
54	0.22	Type II	⅝	60⅜	58	9/16	44	35	50	20.0
60	0.30	Type II	⅝	66⅜	64	9/16	52	35	50	24.0
72	0.30	Type II	¾	78⅜	76	9/16	60	40	60	25.0
84	0.30	Type II	¾	90⅜	88	9/16	72	40	60	25.5
96	0.30	Type II	¾	102⅜	100	9/16	80	40	60	26.0

[A] Based on 10 ft (3.0 m) between stiffeners for 5-in. (127.0 mm) H_2O vacuum service. See Specification C 582 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.
[C] Special design consideration must be given to hanger spacing for rectangular duct.
[D] Based on experience involving duct systems not subjected to severe service conditions such as significant additional weight caused by liquid or solids buildup, effects of wind loading, or possible failure of intermediate hangers. These are maximum spacings that must not be exceeded even when design may indicate a longer spacing. Shorter spacings may be required due to other loads.

inside diameter. This diameter can be used to determine the flange thickness, minimum wall thickness and bolt-hole diameter, or tolerances.

7.6 There is no standard drilling pattern for rectangular duct. Bolt-hole spacing shall be designed for a proper seal with a maximum spacing of 4½ in. (114.3 mm).

7.7 All bolt holes straddle major centerlines unless otherwise specified.

8. Tolerances

8.1 Terminology for tolerances is given in 3.2.

8.2 *Out of Roundness*:

≤6-in. (152.4-mm) inside diameter, tolerance = ±1/16 in. (1.6 mm)
>6-in. inside diameter, tolerance = ±⅛ in. (3.2 mm) or ±1 % (whichever is greater)

not to exceed maximum = ¾ in. (19.1 mm)

8.3 Overall lengths shall be ±¼ in. (6.4 mm) maximum.

8.4 Cut ends of round duct shall be square within ±⅛ in. (3.2 mm) for <24-in. (609.6-mm) inside diameter, ±3/16 in. (4.8 mm) for between 24 and 48-in. (609.6 to 1219.2-mm) inside diameter, and ±¼ in. (6.4 mm) for ≥48-in. (1219.2-mm) inside diameter.

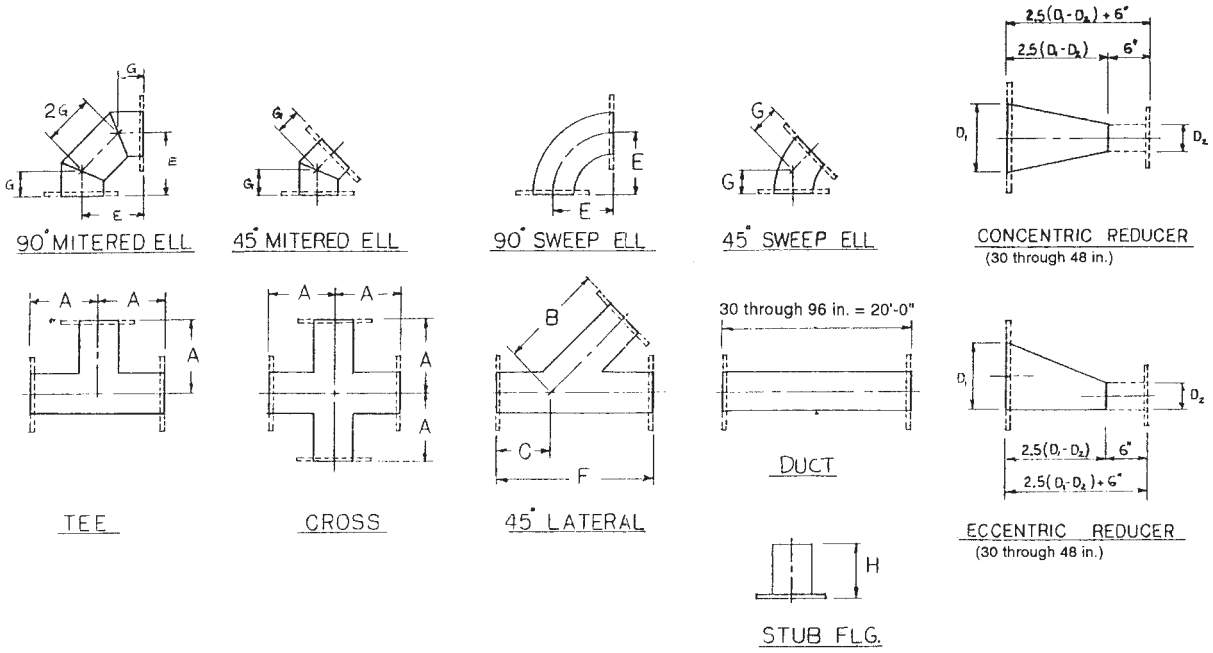
8.5 Flanged or plain ends of duct and fittings must be within the following angles from their theoretical location: ≤24 in. (609.6 mm) within ±1°, >24 to ≤48 in. (1219.2 mm) within ±¾ °, and >48 in. (1219.2 mm) within ±½ °.

8.6 Flange warpage = ±3°; offset = ±⅛ in. (3.2 mm); flange perpendicularity = ±½ °; cant = ±½ °, and flange flatness = ±1/32 in. (0.8 mm) for ≤18-in. (457.2-mm) inside diameter and ±1/16 in. (1.6 mm) for >18-in. (457.2-mm) inside diameter.

8.7 For rectangular ducting for each side, increase the side to the nearest standard-round-duct inside diameter and use that diameter to determine the tolerance for that particular side.

8.8 Back of flange shall be parallel with the flange face within ±1°, otherwise spotface for acceptable washer seating. (See Specification F 436 for washer dimensions.)

8.9 All corners of rectangular duct shall be radiused with ½-in. (12.7-mm) radius for corners adjoining a wall ≤24 in. (609.6 mm) in length, 1-in. (25-mm) radius for corners adjoining a wall between 24 and 48 in. (609.6 to 1219.2 mm) in length, and 1½-in. (38.1-mm) radius for corners adjoining a wall ≥48 in. (1219.2 mm) in length.



NOTE 1—FLGs are optional.
NOTE 2—FLG bolt holes straddle major centerlines.
NOTE 3—FLG backs flat for SAE washers.
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

9. Fabrication

9.1 All reinforcing materials shall be overlapped in accordance with Specification C 582. Overlaps in subsequent plies shall be staggered 2.25 in. (57.2 mm) minimum from overlaps in the preceding ply.

9.2 *Joints*:

9.2.1 See Table 2 for minimum total weld widths. The weld shall be centered on the joint within ½ in. (12.7 mm).

9.2.2 The weld construction and thickness shall be that of the thickest section being joined (see Fig. 5).

9.2.3 All welds shall have a 6:1 taper minimum (see Fig. 5).

9.2.4 All gaps between mating ends of duct or fittings to be less than ⅜ in. (9.5 mm).

TABLE 2 Minimum Weld Widths

Minimum Cylinder Wall Thickness		Minimum Total Weld Width	
in.	(mm)	in.	(mm)
0.14	(3.6)	4	(101.6)
0.18	(4.6)	5	(127.0)
0.22	(5.6)	6	(152.4)
0.30	(7.6)	6	(152.4)

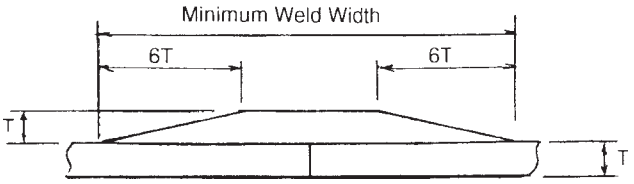


FIG. 5 Weld Width and Thickness

9.2.5 All exposed cut edges to be coated in accordance with 4.2.3.

9.3 *Flanges*:

9.3.1 See Fig. 6 for flange attachment.

9.3.2 In a "flange on pipe" type flange, the same inner surface and interior layer of the duct shall also be on the flange face.

9.3.3 In an "integral" type flange the same inner surface and interior layer must continue onto the flange face.

9.3.4 Flanges shall be vapor-tight at the design pressure when using a ⅛ in. (3.2 mm) thick 60 durometer gasket and torqued to the recommended tightness in accordance with Table 1.

9.3.5 Flanges shall be drilled with the pattern specified in Table 1 with bold holes straddling major centerlines unless otherwise specified.

9.3.6 Back of flanges to be flat and parallel to provide a good seat for washers (see 8.8).

9.3.7 Flange construction shall be Type I or Type II in accordance with Specification C 582.

10. Inspection

10.1 The finished laminate shall conform to visual acceptance criteria of Table 5 in Specification C 582.

10.2 All dimensions shall be within the acceptable tolerances in Section 8.

10.3 Barcol hardness shall be determined in accordance with Test Method D 2583. Finished laminate shall have a minimum of 90 % of the resin manufacturer's published Barcol hardness for a cured resin.

10.4 The finished laminate shall not be tacky in accordance with the acetone sensitivity test. This involves application of a small amount of acetone to the surface, rubbing with finger until acetone evaporates and checking for tackiness. It is recommended ~~wearing~~ that gloves be worn while performing this test.

10.5 Inspection at the manufacturer's shop by the end user is recommended.

11. Shipping, Handling and Installation[4,5]

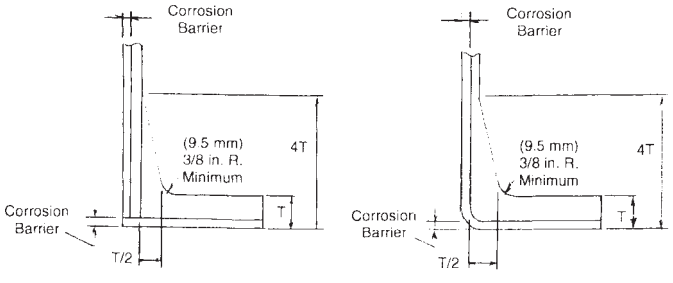
11.1 See Table 1 for recommended hanger spacing.

~~*Annual Book of ASTM Standards*, Vol 08.02.~~

[4] Store resin, glass reinforcing and curing agents in a cool, dry area to maximize shelf life.

~~*Annual Book of ASTM Standards*, Vol 15.08.~~

[5] Upon arrival at the installation site the customer shall examine the equipment for damage in transit. If damage has occurred the customer shall file a claim with the carrier.



(a) "Flange on Pipe" Type (b) "Integral" Type

FIG. 6 Flange Attachment

11.2 Use properly designed hangers ~~wi~~. Saddle supports should have a minimum of 150° circumferential contact and one third of the diameter (2 in. (51 mm) minimum) longitudinal contact. Hanger supports should have 360° circumferential contact and a longitudinal contact equal to diameter/12 with a minimum of 2 in. (51 mm).

11.3 All other equipment or service loads shall be supported independently. Use flexible connections to isolate ductwork from vibration caused by air-moving equipment.

11.4 Because of the light weight of fiberglass duct and hoods the primary determinants of the overall dimensions of the sub-assemblies will be the dimensional shipping limitations. The dimensions of the sub-assemblies shall be determined by the manufacturer and the purchaser.

11.5 Unload the equipment with care and store in a location where it will be free of damage. Impact of a tool or other heavy object may result in a fracture of the inner lining and may affect the service life.

11.6 Support large sub-assemblies during shipment and unloading, to prevent excessive deflection and over stressing.

11.7 Protect all flange surfaces with wooden blinds or other approved material during shipment. Protect all ductwork, and especially appurtenances that could be easily damaged, to prevent shipping or handling damage.

11.8 Use full-face gaskets to eliminate any cantilever effect caused from bolting.

11.9 Tighten bolting on flanged connections following torque values given in Table 1. Tighten bolts following the sequential concept shown in Fig. 7. Use washers under bolt heads and nuts.

11.10 The vendor shall specify the quantity of field-joining kits subject to the concurrence of the customer. The vendor shall supply material safety data sheets and field-joining instructions along with the joining materials.

11.11 Clean bonding surfaces to remove grease, oil, dirt, moisture, or any other contaminants. In addition, sand or grind surface to remove the surface gloss. Do not use solvents on any freshly sanded or ground surfaces.

11.12 Anchor all joints to eliminate any movement during the welding and curing process.

12. Keywords

12.1 chemical resistance; contact molding; ducts; flanges; hoods; polyester resin; reinforced plastic

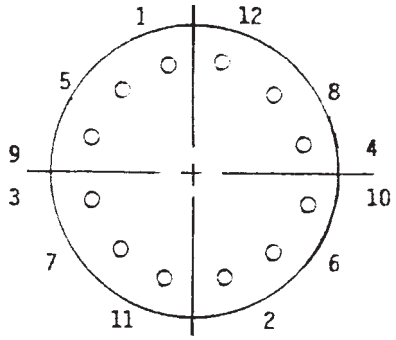


FIG. 7 Bolt Tightening Sequence