Designation: C582 – 09 (Reapproved 2016)

An American National Standard

Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion-Resistant Equipment[1]

This standard is issued under the fixed designation C582; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This specification covers composition, thickness, fabricating procedures, and physical property requirements for glass fiber reinforced thermoset polyester, vinyl ester, or other qualified thermosetting resin laminates comprising the materials of construction for RTP corrosion-resistant tanks, piping, and equipment. This specification is limited to fabrication by contact molding.

NOTE 1—The laminates covered by this specification are manufactured during fabrication of contact-molded RTP tanks, piping, and other equipment.

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

1.2 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.

1.3 The following safety hazards caveat pertains only to the test method portion, Section 8, 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.*

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

D638 Test Method for Tensile Properties of Plastics

D695 Test Method for Compressive Properties of Rigid Plastics

D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D883 Terminology Relating to Plastics

D2583 Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor

D2584 Test Method for Ignition Loss of Cured Reinforced Resins

D3681 Test Method for Chemical Resistance of "Fiberglass" (Glass–Fiber–Reinforced Thermosetting-Resin) Pipe in a Deflected Condition

E84 Test Method for Surface Burning Characteristics of Building Materials

3. Definitions

3.1 Definitions used in this specification are in accordance with Terminology D883 unless otherwise indicated. The abbreviation for reinforced thermoset plastic is RTP.

3.2 *polyester*—resins produced by the polycondensation of dihydroxyderivatives and dibasic organic acids or anhydrides, wherein at least one component contributes ethylenic unsaturation yielding resins that can be compounded with styryl monomers and reacted to give highly crosslinked thermoset copolymers.

3.3 *vinyl ester*—resins characterized by reactive unsaturation located predominately in terminal positions that can be compounded with styryl monomers and reacted to give highly crosslinked thermoset copolymers.

NOTE 3—These resins are handled in the same way as polyesters in fabrication of RTP components.

3.4 *contact molding*—a method of fabrication wherein the glass-fiber reinforcement is applied to the mold, in the form of chopped strand mat or woven roving, by hand or from a reel, or in the form of chopped strands of continuous-filament glass from a chopper-spray gun. The resin matrix is applied by various methods, including brush, roller, or spray gun. Consolidation of the composite laminate is by rolling.

4. Classification

4.1 Laminates shall be classified according to type, class, and grade.

[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.

4.1.1 *Type*—In Roman numerals, shall designate the reinforcement structure comprised of specific plies of glass fiber in specific sequences.

4.1.1.1 *Type I*—A standard all-mat or chopped-roving construction, or both, as shown in Table 1.

4.1.1.2 *Type II*—A standard mat or chopped-roving and woven-roving construction, or combination thereof, as shown in Table 2.

4.1.1.3 Other types, such as standard mat or chopped roving with alternating layers of nonwoven biaxial or unidirectional reinforcement in the structured plies. may be qualified in accordance with Appendix X2.

4.1.2 *Class*—In capital letters, shall designate the generic resin: "P" for polyester and "V" for vinyl ester. The letters "FS" followed by parenthesis, "FS( )," shall designate fire retardancy, if specified, with maximum flame spread in the parentheses in accordance with Test Method E84.

NOTE 4—Fire retardancy by Test Method E84 is determined for 0.125-in. (3.175-mm) thick, flat laminates with all-mat glass content of 25 to 30 %.

NOTE 5—Maximum flame spread designation by Test Method E84 relates to measurement and description of the properties of materials, products, or systems in response to heat and flame under controlled laboratory conditions and should not be considered or used for the description or appraisal of the fire hazard of materials, products, or systems under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment that takes into account all the factors that are pertinent to an assessment of the fire hazard or a particular end use.

4.1.3 *Grade*—In Arabic numerals, shall designate the minimum physical property levels of a laminate at 73.4 ± 3.6°F (23 ± 2°C).

NOTE 6—The five Arabic grade numbers designate minimum physical property levels of a laminate obtained from tests of representative production process samples. They are not arbitrarily selected values.

4.1.4 *Thickness*—Nominal, shall be designated by Arabic number in decimal hundredths of an inch. (See Table 1 and Table 2 for standard thicknesses.)

NOTE 7—Table 1 and Table 2 are for reference purposes and do not preclude other laminate-type constructions, such as nonwoven biaxial or unidirectional fabric, which may be agreed upon between the buyer and the seller, or may be added to this specification if they have been fully identified and characterized, as shown in Appendix X2.

4.1.5 *Classification Requirements for Different Laminates*—Laminate designation from Table 3 shall consist of the abbreviation RTP followed by (*1*) type in Roman numerals; (*2*) class in capital letters followed by FS( ) if required; (*3*) grade consisting of five Arabic numbers to designate minimum levels of physical properties and (*4*) thickness designated by Arabic number in decimal inches (or ALL, if properties apply to all thicknesses).

4.1.5.1 *Examples:*

(1) RTP I 1 ALL, designates Type I polyester laminate, non-fire-retardant Grade 13211, having the following minimum physical property levels (see Table 3):

Tensile strength, ultimate—9000 psi (62 MPa).
Tensile modulus—1 050 000 psi (7242 MPa).
Flexural strength, ultimate—18 000 psi (124 MPa).
Flexural modulus—700 000 psi (4828 MPa).
Glass content—25 %.
Thickness—"ALL" thicknesses.

(2) RTP II P FS(25) 55433.30, designates Type II, polyester fire-retardant resin laminate with a maximum flame spread of 25, Grade 55433 having the following minimum physical property levels (see Table 3):

Tensile strength, ultimate—17 500 psi (121 MPa).
Tensile modulus—1 300 000 psi (8966 MPa).
Flexural strength, ultimate—22 000 psi (152 MPa).
Flexural modulus—1 000 000 psi (6897 MPa).

TABLE 1 Standard Laminate Composition Type I[A]

Calculated Thickness[BC]		Corrosion Barrier[D]	Structural Plies[E] Number and Sequence of Plies																	Drafting Symbols
in.	(mm)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
0.18	(4.6)	V	M	M	M	M														V, 4M
0.23	(5.8)	V	M	M	M	M	M													V, 5M
0.27	(6.9)	V	M	M	M	M	M	M												V, 6M
0.31	(7.9)	V	M	M	M	M	M	M	M											V, 7M
0.35	(8.9)	V	M	M	M	M	M	M	M	M										V, 8M
0.40	(10.2)	V	M	M	M	M	M	M	M	M	M									V, 9M
0.44	(11.2)	V	M	M	M	M	M	M	M	M	M	M								V, 10M
0.48	(12.2)	V	M	M	M	M	M	M	M	M	M	M	M							V, 11M
0.53	(13.5)	V	M	M	M	M	M	M	M	M	M	M	M	M						V, 12M
0.57	(14.5)	V	M	M	M	M	M	M	M	M	M	M	M	M	M					V, 13M
0.61	(15.5)	V	M	M	M	M	M	M	M	M	M	M	M	M	M	M				V, 14M
0.66	(16.8)	V	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M			V, 15M
0.70	(17.8)	V	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M		V, 16M
0.74	(18.8)	V	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M	V, 17M

[A] Glass content, weight, % = 25 to 30, all thickness.
[B] Calculated thickness for design purposes is determined as follows:
V = Surfacing mat – 0.010 in./ply (0.25 mm/ply) when saturated with resin.
M = 1 ½ oz/ft^2 (459 g/m^2) mat – 0.043 in./ply (1.1 mm/ply) when saturated with resin.
[C] The thickness shall be not less than 90 % of the calculated thickness shown.
[D] Corrosion barrier (Plies 1, 2, and 3) shall gel before structural plies are added.
[E] Structural lay-up may be interrupted at intervals long enough to exotherm if required by the laminate manufacturing procedure and 6.3.1.

TABLE 2 Standard Laminate Composition Type II

Calculated Thickness[AB]		Glass Content (weight, %)	Corrosion Barrier[C]			Structural Plies[D] Number and Sequence of Plies																Drafting Symbols
in.	(mm)		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
0.22	(5.6)	28 to 33	V	M	M	M	R	M																V, 2M, MRM
0.29	(7.4)	30 to 35	V	M	M	M	R	M	R	M														V, 2M, 2(MR)M
0.37	(9.4)	30 to 35	V	M	M	M	R	M	R	M	R	M												V, 2M, 3(MR)M
0.41	(10.4)	30 to 35	V	M	M	M	R	M	R	M	R	M	M											V, 2M, 3(MR)M, M
0.49	(12.5)	34 to 38	V	M	M	M	R	M	R	M	R	M	M	R	M									V, 2M, 3(MR)M, MRM
0.57	(14.5)	34 to 38	V	M	M	M	R	M	R	M	R	M	M	R	M	R	M							V, 2M, 3(MR)M, 2(MR)M
0.64	(16.3)	37 to 41	V	M	M	M	R	M	R	M	R	M	M	R	M	R	M	R	M					V, 2M, 3(MR)M, 3(MR)M
0.69	(17.5)	37 to 41	V	M	M	M	R	M	R	M	R	M	M	R	M	R	M	R	M	M				V, 2M, 3(MR)M, 3(MR)M,M
0.76	(19.3)	37 to 41	V	M	M	M	R	M	R	M	R	M	M	R	M	R	M	R	M	M	R	M		V, 2M, 3(MR)M, 3(MR)M, MRM

[A] Calculated thickness for design purposes is determined as follows:
V = Surfacing mat – 0.010 in./ply (0.25 mm/ply) when saturated with resin.
M = 1 ½ oz/ft^2 (459 g/m^2) mat = 0.043 in./ply (1.1 mm/ply) when saturated with resin.
R = 24½ oz/yd^2 (832 g/m^2) 5 × 4 woven roving = 0.033 in./ply (0.84 mm/ply) when saturated with resin.
[B] The thickness shall be not less than 90 % of the calculated thickness shown.
[C] Corrosion barrier (Plies 1, 2, and 3) shall gel before structural plies are added.
[D] Structural lay-up may be interrupted long enough to exotherm following an "M" ply, if required by the laminate manufacturing procedure. Location of exotherm plies may be shifted within the laminate body. No plies may be omitted. Refer to 6.3.1.

TABLE 3 Classification System for Hand Lay-up Laminates Using Minimum Property Values[A]

Classification Order											
RTP followed by:											
(1)	Type	I	II	III	IV	V					
(2)	Class	P Polyester	V Vinylester	. . .	. . .	. . .			followed by FS ( ), if specified with flame spread in parentheses in accordance with Test Method E84		
					Physical and Mechanical Properties						
(3)	Grade	1	2	3	4	5	6	7	8	9	0
1st Digit:	Tensile strength, ultimate psi × 10^3	9	11	13	15	17.5	20	. . .	. . .	. . .	. . .
	(MPa)	(62)	(76)	(90)	(104)	(121)	(138)	. . .	. . .	. . .	. . .
2nd Digit:	Tensile modulus, tangent psi × 10^3	0.85	0.95	1.05	1.15	1.3	1.5	1.75	2.0	. . .	. . .
	(MPa)	(5 863)	(6 552)	(7 242)	(7 932)	(8 966)	(10 346)	(12 070)	(13 794)	. . .	. . .
3rd Digit:	Flexural strength, ultimate psi × 10^3	16	18	20	22	24	. . .	. . .	. . .	. . .	. . .
	(MPa)	(110)	(124)	(138)	(152)	(166)	. . .	. . .	. . .	. . .	. . .
4th Digit:	Flexural modulus, psi × 10^6	0.7	0.85	1.0	1.15	1.3	1.5	. . .	. . .	. . .	. . .
	(MPa)	(4 828)	(5 863)	(6 897)	(7 932)	(8 966)	(10 346)	. . .	. . .	. . .	. . .
5th Digit:	Glass content, by weight, %	25	28	30	34	37	40	44	. . .	. . .	. . .

[A] Table will be completed as new resins and higher strength laminates become available.

Glass content—30 %.
Thickness—0.30 in. (7.62 mm).

5. Materials

5.1 *Resin Matrix System:*

5.1.1 The resin shall be determined to be acceptable for the service either by test, see 8.6, or by verified case history.

5.1.2 *Catalyst/Promoter System,* shall be as recommended or approved by the resin producer.

5.1.3 *Diluents,* such as added styrene, fillers, dyes, pigments, or flame retardants shall be used only when agreed upon between the fabricator and the buyer. When such items are required, limits for each shall be agreed upon between the fabricator and the buyer. A thixotropic agent may be added to the resin for viscosity control.

NOTE 8—The addition of fillers, dyes, pigments, flame retardants, and thixotropic agents may interfere with visual inspection of laminate quality.

NOTE 9—Chemical resistance can be significantly affected by the

catalyst/promoter system, diluents, dyes, fillers, flame retardants, or thixotropic agent used in the resin.

5.1.4 *Resin Pastes,* used where necessary to fill crevices formed by joining subassemblies before overlay shall not be subject to the limitations of 5.1.3. Pastes shall be made with thixotropic agents.

5.1.5 *Ultraviolet Absorbers,* may be added to the exterior surface for improved weather resistance when agreed upon between the fabricator and the buyer.

5.2 *Fiber Reinforcement:*

5.2.1 *Surfacing Mat (veil)* is a thin mat of fine fibers used primarily to produce a smooth surface on a reinforced plastic.

5.2.1.1 Veil shall be determined to be acceptable for the service either by Test Methods C581 or D3681, or by a verified case history.

5.2.1.2 Requirements of acceptable surface veils are:

(a) Resin compatibility,

(b) Uniform fiber distribution,

(c) Single filaments (not bundled),

(d) The thickness shall be a minimum of 10 mils per ply when saturated with resin, and

(e) Minimum fiber length shall be 0.5 in.

NOTE 10—The chemical resistance of the RTP laminate is provided by the resin. In combination with the cured resin, the surfacing veil helps determine the thickness of the resin-rich layer, reduces microcracking, and provides a nonwicking chemically resistant layer.

Additional desirable considerations in choosing a veil for a specific application include:

(a) Drapability (surfacing veil should conform to mold shape),

(b) Dry and wet tensile strength,

(c) Binder solubility (if used),

(d) Wetability,

(e) Surfacing veil shall wet-out completely without trapping air during laminating, and

(f) Surfacing veil should not inhibit resin cure.

5.2.2 *Chopped-Strand Mat,* shall be "E" or "ECR" type glass fiber, 1½ oz/ft^2 (459 g/m^2), with sizing and binder compatible with the resin.

5.2.3 *Woven Roving,* shall be "E" or "ECR" type glass, 24½ oz/yd^2 (832 g/m^2), 5 by 4 square weave fabric having a sizing compatible with the resin.

5.2.4 *Roving,* used in chopper guns for spray-up application, shall be "E" or "ECR" type glass with sizing compatible with the resin.

5.2.5 *Other Reinforcements,* such as nonwoven biaxial or unidirectional fabric. These products shall be a commercial grade of "E" or "ECR" type glass fiber with a sizing that is compatible with the resin.

5.3 *Laminates:*

5.3.1 Laminate construction shall be in accordance with the tabulated lay-up sequence for the specified type.

5.3.2 *Type I,* laminate structure is detailed in Table 1.

5.3.3 *Type II,* laminate structure is detailed in Table 2.

6. Laminate Fabrication

6.1 Apply the catalyzed resin to a mold or mandrel properly prepared with a parting agent or film suitable for the lay-up resin. Next apply the specified surface mat, rolling so as to draw the resin through the mat for thorough wet-out and deaeration.

6.2 Apply resin and two plies of 1½-oz (42.6-g) mat. As an alternative, a minimum of two passes of chopped roving (minimum fiber length 1 in. (25.4 mm) and resin may be applied by the spray-up process equivalent in weight and thickness to 3 oz/ft^2 (918 g/m^2) of chopped mat. Each pass of chopped roving or ply of chopped-strand mat shall be thoroughly rolled out. This section of the laminate shall be allowed to exotherm prior to application of subsequent plies of reinforcement.

6.3 Continue lay-up in the sequence of plies, tabulated for the specified laminate type. Roll each ply for thorough wet-out and deaeration.

6.3.1 Interruption of laminate construction for exotherm shall follow instructions noted on Table 1 and Table 2 for the particular laminate type. The final ply of reinforcement before interruption for exotherm shall be 1½-oz/ft^2 (459-g/m^2) mat or chopped roving equivalent. The initial ply of the following lamination shall be 1½-oz/ft^2 mat or chopped roving equivalent.

6.4 The outer surface of the fabricated laminate shall be smooth and free of exposed glass fibers. The final ply shall be mat or chopped roving equivalent. A surfacing mat is not required unless specified. Surface resin may require the addition of paraffin or may be sealed with overlaid film, as required or approved by the resin producer, to ensure proper surface cure.

6.4.1 When pigmentation is specified, the pigment shall be incorporated only in the resin used to lay-up the final laminate ply.

6.5 All edges of reinforcement material except surfacing mat shall be lapped 1-in. (25.4-mm) minimum. Lapped edges of adjacent layers shall be staggered. Surfacing mat shall be butted together or have overlaps no more than ½ in. (12.7 mm). Gaps are not permitted.

7. Physical and Mechanical Properties

7.1 The composition and sequence requirements for Type I and II laminates are shown in Table 1 and Table 2.

7.2 The mechanical property requirements for Type I and II laminates are shown in Table 4.

7.3 Physical properties of each type and grade of laminate shall be established on flat laminates prepared under shop conditions. In Type II laminates the woven roving is to be laid square, and test specimens are to be cut parallel to the warp rovings.

7.3.1 Test specimens cut from fabricated equipment usually are not parallel to warp rovings. Interpretation of mechanical property data obtained from such specimens is discussed in Appendix X1.

8. Test Methods

8.1 *Tensile Strength and Tangent Modulus of Elasticity*—Test Method D638.

TABLE 4 Standard Laminate Properties

Calculated Thickness,[A] in. (mm)	Type	Tensile[B]		Mechanical Properties, min, psi (MPa)[C]		
		Ultimate Stress × 10^{-3} (MPa)	Modulus × 10^{-6} (MPa)	Flexural[D]		Edge Compression[E]
				Ultimate Stress × 10^{-3} (MPa)	Modulus × 10^{-6} (MPa)	Ultimate Stress × 10^{-3} (MPa)
ALL	I	9.0 (62)	0.85 (5862)	16.0 (110)	0.7 (4828)	16 (110)
0.22 (5.6)	II	12.0 (83)	0.9 (6207)	19.0 (131)	0.8 (5518)	16 (110)
0.30 (7.6)	II	13.5 (93)	1.1 (7587)	20.0 (138)	0.9 (6207)	18 (124)
0.37 (9.4) and up	II	15.0 (104)	1.2 (8276)	22.0 (152)	1.0 (6897)	20 (138)

[A] The thickness shall be not less than 90 % of the calculated thickness shown.
[B] Test Method D638.
[C] Barcol hardness should be 90 % (minimum) of cast resin hardness.
[D] Test Method D790.
[E] Test Method D695.

8.1.1 Specimens shall be in accordance with Type III, Fig. 1 of Test Method D638 for all laminate thicknesses.

8.2 *Flexural Strength and Tangent Modulus of Elasticity*—Test Methods D790, Method I, Procedure A, and Table 1, 1/*d* = 16 to 1.

8.2.1 Specimens shall be the full thickness of the laminate as fabricated.

8.2.2 The loading nose shall be applied to the inner face of the laminate specimen.

8.3 *Glass Content*—Test Method D2584.

8.3.1 The residual, undisturbed glass-fiber plies from the ignition shall be separated carefully and counted to confirm standard lay-up sequence.

8.4 *Thickness* shall be measured with a ball-foot micrometer.

8.5 *Hardness*—Test Method D2583.

8.6 *Chemical Resistance*—Test Method C581.

8.6.1 Exposure tests under plant operating conditions shall employ Test Method C581 standard test laminate samples.

NOTE 11—Thicker laminates shall not be used for such tests, as results will vary significantly compared to exposure of standard samples in Test Method C581.

8.7 *Surface Flame-Spread Classification*—Test Method E84.

9. Workmanship and Finish

9.1 The finished laminate shall conform to visual acceptance criteria of Table 5.

9.2 The surface exposed to the chemical environment (process side) shall be smooth, resin-rich, and fully cured. The exterior surface shall also be fully cured.

9.2.1 The degree of cure shall be measured by a Barcol hardness test in accordance with Test Method D2583. At least 80 % of the random readings shall exceed at least 90 % of the resin manufacturer's recommended hardness for the cured resin.

9.2.2 Potential air-inhibited, undercured surfaces (both interior secondary lamination and exterior non-mold surfaces) shall be tested using an acetone sensitivity test. Four to five drops of acetone rubbed with a finger on the laminate surface, free of mold release, wax, dust, or dirt, until it evaporates, will not result in surface softness or tackiness.

10. Keywords

10.1 contact molded; corrosion-resistant equipment; glass-fiber-reinforced; laminate; reinforced thermosetting plastic (RTP); thermoset polyester resin; thermoset vinyl ester resin

TABLE 5 Visual Acceptance Criteria

Visual Observation	Surface Inspected	
	Process Side	Nonprocess Side
Cracks	None	None
Crazing (fine resin-rich surface cracks)	None	Maximum dimension 1 in. (25.4 mm). Maximum density 5/ft^2 (0.1 m^2).[A]
Blisters (rounded elevations of the laminate surface over bubbles)	None	Maximum ¼ -in. (6.4-mm) diameter by ⅛ in. (3.2 mm) high. Maximum 2/ft^2 (2/0.1 m^2).[A]
Wrinkles and solid blisters	Maximum deviation, 20 % of wall thickness, but not exceeding ⅛ in. (3.2 mm).[A]	Maximum deviation, 20 % of wall thickness, but not exceeding 3⁄16 in. (4.8 mm).[A]
Pits (craters in the laminate surface)	Maximum dimensions, ⅛ -in. (3.2-mm) diameter by 1⁄32 in. (0.8 mm) deep. Maximum number 10/ft^2 (10/0.1 mm^2).[A]	Maximum dimension ⅛ -in. (3.2-mm) diameter by 1⁄16 in. (1.6 mm) deep. Maximum density 10/ft^2 (10/0.1 m^2).[A]
Surface porosity, pin holes, or pores in the laminate	Maximum dimensions, 1⁄16 -in. (1.6-mm) diameter by 1⁄32 in. (0.8 mm) deep. Maximum number 20/ft^2 (20⁄0.1 m^2) by 1⁄16 in. (1.6 mm). Must be resin-rich.[A]	Maximum dimension 1⁄16 -in. (1.6-mm) diameter by 1⁄16 in. deep. Maximum number 20/ft^2 (20/0.1 m^2). Must be resin-rich.[A]
Chips (small piece broken from edge or surface)	Maximum dimensions, ⅛ -in. (3.2-mm) diameter by 1⁄32 in. (0.8 mm) deep. Maximum number 1/ft^2 (1/0.1 m^2).[A]	Maximum dimension ¼ -in. (6.4-mm) diameter by 1⁄16 in. (1.6 mm) deep. Maximum number 5/ft^2 (5/0.1 m^2).[A]
Dry spot (non-wetted reinforcing)	None	Maximum dimensions 2 in.^{2} (13 cm^2) per ft^2 (0.1 m^2).[A]
Entrapped air (bubbles or voids or delaminations in the laminate)	Maximum diameter 1⁄16 in. (1.6 mm), 10/in.^{2} (10⁄6.5 cm^2) maximum density. Maximum diameter ⅛ in. (3.2 mm), 2/in.^{2} (2/6.5 cm^2) maximum density. Maximum depth of 1⁄32 in. (0.8 mm).[AB]	Maximum diameter 1⁄16 in. (1.6 mm). 10/in.^{2} (10⁄6.5 cm^2) maximum density. Maximum diameter ⅛ in. (3.2 mm), 2/in.^{2} (2/6.5 cm^2) maximum density. Maximum diameter 3⁄16 in. (4.8 mm), 2/ft^2 (2/0.1 m^2). Maximum density.[AB]
Exposed glass	None	None
Burned areas	None	None
Exposure of cut edges	None[C]	None[C]
Scratches	None over 0.005 in. deep and 4 in. long	Maximum length 12 in. (3.5 mm). Maximum depth 0.010 in. (0.25 mm) 2/ft^2 (2/0.1 m^2), maximum density.[A]
Foreign matter	None	⅛-in. (3.2-mm) diameter, maximum density 1/ft^2 (1⁄0.1 m^2). 3⁄16 -in. (4.8-mm) diameter, maximum density 1/ft^2 (1/0.1 m^2).[AD]

[A] Maximum 5 % of total surface area affected.
[B] Entrapped air or bubbles described are allowed, provided the surface cannot easily be broken with a pointed object, such as a knife blade.
[C] Cut edges must be covered with resin.
[D] Foreign matter must not penetrate the surface and must not contribute to entrapped air or other defects not allowed.

APPENDIXES

(Nonmandatory Information)

X1. INTERPRETATION OF DATA FROM ANISOTROPIC LAMINATES

X1.1 *General*—Mechanical properties of laminates containing alternative plies of woven roving and chopped strand mat are dependent upon relationship between the direction of the applied load and the direction of the roving strands. For 5 by 4 square weave roving, the approximate relationship is shown in Fig. X1.1.

X2. QUALIFICATION OF LAMINATE STRUCTURE FOR TYPE, CLASS, AND GRADE DESIGNATION

X2.1 *General*—The RTP laminate structures other than those covered by this specification may be characterized for designation as standard type, class, and grade by means of the following procedure.

X2.2 *Laminate Preparation:*

X2.2.1 Under shop fabrication conditions, lay up 12 by 25-in. (305 by 635-mm) flat laminates of the proposed laminate structure in nominal thicknesses of 3⁄16, 5⁄16, ½, and ¾ in. (4.8, 8, 12.8, and 19.2 mm).

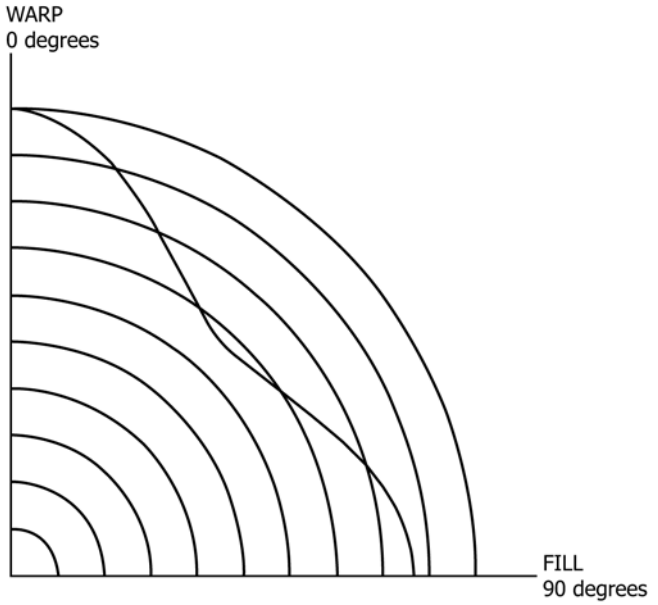
X2.2.1.1 Orientation of reinforcing fibers of fabrics shall be such as to produce maximum properties in the 25-in. (635-mm) direction of the laminate.

X2.2.1.2 Laminates having essentially unidirectional fiber reinforcement shall be 25 by 25-in. (635 by 635-mm) size to provide sufficient laminate for testing in two directions.

X2.2.1.3 The degree of cure of the surface exposed to the chemical environment (process side) shall be measured by a Barcol hardness test in accordance with Test Method D2583. At least 80 % of the random readings shall exceed at least 90 % of the resin manufacturer's recommended hardness for the cured resin.

X2.2.1.4 Cured laminates shall be flat within the limits of ⅛-in./ft (3.2-mm/0.1 m^2) deviation from a plane surface.

X2.3 *Testing:*



			Standard Deviation
Note:	At 45°,	Tensile strength is 69 % of 0°.	11 %
		Tensile modulus is 86 % of 0°.	2 %
	At 45°,	Flexural strength is 62 % of 0°.	14 %
		Flexural modulus is 72 % of 0°.	14 %
	At 45°,	Composition strength is 100 % of 0°.	11 %
		Composition modulus is 73 % of 0°.	20 %

FIG. X1.1 Directional Properties of RTP Alternating Mat/Woven Roving

X2.3.1 Tests shall be performed, and results certified, by a recognized independent testing laboratory experienced in the testing of RTP laminates.

X2.3.2 Determine mechanical and physical properties as required by Sections 7 and 8 of this specification.

X2.3.2.1 Unidirectional laminates, as described in X2.2.1.2, shall have properties determined both parallel to, and at 90° to, the direction of reinforcement.

X2.4 *Report:*

X2.4.1 The report shall describe laminate manufacture, date of manufacture, resin used with batch number noted, identification of reinforcements used, cure components, additives, and all pertinent cure information.

X2.4.2 The report shall contain the data obtained on all specimens, the laboratory that performed the tests, and the date performed.