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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 C 582; 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 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 similar or equivalent ISO standard.~~

~~1.2~~ 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]

C 581 Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service
D 638 Test Method for Tensile Properties of Plastics
D 695 Test Method for Compressive Properties of Rigid Plastics
D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
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
D 3681 Test Method for Chemical Resistance of ~~"Fiberglass" (Glass-Fiber-Reinforced~~Fiberglass (GlassFiberReinforced Thermosetting-Resin) Pipe in a Deflected Condition
E 84 Test Method for Surface Burning Characteristics of Building Materials

3. Definitions

3.1 Definitions used in this specification are in accordance with Terminology D 883 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.

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[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* ~~, Vol 08.04.~~volume information, refer to the standard's Document Summary page on the ASTM website.

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.

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 E 84.

NOTE 4—Fire retardancy by Test Method E 84 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 E 84 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).

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 1 / 2 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 1/2 oz/ft^2 (459 g/m^2) mat = 0.043 in./ply (1.1 mm/ply) when saturated with resin.
R = 24 1/2 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 E 84			
		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.

4.1.5.1 *Examples*:

(1) RTP I P 13211 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).
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 C 581 or D 3681, 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.