U.S. Department of Commerce
National Institute of Standards and Technology
(formerly National Bureau of Standards-NBS)

Product Standard PS15-69
Custom Contact-Molded Reinforced-Polyester
Chemical-Resistant Process Equipment

Product Standard PS15-69, 'Custom Contact-Molded Reinforced-Polyester Chemical-Resistant Process Equipment' was withdrawn by the U.S. Department of Commerce on January 20, 1982.

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The following are select ASTM standards that were used to replace withdrawn PS15-69:

- ASTM D2996, Specification for Filament-Wound Reinforced Thermosetting Resin Pipe
- ASTM D3299, Filament-Wound Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks
- ASTM D4021, Glass Fiber-Reinforced Polyester Underground Petroleum Storage Tanks
- ASTM D4097, Contact-Molded Glass-Fiber-Reinforced Thermoset Resin Chemical-Resistant Tanks

These standards are under the jurisdiction of Committee D20 on Plastics and under the direct responsibility of Subcommittee D20.23, Reinforced Plastic Piping Systems and Chemical Equipment.

For assistance and additional information on other related standards, subcommittee sources and copies, please contact:

American Society for Testing and Materials (ASTM)
100 Barr Harbor Drive
West Conshohocken, Pennsylvania 19428-2959, USA
Telephone: (610) 832-9500/-9585
Fax: (610) 832-9555; Information Center E-Mail: infoctr@astm.org
http://www.astm.org (click on standards, technical committees, et al)

Staff Manager for ASTM Technical Committee D20 on Plastics
Telephone: (610) 832-9721; Technical Committees Fax: (610) 832-9666

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The following organizations can provide assistance, additional information and sources , contact:
Plastics Pipe Institute-PPI (formerly Thermoplastic Pipe Division of the Society of the Plastics Industry), 1825 Connecticut Avenue, NW, Suite 680, Washington, DC 20009, USA; Telephone: (202)462-9607; Fax: (202) 462-9779; http://www.plasticpipe.org and, the **Society of the Plastics Industry (SPI)**, 1801 K Street, NW, Suite 600, Washington, DC 20006, USA; Telephone: (202) 974-5200; Fax: (202) 296-7005; Internet: http://www.socplas.org .

5/2002

National Bureau of Standards

Status Report on Voluntary Product Standards

AGENCY: National Bureau of Standards; Commerce.

ACTION: Maintenance, retention, replacement, and withdrawal of certain voluntary product standards

On August 19, 1980, the Department of Commerce (Department) announced in the Federal Register (45 FR 55250-2) the status of 80 documents classified as Voluntary Product Standards. The announcement was made in accordance with the revised Procedures for the Development of Voluntary Product Standards (15 CFR Part 10). Section 10.0(b) of the Procedures specifies six criteria that must be met for the Department to sponsor the development or maintenance of a Voluntary Product Standard.

Numerous requests to retain or maintain various standards were received in response to the August 19, 1980, notice. A number of the requests specified retention of standards for fixed periods of time that have now elapsed. The current status of all such standards is indicated below.

Based on proposals from the proponent organizations identified after the following titles, the following product standards will continue to be sponsored by the Department:

PS 1-74, Construction and Industrial Plywood; American Plywood Association
PS 20-70, American Softwood Lumber Standard; American Lumber Standards Committee
PS 72-76, Toy Safety; Toy Manufacturers of America
PS 73-77, Carbonated Soft Drink Bottles; Glass Packaging Institute
TS 231, Proposed Voluntary Product Standard, Production of Carbonated Soft Drinks In Glass Bottles; National Soft Drink Association

Based on documented activity within a private standards-writing organization, the following standards will be retained by the National Bureau of Standards for the periods of time stated below to permit the orderly transfer of sponsorship of such standards from the Department to the identified organizations. The periods of time stated below shall commence from the date this notice is published in the Federal Register and supersede the periods of time stated for those standards in the August 19, 1980 notice.

PS 30-70, School Chalk; the Crayon, Water Color and Craft Institute, Inc.; 6 months
PS 36-70, Body Measurements for the Sizing of Boys' Apparel; Mail Order Association of America; 12 months
PS 42-70, Body Measurements for the Sizing of Women's Patterns and Apparel; Mail Order Association of America; 12 months
PS 45-71, Body Measurements for the Sizing of Apparel for Young Men (Students); Mail Order Association of America; 12 months
PS 46-71, Flame-Resistant Paper and Paperboard; American Society for Testing and Materials; 6 months
PS 51-71, Hardwood and Decorative Plywood; Hardwood Plywood Manufacturers Association; 12 months
PS 54-72, Body Measurements for the Sizing of Girls' Apparel; Mail Order Association of America; 12 months
PS 63-75, Latex Foam Mattresses for Hospitals; American Society for Testing and Materials; 12 months
PS 64-75, School Paste; The Crayon Water Color and Craft Institute, Inc.; 6 months
PS 65-75, Paints and Inks for Art Education in Schools; The Crayon, Water Color and Craft Institute, Inc.; 6 months
PS 67-76, Marking of Gold Filled and Rolled Gold Plate Articles Other Than Watchcases; Jewelers Vigilance Committee; 24 months
PS 68-76, Marking of Articles Made of Silver in Combination with Gold; Jewelers Vigilance Committee; 24 months
PS 69-76, Marking of Articles Made Wholly or in Part of Platinum; Jewelers Vigilance Committee; 2 months
PS 70-76, Marking of Articles Made of Karat Gold; Jewelers Vigilance Committee; 24 months
PS 71-76, Marking of Jewelry and Novelties of Silver; Jewelers Vigilance Committee; 24 months
CS 98-62, Artists Oil Paints; Artists Equity Association, Inc.; 6 months
CS 130-60, Color Materials for Art Education in Schools; the Crayon, Water Color and Craft Insitute, Inc.; 6 months
CS 151-50, Body Measurements for the Sizing of Apparel for Infants, Babies, Toddlers and Children (for the Knit Underwear Industry); Mail Order Association of America; 12 months
R 192-63, Crayons and Related Art Materials for School Use (Types, Sizes, Packages and Colors); The Crayon, Water Color and Craft Institute, Inc.; 6 months

The following standard has been replaced by a standard being developed or published by a private standards-writing organization and, therefore, Department of Commerce sponsorship is no longer need for it:

PS 17-69, Polyethylene-sheeting (construction, industrial and agricultural applications); Society of the Plastics Industry

In the absence of any request for retention or maintenance, the following standards are withdrawn:

PS 13-69, Uncorded Slab Urethane Foam for Bedding and Furniture Cushioning
PS 15-69, Custom Contact-Molded Reinforced Polyestyer Chemical-Resistant Process Equipment
PS 23-70, Horticultural Grade Perlite
PS 24-70, Melamine Dinnerware (Alpha-Cellulose Filled) for Household Use
PS 25-70, Heavy-Duty Alpha-Cellulose-Filled Melamine Tableware
PS 27-70, Mosaic-Parquet Hardwood Slat Flooring
PS 29-70, Plastic Heat-Shrinkable Film
PS 31-70, Polystyrene Plastic Sheet
PS 34-70, Fluorinated Ethylene-Propylene (FEP) Plastic-Lined Steel Pipe and Fittings
PS 52-71, Polytetrafluorethylene (PTFE)
PS 53-72, Glass-Fiber Reinforced Polyester Structural Plastic Panels
PS 56-73, Structural Glued Laminated Timber
PS 57-73, Cellulosic Fiber Insulation Board
PS 58-73, Basic Hardboard
PS 59-73, Prefinished Hardboard Paneling
PS 60-73, Hardboard Siding
PS 62-74, Grading of Diamond Powder in Sub-Sieve Sizes
CS 138-55, Insect Wire Screening
CS 192-53, General Purpose Vinyl Plastic Film
CS 201-55, Rigid Polyvinyl Chloride Sheets
CS 227-59, Polyethylene Film
CS 245-62, Vinyl-Metal Laminates
CS 257-63, TFE-Fluorocarbon (Polytetrafluorethylene) Resin Molded Basic Shapes
CS 268-65, Hide-Trim Pattern for Domestic Cattlehides
CS 274-66, TFE-Fluorocarbon Resin Sintered Thin Coatings for Dry Film Lubrication
R2-62, Bedding Products and Components

In accordance with § 10.1(e) of the revised Procedures for the Development of Voluntary Product Standards and by agreement with the Consumer Product Safety Commission, the Department will retain sponsorship of the following Voluntary Product Standard for the period of time stated below to allow for arrangements to be made for its sponsorship by a private standards writing organization.

PS 66-75, Safety Requirements for Home Playground Equipment; 12 months

For further information contact Eric A. Vadelund, Office of Engineering Standards, National Bureau of Standards, Washington, D.C. 20234. Telephone: (301) 921-3272.

Dated: January 13, 1982.

Ernest Ambler,

Director.

[FR Doc. 82-1316 Filed 1-19-82; 8:45 am]
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A UNITED STATES DEPARTMENT OF COMMERCE PUBLICATION

NBS Voluntary Product Standard

PS 15—69

Custom Contact-Molded Reinforced-Polyester Chemical-Resistant Process Equipment

A Voluntary Standard Developed by Producers, Distributors, and Users With the Cooperation of the National Bureau of Standards

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (Order by SD Catalog No. C13.20:2:15-69). Price 20 cents.

U.S. DEPARTMENT OF COMMERCE

National Bureau of Standards

PRODUCT STANDARDS

Product Standards are published voluntary standards that establish (1) dimensional requirements for standard sizes and types of various products, (2) technical requirements for the product, and (3) methods of testing, grading, and marking these products. The objective is to define requirements for these products in accordance with the principal demands of the trade. *Product Standards* are published by the National Bureau of Standards of the U. S. Department of Commerce.

Development of a PRODUCT STANDARD

The Bureau's Office of Engineering Standards Services works closely with business firms, trade organizations, testing laboratories, and other appropriate groups to develop such standards. (A group interested in developing a *Product Standard* may submit a written request to the Office of Engineering Standards Services, National Bureau of Standards.) After determining that the desired standard would be technically feasible and in the public interest, a specific proposal is developed in consultation with interested trade groups and circulated for industry consideration and comment.

Subsequently, a Standard Review Committee is established to review the proposed standard for conformance with the Department of Commerce procedures. The committee includes qualified representatives of producers, distributors, and users or consumers of the product. When approved by the committee, copies of the recommended standard are distributed for consideration and acceptance. When the acceptances show general agreement by all segments of the industry, and when there is no substantive objection deemed valid by the National Bureau of Standards, the Bureau announces approval of the *Product Standard* and proceeds with its publication.

Use of a PRODUCT STANDARD

Product Standards are developed for the maximum use of industry by ensuring that producers, distributors, and users or consumers cooperate in the development of a voluntary *Product Standard*. The adoption and use of a *Product Standard* is *voluntary*. *Product Standards* are used most effectively in conjunction with legal instrumentalities such as building codes, purchase orders, and sales contracts. When a standard is made part of such a contract, compliance with the standard is enforceable by the buyer or the seller along with other provisions of the contract. There is *no* governmental regulation or control involved.

Purchasers may order products that comply with *Product Standards* and determine for themselves that their requirements are met. More often, manufacturers refer to the standards in sales catalogs, advertising, invoices, and labels on the product. Commercial inspection and testing programs are also employed for greater effectiveness together with grade labels, hallmarks, and certificates. Such assurance of compliance promotes confidence and understanding between buyers and sellers.

EFFECTIVE DATE

Having been passed through the regular procedures of the Office of Engineering Standards Services, National Bureau of Standards and approved by the acceptors hereinafter listed, this Product Standard is issued by the National Bureau of Standards, effective

November 15, 1969. (See section 6.)

Lewis M. Branscomb, *Director*

Nat. Bur. Stand. (U.S.), Prod. Stand. 15-69, 28 pages (June 1970)
CODEN: XNPSA

Custom Contact-Molded Reinforced-Polyester Chemical-Resistant Process Equipment

(This voluntary standard, initiated by the Society of the Plastics Industry, Inc., has been developed under the *Procedures for the Development of Voluntary Product Standards*, published by the Department of Commerce. See section 7, *History of Project*, for further information.)

1. PURPOSE

1.1. The purpose of this Product Standard is to establish on a national basis the standard sizes and dimensions and significant quality requirements for commercially available glass-fiber-reinforced chemical-resistant process equipment for chemical service. The information contained in this Product Standard will be helpful to producers, distributors, and users and will promote understanding between buyers and sellers.

2. SCOPE

2.1. This Product Standard covers materials, construction and workmanship, physical properties, and methods of testing reinforced-polyester materials for process equipment and auxiliaries intended for use in aggressive chemical environments, including but not limited to pipe, ducts, and tanks. The Standard is based on the technology of fabrication by hand lay-up or contact pressure molding. Methods for identifying products which comply with the requirements of this Standard are included.

2.2. This Standard does not cover: (1) resins other than polyesters, (2) reinforcing materials other than glass fibers, (3) laminate constructions, or (4) filament wound fabrication methods. (The industry has initiated the development of additional standards to cover these items.)

3. REQUIREMENTS

3.1. General

3.1.1. **Terminology**—Unless otherwise indicated, the plastics terminology used in this Standard shall be in accordance with the definitions given in American Society for Testing and Materials (ASTM) Designation D883-69, *Standard Nomenclature Relating to Plastics*.[1]

3.1.2. **General description**—This Standard describes glass-fiber-reinforced process equipment for chemical service. Other materials may be used for reinforcement of the surface exposed to the chemical environment. This Standard is not intended to cover selection of the exact resin or reinforcement combination for use in specific chemical and structural conditions. For recommended chemical resistance test procedures, see the appendix.

3.2. Materials

3.2.1. **Resin**—The resin used shall be of a commercial grade and shall either be evaluated as a laminate by test (see appendix for a recommended test) or determined by previous service to be acceptable for the environment.

3.2.2. **Fillers and pigments**—The resins used shall not contain

[1] Later issues of the ASTM publications specified in this Product Standard may be used providing the requirements are applicable and consistent with the issue designated. Copies of ASTM publications are obtainable from the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.

fillers except as required for viscosity control or fire retardance. Up to 5 percent by weight of thixotropic agent which will not interfere with visual inspection may be added to the resin for viscosity control. Resins may contain pigments and dyes by agreement between fabricator and purchaser, recognizing that such additions may interfere with visual inspection of laminate quality. Antimony compounds or other fire retardant agents may be added as required for improved fire resistance.

3.2.3. **Reinforcing material**—The reinforcing material shall be a commercial grade of glass fiber having a coupling agent which will provide a suitable bond between the glass reinforcement and the resin.

3.2.4. **Surfacing materials**—Unless otherwise agreed upon between fabricator and purchaser, material used as reinforcing on the surface exposed to chemical attack shall be a commercial grade chemical-resistant glass having a coupling agent.

Note: The use of other fibrous materials such as acrylic and polyester fibers and asbestos may affect the values obtained for the Barcol hardness of the surface.

3.3. **Laminate**—The laminate shall consist of an inner surface, an interior layer, and an exterior layer or laminate body. The compositions specified for the inner surface and interior layer are intended to achieve optimum chemical resistance.

3.3.1. **Inner surface**—The inner surface shall be free of cracks and crazing with a smooth finish and with an average of not over 2 pits per square foot, providing the pits are less than 1/8 inch in diameter and not over 1/32 inch deep and are covered with sufficient resin to avoid exposure of inner surface fabric. Some waviness is permissible as long as the surface is smooth and free of pits. Between 0.010 and 0.020 inches of reinforced resin-rich surface shall be provided.[2] This surface may be reinforced with glass surfacing mat, synthetic fibers, asbestos, or other material as usage requires.

3.3.2. **Interior layer**—A minimum of 0.100 inch of the laminate next to the inner surface shall be reinforced with not less than 20 percent nor more than 30 percent by weight of noncontinuous glass strands (see 4.3.1), e.g., having fiber lengths from 0.5 to 2.0 inches.

3.3.3. **Exterior layer**—The exterior layer or body of the laminate shall be of chemically resistant construction suitable for the service and providing the additional strength necessary to meet the tensile and flexural requirements. Where separate layers such as mat, cloth, or woven roving are used, all layers shall be lapped a minimum of 1 inch. Laps shall be staggered as much as possible. If woven roving or cloth is used, a layer of chopped-strand glass shall be placed as alternate layers. The exterior surface shall be relatively smooth with no exposed fibers or sharp projections. Hand work finish is acceptable, but enough resin shall be present to prevent fiber show.

3.3.3.1. When the outer surface is subject to a corrosive environment, the exterior surface shall consist of a chopped-strand glass over which shall be applied a resin-rich coating as described in 3.3.1. Other methods of surface protection may be used as agreed upon between buyer and seller.

3.3.4. **Cut edges**—All cut edges shall be coated with resin so that no glass fibers are exposed and all voids filled. Structural elements

[2] This resin-rich surface layer will usually contain less than 20 percent of reinforcing material. A specific limit is not included because of the impracticability of determining this value in the finished product.

having edges exposed to the chemical environment shall be made with chopped-strand glass reinforcement only.

3.3.5. **Joints**—Finished joints shall be built up in successive layers and be as strong as the pieces being joined and as crevice free as is commercially practicable. The width of the first layer shall be 2 inches minimum. Successive layers shall increase uniformly to provide the specified minimum total width of overlay which shall be centered on the joint. (See 3.3.1, 3.4.6.1, 3.5.6, and 3.6.5.) Crevices between jointed pieces shall be filled with resin or thixotropic resin paste, leaving a smooth inner surface. (See 3.3.1.) The interior of joints may also be sealed by covering with not less than 0.100 inch of reinforced resin-rich surface as described in 3.3.1 and 3.3.2.

3.3.6. **Wall thickness**—The minimum wall thickness shall be as specified in the tables under the appropriate sections, but in no case shall be less than 1/8 inch in the case of ducts and 3/16 inch in pipes and tanks regardless of operating conditions. Isolated small spots may be as thin as 80 percent of the minimum wall thickness, but in no case more than 1/8 inch below the specified wall thickness.

3.3.7. **Mechanical properties**—In order to establish proper wall thickness and other design characteristics, the minimum physical properties for any laminate shall be as shown in table 1 and 3.3.7.1. Laminates which do not meet the minimum values of table 1 are considered acceptable provided they are made to afford the same overall strength that would be obtained with a laminate meeting the specified thickness. For example, if the specified thickness for a laminate is 1/4 inch, reading from table 1 a minimum tensile strength of 12,000 psi is required. By multiplying thickness times minimum tensile strength a value of 3,000 pound breaking load for a 1-inch-wide specimen is obtained. A laminate having a tensile strength of 10,000 psi will, therefore, be acceptable for the 1/4-inch requirement if it has an actual thickness of at least 0.3 inch.

3.3.7.1. **Surface hardness**—The laminate shall have a Barcol hardness of at least 90 percent of the resin manufacturer's minimum specified hardness for the cured resin when tested in accordance with 4.3.5. This applies to both interior and exterior surfaces.

3.3.8. **Appearance**—The finished laminate shall be as free as commercially practicable from visual defects such as foreign inclusions, dry spots, air bubbles, pinholes, pimples, and delamination.

3.3.9. By agreement between buyer and seller, a representative laminate sample may be used for determination of acceptable surface finish and visual defects (see 3.3.1, 3.3.3, and 3.3.8).

TABLE 1. *Requirements for properties of reinforced-polyester laminates*

Property at 73.4 °F (23 °C)	Thickness (inches)			
	1/8 to 3/16	1/4	5/16	3/8 and up
	psi	*psi*	*psi*	*psi*
Ultimate tensile strength-minimum [1]	9,000	12,000	13,500	15,000
Flexural strength-minimum [2]	16,000	19,000	20,000	22,000
Flexural modulus of elasticity (tangent)-minimum [3]	700,000	800,000	900,000	1,000,000

[1] See 4.3.2.
[2] See 4.3.3.
[3] See 4.3.4.

3.4. Reinforced-polyester round and rectangular ducting[1]

3.4.1. Duct size and tolerances

3.4.1.1. Round ducting—The size of round ducting shall be determined by the inside diameter in inches. The standard sizes shall be 2, 3, 4, 6, 8, 10, 12, 14, 16, 18, 20, 24, 30, 36, 42, 48, 54, and 60 inches. Unless otherwise specified, the tolerance, including out-of-roundness, shall be ±1/16 inch for ducting up to and including 6-inch inside diameter, and ±1/8 inch or ±1 percent, whichever is greater, for ducting exceeding 6 inches in inside diameter.[4]

3.4.1.2. Rectangular ducting—The sizes of rectangular ducting shall be determined by the inside dimensions. There are no standard sizes for rectangular ducting. Unless otherwise specified, the tolerances on ordered sizes shall be ±3/16 inch for dimensions of 18 inches and under and ±1 percent for dimensions of over 18 inches.[4]

3.4.2. Lengths—Tolerances on overall lengths shall be ±1/4 inch unless arrangements are made to allow for field trimming.

3.4.3. Wall thickness—The minimum nominal thickness of round ducting shall be in accordance with table 2. For rectangular ducting, the minimum thickness shall be as specified in table 2, substituting the longer side for the diameter. See also 3.3.6.

3.4.4. Squareness of ends—Ends shall be square within ±1/8 inch for round ducting through 24-inch diameter and rectangular ducting through 72-inch perimeter; and ±3/16 inch for larger sizes of both round and rectangular ducting.

3.4.5. Fittings—Tolerances on angles shall be ±1° through 24 inches, ±7/8° for 30 inches, ±3/4° for 36 inches, ±5/8° for 42 inches, and ±1/2° for 48 inches and above. Wall thickness of fittings shall be at least that of ducting of the same size.

TABLE 2. *Reinforced-polyester round duct dimensions*[2]

I.D. *inches*	Wall thickness (Min.) *inches*	Allowable vacuum[3] *inches of water*	Allowable pressure[3] *inches of water*	Flange diameter (O.D.) *inches*	Flange thickness *inches*	Bolt circle diameter *inches*	Bolt hole diameter *inches*	No. of bolt holes
2	0.125	405	750	6-3/8	1/4	5	7/16	4
3	0.125	405	500	7-3/8	1/4	6	7/16	4
4	0.125	210	410	8-3/8	1/4	7	7/16	4
6	0.125	64	350	10-3/8	1/4	9	7/16	8
8	0.125	30	180	12-3/8	1/4	11	7/16	8
10	0.125	16	340	14-3/8	3/8	13	7/16	12
12	0.125	9	280	16-3/8	3/8	15	7/16	12
14	0.125	7	220	18-3/8	3/8	17	7/16	12
16	0.125	6	200	20-3/8	1/2	19	7/16	16
18	0.125	5	240	22-3/8	1/2	21	7/16	16
20	0.125	5	190	24-3/8	1/2	23	7/16	20
24	0.187	9	140	28-3/8	1/2	27	7/16	20
30	0.187	7	100	34-3/8	1/2	33	7/16	28
36	0.187	5	70	40-3/8	1/2	39	7/16	32
42	0.250	10	120	46-3/8	5/8	45	7/16	36
48	0.250	9	100	54-3/8	5/8	52	9/16	44
54	0.250	7	80	60-3/8	5/8	58	9/16	44
60	0.250	6	60	66-3/8	5/8	64	9/16	52

[1] 5 to 1 design factor of safety based on data in table 1. Also based on 10-foot lengths between stiffener rings for vacuum service.

[2] These ratings are suitable for use up to 180 °F (82.2 °C) in pressure service and ambient atmospheric temperatures on vacuum service. For ratings at higher temperatures consult the manufacturer.

[3] Rated at a minimum of 5-inch water vacuum and/or 50-inch water pressure. (See table 2.)

[4] See Footnote 9, page 14.

3.4.5.1. **Ells**—Standard ells shall have a centerline radius of one and one-half times the duct diameter.

3.4.5.2. **Laterals**—Standard laterals shall be 45°.

3.4.5.3. **Reducers, concentric or eccentric**—Length of standard reducers shall be five times the difference in diameters (D_1-D_2). Minimum wall thickness shall be that required for the larger diameter duct as given in table 2.

3.4.6. **Straight connections**

3.4.6.1. **Butt joint**—Strength of the butt joint shall be at least equal to that of the duct itself and shall be made in accordance with 3.3.5. Total minimum width of joint shall be 3 inches for 1/8 inch thickness, 4 inches for 3/16 inch thickness, and 6 inches for 1/4 inch thickness.

3.4.6.2. **Bell and spigot joint**—Straight duct shall be inserted into bell at least one-sixth of duct perimeter or 4 inches, whichever is less, and overwrapped in such a manner as to provide strength at least equal to that of the duct. The opening between the bell and spigot shall be sealed with thixotropic resin paste.

3.4.7. **Flanges**

3.4.7.1. **Flange dimensions**—Dimensions of reinforced plastic flanges for round ducts shall be in accordance with table 2. Flange thicknesses and width [(O.D.-I.D.)/2] of flange faces for rectangular ducts shall correspond to those for round ducts having the same diameter as the longer side of rectangular ducts.

3.4.7.2. **Flange attachment**—Duct wall at hub of flange shall be at least one and one-half times the normal thickness and taper to normal thickness over a distance of at least one flange width. Fillet radius shall be at least 3/8 inch at point where the hub meets the back of the flange.

3.4.7.3. **Face of flange**—Face of flange shall have no projections or depressions greater than 1/32 inch and shall be perpendicular to the centerline of the duct within 1/2°. A camber of 1/8 inch with respect to the centerline, measured at the O.D. of the flange, shall be allowable. The face of the flange shall have a chemical-resistant surface as described in 3.2.4 and 3.3.1.

3.4.7.4. **Drilling**—Standard flanges shall be supplied undrilled.

3.4.7.5. **Flange bolting**—The bolt holes shall straddle centerline unless otherwise specified. Unless otherwise specified, the number of bolt holes and diameters of bolt holes and bolt circles shall be in accordance with table 2. Rectangular flange width and bolt spacing shall be the same as that for diameters corresponding to the longer sides.

3.4.8. **Mechanical properties of ducts**

3.4.8.1. **Laminate**—The minimum mechanical properties shall be in accordance with table 1.

3.4.8.2. **Deflection**—Maximum deflection of a side on a rectangular duct shall not exceed 1 percent of the width of the side under operating conditions. Ribs or other special constructions shall be used if required to meet the deflection requirement.

3.4.9. **Stacks**—Special engineering consideration is required for structural design of stacks, and the manufacturers should be consulted.

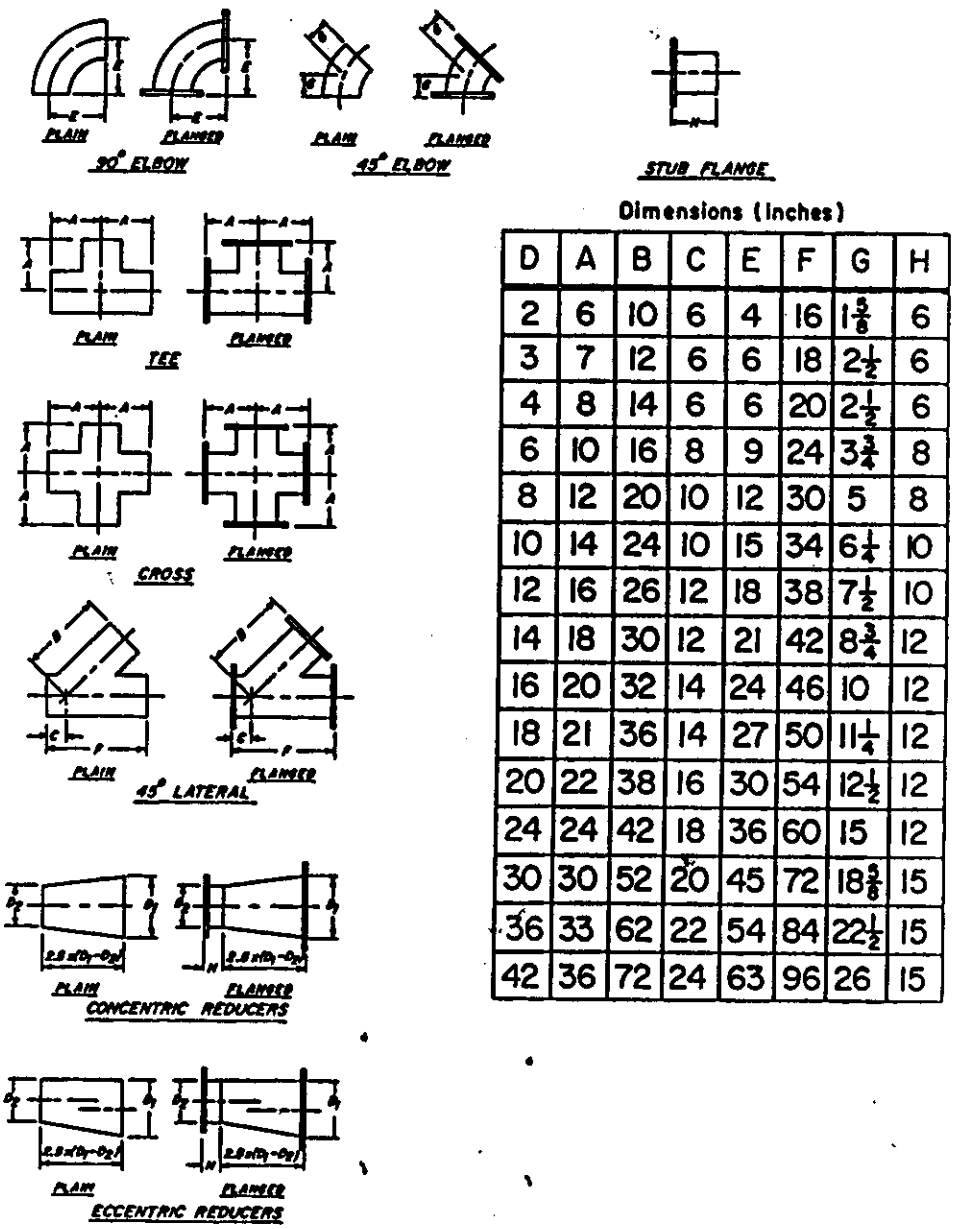
3.5. **Reinforced-polyester pipe** [5]

3.5.1. **Size**—The standard pipe size shall be the inside diameter in

[5] Rated from full vacuum to 150 psi (see table 3).

inches. Standard sizes are 2, 3, 4, 6, 8, 10, 12, 14, 16, 18, 20, 24, 30, 36, and 42 inches. The tolerance including out-of-roundness shall be ±1/16 inch for pipe up to and including 6-inch inside diameter, and ±1/8 inch or ±1 percent, whichever is greater, for pipe exceeding 6 inches in inside diameter. This measurement shall be made at the point of manufacture with the pipe in an unstrained vertical position.

3.5.2. Length—The length of each fabricated piece of pipe shall not vary more than ±1/8 inch from the ordered length unless arrangements are made to allow for trim in the field.



Dimensions (Inches)

D	A	B	C	E	F	G	H
2	6	10	6	4	16	1 5/8	6
3	7	12	6	6	18	2 1/2	6
4	8	14	6	6	20	2 1/2	6
6	10	16	8	9	24	3 3/4	8
8	12	20	10	12	30	5	8
10	14	24	10	15	34	6 1/4	10
12	16	26	12	18	38	7 1/2	10
14	18	30	12	21	42	8 3/4	12
16	20	32	14	24	46	10	12
18	21	36	14	27	50	11 1/4	12
20	22	38	16	30	54	12 1/2	12
24	24	42	18	36	60	15	12
30	30	52	20	45	72	18 5/8	15
36	33	62	22	54	84	22 1/2	15
42	36	72	24	63	96	26	15

FIGURE 1. Dimensions of reinforced-polyester pipe fittings.

3.5.3. **Wall thickness**—The minimum wall thickness of the pipe shall be in accordance with table 3. See also 3.3.6.

3.5.4. **Squareness of ends**—All unflanged pipe shall be cut square with the axis of the pipe within ±1/8 inch up to and including 24-inch diameter and to within ±3/16 inch for all diameters above 24 inches.

3.5.5. **Fittings**—All fittings such as elbows, laterals, T's, and reducers shall be equal or superior in strength to the adjacent pipe section and shall have the same diameter as the adjacent pipe. The dimensions of fittings shall be as shown in figure 1. Tolerance on angles of fittings shall be ±1° through 24 inches in diameter and ±1/2° for 30-inch diameter and above. Where necessary, minimum overlay widths may be less than those specified in table 4, but the joint strength shall be at least equal to the strength of the adjacent pipe.

3.5.5.1. **Elbows**—Standard elbows shall have a centerline radius of one and one-half times the diameter. Standard elbows up to and including 24 inches shall be molded of one piece construction. Elbows of 30-inch diameter and larger may be of mitered construction using pipe for the mitered sections. The width of the overlay on the mitered joint may have to be less than the minimum specified in table 4 to avoid interference on the inner radius, but the joint strength must be at least equal to the strength of the adjacent pipe. Mitered elbows 45° or less will be one-miter, two section. Elbows above 45° through 90° shall have a minimum of two miters. Incorporation of straight pipe extensions on elbows is permissible.

3.5.5.2. **Reducers**—Reducers of either concentric or eccentric style will have a length as determined by the diameter of the large end of the reducer as indicated in figure 1.

3.5.6. **Butt joints**—This type of joint shall be considered the standard means of joining pipe sections and pipe to fittings. The procedure used in making the butt joint will be as outlined in 3.3.5. All pipe 20 inches in diameter and larger shall be overlaid both inside, when accessible, and outside. Pipe less than 20 inches in diameter shall be outside overlaid. The minimum width of the overlay shall relate to wall thickness and shall be of the dimensions indicated in table 4. Inside overlaps may be made to seal the joint if necessary, but shall not be considered in meeting the strength requirement specified in 3.3.5.

3.5.7. **Flanges**—The use of flanges shall normally be kept to a minimum with the butt joint being used as the standard means of joining pipe sections. All flanges shall be of the minimum thickness given in table 5 and accompanying illustration. The construction of flanges is the same as that for laminates. (See 3.3.)

3.5.7.1. **Flange attachment**—The minimum flange shear surface shall be four times the flange thickness indicated in table 5. The thickness of the flange hub reinforcement measured at the top of the fillet radius shall be at least one-half the flange thickness and shall be tapered uniformly the length of the hub reinforcement. The fillet radius, where the back of the flange meets the hub, shall be 3/8 inch minimum.

3.5.7.2. **Flange face**—The flange face shall be perpendicular to the axis of the pipe within 1/2° and shall be flat to ±1/32 inch up to and including 18-inch diameter and ±1/16 inch for larger diameters. The face of the flange shall have a chemical resistant surface as described in 3.2.4 and 3.3.1.

TABLE 3. *Reinforced-polyester pipe wall thickness*

Pipe size	Minimum pipe wall thicknesses[1] at pressure ratings:					
	25 psi	50 psi	75 psi	100 psi	125 psi	150 psi
inches	*inches*	*inches*	*inches*	*inches*	*inches*	*inches*
2	3/16	3/16	3/16	3/16	3/16	3/16
3	3/16	3/16	3/16	3/16	1/4	1/4
4	3/16	3/16	3/16	1/4	1/4	1/4
6	3/16	3/16	1/4	1/4	5/16	3/8
8	3/16	1/4	1/4	5/16	3/8	7/16
10	3/16	1/4	5/16	3/8	7/16	1/2
12	3/16	1/4	3/8	7/16	1/2	5/8
14	1/4	5/16	3/8	1/2	5/8	3/4
16	1/4	5/16	7/16	9/16	11/16	
18	1/4	3/8	1/2	5/8	3/4	
20	1/4	3/8	1/2	11/16		
24	1/4	7/16	5/8	13/16		
30	5/16	1/2	3/4			
36	3/8	5/8				
42	3/8	3/4				

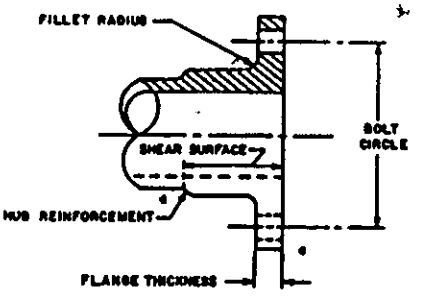
[1] The specified wall thicknesses are based upon a 10 to 1 safety factor for the tensile strength listed in table 1. These ratings are suitable for use up to 180 °F (82.2 °C); for ratings at higher temperatures, consult the manufacturer. For vacuum service see 3.5.9.

TABLE 4. *Minimum total widths of overlays for reinforced-polyester butt joints*

Pipe wall thickness, inches	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4
Minimum total width of overlay, inches	3	4	5	6	7	8	9	10	11	12

3.5.7.3. **Other flange designs**—Other flanges agreed upon between the fabricator and the user are acceptable provided that they produce a tight joint at twice the pressures established for standard joints.

3.5.8. **Mechanical properties of pipe**—The minimum mechanical properties of pipe shall be in accordance with table 1.



3.5.9. **Vacuum service**—In sizes 2 through 18 inches, reinforced-polyester pipe and fittings have an internal pressure rating of 125 psi. Flanges having a rating of 25 psi are suitable for full vacuum service. Special engineering consideration is required for larger pipe sizes and for operation at temperatures above ambient atmospheric temperature.

3.5.10. **Recommended installation practice**

3.5.10.1. **Pipe hangers and spacing**—Hangers shall be band type hangers contacting a minimum of 180° of the pipe surface. The maximum pipe hanger spacing shall be in accordance with table 6.

3.5.10.2. **Underground installation**—Special consideration must be given to installing pipe underground. It is recommended that the manufacturer be consulted for installation procedures.

3.5.10.3. **Expansion**—Since the expansion rate of this plastic pipe is several times that of steel, proper consideration should be given to any pipe installation to accommodate the overall linear expansion.

TABLE 5. *Minimum flange thickness for reinforced-polyester pressure pipe*[1][2][3]

Pipe size	Minimum flange thickness at design pressures:					
	25 psi	50 psi	75 psi	100 psi	125 psi	150 psi
inches	*inches*	*inches*	*inches*	*inches*	*inches*	*inches*
2	1/2	1/2	1/2	9/16	5/8	11/16
3	1/2	1/2	5/8	11/16	3/4	13/16
4	1/2	9/16	11/16	13/16	7/8	15/16
6	1/2	5/8	3/4	7/8	1	1-1/16
8	9/16	3/4	7/8	1	1-1/8	1-1/4
10	11/16	7/8	1-1/16	1-3/16	1-5/16	1-7/16
12	3/4	1	1-1/4	1-7/16	1-5/8	1-3/4
14	13/16	1-1/16	1-5/16	1-1/2	1-3/4	1-7/8
16	7/8	1-3/16	1-7/16	1-5/8	1-7/8	
18	15/16	1-1/4	1-1/2	1-3/4	2	
20	1	1-5/16	1-5/8	1-7/8		
24	1-1/8	1-1/2	1-7/8			
30	1-3/8	1-7/8				
36	1-3/4					
42	2					

[1] Based on flat-faced flanges with full-face soft gaskets.
[2] Flange dimensions (except thickness) and bolting correspond to the following standards:
2-inch through 24-inch sizes: USA Std. B16.5 for 150 lb steel flanges.
30-inch through 42-inch sizes: USA Std. B16.1 for 125 lb C.I. flanges.
[3] This table is based on a safety factor of 8 to 1 and a flexural strength of 20,000 psi. This latter value is slightly under the minimum flexural strength for laminates of 3/8 inch and up (see table 1), due to the manufacturing technique.

3.5.10.4. **Bolts, nuts, and washers**—Bolts, nuts, and washers shall be furnished by the customer. Metal washers shall be used under all nut and bolt heads. All nuts, bolts, and washers shall be of materials suitable for use in the exterior environment.

3.5.10.5. **Gaskets**—Gaskets shall be furnished by the customer. Recommended gasketing materials shall be a minimum of 1/8 inch in thickness with a suitable chemical resistance to the service environment. Gaskets should have a Shore A or Shore A2 Hardness of 40 to 70.

3.6. Reinforced-polyester tanks (stationary nonpressure vessels)

3.6.1. Cylindrical flat-bottom vertical tanks

3.6.1.1. **Sizes**—Standard tank sizes are 2, 2-1/2, 3, 3-1/2, 4, 4-1/2, 5, 5-1/2, 6, 7, 8, 9, 10, 11, and 12 feet in inside diameter.

3.6.1.2. **Dimensions and tolerances**—The tank diameter shall be measured internally. Tolerance on the inside diameter, including out-of-roundness, shall be ±1 percent. Measurement shall be taken with tank in vertical position. Taper, if any, shall be increasing and shall be added to the nominal diameter. Taper shall not exceed 1/2° per side. Tolerance on overall height shall be ±1/2 percent, but shall not exceed ±1/2 inch. The radius at bottom to wall shall be a minimum of 1-1/2 inches.

3.6.1.3. **Wall thickness**—The minimum wall thickness shall be in accordance with table 7. See also 3.3.6.

3.6.2. **Horizontal cylindrical tanks**

3.6.2.1. **Sizes, dimensions, and tolerances**—These shall be the same as for vertical cylindrical tanks (see 3.6.1.). Standard end closures shall be standard convexed, domed heads with a maximum radius of curvature equal to the tank diameter. The knuckle radius shall be a minimum of 1-1/2 inches.[4]

3.6.2.2. **Support cradle**—Two support cradles shall be provided. The cradles shall be at least 6 inches wide, supporting at least 120° of the tank circumference. Wear plates (reinforced areas), 12 inches wide, covering 180° of the support surface shall be provided when required. Laminate construction and minimum thickness shall be as agreed upon between fabricator and purchaser. Tanks longer than 24 feet require special design and support consideration.

3.6.2.3. **Wall thickness**—The minimum wall thickness shall be in accordance with table 8. See also 3.3.6.

3.6.3. **Rectangular tanks**

3.6.3.1. **Sizes**—There are no standard sizes for rectangular tanks.

3.6.3.2. **Dimensions and tolerances**—The length and width shall be measured internally. Tolerances on nominal dimensions of length and width shall be ±1/4 inch or ±1/4 percent, whichever is greater. Overall height tolerance shall be ±3/8 inch. Taper is increasing and should be added to the nominal dimensions. Taper should not exceed 1/2° per side.

3.6.3.3. **Side wall**—Deflection shall not exceed 1/2 percent of span at any location when tested by filling with water.

3.6.3.4. **Wall thickness**—Since the design of rectangular tanks is considerably more complex than that of cylindrical tanks, no simple chart of wall thickness can be given. However, the minimum wall should be similar to that for cylindrical tanks with consideration

TABLE 6. *Maximum spacing of pipe hangers for reinforced-polyester pressure pipe*[1]

Pipe I.D.	Maximum pipe hanger spacing at pressure ratings:					
	25 psi	50 psi	75 psi	100 psi	125 psi	150 psi
inches	*feet*	*feet*	*feet*	*feet*	*feet*	*feet*
2	6.0	6.0	6.0	6.0	6.0	6.0
3	6.5	6.5	6.5	6.5	8.0	8.0
4	7.0	7.0	7.0	8.5	8.5	8.5
6	8.0	8.0	9.0	9.0	10.0	10.5
8	8.5	10.0	10.0	10.5	11.0	11.5
10	9.5	10.5	11.5	12.0	12.5	13.0
12	10.0	11.5	12.5	13.0	13.5	14.0
14	11.5	12.5	13.0	14.0	15.0	15.5
16	12.0	13.0	14.0	15.5	16.5	17.0
18	12.5	14.5	15.0	16.0	16.5	17.5
20	12.5	15.0	15.5	17.0	18.0	18.5
24	8.5	15.0	17.0	18.5	19.0	
30	9.5	17.5	19.5	21.0		
36	10.5	19.5	21.0			
42	8.0	21.0	22.5			

[1] The above table is based on uninsulated pipe containing liquids having a specific gravity of 1.3 and at a maximum temperature of 180 °F. For services at temperatures above 180 °F (82.2 °C), consult the manufacturer relative to hanger spacing.

[4] Larger knuckle radii are commonly used, such as for ASME torispherical heads.

TABLE 7. *Minimum wall and bottom thickness of vertical tanks relative to diameter and distance from top* [1]

Distance from top	Minimum wall and bottom thickness for tanks of diameter:														
feet	2 ft	2½ ft	3 ft	3½ ft	4 ft	4½ ft	5 ft	5½ ft	6 ft	7 ft	8 ft	9 ft	10 ft	11 ft	12 ft
2	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16
4	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16
6	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4
8	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	1/4	1/4	5/16
10	3/16	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	1/4	1/4	5/16	5/16	5/16
12	3/16	3/16	3/16	3/16	3/16	3/16	1/4	1/4	1/4	1/4	1/4	5/16	5/16	5/16	3/8
14	3/16	3/16	3/16	3/16	1/4	1/4	1/4	1/4	1/4	5/16	5/16	5/16	5/16	3/8	3/8
16	3/16	3/16	3/16	1/4	1/4	1/4	1/4	1/4	1/4	5/16	5/16	3/8	3/8	3/8	7/16
18	3/16	3/16	3/16	1/4	1/4	1/4	1/4	5/16	5/16	5/16	3/8	3/8	3/8	7/16	1/2
20	3/16	3/16	1/4	1/4	1/4	1/4	5/16	5/16	5/16	3/8	3/8	3/8	7/16	1/2	1/2
22	3/16	1/4	1/4	1/4	1/4	5/16	5/16	5/16	5/16	3/8	3/8	7/16	1/2	1/2	9/16
24	3/16	1/4	1/4	1/4	1/4	5/16	5/16	5/16	3/8	3/8	7/16	1/2	1/2	9/16	5/8

[1] Based on a safety factor of 10 to 1 using mechanical property data in table 1 and a liquid specific gravity of 1.2. For tanks intended for service above 180 °F (82.2 °C) consideration in design should be given to the physical properties of the material at the operating temperature. Tanks with physical loadings, such as agitation, should be given special design consideration.

TABLE 8. *Minimum wall and head thicknesses for reinforced-polyester horizontal cylindrical tanks using two support cradles*[1]

Tank length	Minimum wall and head thickness for tanks of diameter[2]							
	2 ft	3 ft	4 ft	5 ft[3]	6 ft[4]	8 ft[5]	10 ft[6]	12 ft[7]
ft	*inches*	*inches*	*inches*	*inches*	*inches*	*inches*	*inches*	*inches*
8	3/16	3/16	1/4	1/4	5/16	5/16	7/16	9/16
10	3/16	1/4	1/4	5/16	5/16	3/8	7/16	9/16
12	3/16	1/4	1/4	5/16	5/16	7/16	1/2	5/8
14	1/4	1/4	5/16	5/16	3/8	1/2	9/16	3/4
16	1/4	5/16	5/16	3/8	3/8	9/16	11/16	13/16
18	1/4	5/16	3/8	7/16	7/16	5/8	13/16	15/16
20	5/16	5/16	3/8	7/16	1/2	11/16	7/8	1-1/16
22	5/16	3/8	3/8	1/2	9/16	3/4	15/16	1-3/16
24	5/16	3/8	7/16	1/2	5/8	13/16	1	1-1/4

[1] Based on 5 to 1 safety factor using the mechanical property data in table 1, a liquid specific gravity of 1.2, and support cradles located 1/12 of tank length from each end. For tanks intended for service above 180 °F (82.2 °C) consideration in design should be given to the physical properties of the material at the operating temperature. Tanks with physical loadings (such as agitation), other support designs, stiffening rings, or for use in situations requiring higher safety factors should be given special design consideration. In the use of more than two support cradles, maintenance of uniform support of the tank at all points of support is essential.

[2] For intermediate standard tank inside diameters given in 3.6.1.1, the minimum wall and head thickness shall be that given in this table for the next higher diameter.

[3] Wear plates required for 8-foot tank length.

[4] Wear plates required for 8-, 10-, and 12-foot tank lengths.

[5] Wear plates required for tanks 8 to 18 feet long, inclusive.

[6] Wear plates required for tanks 8 to 20 feet long, inclusive.

[7] Wear plates required for all tank lengths.

given to the height of the tank relative to loadings and the largest span relative to deflection. External ribs shall be used to prevent side wall deflection from exceeding the tolerance in 3.6.3.3. See also 3.3.6.

3.6.4. **Mechanical property requirements for tanks**—The minimum mechanical properties shall be as specified in table 1.

3.6.5. **Shell joints**—Where tanks are manufactured in sections and joined by use of a laminate bond, the joint shall be glass-fiber-reinforced resin at least the thickness of the heaviest section being joined. The reinforcement shall extend on each side of the joint a sufficient distance to make the joint at least as strong as the tank wall and shall be not less than the minimum joint widths specified in table 9. The reinforcement shall be applied both inside and out with the inner reinforcement considered as a corrosion resistant barrier only and not structural material. The inner reinforcement shall consist of a minimum of 3 ounces of glass per square foot, followed by 0.010 inch to 0.020 inch of surfacing material (see 3.3.5).

3.6.6. **Flanges**

3.6.6.1. **Flanged nozzles**—Flanges for liquid inlets and outlets shall meet the same requirements as for pipe (see 3.5.7 to 3.5.7.3 inclusive). At assembly there shall be a minimum dimension of 4 inches from the flange face to the tank. Where angular loadings are anticipated, the flange nozzle shall be supported by a minimum of three gussets or by other suitable means of structural support.

3.6.6.2. **Assembly of flanges**—Standard orientation will have bolt holes straddling principal centerline of vessel unless otherwise specified.

3.6.6.3. **Tolerances**—Tolerances on flange construction shall be the same as for pipe flanges (see 3.5.7 and table 5). Location of nozzles on the vessel shall be held to ±1/8 inch.

3.6.7. **Recommended installation practice**

3.6.7.1. Flat bottom tanks should be supported on a flat surface or on properly-spaced dunnage. It is recommended, where possible, that a flat surface, preferably a reasonably soft surface (confined sand or cinder-filled pad, plywood-surfaced concrete or a concrete grout) be used. Where full bottom support is not possible, special bottom design is required.

3.6.7.2. Closed tanks should have a properly sized vent.

TABLE 9. *Minimum total widths of overlays for reinforced-polyester tank shell joints*

Tank wall thickness, inches	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4
Minimum of outside overlay width, inches	4	4	5	6	7	8	9	10	11	12
Minimum of inside overlay width, inches	4	4	5	5	6	6	6	6	6	6

4. INSPECTION AND TEST PROCEDURES

4.1. **Specimens**—Tests shall be made on specimens cut from waste areas when possible; otherwise, the specimens shall be cut from flat laminates prepared in the same construction and by the same techniques as the process equipment. In all cases, the average value of the indicated number of specimens shall be used to determine conformance with the detailed requirements.

4.2. **Conditioning**—The test specimens shall be conditioned in accordance with Procedure A of ASTM Designation D618-61, *Standard Methods of Conditioning Plastics and Electrical Insulating Materials for Testing.*[7]

4.3. **Tests**

4.3.1. **Glass content**—The glass content shall be determined in accordance with ASTM Designation D2584-67T, *Tentative Method of Test for Ignition Loss of Cured Reinforced Resins*,[8] except that the specimens tested shall be approximately 1 square inch in area, and low temperature preignition prior to placement in muffle furnace is recommended. The average for five specimens shall be considered to be the glass content.

4.3.2. **Tensile strength**—Tensile strength shall be determined in accordance with ASTM Designation D638-68, *Standard Method of Test for Tensile Properties of Plastics*,[7] except that the specimens shall be the actual thickness of the fabricated article and the width of the reduced section shall be 1 inch. Other dimensions of specimens shall be as designated by the ASTM standard for Type I specimens for materials over 1/2 inch to 1 inch inclusive. Specimens shall not be machined on the surface. Tensile strength shall be the average of five specimens tested at 0.20 to 0.25 in/min speed.

4.3.3. **Flexural strength**—Flexural strength shall be determined in accordance with Procedure A and table 1 of ASTM Designation D790-66, *Standard Method of Test for Flexural Properties of Plastics*,[7] except that the specimens shall be the actual thickness of the fabricated article and the width shall be 1 inch. Other dimen-

[7] See footnote 1, page 1.

sions of specimens shall be as designated by the ASTM standard. Specimens shall not be machined on the surface. Tests shall be made with the resin-rich side in compression using five specimens.

4.3.4. **Flexural modulus**—The tangent modulus of elasticity in flexure shall be determined by ASTM Method D790-66 (see 4.3.3).

4.3.5. **Hardness**—The hardness shall be determined in accordance with ASTM Designation D2583-67, *Standard Method of Test for Indentation Hardness of Plastics by Means of a Barcol Impressor.*[8] Calibration of the Barcol instrument shall be verified by comparing with blank specimens having known readings of 85 to 87 and 42 to 46. Ten readings on the clean resin-rich surface shall be made. After eliminating the two high and two low readings, the average of the remainder shall be the reported hardness reading.

4.3.6. **Additional tests**—Recommended test methods for the further testing of reinforced-polyester laminates are given in the appendix. These test methods are included as recommendations and are not to be considered as requirements from the standpoint of determining compliance with the Standard.

5. IDENTIFICATION

5.1. **Labels and literature**—In order that purchasers may identify products complying with all requirements of this Voluntary Product Standard, producers choosing to produce such products in conformance with this voluntary Standard may include a statement in conjunction with their name and address on labels, invoices, sales literature, and the like. The following statement is suggested when sufficient space is available:[9]

> This product conforms to all of the requirements established in Product Standard PS 15-69, developed cooperatively with the industry and published by the National Bureau of Standards under the Voluntary Product Standards procedures of the U.S. Department of Commerce. Full responsibility for the conformance of this product with the standard is assumed by (name and address of producer or distributor).

5.1.1. The following abbreviated statement is suggested when available space on labels is insufficient for the full statement[9]:

> Conforms to PS 15-69 (name and address of producer or distributor).

6. EFFECTIVE DATE

6.1. The effective date of a Voluntary Product Standard is the date upon which reference to the Standard may be made by producers, distributors, users and consumers, and other interested parties. Compliance by producers with the requirements of a Product Standard may not actually occur until some time after the effective date. Products shall not be labeled or otherwise described as conforming to a Product Standard until such time as all applicable requirements established in the Standard are met. The effective date of this Standard is November 15, 1969.

7. HISTORY

7.1. In June 1965, The Society of the Plastics Industry, Inc., requested the assistance of the National Bureau of Standards in the

[8] See footnote 1, page 1.
[9] All tolerances exceeding those stated in 3.4.1.1 and 3.4.1.2 shall be identified as exceptions in statements representing compliance with this Standard.

development of a standard for custom contact-molded reinforced-polyester chemical-resistant process equipment. In February 1966, a proposed standard was circulated to representative producers, distributors, users, and other interested organizations for comment. All comments and suggestions received from this circulation were carefully considered and the proposed standard was adjusted where practicable.

With the approval and recommendation of its Standard Review Committee, the recommended standard was circulated in January 1968, to determine its acceptability to the industry. The comments received from this circulation were considered by the Standard Review Committee, and in accordance with their recommendations a new draft was prepared. This draft was circulated for acceptance in October 1968.

The response to the October 1968 circulation indicated a consensus of acceptability, as defined under the *Procedures for the Development of Voluntary Product Standards*, existed within the industry with regard to the standard. In August and September 1969, the Standard Review Committee and the acceptors were balloted concerning the deletion of the "hallmark" from the standard. The response to this balloting indicated a consensus of acceptance had again been achieved, and on October 17, 1969, the standard, designated PS 15-69, *Custom Contact-Molded Reinforced-Polyester Chemical-Resistant Process Equipment*, was approved for publication by the National Bureau of Standards to be effective November 15, 1969.

Technical Standards Coordinator:
D. R. Stevenson, Product Standards Section, Office of Engineering Standards Services, National Bureau of Standards, Washington, D. C. 20234.

8. STANDING COMMITTEE

8.1. The following individuals comprise the membership of the Standing Committee which is to review all revisions proposed to keep this Standard abreast of progress. Comments concerning the Standard and suggestions for revision may be addressed to any member of the committee or to the Office of Engineering Standards Services, National Bureau of Standards, U.S. Department of Commerce, which acts as secretary for the committee.

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W. F. Carn, Diamond Alkali Company, 300 Union Commerce Building, Cleveland, Ohio 44114

Ronald R. Skabo, Wyandotte Chemicals Corporation, Wyandotte, Michigan 48193

R. W. LaValley, Corrosion Controllers, Inc., 345 Second Street, Washougal, Washington 98671

Representing General Interests

Charles L. Condit, The Society of the Plastics Industry, Inc., 250 Park Avenue, New York, New York 10017

Charles H. Angell, 500 South Avenue, Glencoe, Illinois 60022

9. ACCEPTORS

9.1. The manufacturers, distributors, users, and others listed below have individually indicated in writing their acceptance of this Product Standard prior to its publication. The acceptors have indicated their intention to use the Standard as far as practicable but reserve the right to depart from it when necessary. The list is published to show the extent of recorded public support for the Standard.

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(General Support)

Manufacturing Chemists Association, Washington, D.C.

Society of the Plastics Industry, Inc., New York, New York

Society of the Plastics Industry of Canada, Don Mills, Ontario, Canada

PRODUCERS

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An-Cor Industrial Plastics, Inc., North Tonawanda, New York

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Atlas Plastics, Inc., Buffalo, New York

Beetle Plastics Division ,Crompton & Knowles Corporation, Fall River, Massachusetts

Bittner Industries, Inc., Mobile, Alabama

Carolina Fiberglass Products Company, Wilson, North Carolina

Cellcote, The, Company, Berea, Ohio

Century Fiberglass, Inc., Anaheim, California

Chemical Construction Corporation, New York, New York

Corite Reynolds Corporation, Des Plaines, Illinois

Duriron, The, Company, Inc., Ensinger Division, Angola, New York

Ershig's, Inc., Bellingham, Washington

Fibraco Manufacturing Company, Inc., Clear Lake, Iowa

Glastronics Corporation, New Bedford, Massachusetts

Hasbrouck Plastics, Inc., Hamburg, New York

Hays Manufacturing Company, Erie, Pennsylvania

Heil Process Equipment Corporation, Cleveland, Ohio

Heil Process Equipment Southeast Corporation, Bartow, Florida

Hood Manufacturing, Inc., Wilmington, California

Jones & Hunt, Inc., Orwigsburg, Pennsylvania

Justin Enterprises, Inc., Fairfield, Ohio

Kenner Boat Company, Knoxville, Arkansas

Kenway Corporation, Palermo, Maine

Leopold Reinforced Plastics Company, Zelienople, Pennsylvania

Lunn Laminates, Inc., Wyandanch, New York

Metal-Cladding, Inc., North Tonawanda, New York

Pennwalt Corporation, Philadelphia, Pennsylvania

Polytex Manufacturers, Inc., Houston, Texas

Precisioneering Limited, Scarborough, Ontario, Canada

Protective Plastic Company, Bedford, Ohio

Protective Plastics, Don Mills, Ontario, Canada

Red Ewald Fiber Glass, Karnes City, Texas

Resin Fab Corporation, Belding, Michigan

Rubber & Plastic Applicators, Inc., Mobile, Alabama

Schori Process Corporation, Port Washington, New York

Shell Chemical Company, New York, New York

Simons, H. A. (International) LTD, Vancouver, B. C., Canada

Smith-Inland, A. O., Inc., Little Rock, Arkansas

Technical Service Corporation, St. Louis, Missouri

Warminster Fiberglass Company, Southampton, Pennsylvania

Allegheny Plastics, Inc., Coraopolis, Pennsylvania
American Air Filter—Fiber Glass Group, Louisville, Kentucky
American Cyanamid Company, Bound Brook, New Jersey
American Cyanamid Company, Wallingford, Connecticut
American Standards Testing Bureau, Inc., New York, New York
Angell, Charles H., Consultant, Glencoe, Illinois
Atlas Chemical Industries, Inc., Wilmington, Delaware
Braun, C. F., & Company, Alhambra, California
California Testing Laboratories, Inc., Los Angeles, California
Chemacryl Plastics, LTD, Toronto, Ontario, Canada
Corrosion Controllers, Inc., Washougal, Washington
Diamond Shamrock Chemical Company, Cleveland, Ohio
Durez Division, N. Tonawanda, New York
Eastman Chemical Products, Inc., Kingsport, Tennessee
FMC Corporation, Front Royal, Virginia
Freeman Chemical Corporation, Port Washington, Wisconsin
General Foods Corporation, White Plains, New York
Glidden-Durkee, Strongsville, Ohio
Imperial Chemical Industries of Australia & New Zealand, LTD.
Kahn, P. A., & Company, Newton, Massachusetts
Main, Chas. T., Inc., Boston, Massachusetts
Monsanto Company, St. Louis, Missouri
Omaha Testing Laboratories, Inc. Omaha, Nebraska
Phillips Petroleum Company, Bartlesville, Oklahoma
PPG Industries, Shelby, North Carolina
PPG Industries, Inc., Springdale, Pennsylvania
Proctor & Gamble Company, Cincinnati, Ohio
Reinforced Plastics Testing Laboratory, Lindenhurst, New York
Rohm and Haas Company, Bristol, Pennsylvania
Ryerson, Joseph T., and Son, Inc., Chicago, Illinois
Sandwell International, Inc., Portland, Oregon
Singmaster & Breyer, New York, New York
Star Hi Enterprises, Inc., Melrose Park, Illinois
Stauffer Chemical Company, Dobbs Ferry, New York
Titanium Metals Corporation of America, Henderson, Nevada
Twining, The, Laboratories, Inc., Fresno, California
Union-Camp Corporation, Savannah, Georgia

FEDERAL GOVERNMENT

General Services Administration, Washington, D.C.
Interior, U.S. Department of, Washington, D.C.

10. APPENDIX

Supplemental Information

A.1. Chemical resistance

A1.1. Test—ASTM Designation C581-68, *Standard Method of Test for Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures* [1] is recommended for the evaluation of the chemical resistance of materials to be used in reinforced-polyester chemical-resistant process equipment. The reinforcing materials prescribed in the test laminate are only for the purpose of establishing a uniform basis for comparison. They may not necessarily represent the preferred materials for the particular environment. This procedure may be adapted to test or evaluate components, composition or fabrication variations, and production samples. For information on the basis for selection of the standard test laminate, see Appendix A1 of ASTM C581-68.

A1.1.1. The 10-mil surfacing mat referred to in paragraph 5.1.2.1 of C581-68 shall be made of chemical resistant glass (Type C or equal).

A1.1.2. The standard test laminate shall be cured at room temperature for 16 hours. Further cure shall be given at room or higher temperature, if necessary, to produce a Barcol hardness equal to the resin manufacturer's minimum specified hardness for the cured resin.

[1] This method is based on a test procedure developed by the Reinforced-Plastics Corrosion-Resistant Structures Subcommittee of The Society of the Plastics Industry, Inc. See footnote 1, page 1.

A1.2. Temperature—Tests may be conducted at any or all of these temperatures: 23 °C, 50 °C, 70 °C, 100 °C (±2 °C); reflux temperature; required service temperature.

A1.3. Reagents—The following reagents are suggested for use in obtaining general comparative chemical resistance data. The test solutions shall not be agitated, i.e., the exposures shall be under static conditions.

1. 25% Sulfuric acid
2. 15% Hydrochloric acid
3. 5% Nitric acid
4. 25% Acetic acid
5. 15% Phosphoric acid
6. 5% Sodium hydroxide
7. 10% Sodium carbonate
8. Saturated sodium chloride
9. 95% Ethanol
10. 5-1/4% Sodium hypochlorite*
11. 5% Aluminum potassium sulfate
12. Ethyl acetate
13. Methylethyl ketone
14. Monochlorbenzene
15. Perchlorethylene
16. n-Heptane
17. Kerosine
18. Toluene
19. 5% Hydrogen peroxide*
20. Distilled water*

* Replaced every 48 hours with fresh solution

A1.4. Time—The properties specified in A1.5 shall be determined for specimens immersed in the test solutions for 30 days, 90 days, 180 days, and 1 year for one set of control specimens immediately following the curing period; and for another set after aging in air at the test temperature for the total test period.

A1.5. Properties—Thickness, Barcol hardness, flexural strength and modulus, and appearance shall be determined at each time interval. Appearance observations shall include any surface changes, color changes, obvious softening or hardening, crazing, delamination, exposure of fibers, or other effects indicative of complete degradation or potential failure. Calculation of percentage change in a property shall be based on the property value obtained immediately following the curing period.

A1.6. Report—Data shall be reported in tabular form for all parameters tested. The composition (including resin), accelerators, catalysts, and reinforcements, and the fabricating and curing conditions of the laminate tested shall be adequately described.

A2. Fire retardancy [2]—The fire retardancy may be determined in accordance with ASTM Designation E84-68 *Standard Method of Test for Surface Burning Characteristics of Building Materials.*[3]

A3. Compressive strength (edgewise)—The compressive strength may be determined in accordance with ASTM Designation D695-63T, *Tentative Method of Test for Compressive Properties of Rigid Plastics.*[3]

[2] Work is in progress to develop test procedures and specification requirements for applications requiring fire resistance.
[3] See footnote 1, page 1.

TO THE ACCEPTOR

The following statements answer the usual questions arising in connection with the acceptance and its significance:

1. *Enforcement.*—A Product Standard contains requirements which are vountarily established by mutual consent of those concerned. They present a common basis of understanding between the producer, distributor, and user or consumer and should not be confused with any plan of governmental regulation or control. The National Bureau of Standards has *no* regulatory power in the enforcement of their provisions, but since they represent the will of the interested groups as a whole, their provisions soon become established as trade customs, and are made effective through incorporation into sales contracts, labels, invoices, and the like.

2. *The Responsibility of the Acceptor.*—The purpose of a Product Standard is to establish, for specific items, nationally recognized sizes, grades, material requirements, or performance criteria, and the benefits therefrom will be measurable in direct proportion to their general recognition and actual use. Instances will occur when it may be necessary to deviate from the standard, and the signing of an acceptance does not preclude such departures; however, such signature indicates an intention to follow the standard, where practicable, in the production, distribution, use, or consumption of the product in question.

3. *The Role of the Department of Commerce.*—The National Bureau of Standards, acting under delegation from the Department of Commerce, provides (1) the function of unbiased coordinator to bring all interested parties together for the mutually satisfactory development of a voluntary standard, (2) such assistance and advice as past experience with similar programs may suggest, (3) the determination of acceptability on the part of producers, distributors, and users or consumers, and (4) the publication of the standard for the information and guidance of buyers and sellers of the product.

ACCEPTANCE OF PRODUCT STANDARD

PS 15-69, CUSTOM CONTACT-MOLDED REINFORCED-POLYESTER CHEMICAL-RESISTANT PROCESS EQUIPMENT

If acceptance has not previously been filed, this sheet properly filled in, signed, and returned will provide for the recording of your organization as an acceptor of this Product Standard.

Date_____

Office of Engineering Standards Services
National Bureau of Standards
U.S. Department of Commerce
Washington, D.C. 20234

Gentlemen:

We believe that this Product Standard constitutes a useful standard of practice, and we individually plan to utilize it as far as practicable in the

production[1] distribution[1] use[1] testing[1]

of this commodity.

We reserve the right to depart from the standard as we deem advisable.

We understand, of course, that only those articles which actually comply with the standard in all respects can be identified or labeled as conforming thereto.

Signature of authorized officer_____
(In ink)

(Kindly typewrite or print the following lines)

Name and title of above officer_____

Organization _____
(Fill in exactly as it should be listed.)

Street address _____

City, State and Zip Code _____

[1] Underscore the applicable word. Please see that separate acceptances are filed for all subsidiary companies and affiliates which should be listed separately as acceptors. In the case of related interests, trade associations, trade papers, etc., desiring to record their general support, the words "General support" should be added after the signature.

MISSION AND FUNCTIONS OF THE DEPARTMENT OF COMMERCE

"to foster, serve and promote the nation's economic development and technological advancement"

THE NATIONAL ECONOMIC GOAL

Sustained maximum growth in a free market economy, without inflation, under conditions of full employment and equal opportunity

THE DEPARTMENT OF COMMERCE

The historic mission of the Department is "to foster, promote and develop the foreign and domestic commerce" of the United States. This has evolved, as a result of legislative and administrative additions, to encompass broadly the responsibility to foster, serve and promote the nation's economic development and technological advancement. The Department seeks to fulfill this mission through these activities:

Participating with other government agencies in the creation of national policy, through the President's Cabinet and its subdivisions.

- Cabinet Committee on Economic Policy
- Urban Affairs Council
- Environmental Quality Council

Promoting progressive business policies and growth.

- Business and Defense Services Administration
- Office of Field Services

Assisting states, communities and individuals toward economic progress.

- Economic Development Administration
- Regional Planning Commissions
- Office of Minority Business Enterprise

Strengthening the international economic position of the United States.

- Bureau of International Commerce
- Office of Foreign Commercial Services
- Office of Foreign Direct Investments
- United States Travel Service
- Maritime Administration

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- Environmental Science Services Administration
- Patent Office
- National Bureau of Standards
- Office of Telecommunications
- Office of State Technical Services

Acquiring, analyzing and disseminating information concerning the nation and the economy to help achieve increased social and economic benefit.

- Bureau of the Census
- Office of Business Economics

NOTE: This schematic is neither an organization chart nor a program outline for budget purposes. It is a general statement of the Department's mission in relation to the national goal of economic development.

JULY 1969

U.S. DEPARTMENT OF COMMERCE • Maurice H. Stans, Secretary

NATIONAL BUREAU OF STANDARDS • Lewis M. Branscomb, Director

The National Bureau of Standards[1] was established by an act of Congress March 3, 1901. Today, in addition to serving as the Nation's central measurement laboratory, the Bureau is a principal focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. To this end the Bureau conducts research and provides central national services in four broad program areas. These are: (1) basic measurements and standards, (2) materials measurements and standards, (3) technological measurements and standards, and (4) transfer of technology.

The Bureau comprises the Institute for Basic Standards, the Institute for Materials Research, the Institute for Applied Technology, the Center for Radiation Research, the Center for Computer Sciences and Technology, and the Office for Information Programs.

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D.C. 20234.

[2] Located at Boulder, Colorado 80302.

[3] Located at 5285 Port Royal Road, Springfield, Virginia 22151.

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