STANDARDS

Notes:

Factory Mutual (FM) #4922 Fire Test Set-up
for the Evaluation of Air Handling Ductwork

I. Basic Fume Exhaust Criteria:

Procedure: Air Velocity = 600ft/min (182.9 m/min);
Test Duration = 15 minutes.

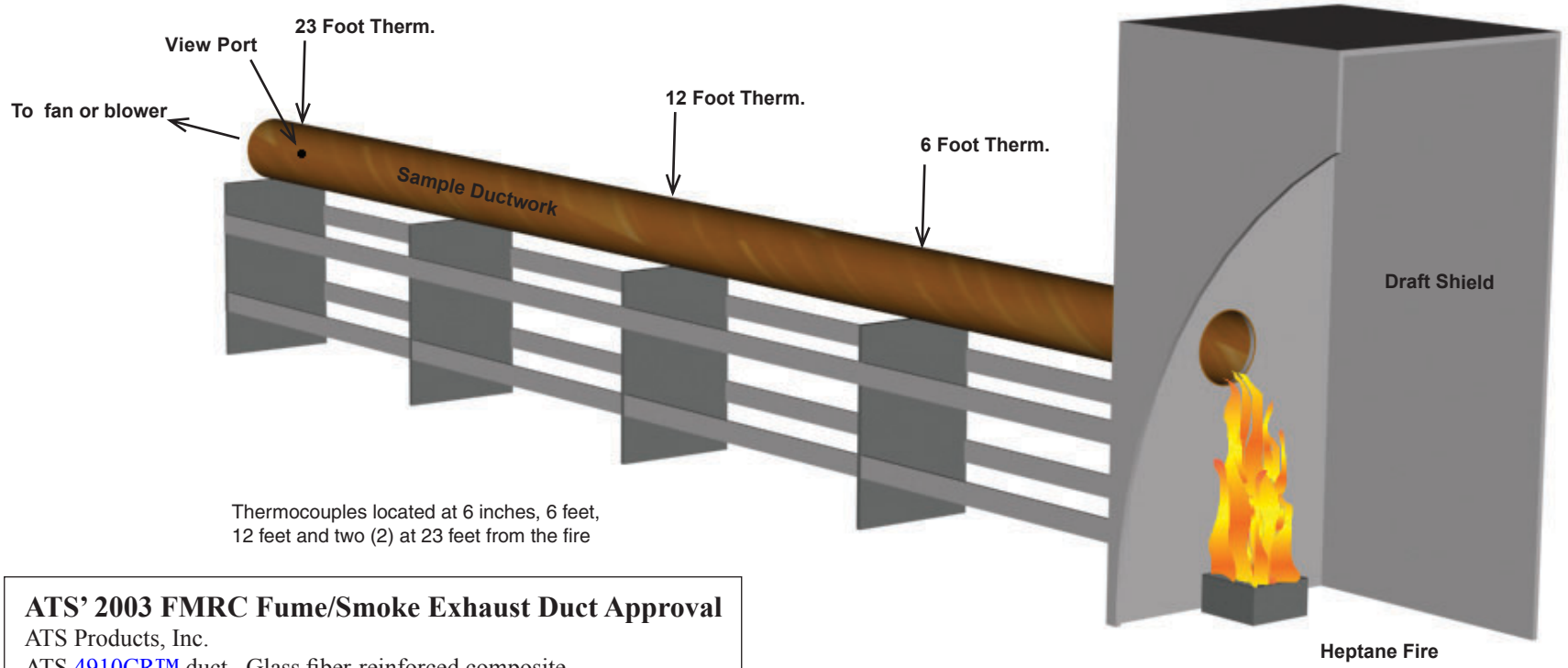
1. The temperature at the 23 foot (7.0 m) thermocouple shall not exceed 1000°F (538°C).
2. Flames shall not be seen at 23 foot (7.0 m) viewport.

II. Smoke removal Criteria:

Procedure: Air Velocity = 2,000 ft/min (609.6 m/min);
Test Duration = 10 minutes.

Smoke removal approved if:

1. The duct retains its integrity and,
2. No smoke was emitted from the fire exposed end or from the exterior surface of the duct (during the fire test).



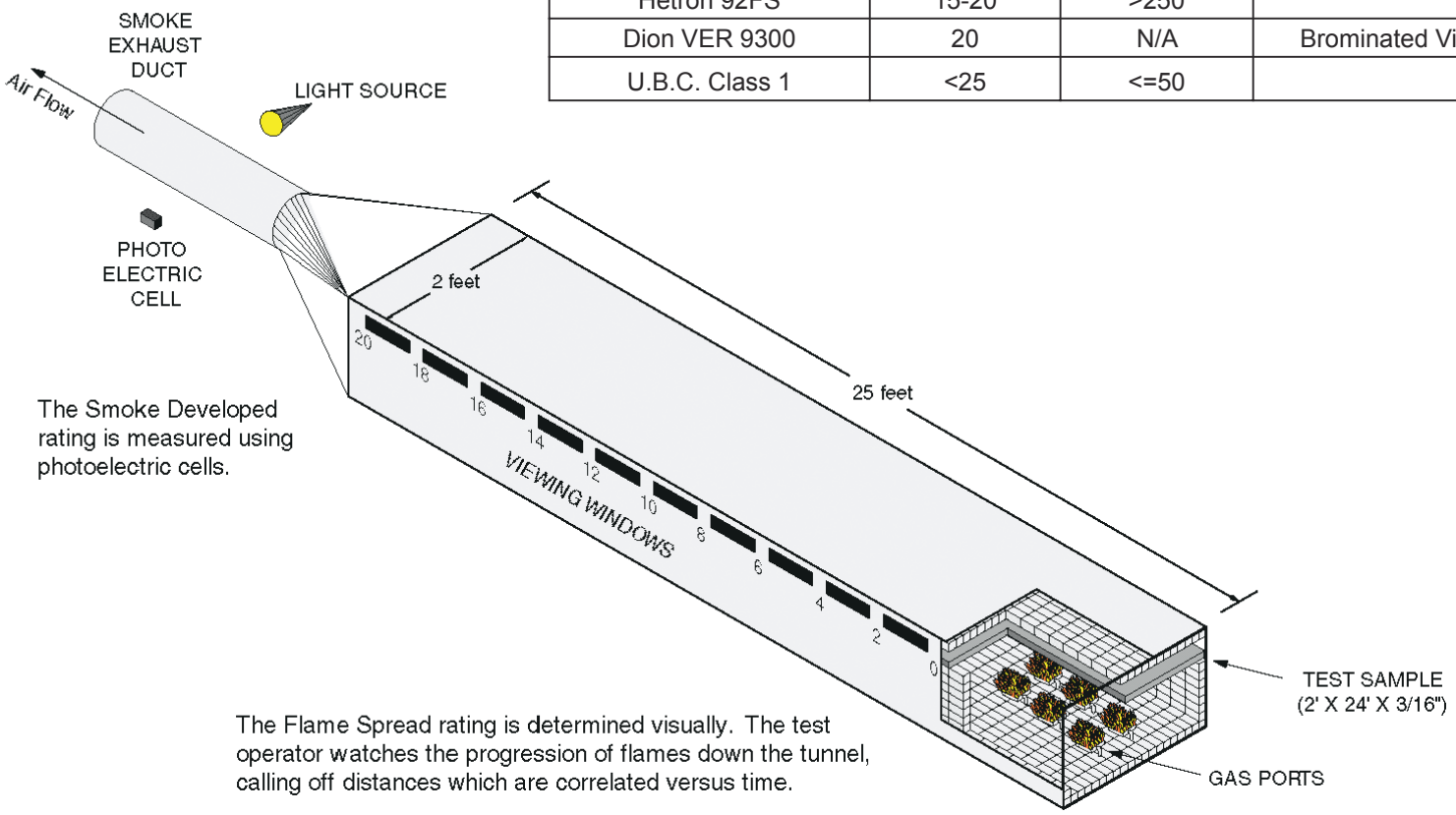
Thermocouples located at 6 inches, 6 feet, 12 feet and two (2) at 23 feet from the fire

ATS' 2003 FMRC Fume/Smoke Exhaust Duct Approval
ATS Products, Inc.
ATS 4910CR™ duct. Glass fiber-reinforced composite, vinyl ester interior 60 mil (1.5 mm) max thickness and a phenolic exterior circular or rectangular duct.
Min 12 in. to max 60 in. (300 mm to 1525 mm) inside dimension.

Steiner Tunnel Test

(ASTM E-84, UL723, UBC 8-1)

Comparison of Flame and Smoke Ratings			
Product	Flame Spread	Smoke Rating	Type of Resin
Inorganic Cement Board	0	0	
Red Oak	100	100	
ATS 4910CR Duct Inside	15	N/A	Vinyl Ester
Outside	5	5	Phenolic
Hetron FR992	25	N/A	Brominated Vinyl Ester
Hetron 92FR	25	750	
Hetron 92FS	15-20	>250	
Dion VER 9300	20	N/A	Brominated Vinyl Ester
U.B.C. Class 1	<25	<=50	



The Smoke Developed rating is measured using photoelectric cells.

The Flame Spread rating is determined visually. The test operator watches the progression of flames down the tunnel, calling off distances which are correlated versus time.

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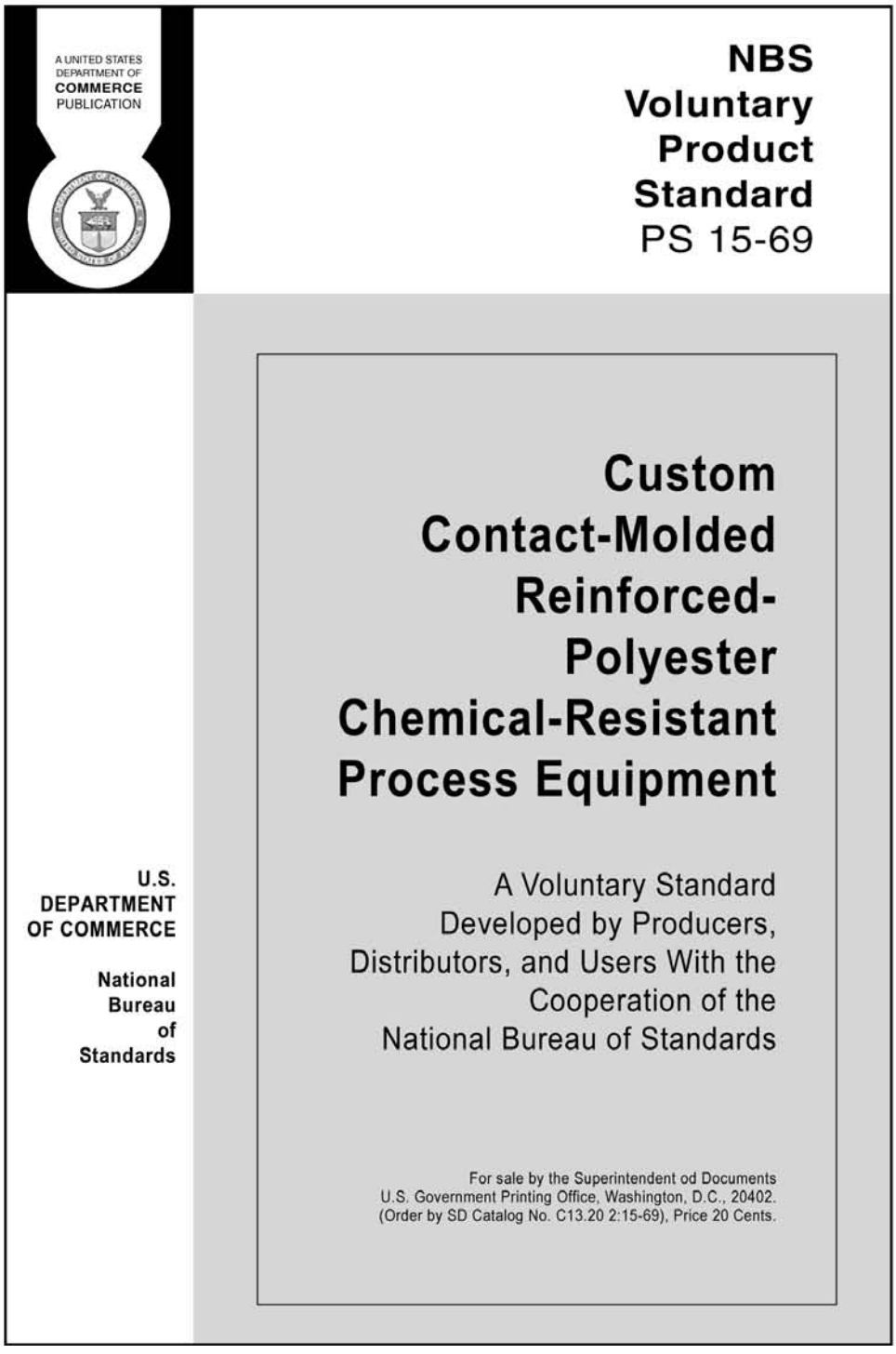
PAGES 1-5



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

(This voluntary standard, initiated by the Society of the Plastic Industry, Inc., has 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 the Product Standard is to establish on a national basis the standard size and dimension 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, duct, and tanks. The Standard is based on the technology of fabrication by hand lay-out or contact pressure molding. Methods for identifying product which comply with the requirements of this Standard are included.

2.2. This Standard does not cover: (1) resins other than polyesters, (2) reinforced 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 definition 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. The Standard is not intended to cover selection of the exact resin or reinforced 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 accepted for the environment.

3.2.2. Fillers and pigments–The resins used shall not contain fillers except as required for viscosity control or fire retardance. Up to 5 percent by weight of thixotropic agent which will not interface 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 addition may interfere with visual inspection of laminate quality. Antimony compounds or other fire retardant agents may be added as required for improved fire resistance.

[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

3.2.3. Reinforcing materials–The reinforcing materials 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 fabrics 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 exterior layer or laminated 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 no 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 provided the additional strength necessary to meet the tensile and flexural requirements. Where separated 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-stand glass over which 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 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 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 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 duct and 3/16 inch in

[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.

pipes and tanks regardless of operating conditions. Isolated small spots may 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 and considered accepted 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).

3.4. Reinforced-polyester round and rectangular ducting

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, included 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.

3.4.1.2. Rectangular ducting–The size of rectangular ducting shall be determined by the inside dimensions. There are no standard sizes for rectangular ducting. Unless otherwise specified, the

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. (at the end of this excerpt)
[2] See 4.3.3.
[3] See 4.3.4.

tolerance on ordered size shall be ± 3/16 inch for dimensions of 18 inches and under and ± 1percent for dimensions over 18 inches.

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 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 and rectangular ducting through 72-inch perimeter; and ± 3/16 inch for larger sizes of both round and rectangular ducting.

3.4.5. Fittings–Tolerance 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.

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 diameter (D1-D2). Minimum wall thickness shall be that required for the larger diameter duct as given in table 2.

Standard Exceeded By ATS

Table 2. *Reinforced-polyester round duct dimensions*[1]

I.D. inches	Wall Thickness (Min) inches	Allowable Vacuum[3] inches of water	Allowable pressure[2] inches of water	Flange diam-eter (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	290	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.)

3.4.6. Straight connections

3.4.6.1. Butt joints–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 1/6 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 accordance with table 2. Flange thickness and width [(O.D.-I.D.)/2] of flange face for rectangular ducts shall correspond to those for round ducts having the same diameter as the longer side 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 hole shall straddle centerline unless otherwise specified. Unless otherwise specified, the number of bolt holes and diameter 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 diameter 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 diameter in 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.

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

3.5 Reinforced-polyester pipe (Rated from full vacuum to 150 psi, see Table 4).

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

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 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° 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. (Note: Figure 1 not shown here. See ATS Mechanical Drawing Guide, pages 80-81.)

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.)

3.5.7.2 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.

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-polysester 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 contracting 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.

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.

Tables 3, 4, and 5 are excerpted from NBS PS15-69 for pipe, section 3.5

Table 3. Reinforced-polyester pipe wall thickness.

Pipe Size Nominal	Minimum pipe wall thickness[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 5. Minimum Flange Thickness for ATS Pipe [1 2 3]

Pipe Size Nominal	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. based on a safety factor of 8 to 1 for flexural strength. 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 for 3/8 inches and up (see table 1), due to the manufacturing technique.

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
Minimum total width of overlay, inches	3	4	5	6	7	8	9	10

NOTE–The following is added as a reference to footnotes on Page 266.

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,* 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,* except that the specimens shall be the actual thickness of the fabricated article and the width shall be 1 inch. Other dimensions of specimens shall be as designated by th 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).

NFPA 318
Standard for the Protection of Cleanrooms 2000 Edition

Origin and Development of NFPA 318
The committee on Cleanrooms was formed in 1988 and held its first meeting during May of that year. The committee was organized into Chapter Subcommittees that separately prepared individual chapters and related appendix material for review by the full Committee at meetings held October 1988, March 1989, September 1989, March 1990, September 1990 and June 1991.

The standard was submitted and adopted at the Fall Meeting in Montréal, Québec, Canada, November 18-20, 1991. The 1992 edition was the first edition of this standard. The standard was revised in 1995, and again in 2000.

ATS 4910CR™ DUCT COMPLIES WITH THE FOLLOWING PARAGRAPHS LISTED BELOW.

2-1.2.6* All combustible exhaust ducts shall have interior automatic sprinklers when the largest interior cross-sectional diameter is equal to or greater than 10 in. (254 mm).

3-3.6* Exhaust duct systems shall be constructed of non-combustible materials or protected with sprinklers in accordance with 2-1.2.6.

3-3.7 The interior and exterior surface on nonmetallic exhaust ducts shall have a flame spread rating of 25 or less, and the exterior surface of nonmetallic exhaust ducts shall have a smoke developed rating of 25 or less when the interior or exterior of the duct is exposed to fire, when tested in accordance with NFPA 255, *Standard method of Test of Surface Burning Characteristics of Building Materials.*

3-5.5** The air-handling system shall be designed to provide smoke exhaust, or a dedicated smoke control system shall be provided.

** Exception: Ducts approved for use without automatic sprinklers.*
*** Exception No. 3: Where the fume exhaust system is capable of smoke removal or preventing smoke migration, the above shall not be required.*