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An American National Standard

Standard Specification for Contact-Molded "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Corrosion Resistant Pipe and Fittings[1]

This standard is issued under the fixed designation D 6041; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers pipe and fittings fabricated by contact molding, for pressures to 150 psi and made of a commercial-grade polyester resin. Included are requirements for materials, properties, design, construction, dimensions, tolerances, workmanship, and appearance.

1.2 This specification does not cover resins other than polyester, reinforcing materials other than glass fibers or fabrication methods other than contact molding.

NOTE 1—For the purposes of this specification, the term polyester resin will include both polyester and vinylester resins.

1.3 This specification does not cover the design of pipe and fittings intended for use with liquids heated above their flash points.

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

1.5 The following precautionary caveat pertains only to Section 10, the test methods portion, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

NOTE 2—There is no similar or equivalent ISO Standard.

2. Referenced Documents

2.1 *ASTM Standards:*

C 581 Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass Fiber Reinforced Structures Intended for Liquid Service[2]

C 582 Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment[2]

D 618 Practice for Conditioning Plastics for Testing[3]

D 638 Test Method for Tensile Properties of Plastics[3]

D 883 Terminology Relating to Plastics[3]

D 1599 Test Method for Resistance to Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings[2]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[3]

D 2583 Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor[4]

D 2584 Test Method for Ignition Loss of Cured Reinforced Resins[4]

D 3567 Practice for Determining Dimensions of "Fiberglass"(Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings[2]

D 3681 Test Method for Chemical Resistance of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe in a Deflected Condition[2]

D 5421 Specification for Contact Molded "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Flanges[2]

F 412 Definitions of Terms Relating to Plastic Piping Systems[2]

2.2 *ANSI Standards:*

B16.1 Cast Iron Pipe Flanges and Flanged Fittings[5]

B16.5 Pipe Flanges and Flanged Fittings[5]

B18.22 Type "B" Narrow Washers[5]

2.3 *National Sanitation Foundation Standard:*

NSF Standard 61 Drinking Water System Components—Health Effects[6]

3. Terminology

3.1 *Definitions:*

3.1.1 *General*—Definitions are in accordance with Terminology D 883 and Terminology F 412 and abbreviations are in accordance with Terminology D 1600, unless otherwise indicated. The abbreviation for reinforced thermosetting resin pipe is RTRP.

[1] This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.23 on Reinforced Plastic Piping Systems and Chemical Equipment.

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[2] *Annual Book of ASTM Standards*, Vol 08.04.

[3] *Annual Book of ASTM Standards*, Vol 08.01.

[4] *Annual Book of ASTM Standards*, Vol 08.02.

[5] Available from American National Standards Institute, 25 W. 43rd St., 4th Floor, New York, NY 10036.

[6] Available from the National Sanitation Foundation, P.O. Box 130140, Ann Arbor, MI 48113.

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3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *contact molding, n*—a process for molding reinforced plastics in which reinforcement and resin are placed on an open mold or mandrel by either the "hand lay-up"(where resin and glass mat are applied by hand), or the "spray-up" manufacturing processes (where resin and chopped glass fibers are sprayed under pressure), or a combination of the two. The resulting laminate is then consolidated by rolling and cured without the application of pressure.

3.2.2 *fiberglass pipe, n*—a tubular product containing glass fiber reinforcements embedded in or surrounded by cured thermosetting resin. The composite structure may contain granular or platelet fillers, thixotropic agents, pigments, or dyes. Thermoplastic or thermosetting liners may be included.

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

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

4. Materials and Manufacture

NOTE 3—Specification C 582 provides additional information on the materials and manufacturing of contact–molded laminates.

NOTE 4—Fiberglass pipe intended for use in the transport of potable water should be evaluated and certified as safe for this purpose by a testing agency acceptable to the local health authority. The evaluation should be in accordance with requirements for chemical extraction, taste, and odor that are no less restrictive than those included in National Sanitation Foundation (NSF) Standard 61. The seal or mark of the laboratory making the evaluation should be included on the fiberglass pipe.

4.1 *Resin System:*

4.1.1 The resin used shall be a commercial grade, corrosion-resistant polyester that has been determined to be acceptable for the service either by test, (see Practice C 581), or by previous documented service. Where service conditions have not been evaluated a suitable resin may also be selected by agreement between manufacturer and purchaser.

4.1.1.1 The use of one resin in the corrosion barrier and a different resin in the structural layer (see Section 6) is permitted with the acceptance of the purchaser.

4.1.2 *Additives*, such as additional styrene, fillers, dyes, pigments, or flame retardants may be used when agreed upon between the fabricator and purchaser. Thixotropic agents may be added to the resin for viscosity control.

NOTE 5—The addition of fillers, dyes, pigments, flame retardants, and thixotropic agents may interfere with visual inspection of laminate quality.

NOTE 6—Chemical resistance can be affected by the catalyst/promoter system, diluents, dyes, fillers, flame retardants, or thixotropic agents used in the resin.

NOTE 7—Antimony compounds or other fire-retardant agents may be added to halogenated resins for improved fire resistance, if agreed upon between the manufacturer and the purchaser. These compounds do not improve the flame retardancy of non-halogenated resins.

4.1.3 *Ultraviolet Absorbers* may be added for improved weather resistance when agreed upon between the manufacturer and the purchaser.

4.1.4 *Resin Pastes*, used where necessary to fill crevices at joints prior to applying the joint laminate shall not be subject to the limitations of 4.1.3. Pastes shall be made with resin and fillers. The resin used in the paste must be compatible with the resin used in the pipe and fittings.

4.2 *Fiber Reinforcements:*

4.2.1 *Surfacing Mat (Veil)* is a thin mat of fine fibers used primarily to produce a smooth and corrosion–resistant resin–rich surface on a reinforced plastic laminate.

4.2.1.1 Veils are made from chemical resistant (type "C") glass or organic fiber. The use of an organic-fiber surface mat is recommended for environments that attack glass. The veil used in a laminate shall be determined to be acceptable for the chemical service either by Practice C 581 or by verified case history.

4.2.1.2 The veil shall be a minimum of 10 mils in dry thickness and produce a thickness of 0.010 to 0.020 in. (0.25 to 0.50 mm) when saturated with resin.

NOTE 8—The primary chemical resistance of the RTR pipe is provided by the resin. In combination with the cured resin, the surfacing veil helps determine the thickness of the resin-rich layer, and reduces microcracking.

4.2.2 *Chopped-strand Reinforcements* shall be "E"-type or "ECR"-type glass fibers 1 to 2 in. (25 to 50 mm) long applied in a uniform layer with random orientation. The fibers shall have a sizing compatible with the selected resin. Chopped strand reinforcements may be purchased and applied as a mat or as continuous strand roving which is chopped into short lengths and sprayed onto the laminate in a process known as "spray up." Either form is most commonly applied in layers weighing 1½oz/ft ^{2}(450 g/m^2) although other weights are available and may be used.

4.2.3 *Woven Roving*, shall be "E"-type or "ECR"-type glass roving, woven into a fabric. The sizing on the roving shall be compatible with the resin. The most common woven roving has a 5 by 4 weave and a weight of 24 oz/yd^2 (832 g/m^2).

4.2.4 *Non-woven Roving* "E type or "ECR" glass reinforcing fabrics such as biaxials and uni-directionals may be used in special applications such as reinforcing tees and other fittings or to improve the physical properties of the laminate in a specific direction.

4.2.5 *Multiple Layer Reinforcements* are fabrics composed of two or more layers of reinforcement combined into one fabric. The most common form is one layer of 1 ½ oz/ft^2 chopped strand mat combined with one layer of 24 oz/yd^2 woven roving. The pipe manufacturer must use extra caution to ensure proper laminate quality is maintained when using multiple layer reinforcements.

5. Design

5.1 *Design Basis:*

5.1.1 *Class A*—For pipe to be manufactured using Type I or Type II laminates as described in Specification C 582, the Ultimate Tensile Stresses shown in Specification C 582 may be used for the design basis.

5.1.2 *Class B*—For pipe manufactured with other than Type I or Type II laminates (in accordance with Specification C 582), or for Ultimate Tensile Stresses greater than those shown in C 582, testing in accordance with 10.5 or 10.6 is required to establish a design basis for each laminate type used by the pipe manufacturer. Testing shall be performed on a sample laminate or pipe of the same type and construction as will be used on the actual pipe and fittings. The thickness of the laminate sample will be ⅜in. (9.5 mm) or the maximum thickness to be provided in the pipe and fittings, whichever is less. If testing in accordance with 10.6, testing is required in both directions if the reinforcement is not applied equally in both directions. The laminate sample shall not include a corrosion barrier. Laminates greater than ⅜ in. (9.5 mm) thick are to be constructed with standard repeating sequences of reinforcement such as those described in Specification C 582. Results from previously tested laminates may be used provided that such laminates were manufactured with the same resin, laminate type, and thickness within the previous five years.

NOTE 9—Reinforcements such as 24 oz/yd^2(832 g/m^2) produced with a 5 by 4 weave are considered equal in both directions for the purpose of 5.1.2.

5.2 *Wall Thickness*—The required wall thickness due to internal pressure shall be determined by the following formula. Other loads such as thermal expansion and bending between supports should also be considered. The minimum wall thickness shall be the greater of 0.18 in. (4.5 mm) or 1 % of the pipe inside diameter.

$$t = \frac{(P*ID)}{(2 * S - P)}$$

where:

t = calculated wall thickness, in. (mm) (see 6.1.2.3),
P = design pressure, psi (kPa),
ID = inside diameter of the pipe, in. (mm),
S = allowable stress (not to exceed ⅙ of the design basis), psi (kPa).

5.3 Standard pressure classes are 25, 50, 75, 100, 125, and 150 psi, however, custom classes are allowed.

NOTE 10—Special design consideration should be given to pipe and fittings subject to vacuum or superimposed mechanical forces, or both, such as earthquakes, wind load, or burial loads, and to pipe and fittings subject to service temperature in excess of 180°F (82°C).

6. Laminates

6.1 *Laminate Construction*—The laminate comprising the pipe wall shall consist of a corrosion barrier comprised of an inner surface and interior layer, a structural layer, and an outer surface.

6.1.1 The *Corrosion Barrier*, consisting of the inner surface and interior layers, shall be included in the total thickness for all design calculations unless otherwise specified.

6.1.1.1 *Inner Surface*—The inner surface exposed to the chemical environment shall be resin-rich and reinforced with at least one layer of a suitable surfacing veil in accordance with 4.2.1. Some chemical environments may warrant the use of a second layer of surfacing veil. This resin-rich inner surface will contain less than 20 % by weight of reinforcing material and have a thickness between 0.010 and 0.020 in. (0.25 to 0.50 mm)

6.1.1.2 *Interior Layer*—The inner surface layer shall be followed with a layer composed of resin reinforced only with noncontinuous glass-fiber strands. This reinforcement shall be applied as chopped strand mat or as chopped roving (spray up process) (either in accordance with 4.2.2) resulting in a minimum reinforcement weight of 1 ½ oz/ft^2 (459 g/m^2). The combined thickness of the inner surface and interior layer shall not be less than 0.05 in. Depending on the chemical environment, multiple 1 ½ oz/ft^2 (459 g/m^2) layers of chopped strand applied as mat or spray up may be required. Two layers are most commonly used with as many as four or five layers occasionally used in severe environments. When multiple layers are used, each ply of mat or pass of chopped roving shall be well rolled to eliminate all trapped air prior to the application of additional reinforcement. Glass content of the inner surface and the interior layer combined shall be 27 ± 5 % by weight, when tested in accordance with 10.4.

6.1.2 *Structural Layer*—Subsequent reinforcement shall be Type I or Type II or "other" as described below. Types I and II are described in further detail including laminate sequences and thicknesses in Specification C 582.

6.1.2.1 *Type I* laminates consist of multiple layers of 1.5 oz/ft^2(0.46 kg/m^2) chopped strand mat or equivalent weight of chopped roving as required to achieve the thickness as calculated according to Section 5. Each successive ply or pass of reinforcement shall be well-rolled prior to the application of additional reinforcement. The exterior surface shall be relatively smooth with no exposed fibers or sharp projections and enough resin shall be present to prevent fiber show.

6.1.2.2 *Type II* laminates consist of multiple layers of 1.5 oz/ft^2(0.46 kg/m^2) chopped strand mat or equivalent weight of chopped roving alternating with layers of 24 oz/yd^2(814 g/m^2) woven or non-woven roving as required to achieve the thickness as calculated according to Section 5. Each successive ply or pass of reinforcement shall be well-rolled prior to the application of additional reinforcement. The exterior surface shall be relatively smooth with no exposed fibers or sharp projections and enough resin shall be present to prevent fiber show.

6.1.2.3 *Other* laminates may consist of similar layers to those used in Types I and II except for the use of different configurations and weights of reinforcements. A common example is the use of ¾ oz/ft^2(230 g/m ^{2}) chopped strand mat in a Type II laminate. Other options include the use of reinforcements listed in 4.2.4 and 4.2.5. Each successive ply or pass of reinforcement shall be well-rolled prior to the application of additional reinforcement. The exterior surface shall be relatively smooth with no exposed fibers or sharp projections and enough resin shall be present to prevent fiber show.

6.1.2.4 With all types of laminate, the first and last layer must be chopped strand mat or spray up, 1 ½ oz/ft^2(460 g/m^2). Interruption of the laminating process to allow the resin to exotherm and cool shall only follow a mat layer and lamination must restart with a mat layer. Adjacent layers of roving reinforcements such as woven or unidirectional roving must be

separated by a minimum of ¾oz/ft ^{2}(230 g/m^2) of chopped strand. Each successive ply or pass of reinforcement shall be well-rolled prior to the application of additional reinforcement.

6.1.3 *Outer Surface*—The exterior surface shall be relatively smooth with no exposed glass fibers. The final ply shall be mat or chopped roving equivalent. A surfacing mat is not required unless specified. Surface resin may require the addition of paraffin or may be sealed with a sprayed, wrapped, or overlaid film, as required or approved by the resin producer, to ensure proper surface cure.

6.1.3.1 When pigmentation is required, it shall be incorporated only in the resin used for the final surface coating. Pigmented resin may be used in the laminate only if agreed to with the purchaser.

6.1.3.2 Piping used for outdoor service or otherwise subject to ultraviolet exposure shall incorporate provisions to minimize ultraviolet degradation. Suitable methods include the use of ultraviolet absorbers or screening agents, incorporation of pigment of sufficient opacity in the outer surface of the resin rich layer, or use of resins inherently resistant to ultraviolet degradation.

6.2 *Joints*

6.2.1 Laminated butt joints shall be considered the standard means to join pipe to pipe or to join pipe to fittings. The thickness of the structural joint overlay shall be as determined in Section 5.

6.2.2 The minimum width of the first layer of joint overlay shall be 3 in. (76 mm). Successive layers shall increase in width to form a uniform taper. The total width of the joint laminate shall be at least sixteen times the joint thickness and shall be centered on the joint.

6.2.3 A highly filled resin paste (resin putty) shall be placed in the crevices between joined pieces, leaving a smooth surface for lay-up. Excess putty shall be removed by abrading the surface prior to applying the joint laminate. No resin paste is to be left inside the pipe.

6.2.4 The cured resin surfaces of parts to be joined shall be roughened to remove surface gloss. This roughened area shall extend beyond the lay-up areas so that no reinforcement is applied to an unprepared surface. Surfaces shall be clean and dry before lay-up. The entire roughened area shall be finished in accordance with 6.1.3.

6.2.5 All joints in pipe 24 in. (610 mm) in diameter or larger shall receive an inside sealing overlay. The inside overlay of a joint shall consist of a minimum of two plies of 1.5 oz/ft^2(0.46 kg/m^2) chopped strand mat reinforcement followed by a resin-rich layer reinforced with surfacing mat. This overlay shall be a minimum of 4 in. (100 mm) wide and shall be the equivalent of 6.1.1 and 6.1.2 combined, and shall be centered on the joint. It shall be finished in accordance with 6.1.3. Inside overlays less than 0.18 in. (4.5 mm) thick shall not be considered in meeting joint strength requirements.

NOTE 11—Any resin spilled on unprepared surface on the inside of the pipe must be removed to avoid clogging of pumps, filters, etc.

6.3 *Fittings*—All fittings such as elbows, laterals, tees, and reducers shall be equal or superior in strength to the adjacent pipe section and shall have the same inside diameter as the adjacent pipe. Tolerance on angles of fittings shall be ± 1° through 24 in. (600 mm) in diameter and ±½° for 30-in. diameter and above.

6.3.1 *Elbows*—Standard elbows shall have a centerline radius of one and one-half times the diameter except 2 and 3 in. elbows which shall have a centerline radius of two times the diameter. Elbows may be smooth turn or of mitered construction using pipe for the mitered sections. The laminates from adjacent joints may overlap each other. Mitered elbows 30° or less will be one-miter, two sections. Elbows above 30° and less than 60° shall have two miters. Elbows 60° to 90° shall have three miters. If specified by the purchaser, elbows with more miters may be provided. Incorporation of straight pipe extensions on elbows is permissible.

6.3.2 *Reducers*—Reducers of either concentric or eccentric style will have a length at least 2.5 times the difference in diameters.

6.3.2.1 When reducers are produced with a flange on the small end, the flange neck shall have enough length to allow for installation and tightening of flange bolts. See 6.3.4.2.

6.3.3 *Tees and Laterals*—shall have sufficient free length to accommodate the laminate used to join the fitting to adjacent pipe and any reinforcing laminate which may be required.

6.3.4 *Flanges*—All flanges shall meet the requirements of Specification D 5421. 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.

6.3.4.1 *Flange Attachment*—The minimum flange shear surface shall be four times the flange thickness. The thickness of the flange hub 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. The fillet radius, where the back of the flange meets the hub, shall be ⅜ in. minimum (see Fig. 1).

6.3.4.2 *Flange Neck Length*—Flanges shall have sufficient free length to accommodate the laminate used to join the flange to adjacent pipe or fittings.

6.3.5 All cut edges directly in contact with the chemical being contained and any machined flange faces shall be coated with resin. The resin used shall be the same as the resin used in the equipment laminate and must contain paraffin to ensure adequate cure.

7. Requirements

7.1 *Proof of Design:*

7.1.1 Pipe, and fittings shall be pressure tested using free end closures to ensure loading in both the hoop and longitudinal directions using the procedures described in Test Method D 1599. The test pipe and fitting shall be made with the same laminate type and resin as used on the production pipe. The minimum diameter shall be 8 in. (200 mm) and it shall have a minimum wall thickness of ¼ in. (6.5 mm). The actual diameter and thickness tested shall be agreed upon between the purchaser and the manufacturer.

7.1.1.1 The pipe may be tested using ambient temperature (50 to 80°F) (10 to 25°C) water as a test medium in lieu of the conditions required by Test Method D 1599. For Proof of Design, the pipe or fitting, or both must withstand four times

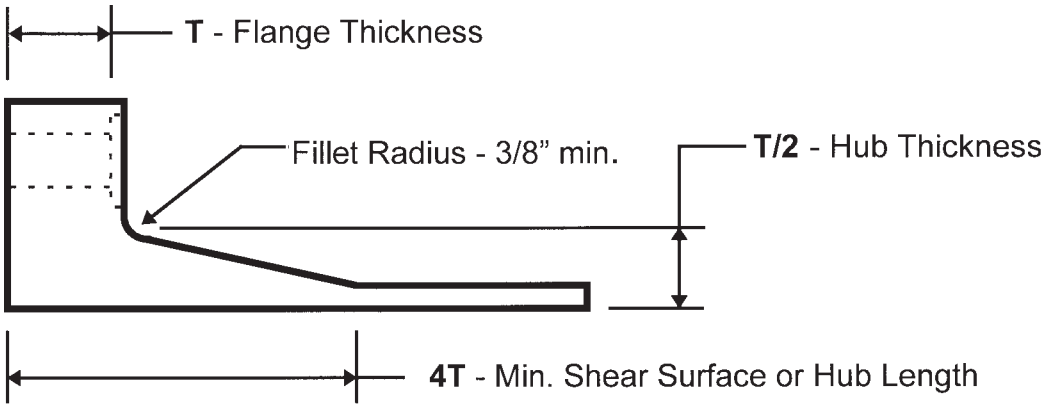

FIG. 1 Flange Dimensions

design pressure for one hour without leaking. Testing to destruction is not required.

7.1.1.2 Results from previously manufactured and tested pipe may be accepted by the purchaser provided that such pipe was manufactured with the same resin, laminate type, and thickness range within the previous five years.

NOTE 12—The test results for pipe manufactured with a non-structural corrosion barrier must be modified to determine the ultimate strength of the structural portion alone.

7.1.1.3 The intent of the testing is to demonstrate that the laminate type and thickness range used to fabricate the pipe meets the ultimate strength used in design. It is not necessary to test all diameters or thicknesses. The minimum testing is as follows: when ultimate strength is affected by thickness within a given laminate type, the thinnest laminate within each ultimate strength grade shall be tested, and, the diameter of the pipe used to test a given laminate shall be at least 15 times the laminate thickness. If the production pipe has a diameter to thickness ratio less than 15, then that ratio will be the minimum for the test pipe.

7.1.2 Pipe manufactured according to Design Basis Class A (See 5.1.1) and using a minimum design factor of ten need not be proof tested unless specified by the purchaser.

7.2 *Joints*—Joint strength must be demonstrated by testing in accordance with 10.5. A representative joint must withstand 4 times design pressure for one hour without leaking.

7.3 *Degree of Cure:*

7.3.1 *Barcol Hardness*—Degree of cure of the laminate shall be found by determining the Barcol hardness in accordance with Test Method D 2583. The minimum Barcol hardness shall be 90 % of the resin manufacturer's published value.

NOTE 13—The use of organic reinforcing materials may reduce the Barcol hardness readings without necessarily indicating undercure.

NOTE 14—*Acetone Sensitivity*—A convenient check for the surface cure of polyester resins is as follows: remove mold release or paraffin wax, if present, and wipe clean of dust. Rub four or five drops of acetone on the laminate surface until it evaporates. If the surface becomes softened or tacky, it is an indication of undercure.

8. Dimensions and Tolerances

8.1 Standard diameters, based on internal measurements are 2, 3, 4, 6, 8, 10, 12, 14, 16, 18, 20, 24, 30, 36, 42, and 48 in. (50, 75, 100, 150, 200, 250, 300, 355, 400, 460, 510, 610, 760, 915, 1065, 1220 mm). The tolerance for out-of-roundness, shall be ± 1/16 in. (± 1.5 mm) for pipe up to and including 6-in. (150 mm) inside diameter and ± 1/8 in. (± 3 mm) or ± 1 %, whichever is greater, for pipe exceeding 6 in. (150 mm) in inside diameter. This measurement shall be made at the point of manufacture with the pipe in an unstrained horizontal position.

8.2 *Wall Thickness*—The minimum average wall thickness of the pipe shall be as calculated in accordance with Section 5. For pipe walls less than 5/8 in. (16 mm) thick, the minimum wall thickness at any point shall not be less than 80 % of the specified thickness. For pipe walls 5/8 in. (16 mm) or thicker, the minimum thickness at any point shall be 1/8 in. (3 mm) less than the specified wall thickness. Wall thickness shall be measured in accordance with Practice D 3567.

8.3 *Length*—The length of each piece of plain end pipe shall not vary more than ±2 in. (± 50 mm) from the ordered length unless arrangements are made to allow for trim in the field.

8.4 *Squareness of Ends*—All unflanged pipe shall be cut square with the axis of the pipe within ±1/8 in. (±3 mm) up to and including 24 in. (610 mm) diameter and to within ±3/16 in. (5 mm) for all diameters above 24 in. (610 mm).

8.5 *Flange Faces*—Tolerance on perpendicularity and flatness shall be as specified in Test Method D 5421. Other dimensions shall be as described in 6.3.3.

8.6 *Elbows, Tees, and Laterals*—The tolerance on the angles of elbows, tees, and laterals shall be ±1° for fittings through 24 in. in diameter and ±½° for larger diameters.

9. Workmanship, Finish, and Appearance

9.1 The minimum acceptable level for workmanship and finish of the finished laminate shall conform to the requirements specified in Specification C 582.

NOTE 15—A representative laminate sample may be used for determination of an acceptable surface finish and acceptable level of visual imperfections.

10. Test Methods

10.1 *Test Conditions*—Conduct the test at a laboratory temperature of 70 to 77°F (21 to 25°C) unless otherwise specified.

10.2 *Chemical Resistance of Resin*—Determine the chemical resistance of the resin in accordance with Practice C 581.

10.3 *Glass Content*—When required by the purchaser, determine the glass content in accordance with Test Method D 2584.

10.4 *Tensile Strength*—Tensile strength of the laminate shall be determined using procedures in accordance with Test Method D 638 except thickness.

10.5 *Short-time Hydraulic Failure Pressure* of the laminate shall be determined in accordance with Test Method D 1599 using free end closures to ensure loading in both the hoop and longitudinal directions. The pipe may be tested at ambient temperature using ambient temperature (50 to 80°F) (10 to 25°C) water as a test medium in lieu of the conditions required by Test Method D 1599.

10.6 *Physical Properties*—Where required, physical properties shall be determined in accordance with the test methods listed in Specification C 582.

11. Marking

11.1 Pipe shall be marked at least once per section with the following information in such a manner that it remains legible under normal handling and installation practices:

11.1.1 ASTM D 6041 with which the pipe complies,

11.1.2 Nominal pipe size (for example, 12 in. (305 mm) diameter),

11.1.3 Pressure rating (for example, 150 psi (1034 kpa)),

11.1.4 Manufacturer's name or trademark, and

11.1.5 A 12 in. (305 mm) diameter 150 psi (1034 kpa) rated pipe would have the following marking: "ASTM D 6041–12"(305 mm) Dia. 150 psi (1034 kpa) XYZ Manufacturing Co."

12. Keywords

12.1 chemical resistant; contact molded; fiberglass; fittings; glass–fiber–reinforced thermosetting plastic; pipe

APPENDIXES

(Nonmandatory Information)

X1. INSTALLATION

X1.1 *Pipe Hangers*—Hangers shall be band type hangers contacting a minimum of 120° of the pipe surface. The width of the hanger band shall be based on the pipe diameter and wall thickness and the total load supported by the hanger.

X1.2 *Underground Installation*—Special consideration must be given to installing pipe underground. It is recommended that the manufacturer be consulted for installation and design procedures.

X1.3 *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.

X1.4 *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.

X1.5 *Gaskets*—Gaskets shall be furnished by the customer. Recommended gasketing materials shall be a minimum of ⅛ in. (3 mm) 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.

X2. HANDLING

X2.1 The following normal precautions should be taken in handling the pipe at the destination:

X2.2 Proper rigging practices should be observed at all times. Hoisting equipment operators should attach a guide line to prevent pipe from swinging out of control.

X2.3 Under no conditions should chains or cables be allowed to contact a pipe. Full protection must be provided when using chains or cables. Do not attach lifting devices to any fitting.

X2.4 The pipe should not be dropped or allowed to strike any other object. Damage caused by dropping or striking other objects may result in cracking the inner corrosion-resistant liner as well as the structural portion of the pipe.

X2.5 The pipe should not be rolled or slid on rough ground. Never set pipe upon a fitting or other protrusion that may be attached to it.

X2.6 In working around pipe care should be exercised to prevent tools, scaffolding, or other objects from striking the pipe or being dropped on or inside the pipe. Soft-soled shoes should be worn by workmen entering large pipe.

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