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Specification for Low Pressure Fiberglass Line Pipe

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SUGGESTIONS FOR ORDERING API FIBERGLASS LINE PIPE

In placing orders for line pipe to be manufactured in accordance with API Spec 15LR the purchaser may specify the following on the purchase order:

Specification	API Spec 15LR
Quantity	
Pressure Rating	Par. 1.1
Physical Properties	Par. 4.1
Process of Manufacture	Par. 2.1
Resin System	Par. 2.2
Nominal Size or Outside Diameter	Table 6.1
Length	Par. 6.2
Pipe Ends	Par. 7.1
Mill Inspection by Purchaser	Par. 9.1, 9.2
Delivery Date and Shipping Instructions	

Attention is called to the following paragraphs which may require additional discussion or agreement between the purchaser and the manufacturer.

Service Factors	Par. 4.4
Pipe Connection Drawings	Par. 7.2

NOTE: *This specification supersedes the fifth edition of Spec 15LR dated October 1986. This specification was originally adopted in 1967. It was issued as tentative in 1968, and as Spec 5LR in 1972.*

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API SPECIFICATION FOR LOW PRESSURE FIBERGLASS LINE PIPE

FOREWORD

a. This specification is under the jurisdiction of the Committee on Standardization of Plastic Pipe of the American Petroleum Institute.

b. The purpose of this specification is to provide standards for Low Pressure Fiberglass Line Pipe for use in conveying produced fluids including oil, gas, nonportable water and mixtures thereof in the oil and gas producing industries.

c. Nothing in this specification should be interpreted as indicating a preference by the committee for any material or process or as indicating equality between the various materials or processes. In the selection of materials and processes, the purchaser must be guided by his experience and by the service for which the pipe is intended.

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h. The procedure for obtaining authorization to use the API monogram is given in Appendix H.

i. This Standard shall become effective on the date printed on the cover but may be used voluntarily from the date of distribution.

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SECTION 1
SCOPE

1.1 Coverage. This specification covers centrifugally cast (CC) and filament wound (FW) fiberglass line pipe and fittings for these pipe in diameters up to and including 16 inches rated for cyclic operating pressures up to and including 1000 psig. It is recommended that the pipe and fittings be purchased by pressure rating. The standard pressure ratings are 150 psig, 200 psig, 250 psig, and 300 psig. Pipe with pressure ratings greater than 300 psig can be purchased in 100 psig increments all based on cyclic pressures. For static pressure conditions higher pressure ratings may be used [refer to Par. 4.5(b)]. Quality control tests, hydrostatic mill tests, dimensions, weights, material properties, physical properties, and minimum performance requirements are included.

1.2 Referenced Standards

a. **General.** This specification includes by reference, either in total or in part, other API, industry and government standards listed in Appendix F.

b. **Requirements.** Requirements of other standards included by reference in this specification are essential to the safety and interchangeability of the quipment produced.

c. **Equivalent Standards.** Other nationally or internationally recognized standards shall be submitted to and approved by API for inclusion in this specification prior to use as equivalent standards.

1.3 Unit Conversion. A decimal/inch system is the standard for the dimensions shown in this specification. Norminal sizes will continue to be shown as fractions. For the purposes of this specification, the fractions and their decimal equivalents are equal and interchangeable. Metric conversions are described in Appendix I.

SECTION 2
PROCESS OF MANUFACTURE AND MATERIALS

2.1 Process of Manufacture. Pipe furnished to this specification shall be produced by the centrifugal casting (CC) or filament winding (FW) methods.

2.2 Material. The reinforced wall of pipe and fittings shall consist of thermosetting polymers reinforced with glass fibers. Acceptable polymers are epoxy resins, polyester resins, and vinyl ester resins. Couplings, connections, fittings, and adhesives shall meet the performance properties listed in Par. 4.6 and Par. 4.7 and shall be manufactured by a process and from materials compatible with the pipe system. They shall at least be equally resistant to the same fluids and environments as the pipe.

NOTES:
(1.) Other resins and reinforcements shall be considered for inclusion in this standard when evidence is presented to show that they are suitable for the applications covered by this standard.

(2.) Vinyl ester resins are defined in ASTM C-582.

SECTION 3
MATERIAL PROPERTIES AND TESTS

3.1 Pipe and fittings furnished to this specification shall conform to the material requirements listed in Par. 2.2.

3.2 Degree of Cure. Degree of cure shall be determined by differential scanning calorimetry (DSC). The glass transition temperature (T_g) shall be no less than the average production T_g value minus three standard deviations. The average production T_g shall be established by the manufacturer from DSC tests taken from typical API 15LR qualified production product.

Manufacturers shall establish these values for each resin system used.

3.3 Methods of Material Analysis

a. Degree of cure (T_g) shall be determined following the procedure in Appendix B.

b. Glass-resin ratios shall be determined following the procedures of Appendix A.

3.4 Frequency of Tests. The manufacturer shall supply a report showing the degree of cure (T_g) per Par. 3.2 and 3.3 at the frequency required by Par. 5.1(d) for pipe. Samples for material analysis shall be taken from production runs.

SECTION 4
PHYSICAL PROPERTIES AND TESTS

4.1 Physical Properties. Pipe furnished to this specification shall conform to physical property requirements in Par. 4.3. Certain other properties do not have specified requirements but are nevertheless important in piping system design. The manufacturer shall perform the tests shown in Pars. 4.1(a) — 4.1(h) as well as prepare all test reports in compliance with the applicable ASTM standard. Use of the reporting format shown in Appendix G is recommended. These results shall be available upon request.

a. Long-term hydrostatic strength cyclic at 150°F. ASTM D-2992 Procedure A.

b. Thermal Coefficient of Expansion, ASTM D-696.

c. Axial Tensile Modulus of Elasticity, ASTM D-2105.

d. Parallel Plate Crush, SF at 5% deflection, ASTM D-2412.

e. Ultimate Axial Tensile Strength, ASTM D-2105.

f. Hydrostatic Collapse Pressure, ASTM D-2924.

g. Short-time Hydraulic Failure Pressure of Plastic Pipe, Tubing, and Fittings, ASTM D-1599.

h. Beam bending modulus to determine pipe support spacing at 73.4°F and 150°F or maximum rated temperature when determined in accordance with ASTM D-2925.

4.2 Frequency of Tests. Pipe furnished to this specification shall be tested by the manufacturer as follows:

a. The short-term test which shall be performed at ambient temperature at the minimum frequency of one per lot as defined in 5.1(b) shall be one of the following:

1. Short-time hydrostatic failure pressure per ASTM D-1599.
2. Cyclic Pressure Strength (short-term) per ASTM D-2143 for 750 cycles minimum.

b. One long-term cyclic hydrostatic regression test to determine the hydrostatic design basis (HDB) shall be performed at 150°F(1) on pipe manufactured by each process which contains no significant product characteristic differences such as listed in Appendix E. The tests shall be conducted as follows:

NOTE (1): *When pipe is to be rated for temperatures higher than 150°F, the tests shall be conducted at the higher temperature.*

1. Initial tests — long-term cyclic hydrostatic pressure tests in compliance with ASTM D-2992 Procedure A.
2. Requalification Tests. The long-term cyclic HDB shall be verified at 150°F after any change as described in Appendix E by conducting abridged tests as follows:

Minimum Number of Samples	Cycles to Failure
2	1,000 to 10,000
2	10,000 to 3×10^6
2	at least 3×10^6

The failure points from these tests shall be combined with the failure points determined during the initial testing. The regression line determined

on the combined data shall be extrapolated to obtain a requalification Long-Term Hydrostatic Strength (LTHS). If the LTHS for the combined data is greater than or equal to the corresponding lower confidence limit (per ASTM D-2992 Annex A2) of the initial tests, then the initial LTHS may be used. Otherwise, the changed product shall be retested per Section 4 to obtain a new LTHS.

NOTE: *To qualify a changed product at a higher HDB, the product must be retested per Par. 4.2(b)1 to obtain the new HDB.*

c. Impact resistance. The impact resistance of 2″ through 6″ pipe with cyclic pressure ratings of 300 psi and less shall be tested initially following the procedure in Appendix C.

4.3 Minimum Properties. The minimum performance properties for tests specified in Par. 4.2 are:

a. Pipe shall hold for one minute a minimum hydrostatic pressure of 4.0 times its calculated cyclic operating pressure without failure when tested as per Par. 4.2(a)(1).

b. Pipe shall have a minimum short-term cyclic pressure life of 750 cycles when tested at a pressure equal to or greater than the lower confidence limit on the long-term cyclic hydrostatic pressure regression line when back calculated to 750 cycles.

c. The hydrostatic design basis (HDB) extrapolated to 150 million cycles shall equal or exceed the manufacturers published value current at the time of purchase.

d. All 2″ through 6″ pipe with cyclic pressure ratings of 300 psig or less shall have impact resistance which exceeds the requirements of Appendix C. NOTE: *This test is not considered applicable for other pipe.*

4.4 Service Factors. The maximum recommended service factor is 1.0 for the long-term cyclic HDB.

4.5 Pressure Rating.

a. The cyclic pressure rating for a pipe shall be calculated by using the following formula and the hoop stress values determined by the long-term cyclic test listed in Par. 4.2(b)1. The formula is:

$$P_c = \frac{2S_c t}{D}$$

Where:

P_c = internal cyclic pressure rating, psi

S_c = hoop stress = HDB × service factor, psi

t = minimum reinforced wall thickness, inches

D = average diameter inches (OD-t)

HDB_c = Hydrostatic Design Basis, cyclic, psi

b. **Static Pressure.** Additionally, a static pressure rating can be determined by use of one of the following:

$$P_s = 1.5 \times P_c$$

Where P_c is defined in Par. 4.5a and P_s is the internal static pressure rating, psi; or

$$P_s = 0.5 \times \frac{2S_s t}{D}$$

Where HDB_s (S_s) is determined by ASTM D-2992, Procedure B.

NOTE: *Except as indicated above, all references to HDB in this specification refer to the cyclic HDB, and all piping shall be given pressure ratings on the cyclic basis.*

4.6 Qualification Requirements for Fittings. Fittings, couplings, connections and adhesives shall meet the following performance requirements when tested with unrestrained ends in accordance with Par. 4.7.

a. Each component and its field-jointed configuration shall sustain a short-time hydrostatic pressure of at least four (4) times its cyclic rated pressure for one minute without visible weeping or leakage.

b. Each component shall meet or exceed the cycle test requirements of Par. 4.7.b.

4.7 Qualification Tests for Fittings, Couplings, and Connections. Test specimens shall include at least one fitting in each configuration, for example, 45 degree and 90 degree elbow, tee, flange, coupling (includes integral coupling) etc., joined to pipe sections at least 18 inches long or 2 diameters, whichever is longer, using the joining method, design, and adhesive intended for field assembly. Specimen diameters for test in each configuration shall include the maximum product size in each pressure class and each method of manufacture. In addition, smaller sizes in the pressure rating shall be tested as follows:

Product Size Range (inches)	Test Size (inches)
2, 2½, 3	3
4, 6	6
8, 10, 12	12
14, 16	16

In each range of size the manufacturer may elect at its option to test a smaller product size to qualify only the smaller size.

a. Short-time hydrostatic failure pressure tests to determine compliance with Par. 4.6 performed with unrestrained ends at ambient temperature in accordance with ASTM D-1599 using specimens and sizes as described above.

b. Cyclic Testing.

1. Using the cyclic test data and regression analysis as developed for the pipe under Par. 4.2(b)(1), a regression line is constructed converting the stress vs. cycle data to pressure vs. cycle data for pipe of the intended pressure class.

2. The gauge pressure at the peak pressure of the cycle shall be not less than 1½ nor more than 2 times the pressure rating of the corresponding pipe. The cycle amplitude pressure shall be at least 80% of the selected peak pressure.

3. Test each component specimen as required above with unrestrained ends in accordance with ASTM D-2143 at a test temperature of 150°F. (For components which are to be used at higher temperatures, the higher temperature shall be used.)

4. The number of cycles to failure for the component must be no less than that predicted by the HDB line lower 97.5% confidence limit of the corresponding pipe.

4.8 Requalification Tests for Fittings, Couplings, Connections and Adhesives. The qualification tests of Par. 4.7 shall be repeated after any change as described in Appendix E.

SECTION 5
QUALITY CONTROL TESTS

5.1 Pipe.

a. Mill Pressure Tests. Hydrostatic testing of pipe manufactured to this specification shall be done at a pressure of not less than 1.5 times the calculated cyclic pressure rating. The hydrostatic mill tests shall be conducted randomly with lengths taken during each shift from each production line, unless otherwise agreed upon between manufacturer and purchaser. All mill jointers shall be hydrostatically tested.

b. A lot of pipe shall consist of 5,000 feet or fraction thereof of one size, wall thickness and grade in continuous production.

c. The short-term cyclic pressure test or the short-time hydrostatic failure test per Par. 4.2(a) shall be conducted at a minimum frequency of one test per lot.

d. The test for degree of cure (T_g) per Pars. 3.2 and 3.3 shall be conducted at a mininum frequency of one test per lot.

5.2 Fittings.

a. Mill Pressure Tests — Hydrostatic testing or pneumatic testing of 6" and smaller fittings at a pressure equal to 1.5 times pressure rating shall be conducted at the frequency called for in Par. 5.2(a)(1) or Par. 5.2(a)(2).

1. Fittings shall be randomly tested with fittings taken during each shift from each production line, with at least 20 percent of all 45 degree elbows, 90 degree elbows, and tees tested.

2. Fittings (45 degree elbows, 90 degree elbows, and tees) shall be tested following the sampling plan of Appendix D.

5.3 Retests. If any test specimen of the tests specifically mentioned in Pars. 4.2(a), 5.1 and 5.2(a)(1) fails to conform to the specified requirements, the manufacturer may elect to make retests on two additional lengths or fittings from the same lot. If both of the retest specimens conform to the requirements, all of the lengths or fittings in the lot shall be accepted, except the length or fitting from which the initial specimen was taken. If one or both of the retest specimens fail to conform to the specified requirements, the manufacturer may elect to test individually the remaining lengths or fittings in the lot, in which case determinations are required only for the particular requirements with which the specimens failed to comply in the preceding test.

SECTION 6
DIMENSIONS AND LENGTHS

6.1 Dimensions. Fiberglass pipe shall be furnished in sizes shown in Table 6.1 as specified on the purchase order.

TABLE 6.1
DIMENSIONS

Nominal Size (inches)	Outside [1] Dia. (inches)	Inside[2] Dia. (inches) Minimum
2	2.375	2.00
2½	2.875	2.40
3	3.500	3.00
4	4.500	4.00
6	6.625	5.80
8	8.625	8.20
10	10.750	10.30
12	12.750	11.90
14	(3)	13.50
16	(3)	15.40

NOTES:

1. The outer diameters are applicable to:
   - A. Sizes 2″ through 6″ with 300 psi cyclic pressure ratings.
   - B. Sizes 8″ through 12″ with 150 psi cyclic pressure ratings.
   - C. All centrifugal cast pipe.
   - D. Other outside diameters shall be permitted by agreement between purchaser and manufacturer.
2. The minimum inside diameters are applicable to all filament wound pipe with cyclic pressure ratings greater than pipe covered by Note 1.
3. The minimum inside diameters are applicable to all pressure ratings of 14″ and 16″ diameter pipe.

6.2 Length. Pipe shall be furnished in lengths according to the following schedule.

Length 1	Length 2	Length 3
15 to 21 feet	21 to 34 feet	34 or more feet

Jointers (two pieces coupled to make a standard length) may be furnished to a maximum of 5 percent of the order; but no length used in making a jointer shall be less than 5 feet. Two standard lengths joined to make one long length is not a jointer, but shall be mill hydrotested at a pressure of 1.5 times the cyclic pressure rating.

6.3 Tolerances. Outside diameter of pipe furnished to this specification shall be within the tolerances listed in Table 6.2. The measurements shall be made in accordance with ASTM D-3567.

6.4 Wall Thickness. The pipe's minimum reinforced wall thickness shall not be less than that wall thickness calculated for its pressure class using Par. 4.5(a) and when measured per ASTM D-3567.

TABLE 6.2
DIMENSIONAL TOLERANCES

Nominal Size (Inches)	Outside Diameter (Inches)
2	+0.060,-0.018
2½	+0.060,-0.018
3	+0.060,-0.018
4	+0.066,-0.028
6	+0.086,-0.040
8	+0.108,-0.043
10	+0.128,-0.056
12	+0.145,-0.062
16	+0.165,-0.074

SECTION 7
PIPE ENDS, CONNECTIONS, END PROTECTION, AND WORKMANSHIP

7.1 Pipe Ends. Pipe shall be furnished threaded, plain end, tapered, special and, or with alternate tapered ends as specified on the purchase order.

a. **Threaded Ends.** Threaded ends shall consist of male and female threads per ASTM D1694 or to API Spec 5B. Threaded joints shall meet the performance requirements of Pars. 4.6 and 4.7.

b. **Plain Ends.** Plain end pipe shall be furnished in lengths specified on the purchase order with square cut ends. Bell and spigot dimensions and tolerances are shown in Table 7.2.

c. **Tapered Ends.** Tapered ends shall consist of tapered spigots with either integral bells or sleeve couplings. Male and female ends shall conform to dimensions shown in Tables 7.1.a & 7.1.b. Tapered joints, when bonded in accordance with manufacturer's recommendation, shall meet the performance requirements of Pars. 4.6 and 4.7.

d. **Special Ends.** When so specified on the purchase order, pipe shall be furnished with ends suitable for use with special couplings. Mechanical joints with elastomeric seals are considered special ends and shall be in accordance with ASTM D4161. These special end connections, when joined in accordance with manufacturer's recommendations, shall meet the performance requirements of Par. 4.6 and 4.7.

e. **Alternate Tapered Ends.** Alternate tapered ends which do not meet the taper angle and spigot end diameter requirements shown in Table 7.1a for nominal sizes 8 inches through 16 inches shall be allowed and shall be identified by the letters "ATE" following the API monogram. Alternate tapered end joints, when bonded in accordance with manufacturer's recommendation, shall meet the performance requirement of Par. 4.6 and 4.7. The angle of alternate taper angle shall be identified in the pipe marking immediately following "ATE" when an alternate taper angle is used.

7.2 Pipe Drawings. The manufacturer shall furnish drawings of the pipe and any special couplings or sealing devices, including dimensions and tolerances, when requested by the purchaser.

7.3 Workmanship. All pipe furnished to this specification shall meet the visual inspection limits listed in Table 7.3.

NOTE: *The dimensions of the spigots for the tapered end adhesive bonded joints are substantially changed from API 5LR dated March 1976; therefore, materials manufactured prior to March 1976 shall be in compliance with 5LR and materials manufactured after October 15, 1986 shall be in compliance with 15LR.*

7.4 Repair of Surface Imperfections. Removal of surface imperfections by methods such as grinding or filing shall be permissible, provided the grinding or filing does not cut into any of the reinforcement, and that all ground or filed areas are coated prior to shipment with the same base resin as was used in the manufacture of the product.

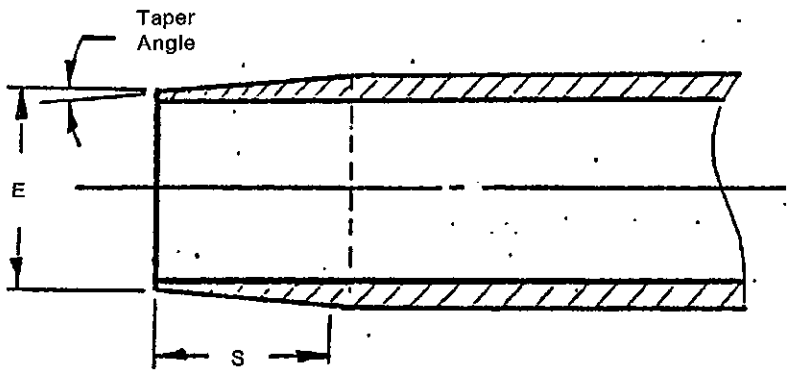
7.5 End Protection. The manufacturer shall provide end protection of such design, material and mechanical strength to protect the ends of the pipe, fittings and end connections from damage under normal handling and transportation. The end protector for female ends shall cover the end to prevent damage by ultra-violet radiation and other weather elements. The end protector's length shall be long enough to cover:

a. All threads of male threaded (pin end) pipe.

b. All machined or ground surfaces of male end (spigot) adhesive bonded joint pipe.

c. All sealing surfaces of elastomeric sealed joints.

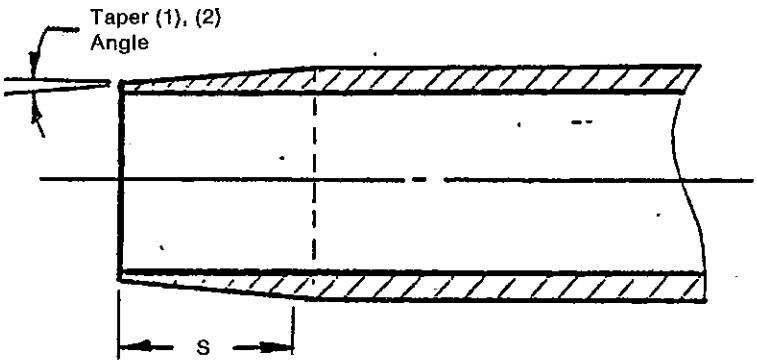
TABLE 7.1a
SPIGOT DIMENSIONS FOR TAPERED ENDS
ADHESIVE BONDED JOINTS



Nominal Pipe Size (in.)	Taper Angle (degrees)	Spigot End Dia.[1] E (in.)	Minimum Bond Length[2] S (in.)	Maximum Cyclic Pressure Rating (psi)
2	$1\frac{3}{4}{}^{+0}_{-1/4}$	2.291	.900	300
2½	$1\frac{3}{4}{}^{+0}_{-1/4}$	2.783	1.070	300
3	$1\frac{3}{4}{}^{+0}_{-1/4}$	3.401	1.370	300
4	$1\frac{3}{4}{}^{+0}_{-1/4}$	4.370	1.895	300
6	$1\frac{3}{4}{}^{+0}_{-1/4}$	6.472	2.690	300
8	$1\frac{3}{4}{}^{+0}_{-1/4}$	8.457	2.060	150
10	$1\frac{3}{4}{}^{+0}_{-1/4}$	10.567	2.595	150
12	$1\frac{3}{4}{}^{+0}_{-1/4}$	12.544	2.920	150
14	$1\frac{3}{4}{}^{+0}_{-1/4}$	13.778	3.420	150
16	$1\frac{3}{4}{}^{+0}_{-1/4}$	15.756	3.895	150

[1]Spigot end diameter (E) is a reference dimension; the actual spigot diameter may be smaller.
[2]The minimum bond lengths are based on an adhesive shear stress of approximately 145 psi at the cyclic pressure rating.

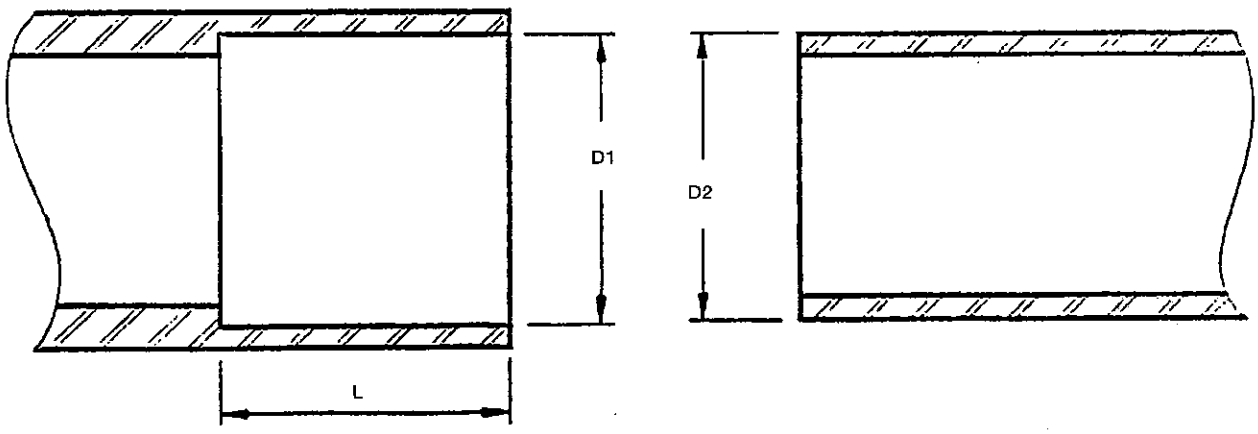
TABLE 7.1b
SPIGOT DIMENSIONS FOR
HIGHER PRESSURE RATINGS



Nominal Pipe Size (in.)	Minimum Bond Length[3] S (in.)	Maximum Cyclic Pressure Rating (psi)	Minimum Bond Length S (in.)	Cyclic Pressure Rating (psi)
2	1.505	500	1.810	600
2½	1.785	500	2.140	600
3	2.280	500	2.740	600
4	3.155	500	3.790	600
6	4.480	500	5.375	600
8	2.740	200	4.110	300
10	3.460	200	5.195	300
12	3.895	200	5.840	300
14	4.560	200	6.840	300
16	5.190	200	7.785	300

(1) Taper angle varies according to wall thickness. Standard angles are: 1¾, 3½, 5, and 7 degrees.
(2) Tolerance for taper angle is +0 degrees, –¼ degrees.
(3) The minimum bond lengths are based on an adhesive shear stress of approximately 145 psi at the cyclic pressure rating.

TABLE 7.2
SOCKET DIMENSIONS FOR ADHESIVE BONDED JOINTS USING NON-TAPERED PIPE ENDS
Applies Only to Centrifugally Cast Pipe



Nominal Pipe Size (in.)	SOCKET DIMENSIONS			PIPE DIMENSIONS	
	Length Minimum L (in.)	Diameter of Bore D1 (in.) Min.	Max.	Outside Diameter D2 (in.)	Outside Diameter Tolerances (in.)
2	1¾	2.387	2.437	2.375	±0.012
2½	1¾	2.887	2.937	2.875	±0.012
3	1¾	3.512	3.562	3.500	±0.012
4	1¾	4.515	4.562	4.500	±0.015
6	1¾	6.650	6.687	6.625	±0.025
8	1¾	8.650	8.687	8.625	±0.025
10	3¾	10.775	10.812	10.750	±0.025
12	3¾	12.775	12.812	12.750	±0.025
14	3¾	14.025	14.062	14.000	±0.025

TABLE 7.3
VISUAL STANDARDS

DEFECT	DESCRIPTION	MAXIMUM SIZE
PIPE BODY AND COLLAR		
Burn	thermal decomposition evidenced by distortion or discoloration of the surface	20% area—lightly blemished 5%, area—moderate burn of outer resin layer, structural roving
Chip	small piece broken from edge or surface	permitted if laminate has not been fractured
Crazing	fine cracks at or under the surface as seen by the unaided eye	none permitted
Cut Roving	broken or cut outer rovings due to scraping or scuffing or manufacturing process	maximum 3 per pipe with one square inch maximum size maximum depth of 10% of the nominal wall thickness
Dry Spot	area where reinforcement was not thoroughly wet with resin	maximum 3 streaks per pipe — ½ inch wide, 4 in. long, no dry reinforcement exposed
Fracture	Rupture of laminate without complete penetration. Visible as lighter colored area of interlaminar separation	none permitted
Pits (pinholes)	small craters in the surface	maximum 1/16" deep, no limit on number
Resin Drip	resin protrusion	maximum ⅛ in. high, no limit on number
Scratch	shallow mark caused by improper handling	no limit on number if reinforcement is not exposed
THREADS		
Air Bubbles	light patch at the root of the thread caused by entrapped air	maximum size ⅛" in any direction and one bubble allowed per connection
Chips	areas where over 10% of thread height is removed	maximum ½" long in one thread per connection

SECTION 8
MARKING

8.1 Pipe manufactured in conformance with this specification shall be marked by the manufacturer as specified in Section 8.2. (Additional markings as desired by the manufacturer or as requested by the purchaser are not prohibited.) Markings shall be permanent, shall not overlap, and shall be applied in such manner as not to damage the pipe.

8.2 Pipe shall be marked with the following:

a. Manufacturer's name or mark

b. Size, nominal, inches

c. Cyclic pressure rating

d. Lot number

e. "Spec 15LR"*

*Users of this specification should note that there is no longer a requirement for marking a product with the API monogram. The American Petroleum Institute continues to license use of the monogram on products covered by this specification but it is administered by the staff of the Institute separately from the specification. The policy describing licensing and use of the monogram is contained in Appendix H, herein. No other use of the monogram is permitted. Licensees should refer to Par. H-13 for marking requirements.

SECTION 9
INSPECTION AND REJECTION

9.1 Inspection Notice. Where the purchaser or his authorized inspector desires to inspect this pipe, the manufacturer shall give reasonable notice as to when the pipe shall be ready for inspection.

9.2 Plant Access. The inspector representing the purchaser shall have free entry at all times while work on contract of the purchaser is being performed, to all parts of the manufacturer's plant which will concern the inspection of pipe ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the pipe is being furnished in accordance with this specification. All inspections shall be made at the place of manufacture prior to shipment, unless otherwise specified on the purchase order, and shall be so conducted as not to interfere with plant operations.

9.3 Compliance. The manufacturer is responsible for complying with all provisions of this specification. The purchaser may make any investigation necessary to satisfy himself of compliance by the manufacturer and may reject any material that does not comply with this specification. If tests that require the destruction of material are made other than at the place of manufacture, the purchaser shall accept that material which meets the specification but shall reject material which fails to meet the specification.

APPENDIX A
METHOD OF TEST FOR GLASS-RESIN RATIO OF FIBERGLASS PIPE

Scope

A-1 This appendix covers method of test for the determination of the glass-resin ratio of fiberglass pipe.

Summary of Method

A-2 The Glass-Resin Ratio Test consists of cutting a 1 inch × 1 inch sample from the pipe wall, containing it in a crucible, igniting the material, and allowing it to burn until only ash and carbon remain. The carbonaceous residue is reduced to an ash by heating in a muffle furnace at 1050°F (565°C) cooled in a desiccator and weighed.

A-3 Equipment:

a. Crucible, made of platinum or porcelain, approximately 30 ml capacity.

b. Electric Muffle Furnace, capable of maintaining a temperature of 1050 ±50°F (565 ±28°C).

A-4 Procedure:

a. Heat a crucible at 932 to 1112°F (500 to 600°C) for 10 minutes or more. Cool to room temperature in a desiccator and weigh to the nearest 1.0 mg.

b. Place approximately 5 g. of sample in the crucible and weigh to the nearest 1.0 mg. The maximum size of the sample pieces shall be 1 inch × 1 inch × thickness (25.4 × 25.4 mm). Heat the crucible and sample in a Bunsen flame until the contents ignite. Maintain such a temperature that the sample burns at a uniform and moderate rate until only ash and carbon remain when the burning ceases.

NOTE 1: *It is often convenient to use samples obtained from specimens that have been tested for mechanical properties such as flexural or tensile strength. The samples must be dry and the fractured areas removed, leaving square, unfrayed faces, before these samples are weighed and ignited.*

NOTE 2: *It is not absolutely necessary to ignite the sample in a Bunsen flame. Instead the crucible and contents can be placed in a muffle furnace at a temperature lower than 1050°F (565°C) and ignited. Care must be taken that there will be no mechanical loss of the noncombustible residue.*

NOTE 3: *If the "volatile" content of the sample is desired, determine the weight loss of the crucible and contents after placing in an oven at 212°F (100°C) before ignition. The time crucible and contents must remain in the oven is dependent on the type of "volatiles" present and the specimen geometry.*

c. Heat the crucible and residue in the muffle furnace at 1050 ±50°F (568 ±28°C) until all carbonaceous material has disappeared. Cool the crucible to room temperature in a desiccator and weigh to the nearest 1.0 mg.

NOTE 4: *The time for the carbonaceous residue to disappear is dependent largely on the sample geometry. It can be up to six hours but is usually much less.*

d. Reheat the crucible at 1050°F (565°C) for 10 to 20 minutes, cool in a desiccator and reweigh. Repeat the heating and weighing until consecutive weighings differ by no more than 1.0 mg.

e. Determine the ignition loss on at least two more portions of the same reinforced resin sample.

A-5 Calculations:

a. Calculate the ignition loss of the sample as follows:

$$\text{Ignition loss, \% w} = \frac{(W_1 - W_2) \times 100}{W_1}$$

where:

W_1 = weight of the sample, grams.

W_2 = weight of the residue, grams.

b. Calculate the estimated standard deviation as follows:

$$s = \sqrt{\frac{x^2 - n(\bar{x})^2}{n-1}}$$

s = estimated standard deviation.

x = value of single observation.

n = number of observations.

$\bar{x}$ = arithmetic mean of the set of observations.

A-6 Report: The report shall include the following:

a. The ignition loss, %w and standard deviation. If only glass reinforcement and organic resin were present, the ignition loss can be considered to be the resin content.

b. Observations in regard to any irregularities noted in the physical properties of the residue, such as melting.

c. Pipe identification from number on pipe.

d. Any irregularities noted during the test.

e. Date of test.

APPENDIX B
METHOD OF TEST FOR THE DETERMINATION OF DEGREE OF CURE BY DIFFERENTIAL SCANNING CALORIMETRY (DSC)

B-1 Scope. This test determines the degree of cure of a fiberglass pipe test specimen relative to statistically significant values obtained from typical production product.

B-2 Definition. Glass transition temperature (T_g) is defined as the midpoint of the inflection temperature at the DSC curve (heat flow vs. temperature).

B-3 Apparatus. Differential scanning calorimeter (DSC).

B-4 Test Specimens.

a. **Size.** The size of the specimen is limited by the size of the DSC sample pan. All specimens *can be a chip* or filed into a fine powder to provide easy weighing and uniform contact with the pan.

b. **Location.** For any given piece of pipe, a sample should be taken 0-10 mils from the outer surface, as well as 0-10 mils from the inner surface. If the pipe sample has a liner, then a specimen should be taken from the liner as well as the inner and outer edges of the over-wrap.

B-5 Procedure.

a. *Maximum* heating rate is *40*°C/minute.

b. Run the scan from room temperature to at least 30°C above the expected glass transition temperature and no more than 250°C.

c. Obtain the T_g (midpoint of the inflection in the DSC curve).

B-6 Report. The report shall include the following items.

a. Complete identification of the specimens, including material, manufacturer's name and lot number (Section 9).

b. Pipe dimensions, including nominal size, minimum reinforced wall thickness, and average outside diameter of reinforced wall. Unreinforced thicknesses (i.e., liner) shall also be reported.

c. Number of specimens tested and where the specimens were taken from the pipe.

d. Heat-up rate for DSC initial temperature and final temperature for both scans.

e. Record glass transition temperature (inflection value) for the first scan as T_g.

f. Date of test.

APPENDIX C
METHOD OF TEST FOR IMPACT RESISTANCE OF FIBERGLASS PIPE

C-1 Scope. This appendix covers the method of test for the determination of impact resistance of fiberglass pipe.

C-2 Apparatus.

a. A steel ball 2.0 inches in diameter weighing about 1.2 pounds and flat pipe support.

b. Pipe specimen pressurization equipment, soluble fluorescent dye, and ultraviolet lamp.

C-3 Test Specimens and Conditions. One sample each in 2, 3, 4 and 6-inch diameter shall be tested at 73.4F. The pipe shall be fitted with suitable end closures to permit the sample to be pressurized. The specimen length between the end closures shall be not less than five times the outside diameter of the pipe, but in no case less than 12 inches.

C-4 Procedure.

a. A steel ball 2.0 inches in diameter and weighing about 1.2 pounds shall be dropped squarely onto the surface of the pipe with a free fall (which may be guided) for a distance of 12 inches. The ball may be caught or deflected after the hit so that the rebound does not hit the pipe. The pipe shall be full of water containing a soluble fluorescent dye, but not pressurized.

b. The pipe shall be supported on its bottom axis on a solid flat support. Four drops shall be made on randomly selected areas which are a minimum of one pipe diameter and 90 degrees clockwise from each other.

c. The pipe shall then be pressurized to 3.5 times the rated pressure and shall remain at this pressure for five minutes.

d. The pipe shall be examined with an ultraviolet lamp and the unaided eye. Failure in the test specimens shall be leaking or porosity, or any visible shattering, crack, or split from the impact.

C-5 Report. The report shall include the following items:

a. Complete identification of the specimens, including material, manufacturer's name and lot number.

b. Pipe dimensions including nominal size, minimum reinforced wall thickness and average outside diameter of reinforced wall. Unreinforced thicknesses (i.e., liner) shall also be reported.

c. Number of specimens tested and where the specimens were taken from the pipe.

d. Node of failure or other visual indications.

e. Date of test.

APPENDIX D
SAMPLING PLAN
BASIS: 0.75% AOQL (AVERAGE OUTGOING QUALITY LIMIT)

Lot Size	Sample Size	Allowable No. of Failures To Accept Lot	No. of Failures To Reject Lot
0- 80	ALL	0	1
31- 50	25	0	1
51- 100	33	0	1
101- 200	39	0	1
201- 400	44	0	1
401- 600	45	0	1
	95	1	2
601- 800	46	0	1
	100	1	2
801-1000	47	0	1
	100	1	2

APPENDIX E
PRODUCT CHARACTERISTICS

Changes in the following characteristics of the system shall require testing in accordance with 4.2(b)2.

E-1 Reinforcement. Significant changes shall be filament diameter, yield, or weight; reinforcement finish (sizing); reinforcement manufacturing process (e.g., single end or multiple end); and reinforcement composition.

E-2 Matrix Material (Resin System). Significant changes shall be resin type, curing agent(s) system, curing temperature, and curing schedule for heat-cured products outside manufacturer's specified tolerances.

E-3 Liner. Significant changes shall be the composition, curing, and thickness outside manufacturer's specified tolerances.

E-4 Geometry. Significant changes shall be the winding angle(s) in excess of ±5 degrees; number of resin reinforcement layers and/or reinforcement layer thickness in excess of 30 percent and/or stacking sequence; percent reinforcement in each direction in excess of ±3 percent; and glass to resin ratio in excess of ±3 percent.

E-5 Report. Use of the following reporting format is recommended.

REPORTING FORMAT FOR API SPEC 15LR APPENDIX E — PRODUCT CHARACTERISTICS

E-1 Reinforcement:

Reinforcement manufacturer: _____

Reinforcement manufacturer's product code number: _____

Filament Diameter: _____

Nominal Yield: _____

Reinforcement manufacturer's sizing code number: _____

Form (e.g. single end or multiple end): _____

Reinforcement composition: _____

E-2 Matrix material:

Resin type: _____

Resin manufacturer: _____

Resin manufacturer's product code number: _____

Curing agent(s) system: _____

Curing temperature: _____

Curing schedule: _____

E-3 Liner (if any):

Resin type: _____

Resin manufacturer: _____

Resin manufacturer's product code number: _____

Curing agent(s) system: _____

Curing temperature: _____

Curing schedule: _____

Nominal thickness: _____

Minimum thickness: _____

Maximum thickness: _____

E-4 Geometry:

Wind angle(s): _____

Number of reinforcement layers: _____

Nominal reinforcement layer thickness: _____

Stacking sequence: _____

Percent reinforcement in each direction: _____

Glass to resin ratio: _____

APPENDIX F
REFERENCED STANDARDS

	Designation	Title	Applicable Revision
1.	API Std 5B;	Specification for Threading, Gaging, and Thread Inspection of Casing, Tubing, and Line Pipe Threads	Latest Edition
2.	API Spec. Q1;	Specification for Quality Programs	Latest Edition
3.	ASTM C-582;	Standard Specification for Contact-Molded Reinforced Thermosetting Plastic (RTP) Laminates for Corrosion Resistant Equipment	1987*
4.	ASTM D-696;	Test Method for Coefficient of Linear Thermal Expansion of Plastics	1988*
5.	ASTM D-1599;	Test Method for Short-Time Hydraulic Failure Pressure of Plastic Pipe, Tubing and Fittings	1988*
6.	ASTM D-1694;	Specification for Threads for Reinforced Thermosetting Resin Pipe	1987*
7.	ASTM D-2105;	Test Method for Longitudinal Tensile Properties of Reinforced Thermosetting Plastic Pipe and Tube	1985*
8.	ASTM D-2143;	Test Method for Cyclic Pressure Strength of Reinforced, Thermosetting Plastic Pipe	1987*
9.	ASTM D-2412;	Test Method for External Loading Properties of Plastic Pipe by Parallel — Plate Loading	1987*
10.	ASTM D-2924;	Test Method for External Pressure Resistance of Reinforced Thermosetting Resin Pipe	1986*
11.	ASTM D-2925;	Test Method for Beam Deflection of Reinforced Thermosetting Plastic Pipe Under Full Bore Flow	1976*
12.	ASTM D-2992 — Procedure A and B;	Method for Obtaining Hydrostatic Design Basis for Reinforced Thermosetting Resin Pipe and Fittings	1987*
13.	ASTM D-3567;	Method for Determining Dimensions of Reinforced Thermosetting Resin Pipe (RTRP) and Fittings	1985*
14.	ASTM D-4161;	Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals	1986*

*This was the latest revision available for review by the API Committee on Standardization of Plastic Pipe at the time this edition was printed. Subsequent revisions are subject to API Committee review prior to acceptance as a referenced standard to this specification.

APPENDIX G
REPORTING FORMAT FOR API SPEC 15LR PARAGRAPH 4.1-a "LONG TERM HYDROSTATIC STRENGTH CYCLIC AT 150°F, ASTM D-2992 PROCEDURE A"

Identification of test samples:

Material type (a generic resin description): _____

Material source: _____

Manufacturer's name: _____

Product code number: _____

Previous significant history: _____

Pipe Dimensions:

Nominal size: _____

Average wall thickness: _____

Minimum wall thickness: _____

Average outside diameter: _____

Liner material (if lined): _____

Liner thickness (if lined): _____

Fitting Dimensions:

Nominal size: _____

Average wall thickness: _____

Minimum wall thickness: _____

Average outside diameter: _____

Liner material (if lined): _____

Liner thickness (if lined): _____

Type of fitting: _____

Test temperature: _____

Test environment:

Inside of pipe: _____

Outside of pipe: _____

A table containing the following information for all the specimens tested:

Pipe wall stresses in pounds per square inch

Numbers of cycles to failure (Procedure A)

The nature of the failures (e.g. wall fracture, weep, thread leak,: etc.

Failed part (i.e., fitting or pipe)

Identify specimens under stress for more than 1.5×10^7 cycles.

Estimated long term hydrostatic strength: _____

Stress at log cycles 8.1761 (1.5 x 10^8 cycles) (psi): _____

The hydrostatic design basis (psi): _____

The source of the hydrostatic design basis:

Extrapolated stress value at log cycle 8.1761: _____

Lower confidence value of stress at log cycle 8.1761: _____

The quantity M in Annex A2: _____

The quantity b in equation h = a + bf in Annex A1: _____

The quantity f in equation h = a + bf using values for a and b calculated in Annex A1 and 8.1761 for h: _____

Calculated Hydrostatic Design Basis: _____

Hydrostatic Design Basis category: _____

Any unusual observations:

Dates of tests: _____

Name of laboratory and supervisor: _____

APPENDIX H
USE OF API MONOGRAM

H-1 Board Resolution. The original resolutions adopted by the Board of Directors of the American Petroleum Institute on October 20, 1924, embodied the purpose and conditions under which such official monogram may be used. A restatement of the resolutions was adopted by the Board of Directors on November 14, 1977, and is reproduced herein as Exhibit A.

H-2 API Monogram. The API monogram — API — is a registered trademark/servicemark of the American Petroleum Institute. Authorization to use the monogram is granted by the Institute to qualified licensees for use as a warranty that they have obtained a valid license to use the monogram and that each individual item which bears the monogram conformed, in every detail, with the API Specification applicable at the date of manufacture. However, the American Petroleum Institute does not represent, warrant or guarantee that products bearing the API monogram do in fact conform to the applicable API specification. Such authorization does not include use of the monogram on letterheads or in advertising without the express statement of fact describing the scope of licensee's authorization and further does not include use of the monogram, the name AMERICAN PETROLEUM INSTITUTE or the description "API" in any advertising or otherwise to indicate API approval or endorsement of products.

The formulation and publication of API Specifications and the API monogram program is not intended in any way to inhibit the purchase of products from companies not licensed to use the API monogram.

H-3 Application for Authority to Use Monogram. Manufacturers desiring to mark their products with the monogram may apply for a license to use the monogram with forms provided in an appendix to each applicable API specification.

Separate applications shall be made for each facility at which the manufacturer desires to apply the monogram and for each API Specification, or part thereof, under which authorization is desired to monogram products at that facility.

The monogram program that involves conformance with API Spec Q1 and surveys, as noted in Par. 3.4, 3.7 and 3.8, will be implemented under each API specification according to a schedule developed by the API staff. Existing licensees and applicants under those specifications which have these requirements will be notified prior to implementation. For specifications not yet under the Spec Q1 and survey program, a decision to award or withhold monogram rights will be made on an objective basis by the Institute from information gained from the "Statement of Manufacturer's Qualifications" form provided in the appendix of that specification.

H-4 Authorization to Use the Monogram. Applicants shall have an approved quality program functioning in conformance with API Spec Q1 and with specific requirements of the applicable API Specification at any particular facility prior to being issued a license to use the API monogram at that facility.

A decision to award or withhold monogram rights will be made by the staff of the Institute subsequent to a survey of the applicant's facilities located at the facility where the monogram is to be applied. The decision will be based upon the extent to which the objective evidence collected during the survey substantiates the manufacturer's conformance to his quality program as described in his Quality Manual which shall meet the requirements of the appropriate API specifications including API Spec Q1.

Each facility where the monogram is to be applied will be judged separately. If approved, a separate license will be granted at that facility. These licenses shall not be assignable or transferable by the Licensee in any manner nor shall Licensee have the right to grant sublicenses. The application of the monogram may not be subcontracted.

Each authorization shall be effective for a period of three years, subject to cancellation for cause.

H-5 Application of the Monogram to the Product.

a. The monogram may be applied at any time appropriate to the manufacturing process.

b. Only an API licensee may apply his monogram.

c. The monogram shall be applied at the licensed facility.

d. A marking procedure specified by the applicable API Specification shall be used to apply the monogram and the date of manufacture.

H-6 Fee for Use of Monogram. The fees assessed are to defray the cost of administering the Monogram Program.

Initial Authorization Fee. The applicant will be assessed an initial authorization fee for the first Specification included in the application, and a separate fee for each additional Specification included in the application.

Annual Renewal Fee. In addition to the initial authorization fee, licensees will be assessed an annual renewal fee for each specification under which he is authorized to use the monogram. First-time applicants issued monogram certificates dated November 1 through December 31 shall not be required to pay a renewal fee for the following year.

H-7 Surveys.

Initial and Renewal Surveys. First-time applicants and licensees on every third year renewal of license shall be surveyed by qualified surveyors. The parameters of these surveys shall be the appropriate API specifications and the manufacturer's quality manual. The surveys will be performed to gather objective evidence for API's use in verifying that the manufacturer is in conformance with the provisions of the Manufacturers Quality Program as applicable to the API specifications. The manufacturer will be invoiced for the cost of these surveys.

Periodic Surveys. Existing licensees will be periodically surveyed by an approved API surveyor on a nondiscriminatory basis to determine whether or not they continue to qualify for authorization to use the monogram. The frequency of the periodic surveys will be at the discretion of the staff of the Institute. Costs of periodic surveys will be paid by the Institute.

H-8 Cancellation of Monogram Rights. The right to use the monogram is subject to cancellation for the following causes:

a. Applying the monogram on any product that does not meet the Specification.

b. Failure to maintain or have access to properly maintained reference master gages when required by the Specifications.

c. Failure to meet the requirements of a survey.

d. Failure to pay the annual renewal fee for use of the monogram.

e. For any other nondiscriminatory reason satisfactory to the API Staff.

H-9 Reinstatement of Monogram Rights. Manufacturers whose authorization to use the monogram has been cancelled may request reinstatement at any time. If a request for reinstatement is made within sixty (60) days after cancellation, and if the reason for cancellation has been corrected, no new application is necessary. A resurvey of the manufacturer's facilities will be made by an approved Institute surveyor prior to a decision to reinstate monogram rights. The manufacturer will be invoiced for this resurvey regardless of the Institute's decision on reinstatement. If the result of the resurvey indicates to the API staff that the manufacturer is qualified, the license will be reissued.

Request for reinstatement made more than sixty (60) days after cancellation shall be treated as a new application unless circumstances dictate an extension of this time period as agreed upon by the API staff.

H-10 Appeals. An interested party may appeal a decision by the Institute to withhold monogram rights. Appeals shall be directed to the Director, API Production Department and handled by the General Committee of the Production Department with a further right of appeal to the API Management Committee. Competing suppliers or manufacturers of the product or service to which the standard applies or might apply may not be involved in appeals. The General Committee and the Management Committee may convene appeals boards to hear and act on appeals.

H-11 Users Responsibilities. The effectiveness of the API standardization program can be enhanced by users reporting problems encountered with API monogrammed products to the Institute. API solicits information on both new product nonconformance with API requirements and field failures (or malfunctions) which are judged to be caused by either specification deficiencies or nonconformance with API requirements.

H-12 Special API Records. The API staff shall maintain and publish a current list of manufacturers licensed to use the API monogram for each API Specification. The document titled *Composite List of Manufacturers Licensed for Use of the API Monogram* shall be updated twice a year, and a copy shall be mailed to each licensed facility as soon as practical after receipt from the printer. Copies shall be made available to the public at the same time.

The API staff shall also maintain records of reported problems encountered with API monogrammed products. These records will be used internally only by API in evaluation of the quality program and API specifications and will be held in confidence.

H-13 Marking for API Licensees. The following marking requirements apply to licensed manufacturers using the API monogram on products covered by this specification.

a. Pipe manufactured in conformance with this specification shall be marked by the manufacturer as specified in Section 8.2. (Additional markings as desired by the manufacturer or as requested by the purchaser are not prohibited.) Markings shall be permanent, shall not overlap, and shall be applied in such manner as not to damage the pipe.

b. Pipe shall be marked with the following:

1. Manufacturer's name or mark
2. Size, nominal, inches
3. Cyclic pressure rating
4. Lot number
5. API monogram
6. API license number
7. Date of manufacture

EXHIBIT A
BOARD RESOLUTION

The original resolutions adopted by the Board of Directors of the American Petroleum Institute on Oct. 20, 1924, embodied the purpose and conditions under which such official monogram may be used.

The following restatement of the resolutions was adopted by the Board of Directors on November 14, 1977:

WHEREAS, The Board of Directors of the American Petroleum Institute has caused a review of the Institute's program for licensing the use of the API monogram and

WHEREAS, It now appears desirable to restate and clarify such licensing policy and to confirm and make explicitly clear that it is the licensees, not API, who make the representation and warranty that the equipment or material on which they have affixed the API monogram meets the applicable standards and specifications prescribed by the Institute;

NOW, THEREFORE, BE IT RESOLVED, That the purpose of the voluntary Standardization Program and the Monogram Program of the American Petroleum Institute is to establish a procedure by which purchasers of petroleum equipment and material may identify such equipment and materials as are represented and warranted by the manufacturers thereof to conform to applicable standards and specifications of the American Petroleum Institute; and be it further

RESOLVED, That the previous action under which the following monogram was adopted as the official monogram of the American Petroleum Institute is reaffirmed;

BE IT FURTHER RESOLVED, That the American Petroleum Institute's monogram and standardization programs have been beneficial to the general public as well as the petroleum industry and should be continued and the Secretary is hereby authorized to license the use of the monogram to anyone desiring to do so under such terms and conditions as may be authorized by the Board of Directors of the American Petroleum Institute, provided that the licensee shall agree that the use of the monogram by such licensee shall constitute the licensee's representation and warranty that equipment and materials bearing such monogram complies with the applicable standards and specifications of the American Petroleum Institute; and that licensee shall affix the monogram in the following manner;

BE IT FURTHER RESOLVED, That the words "Official Publication" shall be incorporated with said monogram on all such standards and specifications that may hereafter be adopted and published by the American Petroleum Institute, as follows:

OFFICIAL PUBLICATION

REG. U.S. PATENT OFFICE

APPENDIX I
METRIC CONVERSIONS

US Customary units are in all cases preferential and shall be the standard in this specification.

LENGTH

1 inch (in.) = 25.4 millimetres (mm) exactly

PRESSURE

1 pound per square inch (psi) = 0.06894757 Bar

NOTE: 1 Bar = 100 kilopascals (kPa)

STRENGTH OR STRESS

1 pound per square inch (psi) = 0.006894757 Megapascals (MPa)

IMPACT ENERGY

1 foot-pound (ft-lb) = 1.3558181 Joules (J)

TORQUE

1foot-pound (ft-lb) = 1.3558181 newton-metres (N m)

TEMPERATURE

The following formula was used to convert degrees Fahrenheit (°F) to degrees Celsius (°C):

$$°C = 5/9 (F-32)$$

MASS

1 pound (lb) = 0.4535924 kilograms (kg)

PUBLICATIONS LIST

The following related publications are under the jurisdiction of the API Committee on Standardization of Plastic Pipe and are available from the American Petroleum Institute, 1220 L Street, Northwest, Washington, DC 20005; (202) 682-8375.

SPECIFICATIONS

Spec 15HR: Specification for High Pressure Fiberglass Line Pipe.
This specification covers high pressure fiberglass line pipe for use in the production of oil and gas.

RECOMMENDED PRACTICES

RP 15A4: Recommended Practice for Care and Use of Reinforced Thermosetting Resin Casing and Tubing.
Provides information on transporting, handling and installing reinforced thermosetting resin casing and tubing in oil field usage.

RP 15L4: Recommended Practice for Care and Use of Reinforced Thermosetting Resin Line Pipe (RTRP).
Provides information on the transporting, handling, installing, and repairing of reinforced thermosetting resin line pipe (RTRP) in oil field usage.

Order No. 811-07226