Standard Specification
for

Corrugated Polyethylene Pipe, 305 to 915-mm (12- to 36-in.) Diameter

AASHTO DESIGNATION: M 294-94

1. SCOPE

1.1 This specification covers the requirements and methods of tests for corrugated polyethylene (PE) pipe, couplings, and fittings for use in surface and subsurface drainage applications.

1.1.1 Nominal sizes of 305 to 915 mm (12 to 36 in.) are included.

1.1.2 Materials, workmanship, dimensions, pipe stiffness, environmental stress crack resistance, joining systems, brittleness, and form of markings are specified.

1.2 Corrugated polyethylene pipe is intended for surface and subsurface drainage applications where soil provides support to its flexible walls. Its major use is to collect or convey drainage water by open gravity flow, as culverts, storm drains, etc.

NOTE 1—When polyethylene pipe is to be used in locations where the ends may be exposed (as in culverts), consideration should be given to protection of the exposed portions due to combustibility of the polyethylene and the deteriorating effects of prolonged exposure to ultraviolet radiation.

1.3 The values stated in SI units are to be regarded as the standard.

1.4 This specification does not include requirements for bedding, backfill, or earth cover load. Successful performance of this product depends upon proper type of bedding and backfill, and care in installation. The structural design of corrugated polyethylene pipe and the proper installation procedures are given in the AASHTO *Standard Specifications for Highway Bridges*. Upon request of the user or engineer, the manufacturer shall provide profile wall section detail required for a full engineering evaluation.

2. REFERENCED DOCUMENTS

2.1 *ASTM Standards:*

- D 618 Conditioning Plastics and Electrical Insulating Materials for Testing
- D 883 Terms Relating to Plastics
- D 1693 Environmental Stress Cracking of Ethylene Plastics
- D 2122 Determining Dimensions of Thermoplastic Pipe and Fittings
- D 2412 Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
- D 2444 Test for Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)
- D 3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
- F 412 Terms Relating to Plastic Piping Systems

2.2 *AASHTO Standard:*

Standard Specification for Highway Bridges

3. TERMINOLOGY

3.1 The terminology used in this standard is in accordance with the definitions given in ASTM D 883 and ASTM F 412 unless otherwise specified.

3.2 Crack: Any break or split that extends through the wall.

3.3 Crease: An irrecoverable indentation, generally associated with wall buckling.

3.4 Buckling: Any reverse curvature or deformation in the pipe wall that reduces the load carrying capability of the pipe.

3.5 *Reworked Material*—as defined for "reworked plastic (thermoplastic)" in ASTM D 883.

4. CLASSIFICATION

4.1 The corrugated Polyethylene Pipe covered by this specification is classified as follows:

4.1.1 Type C—This pipe shall have a full circular cross-section, with a corrugated surface both inside and outside. Corrugations may be either annular or helical.

4.1.2 Type S—This pipe shall have a full circular cross-section, with an outer corrugated pipe wall and a smooth inner liner. Corrugations may be either annular or helical.

4.1.3 Type CP—This pipe shall be Type C with perforations.

4.1.4 Type SP—This pipe shall be Type S with perforations.

4.2 Two classes of perforations are as described in Sections 7.3.1 and 7.3.2.

5. ORDERING INFORMATION

5.1 Orders using this specification shall include the following information as necessary to adequately describe the desired product.

5.1.1 AASHTO designation and year of issue.

5.1.2 Type of pipe (see Section 4.1).

5.1.3 Diameter and length required, either total length or length of each piece and number of pieces,

5.1.4 Number of couplings,

5.1.5 Class of perforations (Class 2 is furnished if not specified) (see Section 7.3), and

5.1.6 Certification, if desired (see Section 12.1).

6. MATERIALS

6.1 Basic Materials:

6.1.1 *Extruded Pipe and Blow Molded Fittings:* Pipe and fittings shall be made of virgin PE compounds which conform with the requirements of cell class 324420C as defined and described in ASTM D 3350, except that the carbon black content shall not exceed 5 percent. Compounds that have higher cell classifications in one or more properties are acceptable provided product requirements are met.

6.1.2 *Rotational Molded Pipe and Fittings:* Pipe and fittings shall be made of virgin PE compounds which conform with the requirements of cell class 213320C as defined and described in ASTM D 3350, except that the carbon black content shall not exceed 5 percent. Compounds that have higher cell classifications in one or more properties are acceptable provided product requirements are met.

6.2 *Reworked Material:* In lieu of virgin PE, clean reworked material may be used by the manufacturer, provided that it meets the cell class requirements as described in Section 6.1.

7. REQUIREMENTS

7.1 *Workmanship:* The pipe and fittings shall be free of foreign inclusions and visible defects as defined herein. The ends of the pipe shall be cut squarely and cleanly so as not to adversely affect joining or connecting.

7.1.1 *Visible Defects:* Cracks, creases, unpigmented or nonuniformly pigmented pipe are not permissible in the pipe as furnished.

7.1.2 For Type S pipe, the inner liner shall be fused to the outer corrugated shell at all internal corrugation crests.

7.2 *Pipe Dimensions:*

7.2.1 *Nominal Size:* The nominal size for the pipe and fittings is based on the nominal inside diameter of the pipe. Nominal diameters shall be 305, 380, 455, 610, 760, and 915 mm (12, 15, 18, 24, 30 and 36 in.).

7.2.2 *Inside Diameter Tolerances:* The tolerance on the specified inside diameter shall be 3 percent oversize and 1.5 percent undersize, but not more than 12.7 mm (1/2 in.) either oversize or undersize when measured in accordance with Section 9.6.1.

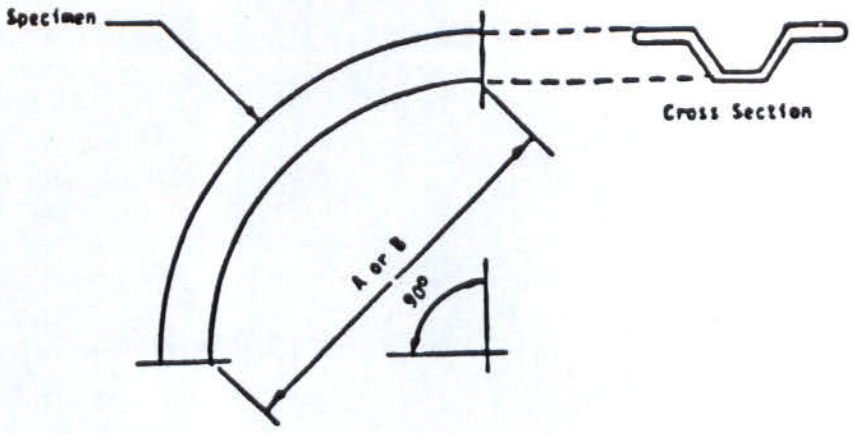


FIGURE 1 Specimen Configuration for Environmental Stress Cracking (Section 9.4.2).

7.2.3 *Length:* Corrugated PE pipe may be sold in any length agreeable to the user. Lengths shall not be less than 99 percent of the stated quantity when measured in accordance with Section 9.6.2.

7.3 *Perforations:* When perforated pipe is specified, the perforations shall conform to the requirements of Class 2, unless otherwise specified in the order. Class 1 perforations are for pipe intended to be used for subsurface drainage or combination storm and underdrain. Class 2 perforations are for pipe intended to be used for subsurface drainage only. The perforations shall be cleanly cut so as not to restrict the inflow of water. Pipe connected by couplings or bands may be unperforated within 100 mm (4 in.) of each end of each length of pipe.

7.3.1 *Class 1 Perforations:* The perforations shall be approximately circular and shall have nominal diameters of not less than 4.8 mm (3/16 in.) nor greater than 9.5 mm (3/8 in.) and shall be arranged in rows parallel to the axis of the pipe. The perforations shall be located in the external valleys with perforations in each row for each corrugation. The rows of perforations shall be arranged in two equal groups placed symmetrically on either side of the lower unperforated segment corresponding to the flow line of the pipe. The spacing of the rows shall be uniform. The distance between the center lines of the rows shall not be less than 25 mm (1 in.). The minimum number of longitudinal rows of perforations, the maximum height of the center lines of the uppermost rows of perforations above the bottom of the invert, and the inside chord lengths of the unperforated segments illustrated in Figure 2 shall be as specified in Table 1.

7.3.2 *Class 2 Perforations:* Circular perforations shall be a minimum of 6.4 mm (1/4 in.) and shall not exceed 9.5 mm (3/8 in.) in diameter. The width of slots shall not exceed 3.2 mm (1/8 in.). The length of slots shall not exceed 64 mm (2.5 in.) for 305 mm (12 in.) and 380 mm (15 in.) pipe and 77 mm (3.0 in.) for 455 mm (18 in.) and larger pipe. Perforations shall be placed in the external valleys and uniformly spaced along the length and circumference of the pipe. The water inlet area shall be a minimum of 31.8 cm²/m (1.5 in.²/ft) for pipe sizes 305 to 455 mm (12 to 18 in.) and 42.3 cm²/m (2.0 in.²/ft) for pipe sizes larger than 455 mm (18 in.). All measurements shall be made in accordance with Section 9.6.3.

7.4 *Pipe Stiffness:* The pipe shall have a minimum pipe stiffness at five percent deflection as follows when tested in accordance with Section 9.1.

Diameter mm	Diameter in.	Pipe Stiffness kPa	Pipe Stiffness psi
305 mm	12	344 kPa	50
380 mm	15	289 kPa	42
455 mm	18	276 kPa	40
610 mm	24	235 kPa	34
760 mm	30	193 kPa	28
915 mm	36	152 kPa	22

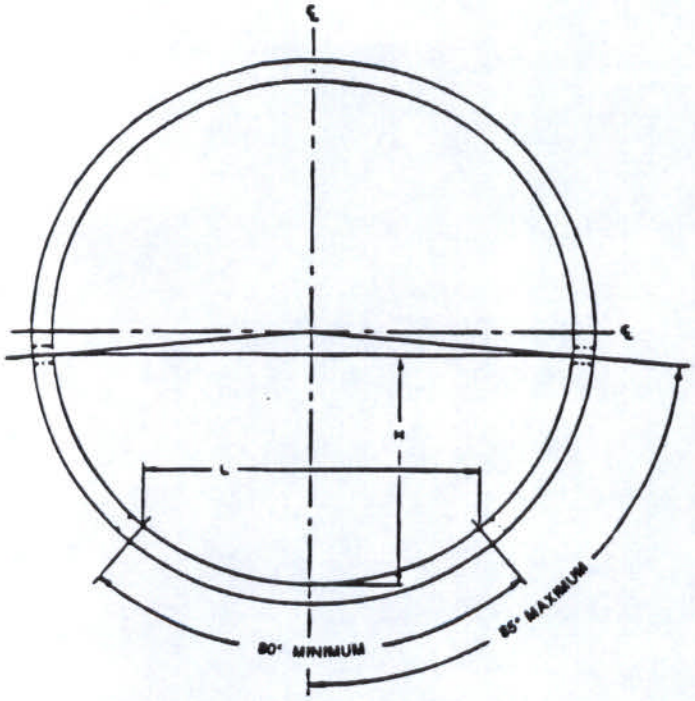


FIGURE 2 Requirements for Perforations

TABLE 1 Rows of Perforations, Height "H" of the Centerline of the Uppermost Rows Above the Invert, and Chord Length "L" of Unperforated Segment, for Class I Perforations

Diameter mm	Nominal in.	Rows of Perforations[A]	H, Maximum[B] mm	H, Maximum[B] in.	L, minimum[B] mm	L, minimum[B] in.
305	12	6	138	5.5	192	7.7
380	15	6	184	6.9	256	9.6
455	18	6	207	8.3	288	11.5
610 and larger	24 and larger	8	(C)	(C)	(C)	(C)

[A] Minimum number of rows. A greater number of rows for increased inlet area shall be subject to agreement between purchaser and manufacturer.

[B] See Figure 2 for location of dimensions "H" and "L."

[C] H (max.) = 0.46D; L (min.) = 0.64D, where D = nominal diameter of pipe, inches or millimeters as appropriate.

7.5 *Pipe Flattening:* There shall be no evidence of wall buckling, cracking, splitting, or delamination, when the pipe is tested in accordance with Section 9.2.

7.6 *Environmental Stress Cracking:* There shall be no cracking of the pipe when tested in accordance with Section 9.4.

7.7 *Brittleness:* Pipe specimens shall not crack or split when tested in accordance with Section 9.3. Five non-failures out of six impacts will be acceptable.

7.8 *Fitting Requirements:*

7.8.1 The fittings shall not reduce or impair the overall integrity or function of the pipe line.

7.8.2 Common corrugated fittings include in-line joint fittings, such as couplings and reducers, and branch or complimentary assembly fittings such as tees, wyes, and end caps. These fittings are installed by various methods, such as snap-on, screw-on, and wrap around.

NOTE 2—Only fittings supplied or recommended by the pipe manufacturer should be used. Joints are not intended to be watertight. Soil tightness is a function of opening size, channel length, and backfill particle size. A backfill material containing a high percentage of fine-graded soils requires investigation for the specific type of joint to be used to guard against soil infiltration. Information regarding joint soil tightness criteria can be found in *AASHTO Standard Specifications for Highway Bridges*, Division II, Section 26.

7.8.3 All fittings shall be within an overall length dimensional tolerance ±12.7 mm (±0.5 in.) of the manufacturer's specified dimensions when measured in accordance with Section 9.6.2.

7.8.4 Fittings shall not reduce the inside diameter of the pipe being joined by more than 12.7 mm (0.5 in.). Reducer fittings shall not reduce the cross-sectional area of the small size.

7.8.5 Couplings shall be corrugated to match the pipe corrugations and shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints. Couplings shall be bell and spigot, split collar, or screw-on collar. Split collar couplings shall engage at least two full corrugations on each pipe section and screw on collars shall be in width at least one-half the nominal diameter of the pipe.

7.8.6 Pipe connections shall not separate to create a gap exceeding 4.8 mm ($^3/_{16}$ in.) when measured in a radial direction between pipe and coupling, or between tongue and groove portions of pipe, when tested according to Section 9.5.1. Fittings shall not crack or delaminate.

7.8.7 The design of the fittings shall be such that when connected with the pipe, the axis of the assembly will be level and true when tested in accordance with Section 9.5.2.

7.8.8 Other types of coupling bands or fastening devices which are equally effective as those described, and which comply with the joint performance criteria of AASHTO *Standard Specifications for Highway Bridges*, Division II, Section 26, may be used when approved by the purchaser.

8. CONDITIONING

8.1 *Conditioning:* Condition the specimen prior to test at 21 to 25°C (70 to 77°F) for not less than 40 hours in accordance with Procedure A in ASTM D 618 for those tests where conditioning is required, and unless otherwise specified.

8.2 *Conditions:* Conduct all tests at a laboratory temperature of 21 to 25°C (70 to 77°F) unless otherwise specified herein.

9. TEST METHODS

9.1 *Pipe Stiffness:* Select a minimum of three (3) pipe specimens and test for

pipe stiffness (PS), as described in ASTM D 2412 except for the following: (1) the test specimens shall be a minimum of one diameter length; (2) locate the first specimen in the loading machine with an imaginary line connecting the two seams formed by the corrugation mold (end view) parallel to the loading plates, when applicable. The specimen must lie flat on the plate within 3.2 mm ($^1/_8$ in.) and may be straightened by hand bending at room temperature to accomplish this. Use the first location as a reference point for rotation and testing of the other two specimens. Test each specimen in one position only; (3) the deflection indicator shall be readable and accurate to ±0.03 mm (±0.001 in.); (4) the residual curvature found in tubing frequently results in an erratic initial load/deflection curve. When this occurs, project the lineal portion of the load/deflection curve between 0 and 5 percent deflection until it intersects the deflection axis. The point shall be considered as the origin of the load deflection curve.

NOTE 3—The parallel plates must exceed the length of the test specimen as specified above.

9.2 *Pipe Flattening:* Flatten the three pipe specimens from Section 9.1 until the vertical inside diameter is reduced by 20 percent. The rate of loading shall be the same as in Section 9.1. Examine the specimen with the unaided eye for cracking, splitting, or delamination. Wall buckling is indicated by reverse curvature in the pipe wall accompanied by a decrease in load carrying ability of the pipe.

9.3 *Brittleness:* Test pipe specimens in accordance with ASTM D 2444 except six specimens shall be tested, or six impacts shall be made on one specimen. In the latter case, successive impacts shall be separated by 120 ± 10 degrees for impacts made on one circle, or at least 0.3 m (1 ft.) longitudinally for impacts made on one element. Impact points shall be at least 150 mm (6 in.) inches from the end of the specimen. Tup B shall be used, with a mass of 4.54 kg (10 lb). The height of drop shall be 3.05 m (10 ft). Use a flat plate specimen holder. Condition the specimens for 24 hours at a temperature of −3.9 ± 2°C (25 ± 3.6°F), and conduct all tests within 60 seconds of removal from this atmosphere. If all tests on a specimen are not completed in 60 seconds from removal from the conditioning temperature, immediately return the specimen to the conditioning environment for a minimum of 20 minutes before continuing the test. The center of the falling tup shall strike on a corrugation crown for all impacts.

9.4 *Environmental Stress Cracking:* Test sections of the pipe for environmental stress cracking in accordance with ASTM D 1693, except for the following modifications:

9.4.1 Three (3) specimens shall be tested.

9.4.2 Each specimen shall consist of a 90 degree arc length of pipe as shown in Figure 1.

9.4.3 Bend the specimens to shorten the inside chord length 20 ± 1 percent and retain in this position using a suitable holding device. Determine the arc chord dimension (B) of the specimen under test as follows:

$$B = 0.8A$$

where:

A = the inside chord dimension before bending
B = the same dimension taken after bending (see Figure 1).

9.4.4 Place the bent specimen in a container of suitable size and cover completely with a preheated wetting agent at 50°C ± 2°C (122 ± 3.6°F). Maintain this temperature for 24 hours, and then remove the sample and inspect immediately. The wetting agent used in this test shall be 100 percent "Igepal CO-630," a trade name for nonylphenoxy poly(ethyleneoxy)ethanol.

9.5 *Fittings:*

9.5.1 *Joint Integrity:* Assemble each fitting or coupling to the appropriate pipe in accordance with the manufacturer's recommendations. Use pipe samples at least 305 mm (12 in.) in length. In the case of tongue and groove connections, assemble a specimen at least 610 mm (24 in.) in length with the connection at the center. Load the connected pipe and fitting between parallel plates at the rate of 12.7 mm/min (0.5 in./min.) per minute until the vertical inside diameter is reduced by at least 20 percent of the nominal diameter of the pipe. Inspect for damage while at the specified deflection, and after load removal. Measure the maximum radial distance between pipe and fittings, or between tongue and groove, during test and after load removal.

9.5.2 *Alignment:* Assure that the assembly or joint is correct and complete. If the pipe is bent, it should be straightened prior to performing this test. Lay the assembly or joint on a flat surface and verify that it will accommodate straight-line flow.

9.6 *Dimensions:*

9.6.1 *Inside Diameter:* Measure the inside diameter of the pipe with a tapered plug in accordance with ASTM D 2122. As an alternative, measure the inside diameter with a suitable device accurate to ± 3 mm (± $^1/_8$ in.) on two sections. Take eight measurements equally spaced around the circumference of each section and average these sixteen measurements. The average inside diameter shall meet the requirements of Section 7.2.2.

9.6.2 *Length:* Measure pipe with any suitable device accurate to 0.2 percent (2 mm/m) (0.24 in./ft). Make all measurements on the pipe while it is stress-free and at rest on a flat surface in a straight line.

9.6.3 *Perforations:* Measure dimensions of perforations on a straight specimen with no external forces applied. Make linear measurements with instruments accurate to 0.2 mm (0.01 in.).

10. INSPECTION AND RETEST

10.1 *Inspection:* Inspection of the material shall be made as agreed upon by the purchaser and the seller as part of the purchase contract.

10.2 *Retest and Rejection:* If any failure to conform to these specifications occurs, the pipe or fittings may be retested to establish conformity in accordance with agreement between the purchaser and seller. Individual results, not averages, constitute failure.

11. MARKING

11.1 All pipe shall be clearly marked at intervals of no more than 3 m (10 ft) as follows:

11.1.1 Manufacturer's name or trademark.

11.1.2 Nominal size.

11.1.3 This specification designation, AASHTO M 294.

11.1.4 The plant designation code.

11.1.5 The date of manufacture or an appropriate code.

11.2 Fittings shall be marked with the designation number of this specification, AASHTO M 294, and with the manufacturer's identification symbol.

12. QUALITY ASSURANCE

12.1 A manufacturer's certificate that the product was manufactured, tested, and supplied in accordance with this specification, together with a report of the test results, and the date each test was completed, shall be furnished upon request. Each certification so furnished shall be signed by a person authorized by the manufacturer.

HANCOR SURE-LOK® ST IB PIPE (per AASHTO) SPECIFICATIONS

Scope
This specification describes 4- through 60-inch (100 to 1500 mm) Hancor Sure-Lok ST IB pipe (per AASHTO) for use in gravity flow drainage applications.

Pipe Requirements
Sure-Lok ST IB pipe (per AASHTO) shall have a smooth interior and annular exterior corrugations.
- 4- through10-inch (100 to 250 mm) shall meet AASHTO M252, Type S.
- 12- through 60-inch (300 to 1500 mm) shall meet AASHTO M294, Type S or ASTM F2306.
- Manning's "n" value for use in design shall be 0.012.

Joint Performance
Pipe shall be joined using a bell & spigot joint meeting AASHTO M252, AASHTO M294 or ASTM F2306. The joint shall be soil-tight and gaskets, when applicable, shall meet the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable wrap to ensure the gasket is free from debris. A joint lubricant supplied by the manufacturer shall be used on the gasket and bell during assembly.

Fittings
Fittings shall conform to AASHTO M252, AASHTO M294, or ASTM F2306. Bell and spigot connections shall utilize a spun-on or welded bell and valley or saddle gasket meeting the soil-tight joint performance requirements of AASHTO M252, AASHTO M294 or ASTM F2306.

Material Properties
Virgin material for pipe and fitting production shall be high density polyethylene conforming with the minimum requirements of cell classification 424420C for 4- through 10-inch (100 to 250 mm) diameters, or 435400C for 12- through 60-inch (300 to 1500 mm) diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 4%. The 12- through 60-inch (300 to 1500 mm) virgin pipe material shall comply with the notched constant ligament-stress (NCLS) test as specified in Sections 9.5 and 5.1 of AASHTO M294 and ASTM F2306, respectively.

Installation
Installation shall be in accordance with ASTM D2321 and Hancor recommended installation guidelines with the exception that minimum cover in trafficked areas for 4- through 48-inch (100 to 1200 mm) diameters shall be one foot (0.3 m) and for 54- and 60-inch (1350 and 1500 mm) diameters shall be 2 ft (0.6 m) in single run applications. Backfill for minimum cover situations shall consist of Class 1, Class 2 (minimum 90% SPD) or Class 3 (minimum 90%) material. Maximum fill heights depend on embedment material and compaction level; please refer to Technical Note 2.01. Contact your local Hancor representative or visit our website at www.hancor.com for a copy of the latest installation guidelines.

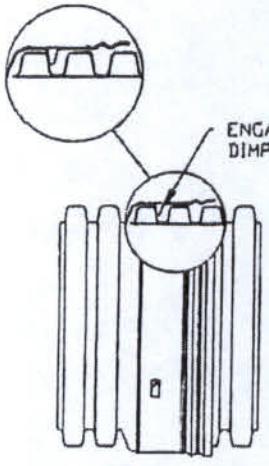
Pipe Dimensions

	Nominal Diameter, in (mm)													
Pipe I.D. in (mm)	4 (100)	6 (150)	8 (200)	10 (250)	12 (300)	15 (375)	18 (450)	24 (600)	30 (750)	36 (900)	42 (1050)	48 (1200)	54* (1350)	60 (1500)
Pipe O.D.** in (mm)	4.8 (122)	6.9 (175)	9.1 (231)	11.4 (290)	14.5 (368)	18 (457)	22 (559)	28 (711)	36 (914)	42 (1067)	48 (1219)	54 (1372)	61 (1549)	67 (1702)
Perforations	All diameters available with or without perforations													

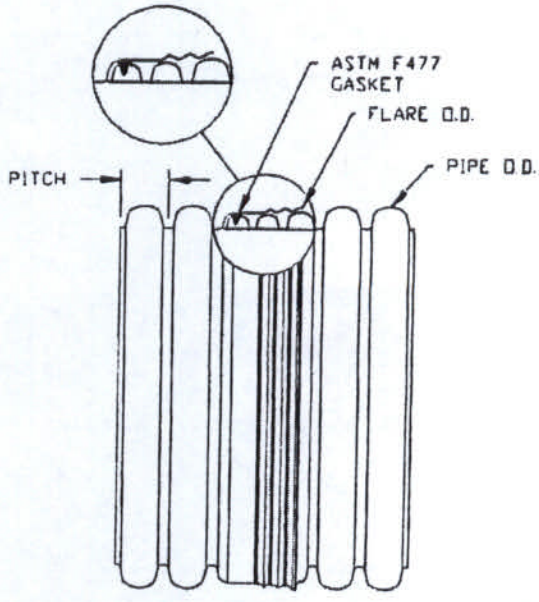
*Check with sales representative for availability by region.
**Pipe O.D. values are provided for reference purposes only, values stated for 12- through 60-inch are ± 1 inch. Contact a sales representative for exact values.

SURE-LOK® ST IB PIPE (per AASHTO) JOINING SYSTEM

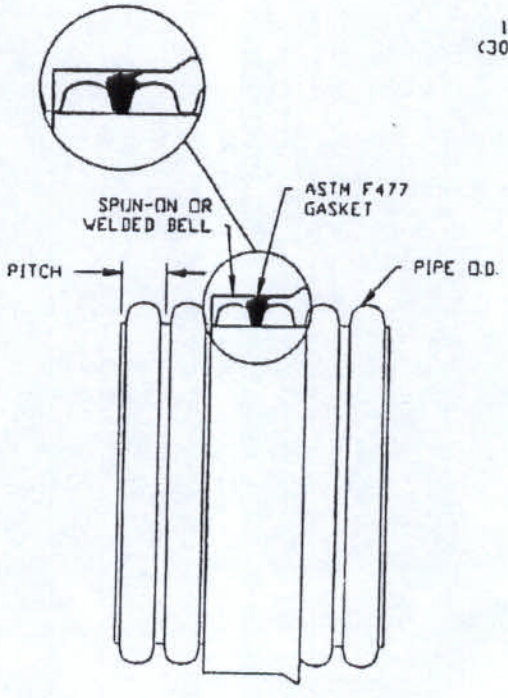
(Joint configuration & availability subject to change without notice. Product detail may differ slightly from actual product appearance.)



4" - 10"
(100-250 MM)



12" - 60"
(300-1500 MM)



4" - 60"
(100-1500 MM)