



# Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe<sup>1</sup>

This standard is issued under the fixed designation F2435; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers requirements and test methods for materials, dimensions, workmanship, elongation, impact resistance, pipe stiffness, perforations, and markings for steel reinforced corrugated polyethylene (PE) piping systems of nominal sizes 8 in. (200 mm), through 80 in. (2000 mm). The steel reinforced polyethylene pipes governed by this standard are intended for use in underground applications where soil provides support for their flexible walls. These pipes will be used to collect or convey stormwater runoff for storm sewers and drainage pipes, or both.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 There is no similar or equivalent ISO standard.

1.4 *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.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

**A591/A591M** Specification for Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Weight [Mass] Applications (Withdrawn 2005)<sup>3</sup>

**A653/A653M** Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

**A1008/A1008M** Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-

Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

**D618** Practice for Conditioning Plastics for Testing

**D2122** Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

**D2321** Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

**D2412** Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

**D3212** Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

**D3350** Specification for Polyethylene Plastics Pipe and Fittings Materials

**F412** Terminology Relating to Plastic Piping Systems

**F449** Practice for Subsurface Installation of Corrugated Polyethylene Pipe for Agricultural Drainage or Water Table Control

**F477** Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

**F2136** Test Method for Notched, Constant Ligament-Stress (NCLS) Test to Determine Slow-Crack-Growth Resistance of HDPE Resins or HDPE Corrugated Pipe

### 2.2 AASHTO Standard<sup>4</sup>

Standard Specification for Highway Bridges, Division II, Section 30, "Metal Culverts."

### 2.3 Federal Standards:<sup>5</sup>

**Fed. Std. No. 123** Marking for Shipment (Civil Agencies)

### 2.4 Military Standards:<sup>5</sup>

**MIL-STD-129** Marking for Shipment and Storage

## 3. Terminology

3.1 **Definitions**—Definitions used in this specification are in accordance with Terminology **F412**, unless otherwise noted.

### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *double-wall steel reinforced polyethylene corrugated pipe, n*—polyethylene corrugated pipe with steel reinforcing helical V-shaped profile encapsulated within the corrugations and with a closed channel on the inside of the pipe (See Fig. 2).

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee **F17** on Plastic Piping Systems and is the direct responsibility of Subcommittee **F17.11** on Composite.

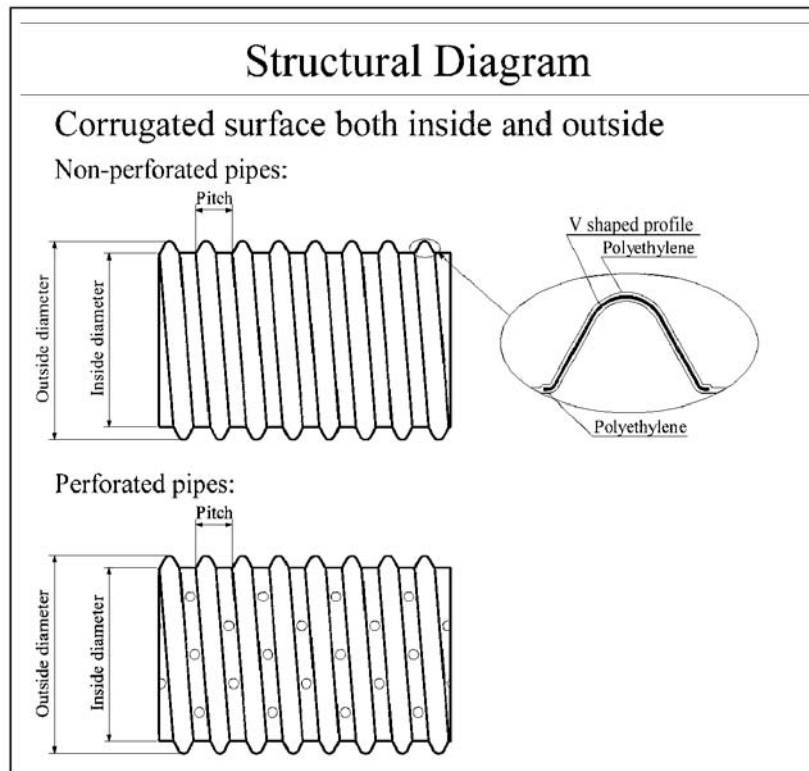
Current edition approved July 1, 2012. Published August 2012.. Originally approved in 2005. Last previous edition approved in 2007 as F2435–07. DOI: 10.1520/F2435-12.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

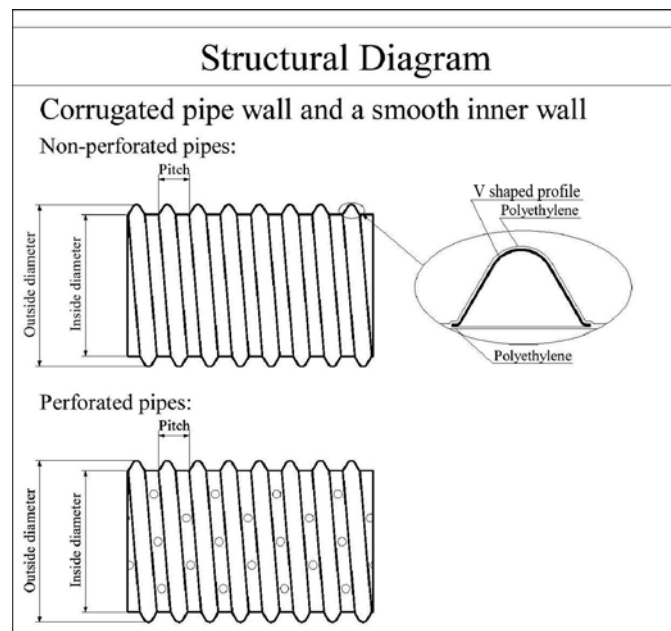
<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>4</sup> Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001.

<sup>5</sup> Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.



**FIG. 1 Single-Wall Steel Reinforced Corrugated Polyethylene Pipe – Types I, III and IV**



**FIG. 2 Double-Wall Steel Reinforced Corrugated Polyethylene Pipe – Types I, III and IV**

3.2.2 *single-wall steel reinforced polyethylene corrugated pipe, n*—polyethylene corrugated pipe with steel reinforcing helical V-shaped profile encapsulated within the corrugations and with an open channel on the inside of the pipe (See Fig. 1).

3.2.3 *triple-wall, adj*—polyethylene corrugated pipe with steel reinforcing profiles either helical V-shaped profiles or U-shaped profiles encapsulated within the corrugations and with steel reinforcing helical flat profiles encapsulated within

the exterior polyethylene layer and with a closed channel (polyethylene layer) on the inside of the pipe (See Fig. 3 and Fig. 4).

3.2.4 *Steel Reinforced Polyethylene Corrugated Pipe (SR-PCP)*, *n*—single wall, double wall or triple wall, helical (spiral) corrugated pipe with steel reinforcing ribs, either V-shaped or U-shaped, encapsulated within polyethylene.

#### 4. Significance and Use

4.1 Steel reinforced corrugated PE pipes are used for underground applications where soil provides support to their flexible walls. Their major use is to collect or convey storm water run-off for sewers and drains, or both.

4.2 Exclusions from recommended use:

4.2.1 Permanent exposure to sunlight and exposure to chemicals whose compatibility with the pipe and fittings is not known.

#### 5. Materials

5.1 *Polyethylene Materials*:

5.1.1 Polyethylene compounds used in the manufacture of steel reinforced corrugated PE drainage pipe shall meet or exceed the requirements of cell classification of 333430C as defined and described in Specification D3350.

5.1.2 Slow crack growth resistance of the polyethylene compound shall be determined by testing in accordance with Test Method F2136. The applied stress shall be 600 psi (4100 kPa). The test specimens must exceed 41 h with no failures. Testing shall be done on polyethylene material taken from the finished pipe.

5.1.3 *Carbon Black Content*—Minimum 2.0 wt. % to a maximum 3.0 wt. % of the total of the polyethylene compound.

5.2 *Steel Materials*:

5.2.1 The minimum thickness of the steel sheet shall be as listed in Tables 1-4. The steel substrate shall conform to Specification A1008/A1008M or A653/A653M, and the minimum yield strength of the steel sheet shall not be less than 24.66 ksi (170 MPa). The zinc-galvanized coating shall have a minimum zinc coating designation of 20Z (intermediate coating) as defined in Specification A591/A591M.

5.2.2 *Steel Material Content*—Maximum 75% ( $\pm 2\%$ ) of the total weight of the pipe. The steel material is fully encapsulated by the polyethylene material with a minimum thickness of the polyethylene at its thinnest point of 0.012 in. (0.3 mm).

5.3 *Rework Material*—Rework material is not to be used in the manufacture of this product.

5.4 *Gaskets*—Elastomeric gaskets shall comply with the requirements specified in Specification F477.

5.5 *Lubricant*—The lubricant used for assembly of gasketed joints shall have no detrimental effect on the gasket or on the pipe.

NOTE 1—The purpose of the HDPE encapsulation of the steel is to attain bonding between the steel and PE to form a composite structure. The PE encapsulation is not for protecting the steel from corrosion damage. The minimum PE thickness of 0.012 in. at the thinnest point still maintains the bond between the steel and PE. The pipe is designed to combine pipe stiffness and buckling performance. The thickness of the HDPE encapsulation does not affect product performance.

#### 6. Requirements

6.1 *Workmanship*—The inside and outside surfaces of the pipe shall be semi-matte or glossy in appearance and free of chalking, sticky, or tacky materials. The pipe wall shall not have cracks, holes, blisters, voids, foreign inclusions or other defects that are visible to the naked eye and that can affect the wall integrity or the bonding to the steel reinforcement. Holes deliberately placed in perforated pipe are permitted. The surface shall be free of bloom.

6.2 *Pipe Dimensions and Tolerances*:

6.2.1 Pipe Dimensions (for both perforated and non-perforated pipe) shall comply with Table 1, Table 3, and Table 4 for single-wall and double-wall pipe and Table 2 for triple-wall pipe, when measured in accordance with Test Method D2122.

6.2.2 *Inside Diameter*—The tolerance on the nominal inside diameter shall be  $\pm 2.0\%$ , when measured in accordance with section 8.3.

6.2.3 *Outside Diameter*—The tolerance on the nominal outside diameter shall be  $\pm 2.0\%$ , when measured in accordance with section 8.4.

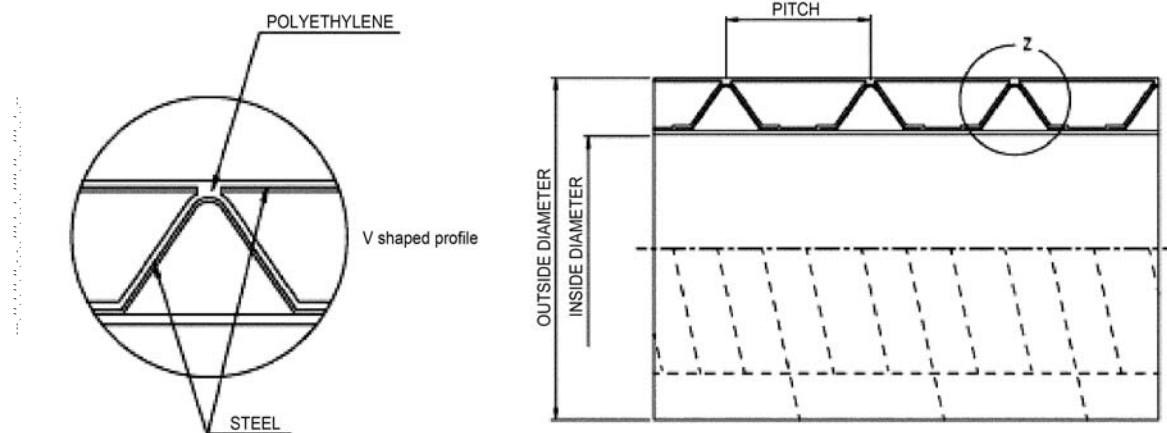


FIG. 3 Triple-Wall Steel Reinforced Corrugated Polyethylene Pipe – Type IIA

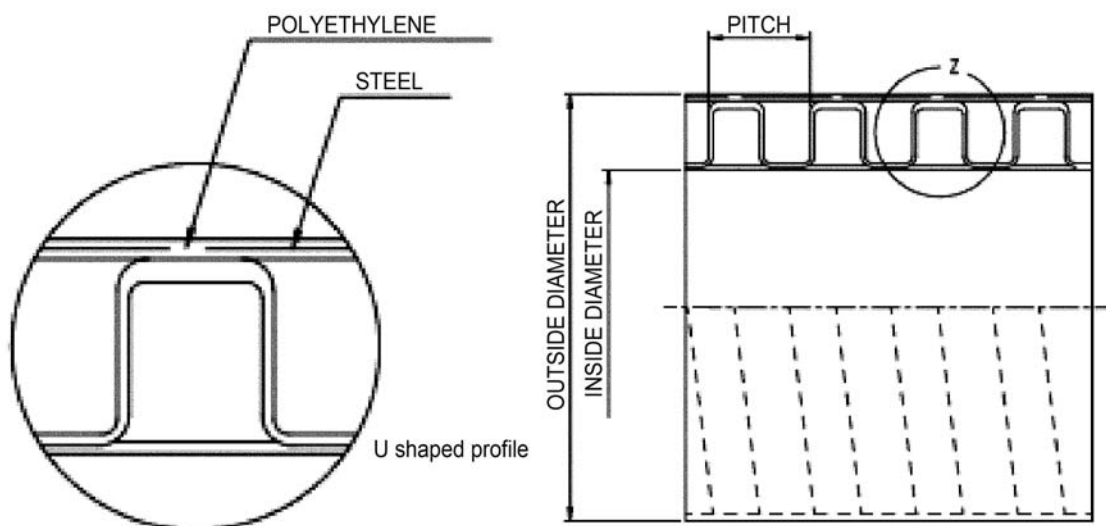


FIG. 4 Triple-Wall Steel Reinforced Corrugated Polyethylene Pipe – Type IIB

TABLE 1 Dimensions and Pipe Stiffness for Single-Wall Pipe and Double-Wall Pipe – Type I (V-shaped profile)

| Nominal Size |      | Inside Diameter |      | Outside Diameter |        | Pitch |       | Waterway Wall Thickness (min) |      | Minimum Steel Thickness |      | Minimum Pipe Stiffness |      |
|--------------|------|-----------------|------|------------------|--------|-------|-------|-------------------------------|------|-------------------------|------|------------------------|------|
| inch         | mm   | inch            | mm   | inch             | mm     | inch  | mm    | inch                          | mm   | inch                    | mm   | psi                    | MPa  |
| 8            | 200  | 8.0             | 203  | 9.1              | 231.1  | 2.16  | 54.9  | 0.13                          | 3.3  | 0.0118                  | 0.30 | 58                     | 0.40 |
| 10           | 250  | 10.0            | 254  | 10.95            | 278.1  | 2.16  | 54.9  | 0.13                          | 3.3  | 0.0118                  | 0.30 | 58                     | 0.40 |
| 12           | 300  | 12.0            | 305  | 13.12            | 333.2  | 2.16  | 54.9  | 0.13                          | 3.3  | 0.0118                  | 0.30 | 58                     | 0.40 |
| 18           | 450  | 18.0            | 457  | 19.58            | 497.3  | 2.63  | 66.8  | 0.165                         | 4.2  | 0.0157                  | 0.40 | 58                     | 0.40 |
| 24           | 600  | 24.0            | 610  | 26.56            | 674.6  | 3.42  | 86.9  | 0.165                         | 4.2  | 0.0157                  | 0.40 | 58                     | 0.40 |
| 28           | 700  | 28.0            | 711  | 30.85            | 783.6  | 3.85  | 97.8  | 0.204                         | 5.2  | 0.0157                  | 0.40 | 58                     | 0.40 |
| 32           | 800  | 32.0            | 813  | 35.11            | 891.8  | 4.25  | 108.0 | 0.212                         | 5.4  | 0.0157                  | 0.40 | 58                     | 0.40 |
| 36           | 900  | 36.0            | 914  | 39.4             | 1000.8 | 4.88  | 124.0 | 0.272                         | 6.9  | 0.0157                  | 0.40 | 58                     | 0.40 |
| 40           | 1000 | 40.0            | 1016 | 47.2             | 1198.9 | 6.69  | 169.9 | 0.382                         | 9.7  | 0.0157                  | 0.40 | 58                     | 0.40 |
| 45           | 1125 | 44.0            | 1118 | 51.73            | 1313.9 | 7.48  | 190.0 | 0.402                         | 10.2 | 0.0157                  | 0.40 | 58                     | 0.40 |
| 48           | 1200 | 48.0            | 1219 | 56.42            | 1432.1 | 8.07  | 205.0 | 0.425                         | 10.8 | 0.0157                  | 0.40 | 58                     | 0.40 |
| 54           | 1375 | 54.0            | 1372 | 63.12            | 1603.2 | 8.85  | 224.8 | 0.449                         | 11.4 | 0.0157                  | 0.40 | 58                     | 0.40 |
| 61           | 1525 | 61.0            | 1524 | 70.41            | 1788.4 | 9.25  | 235.0 | 0.469                         | 11.9 | 0.0157                  | 0.40 | 58                     | 0.40 |
| 67           | 1675 | 67.0            | 1676 | 76.4             | 1940.6 | 9.25  | 235.0 | 0.492                         | 12.5 | 0.0157                  | 0.40 | 58                     | 0.40 |
| 73           | 1825 | 73.0            | 1829 | 82.98            | 2107.7 | 9.25  | 235.0 | 0.512                         | 13.0 | 0.0157                  | 0.40 | 58                     | 0.40 |
| 80           | 2000 | 80.0            | 2032 | 91.25            | 2317.8 | 9.25  | 235.0 | 0.512                         | 13.0 | 0.0157                  | 0.40 | 58                     | 0.40 |

6.2.4 *Wall Thickness*—The tolerance of the minimum wall thickness of the waterway of the pipe (see Tables 1-4) shall be +35 % when measured in accordance with 8.5.

6.2.5 *Length*—The pipe shall be sold in any length agreeable to the user. Length shall not be less than 99 % of the specified length when measured in accordance with section 8.6.

### 6.3 Perforations:

6.3.1 *Drainage Pipe*—When perforations are necessary they shall be cleanly cut and uniformly spaced along the length and circumference of the pipe in a size, shape, and pattern suited to the needs of the user. Perforations shall be in the valley portion of the pipe. The reinforcing steel material shall not be exposed by these perforations.

6.3.2 The inlet area of the perforations shall be a minimum of 1 in.<sup>2</sup>/ft (21 cm<sup>2</sup>/m) of pipe.

6.4 *Pipe Stiffness*—The pipe shall have a minimum pipe stiffness as shown in Tables 1-4 at 5 % deflection, when tested in accordance with section 8.7.

NOTE 2—The 5 % deflection criteria was selected for testing convenience and should not be considered as a limitation with respect to in-use deflection.

NOTE 3—Figs. 1-4 are meant to be representative of the reinforced PE composite pipes described in this standard.

NOTE 4—Tables 1-4 describe four different types of pipes identified as Types I, II, III and IV which are different as to structure (single and double wall and triple wall structure), profile shape (U-shaped or V-shaped), waterway wall thicknesses and steel thicknesses. These differences are detailed in the Tables.

6.5 *Bonding of the Steel to the Polyethylene*—The mechanical bond between the steel reinforcement and the polyethylene resin required for this standard. It shall not be possible to separate any two layers with a probe or with the point of a knife blade so that the layers separate cleanly, or the probe or knife moves freely between the layers. There shall be no separation of the polyethylene from the steel reinforcing plate, when the pipe is deflected 40 %, in accordance with Test Method D2412.

**TABLE 2 Nominal Pipe Sizes, Dimensions, and Pipe Stiffness for Triple-Wall Pipe – Type IIA and IIB**

| Nominal Size |      | Inside Diameter |      | Outside Diameter |      | Pitch |     | Minimum Waterway Wall |     | Minimum Steel Thickness |      | Minimum Pipe Stiffness Type IIA |      | Minimum Pipe Stiffness Type IIB |      |
|--------------|------|-----------------|------|------------------|------|-------|-----|-----------------------|-----|-------------------------|------|---------------------------------|------|---------------------------------|------|
| inch         | mm   | inch            | mm   | inch             | mm   | inch  | mm  | inch                  | mm  | inch                    | mm   | psi                             | MPa  | psi                             | MPa  |
| 12           | 300  | 11.89           | 302  | 13.46            | 342  | 1.18  | 30  | 0.039                 | 1.0 | 0.0118                  | 0.30 |                                 |      | 50.75                           | 0.35 |
| 14           | 350  | 13.66           | 347  | 15.55            | 395  | 1.38  | 35  | 0.047                 | 1.2 | 0.0118                  | 0.30 |                                 |      | 50.75                           | 0.35 |
| 15           | 375  | 14.76           | 375  | 16.73            | 425  | 1.50  | 38  | 0.055                 | 1.4 | 0.0118                  | 0.30 |                                 |      | 43.50                           | 0.30 |
| 16           | 400  | 15.75           | 400  | 17.72            | 450  | 1.50  | 38  | 0.055                 | 1.4 | 0.0118                  | 0.30 |                                 |      | 40.60                           | 0.28 |
| 18           | 450  | 18.07           | 459  | 20.31            | 518  | 1.57  | 40  | 0.055                 | 1.4 | 0.0118                  | 0.30 |                                 |      | 40.60                           | 0.28 |
| 20           | 500  | 19.69           | 500  | 22.24            | 565  | 1.77  | 45  | 0.059                 | 1.5 | 0.0118                  | 0.30 |                                 |      | 40.60                           | 0.28 |
| 21           | 525  | 20.67           | 525  | 23.23            | 590  | 1.77  | 45  | 0.059                 | 1.5 | 0.0118                  | 0.30 |                                 |      | 40.60                           | 0.28 |
| 24           | 600  | 24.02           | 610  | 26.85            | 682  | 2.17  | 55  | 0.059                 | 1.5 | 0.0118                  | 0.30 |                                 |      | 39.15                           | 0.27 |
| 27           | 675  | 26.57           | 675  | 30.51            | 775  | 2.60  | 66  | 0.067                 | 1.7 | 0.0118                  | 0.30 |                                 |      | 39.15                           | 0.27 |
| 28           | 700  | 27.72           | 704  | 31.50            | 800  | 2.60  | 66  | 0.083                 | 2.1 | 0.0118                  | 0.30 |                                 |      | 39.15                           | 0.27 |
| 30           | 750  | 29.53           | 750  | 33.31            | 846  | 2.60  | 66  | 0.083                 | 2.1 | 0.0118                  | 0.30 |                                 |      | 39.15                           | 0.27 |
| 32           | 800  | 31.50           | 800  | 35.83            | 910  | 2.91  | 74  | 0.083                 | 2.1 | 0.0118                  | 0.30 |                                 |      | 39.15                           | 0.27 |
| 36           | 900  | 35.43           | 900  | 40.39            | 1026 | 3.15  | 80  | 0.118                 | 3.0 | 0.0118                  | 0.30 |                                 |      | 39.15                           | 0.27 |
| 40           | 1000 | 39.37           | 1000 | 45.28            | 1150 | 3.39  | 86  | 0.122                 | 3.1 | 0.0118                  | 0.30 |                                 |      | 39.15                           | 0.27 |
| 42           | 1050 | 41.34           | 1050 | 47.24            | 1200 | 3.39  | 86  | 0.122                 | 3.1 | 0.0118                  | 0.30 |                                 |      | 39.15                           | 0.27 |
| 44           | 1100 | 43.31           | 1100 | 50.98            | 1295 | 7.48  | 190 | 0.157                 | 4.0 | 0.0118                  | 0.30 | 58                              | 0.40 |                                 |      |
| 48           | 1200 | 47.24           | 1200 | 54.92            | 1395 | 7.48  | 190 | 0.157                 | 4.0 | 0.0118                  | 0.30 | 58                              | 0.40 |                                 |      |
| 54           | 1375 | 53.15           | 1350 | 60.83            | 1545 | 7.48  | 190 | 0.177                 | 4.5 | 0.0118                  | 0.30 | 58                              | 0.40 |                                 |      |
| 60           | 1524 | 59.06           | 1500 | 67.44            | 1713 | 8.07  | 205 | 0.177                 | 4.5 | 0.0118                  | 0.30 | 58                              | 0.40 |                                 |      |
| 66           | 1650 | 64.96           | 1650 | 73.35            | 1863 | 8.07  | 205 | 0.177                 | 4.5 | 0.0118                  | 0.30 | 58                              | 0.40 |                                 |      |
| 71           | 1800 | 70.87           | 1800 | 79.25            | 2013 | 8.07  | 205 | 0.177                 | 4.5 | 0.0118                  | 0.30 | 58                              | 0.40 |                                 |      |
| 80           | 2000 | 78.74           | 2000 | 87.13            | 2213 | 8.07  | 205 | 0.177                 | 4.5 | 0.0118                  | 0.30 | 58                              | 0.40 |                                 |      |

**TABLE 3 Dimensions and Pipe Stiffness for Single-Wall Pipe and Double-Wall Pipe – Type III (V-shaped profile)**

| Nominal Size |      | Inside Diameter |      | Outside Diameter |        | Pitch |       | Waterway Wall Thickness (min) |     | Minimum Steel Thickness |      | Minimum Pipe Stiffness |     |
|--------------|------|-----------------|------|------------------|--------|-------|-------|-------------------------------|-----|-------------------------|------|------------------------|-----|
| inch         | mm   | inch            | mm   | inch             | mm     | inch  | mm    | inch                          | mm  | inch                    | mm   | MPa                    | psi |
| 8            | 200  | 8.0             | 203  | 9.1              | 231.1  | 2.36  | 60.0  | 0.059                         | 1.5 | 0.0118                  | 0.30 | 0.55                   | 80  |
| 10           | 250  | 10.0            | 254  | 10.95            | 278.1  | 2.36  | 60.0  | 0.059                         | 1.5 | 0.0118                  | 0.30 | 0.55                   | 80  |
| 12           | 300  | 12.0            | 305  | 13.3             | 338.0  | 2.36  | 60.0  | 0.059                         | 1.5 | 0.0118                  | 0.30 | 0.55                   | 80  |
| 15           | 375  | 15.0            | 381  | 16.3             | 413.0  | 2.36  | 60.0  | 0.059                         | 1.5 | 0.0118                  | 0.30 | 0.45                   | 65  |
| 18           | 450  | 18.0            | 457  | 19.3             | 489.0  | 2.44  | 62.0  | 0.059                         | 1.5 | 0.0157                  | 0.40 | 0.40                   | 58  |
| 24           | 600  | 24.0            | 610  | 25.7             | 653.0  | 2.76  | 70.0  | 0.059                         | 1.5 | 0.0157                  | 0.40 | 0.40                   | 58  |
| 30           | 750  | 30.0            | 762  | 32.2             | 817.0  | 3.54  | 90.0  | 0.079                         | 2.0 | 0.0157                  | 0.40 | 0.40                   | 58  |
| 36           | 900  | 36.0            | 915  | 38.2             | 970.0  | 3.94  | 100.0 | 0.079                         | 2.0 | 0.0157                  | 0.40 | 0.40                   | 58  |
| 42           | 1050 | 42.0            | 1067 | 44.4             | 1128.0 | 3.94  | 100.0 | 0.079                         | 2.0 | 0.0157                  | 0.40 | 0.40                   | 58  |
| 48           | 1200 | 48.0            | 1220 | 52.0             | 1320.0 | 6.30  | 160.0 | 0.157                         | 4.0 | 0.0157                  | 0.40 | 0.40                   | 58  |
| 60           | 1500 | 60.0            | 1524 | 65.2             | 1656.0 | 7.68  | 195.0 | 0.157                         | 4.0 | 0.0157                  | 0.40 | 0.40                   | 58  |

**TABLE 4 Dimensions and Pipe Stiffness for Single-Wall Pipe and Double-Wall Pipe – Type IV (V-shaped profile)**

| Nominal Size |      | Inside Diameter |      | Outside Diameter |        | Pitch |       | Waterway Wall Thickness (min) |     | Minimum Steel Thickness |      | Minimum Pipe Stiffness |      |
|--------------|------|-----------------|------|------------------|--------|-------|-------|-------------------------------|-----|-------------------------|------|------------------------|------|
| inch         | mm   | inch            | mm   | inch             | mm     | inch  | mm    | inch                          | mm  | inch                    | mm   | MPa                    | psi  |
| 8            | 200  | 8.0             | 203  | 9.1              | 231.1  | 2.36  | 60.0  | 0.059                         | 1.5 | 0.0118                  | 0.30 | 0.40                   | 58   |
| 10           | 250  | 10.0            | 254  | 10.95            | 278.1  | 2.36  | 60.0  | 0.059                         | 1.5 | 0.0118                  | 0.30 | 0.40                   | 58   |
| 12           | 300  | 12.0            | 305  | 13.3             | 338.0  | 2.36  | 60.0  | 0.059                         | 1.5 | 0.0118                  | 0.30 | 0.40                   | 58   |
| 15           | 375  | 15.0            | 381  | 16.3             | 413.0  | 2.36  | 60.0  | 0.059                         | 1.5 | 0.0118                  | 0.30 | 0.40                   | 58   |
| 18           | 450  | 18.0            | 457  | 19.3             | 489.0  | 2.44  | 62.0  | 0.059                         | 1.5 | 0.0118                  | 0.30 | 0.275                  | 40   |
| 24           | 600  | 24.0            | 610  | 25.7             | 653.0  | 2.76  | 70.0  | 0.059                         | 1.5 | 0.0118                  | 0.30 | 0.235                  | 34   |
| 30           | 750  | 30.0            | 762  | 32.2             | 817.0  | 3.54  | 90.0  | 0.079                         | 2.0 | 0.0118                  | 0.30 | 0.200                  | 29   |
| 36           | 900  | 36.0            | 915  | 38.2             | 970.0  | 3.94  | 100.0 | 0.079                         | 2.0 | 0.0118                  | 0.30 | 0.155                  | 22.5 |
| 42           | 1050 | 42.0            | 1067 | 44.4             | 1128.0 | 3.94  | 100.0 | 0.079                         | 2.0 | 0.0118                  | 0.30 | 0.145                  | 21   |
| 48           | 1200 | 48.0            | 1220 | 52.0             | 1320.0 | 6.30  | 160.0 | 0.157                         | 4.0 | 0.0118                  | 0.30 | 0.135                  | 20   |
| 60           | 1500 | 60.0            | 1524 | 65.2             | 1656.0 | 7.68  | 195.0 | 0.157                         | 4.0 | 0.0118                  | 0.30 | 0.105                  | 15   |

## 6.6 Fitting Requirements:

6.6.1 The fittings shall not reduce or impair the overall integrity or function of the pipeline.

6.6.2 Fittings shall be supplied with joints compatible with the overall system. All joints for watertight gravity flow sewer systems shall meet the requirements of 6.6.3.1. All other joints

shall meet the requirements of a soil tight joint unless otherwise specified by the manufacturer.

### 6.6.3 Joint Tightness:

6.6.3.1 *Watertight Joints*—Gasketed watertight joints, when utilized, shall meet the requirements of Specification using a pressure of a 10.8 psi (74 kPa) and a vacuum of 10.8 psi (74 kPa).

6.6.3.2 *Soil-tight Joints*—Soil tight joints are specified as a function of opening size, channel length and backfill particle size. If the size of the opening exceeds 3 mm, the length of the channel shall be at least four times the size of the opening. 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's Standard Specification for Highway Bridges, Division II, Section 30, "Metal Culverts".

6.6.3.3 *Silt-tight joints*—Silt tight joints shall be used where the backfill material has a high percentage of fines. Silt tight joints shall meet laboratory tests in accordance with Test Method except that the joint shall be tested using 2.0 psi (14 kPa).

6.6.4 Where these connections are not practical or undesirable because of space, layout, or other requirements, joining methods such as external snap couplers, split couplers, and so forth that are equally effective are to be used.

NOTE 5—Only fittings and couplers supplied or recommended by the pipe manufacturer shall be used.

## 7. Sampling and Retest

7.1 *Sampling*—Samples of pipe and fittings sufficient to determine conformance with this specification shall be taken at random from stock by the testing agency. Samples shall be representative of the product type under consideration.

7.2 *Retest and Rejection*.—Retesting in the event of a test failure shall be conducted on samples from the failed lot only under an agreement between purchaser and seller. There shall be no changes to the test procedures or the requirements.

## 8. Test Methods

8.1 *Conditioning Test Specimens*—Condition the specimen prior to test at  $73.4 \pm 3.6^{\circ}\text{F}$  ( $23 \pm 2^{\circ}\text{C}$ ) and  $50 \pm 5\%$  relative humidity for not less than 24 h prior to the test, in accordance with Procedure A in Practice for those tests where conditioning is required, unless otherwise specified.

8.2 *Test Conditions*—Conduct tests in a laboratory atmosphere of  $73.4 \pm 3.6^{\circ}\text{F}$  ( $23 \pm 2^{\circ}\text{C}$ ) and  $50 \pm 5\%$  relative humidity, unless otherwise specified.

8.3 *Inside Diameter*—Measure the inside diameter of three 1-ft (300-mm) long specimens, with any suitable device accurate to  $\pm 1/32$  in. (0.8 mm), at two positions, namely, any point in the circumferential direction and  $90^{\circ}$  from this point, and average the six measurements.

8.4 *Outside Diameter*—Measure the outside diameter of three, 1-ft (300-mm) long specimens, with any suitable device accurate to  $\pm 1/32$  in. (0.8 mm), at two positions, namely, any

point in the circumferential direction and  $90^{\circ}$  from this point, and average the six measurements.

8.5 *Pipe wall*—measure the wall thickness, in the waterway, in the gaps between the profile.

8.6 *Length*—Measure the pipe with any suitable device accurate to  $\pm 1/32$  in. (0.8 mm) in 10 ft. (3 m). Make all measurements on the pipe while it is resting on a relatively flat surface, in a straight line, with no external tensile or compressive forces exerted on the pipe.

8.7 *Pipe Stiffness*—Select a minimum of three pipe specimens and test for pipe stiffness  $F/\Delta y$ , as described in Test Method D2412, except for the following conditions for single-wall pipe, double-wall pipe, and triple-wall pipe: (1) Specimens shall be cut vertically starting parallel to the corrugation, cut mid valley to mid valley along the corrugation, and then cut across the corrugation, or the pipe shall be cut vertically. (2) Specimens shall be longer than 18 inches (457 mm) in length. (3) Locate the first specimen in the loading machine with the imaginary line between two corrugations parallel to the loading plates. The specimen must lie flat on the plate within  $1/8$  in. (3 mm). Use the first location as a reference point for rotation of the other two specimens. Rotate the second specimen  $45^{\circ}$  and the third specimen  $90^{\circ}$ . Test each specimen in one position only. (4) Testing speed of the specimens shall be 0.5 inches (12.7 mm) per minute for testing up to 5 % deflection. For testing beyond 5 % deflection, test at a speed of 5 in./min. (5) The deflection indicator shall be readable and accurate to  $+0.001$  in. ( $+0.02$  mm). (6) The parallel plates must exceed the samples in length.

8.8 *Joint Tightness*—Test for Joint tightness for watertight joints in accordance with Specification D3212.

## 9. Installation

9.1 It is recommended that pipe used in sub drain applications shall be installed in accordance with Practice F449, pipe used in storm sewer and other applications shall be installed in accordance with Practice D2321.

## 10. Certification

10.1 Upon request of the user, the manufacturer shall provide certification that the product was manufactured and tested in accordance with this specification. This certification shall be furnished at the time of shipment.

## 11. Marking

11.1 *Quality of Marking*—The marking shall be applied to the pipe in such a manner that it remains legible (easily read) after installation and inspection. It shall be placed, at least, at the end of each length of pipe or spaced at intervals of not more than 10 ft (3.0 m).

11.2 *Markings*—Each standard and random length of pipe in compliance with this specification shall be clearly marked by the producer with the following information: this designation, (ASTM F2435), the nominal pipe size, the legend SRPCP, the manufacturer's name, trade name, or trademark, the manufacturer's production code, identifying plant location, machine, and date of manufacture.

**12. Report**

12.1 The report shall include the following:

- 12.1.1 Date or dates of tests;
- 12.1.2 Complete identification of the product tested, including size, nomenclature, manufacturer, lot number, previous history, if any, and so forth;
- 12.1.3 Description of manufacturer's product marking;
- 12.1.4 Conditioning method;
- 12.1.5 Details of sampling;
- 12.1.6 Individual test results, and the average test results;
- 12.1.7 Notation describing any retests due to previous test failure; and
- 12.1.8 Description of terms.

**13. Packaging**

13.1 All pipe, unless otherwise specified, shall be packed or loaded onto a carrier, for standard commercial shipment.

**14. Quality Assurance**

14.1 When the product is marked with the designation, Specification F2435, the manufacturer affirms that the product was manufactured, inspected, sampled, and tested in accordance with this specification and has been found to meet the requirements of this specification.

**15. Keywords**

15.1 Corrugated; perforated; polyethylene; steel reinforced; pipe

**SUPPLEMENTARY REQUIREMENTS****GOVERNMENT/MILITARY PROCUREMENT**

These requirements apply only to Federal/Military procurement, not domestic sales or transfers.

**S1. Responsibility for Inspection**—Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspections and test requirements specified herein. The producer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless the purchaser disapproves. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

NOTE S1.1—In U.S. federal contracts, the contractor is responsible for inspection.

**S2. Packaging and Marking for U.S. Government Procurement:**

**S2.1 Packaging**—Unless otherwise specified in the contract, the materials shall be packaged in accordance with the supplier's standard practice in a manner ensuring arrival at destination in satisfactory condition and which will be acceptable to the carrier at lowest rates. Containers and packaging shall comply with Uniform Freight Classification rules or National Motor Freight Classification rules.

**S2.2 Marking**—Marking for shipment shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

NOTE S2.1—The inclusion of U.S. Government procurement requirements should not be construed as an indication that the U.S. Government uses or endorses the products described in this specification.

**APPENDIXES****(Nonmandatory Information)****X1. COUPLINGS**

X1.1 The couplings should not reduce or impair the overall integrity or function of the pipe.

X1.2 Couplings should not reduce the capacity of the pipe being joined.

## **X2. AUTHORITIES**

X2.1 Since this product has a wide variety of uses, approval for its use rests with various agencies. The installer should contact the relevant authority to obtain local installation guidelines. A partial list of authorities, according to product usage is as follows:

X2.1.1 *Farm Drainage*—U.S. Department of Agriculture, Soil Conservation Service, local office: reference, Engineering Standard 606.

X2.1.2 *Roadway Drainage*—Federal, state, county, or local highway authority.

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