Designation: F2736 – 13ε1

Standard Specification for 6 to 30 in. (152 To 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe And Double Wall Pipe[1]

This standard is issued under the fixed designation F2736; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε[1] NOTE—8.7 was editorially corrected in December 2014.

1. Scope*

1.1 This specification covers requirements and test methods for materials, dimensions, workmanship, elongation, brittleness, pipe stiffness, and markings for single wall corrugated polypropylene (PP) pipe and double wall corrugated polypropylene (PP) pipe. It covers nominal sizes 6 in. through 30 in. (152 mm through 762 mm).

1.2 The corrugated polypropylene pipes governed by this standard are intended for use in non-pressure applications for sanitary sewers, storm sewers and drainage pipes. Single wall corrugated polypropylene pipe shall not be used for sanitary sewer applications.

1.3 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.

1.4 *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:*[2]

D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics

D618 Practice for Conditioning Plastics for Testing

D638 Test Method for Tensile Properties of Plastics

D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

D1238 Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

D1505 Test Method for Density of Plastics by the Density-Gradient Technique

D1600 Terminology for Abbreviated Terms Relating to Plastics

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

D2444 Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)

D2990 Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics

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

D3895 Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry

D4101 Specification for Polypropylene Injection and Extrusion Materials

D6992 Test Method for Accelerated Tensile Creep and Creep-Rupture of Geosynthetic Materials Based on Time-Temperature Superposition Using the Stepped Isothermal Method

F412 Terminology Relating to Plastic Piping Systems

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

2.2 *American Association of State Highway and transportation Officials (AASHTO) Standard:*[3]

AASHTO LRFD Bridge Design Specifications

[1] This test method is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.26 on Olefin Based Pipe.

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

[3] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 2001, http://www.transportation.org

***A Summary of Changes section appears at the end of this standard**

2.3 *Transportation Research Record:*[3]
TRR No. 2028 , "Guidelines for Interpreting AASHTO Specifications to Design or Evaluate Buried Structures with Comprehensive Solution Methods," 2007.

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology F412 and abbreviations are accordance with Terminology D1600, unless otherwise specified.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *double wall pipe, n*—corrugated pipe with a coextruded interior liner.

3.2.2 *single wall pipe, n*—corrugated pipe without an interior liner.

3.2.3 *waterway wall, n*—the pipe wall in single wall pipe and the interior wall in double wall pipe.

4. Materials

4.1 *Polypropylene*—Polypropylene compounds used in the manufacture of corrugated single wall and double wall pipe shall have the minimum properties as shown in Table 1. Polypropylene compounds shall be comprised of the base polypropylene virgin material and all additives, colorants, UV inhibitors, and stabilizers. Polypropylene compounds can be pre-compounded or made in-situ during pipe extrusion by combining natural polypropylene material with a color masterbatch or other additives, or both. Conditioning, sampling, preparation and testing of molded specimens shall be in accordance with the requirements in Specification D4101. Material for preparation of molded specimens shall be taken from the pipe.

4.2 *Color and Ultraviolet (UV) Stabilization*— The pipe shall be colored or black. Black polypropylene compounds shall have between 2.0 and 3.0 percent carbon black. Colored polypropylene compounds shall be protected from Ultraviolet (UV) degradation with UV stabilizers. Colored polypropylene compounds shall contain sufficient UV protection to allow pipe made according to this standard to be stored outdoors for at least two years from the date of manufacture without degradation of the stated properties.

4.3 *Rework Material*—Clean polypropylene rework material, generated from the manufacturer's own production of the product and having the same minimum physical properties, may be used by the manufacturer, provided that the pipe produced meets all the requirements of this specification.

4.4 *Rubber Materials*—Rubber compounds used in the manufacture of sealing rings or gaskets shall meet the requirements of Specification F477.

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

5. Joining System

5.1 *Bell and Spigot Joint:*

5.1.1 The pipe ends shall consist of integrally formed bell and spigot designed to accommodate a gasket, which when assembled forms a watertight seal by the radial compression of the gasket between the spigot and the bell ends.

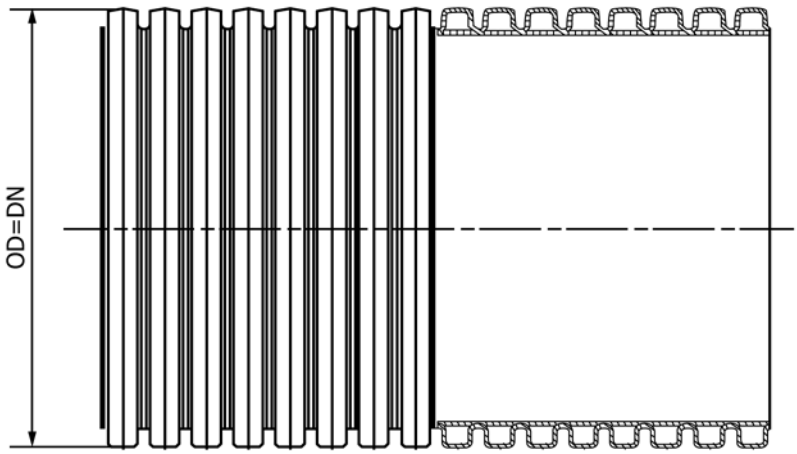
5.1.2 The joint shall be designed to avoid displacement of the gasket when it is assembled in accordance with the manufacturer's recommendations.

5.1.3 The assembly of the joint shall be in accordance with the manufacturer's recommendations.

5.2 *Other Joining Systems*—Where these connections are not practical or undesirable because of space, layout, or other requirements, joining methods such as external snap couplers, split couplers, or other joining methods that are equally effective are to be used in accordance with the manufacturer's recommendations.

6. Requirements

6.1 *Workmanship*—The pipe and fittings shall be homogeneous throughout and be as uniform as commercially practical in color, opacity, and density. The pipe wall shall be free of cracks, holes, blisters, voids, foreign inclusions or other defects



Note-This figure is included for informational purposes only.

FIG. 1 Typical Annular Corrugated Profile Wall Polypropylene Pipe with Interior Liner

TABLE 1 Polypropylene Compound Properties

Property	ASTM Test Method	Units (SI Units)	Minimum Value	Maximum Value
Melt Flow Rate (at 446°F (230°C))	D1238	g/10 min	0.15	0.50
Density	D792, D1505	lb/in3 (g/cm^3)	0.0325 (0.900)	0.343 (0.950)
Tensile Strength at Yield	D638	psi (N/mm^2)	3500 (24.1)	4500 (31)
Elongation at Yield	D638	% (%)	5 (5)	25 (25)
Flexural Modulus (1% secant)	D790	psi (N/mm^2)	175,000 (1200)	275,000 (1500)
IZOD Impact Strength (73°F(23°C))	D256	ft-lb/in^2 (kJ/m^2)	23.8 (50)	No Break
Oxidative-Induction Time (392°F (200°C))	D3895	min	25	200

that are visible to the naked eye and that may affect the wall integrity. The ends shall be cut cleanly and squarely.

6.2 *Pipe Dimensions*:

6.2.1 *Nominal Size*— The nominal size for pipe and fittings shall be as shown in Table 2 and are based on the inside diameter of the pipe.

6.2.2 *Inside Diameter*—Measure the inside diameter in accordance with Test Method D2122. The tolerances are shown in Table 2, when measured in accordance with 8.3, and shall be applied to the stated manufacturer's supplied diameter. In no case shall the manufacturer's stated inside diameter minus the tolerance be less than the required minimum pipe inside diameter listed in 8.4.

NOTE 1—The manufacturer's stated inside diameter is the nominal diameter plus or minus the inside diameter tolerances. The minimum inside diameter is the smallest diameter the pipe can be with these tolerances and is used for the hydraulic design of the pipe.

6.2.3 *Waterway Wall Thickness*—The minimum waterway wall thickness shall meet the requirements given in Table 2, when measured in accordance with 8.4.

6.2.4 Pipe Dimensions shall comply with Table 2, when measured in accordance with Test Method D2122.

6.2.5 *Laying Length*—The pipe may be sold in any laying length agreeable to the user. Laying length shall not be less than 99% of the stated quantity, when measured in accordance with 8.3 at 73°F + 3.6°F (23°C + 2°C).

TABLE 2 Nominal Pipe Sizes, Inside Diameters and Tolerances and Minimum Waterway Wall Thickness for Single Wall and Double Wall Corrugated Polypropylene Pipes

Nominal Pipe Size, in. (mm)	Minimum Inside Diameter, in. (mm)	Inside Diameter Tolerances, in. (mm)	Minimum Waterway Wall Thickness, in. (mm)
6 (150)	5.61 (142)	±0.040 (±1.02)	0.040 (1.02)
7 (175)	6.93 (176)	±0.045 (±1.14)	0.045 (1.14)
8 (200)	7.70 (196)	±0.045 (±1.14)	0.045 (1.14)
9 (225)	8.65 (220)	±0.055 (±1.40)	0.050 (1.27)
10 (250)	9.70 (246)	±0.055 (±1.40)	0.050 (1.27)
11 (275)	10.87 (276)	±0.075 (±1.91)	0.050 (1.27)
12 (300)	11.90 (302)	±0.100 (±2.54)	0.054 (1.38)
14 (350)	13.68 (347)	±0.100 (±2.54)	0.060 (1.52)
15 (375)	14.85 (377)	±0.150 (±3.81)	0.065 (1.65)
17 (425)	16.95 (431)	± 0.125 (±3.18)	0.070 (1.78)
18 (450)	17.93 (455)	±0.170 (±4.32)	0.075 (1.91)
21 (530)	20.75 (527)	±0.170 (±4.32)	0.077 (1.96)
22 (550)	21.48 (546)	±0.170 (±4.32)	0.080 (2.03)
24 (600)	23.90 (607)	±0.227 (± 5.77)	0.080 (2.19)
30 (750)	29.79 (757)	±0.240 (± 6.1)	0.108 (2.74)

NOTE-The manufacturer's stated inside diameter is the nominal diameter plus or minus the inside diameter tolerance. The minimum inside diameter is the smallest diameter the pipe can be with these tolerances and is used for the hydraulic design of the pipe.

6.2.6 *Pipe Stiffness*—The pipe shall have a minimum pipe stiffness of 46 psi (320 KPa) at 5% deflection, when tested in accordance with 8.6.

6.2.7 *Impact*—Pipe specimens shall be tested in accordance with 8.7. The test specimens, when examined under normal light and the unaided eye, shall show no splitting or cracking. The minimum pipe impact strength at 73°F (23°C) shall be 140 ft-lbf (189 J).

6.2.8 *Flattening*—There shall be no evidence of splitting, cracking, breaking, or separation of the ribs, seams, or corrugations, when pipe is tested in accordance with 8.8.

6.3 *Fittings and Joining System Requirements*:

6.3.1 The fittings shall not reduce or impair the overall integrity or function of the pipeline. only fittings made to this specification and couplers supplied or recommended by the pipe manufacturer shall be used. Fittings fabricated from pipe manufactured according to this standard shall meet the same material requirements as the pipe. The outside diameters and the corrugation pitch of products manufactured to this specification are not specified; thus, compatibility between pipe and fittings made to this specification by different manufacturers shall be verified to meet the requirements of 6.3.1 and 6.3.2.

6.3.2 *Joint Tightness*—Gasketed bell and spigot type joints, when utilized with pipe joints or with fittings, shall meet the requirements of Specification D3212.

6.3.3 Joints made with couplers or other joining methods, installed in accordance with the manufacturer's instructions, shall meet the requirements of Specification D3212.

NOTE 2—Fittings may be fabricated from the pipe by a variety of processes including hot plate welding, spin welding or other processes.

6.4 *Long Term Strength:*

6.4.1 *Creep Rupture Strength*—Specimens fabricated in the same manner and composed of the same materials as the finished pipe shall have a 50-year creep rupture tensile strength at 73°F (23°C) of not less than 1000 psi (7 MPa), when determined in accordance with 8.11.

6.4.2 *Creep Modulus Specimens*—fabricated in the same manner and composed of the same materials as the finished pipe shall have a 50-year tensile creep modulus at 73°F (23°C) at a stress level of 500 psi (3.5 MPa) of not less than 27,000 psi (186 MPa). The creep modulus shall be determined in accordance with 8.12.

NOTE 3—The 50-year creep rupture strength and 50-year creep modulus values, determined by the test methods in 8.11 and 8.12, are used to define the slope of the logarithmic regression curves to describe the required material properties sampled from the product. They are not to be interpreted as service life limits.

6.5 *Installation Requirements*—The pipe manufacturer shall provide the purchaser with the requirements for the proper installation of the pipe and the minimum and maximum allowable cover height for specific traffic and non-traffic loading conditions. The installation requirements shall be based on Practice D2321with a design that satisfies the safety factors specified in the AASHTO LRFD Bridge Design Specifications, Section 12 for Thermoplastic Pipe for earth and live loads, with consideration for impact and multiple vehicle presences.

6.6 *Structural Data*—If requested by the purchaser, the pipe manufacturer shall provide data to enable verification of structural design safety factors, including pipe profile geometry, wall centroid, wall area, wall moment of inertia and material strain limits.

7. Sampling and Retest

7.1 *Sampling*—Samples of pipe and fittings sufficient to determine conformance with this specification shall be taken at random by the testing agency. Where a test report is requested for a customer order, the samples shall be taken from the production lot (as indicated by the manufacturer's production code) representing the product to be shipped on the order.

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 + 3.60°F (23 + 20C°) and 50 + 5 % relative humidity for not less than 24 h prior to the test, in accordance with Procedure A in Practice D618 for those tests where conditioning is required, unless otherwise specified.

8.2 *Test Conditions*—Conduct tests in a laboratory atmosphere of 73.4 + 3.60F (23 + 20C) and 50 + 5 % relative humidity, unless otherwise specified.

8.3 *Inside Diameter*—Measure the inside diameter of three 1-ft long (300-mm) specimens, with any suitable device accurate to 0.001 in (0.02 mm), at positions at the seam and 90° from the seam.

8.4 *Wall Thickness*—Measure the minimum wall thickness in the waterway of the pipe in the valley between the corrugations for single wall pipe and under the corrugation for double wall pipe. Measure in accordance with the requirements of Test Method D2122.

8.5 *Length*—Measure the pipe with any suitable device accurate to +1⁄32 in. (0.8 mm) in 10 ft. (1 mm in 3 m). Make all measurements on the pipe while it is resting on a flat surface at ambient temperature, in a straight line, with no external tensile or compressive forces exerted on the pipe.

8.6 *Pipe Stiffness*—Select a minimum of three pipe specimens and test for pipe stiffness F/Δy, as described in Test Method D2412, except for the following conditions: *(1)* The test specimens shall be at least as long as the outside diameter; the exact length shall be an integer multiple of the corrugation pitch; *(2)* Locate the first specimen in the loading machine either along a mold line or with the imaginary line between two corrugations described by the mold line and parallel to the loading plates. The specimen must lay flat on the plate within 1⁄8 in. (3 mm) and may be straightened by hand bending at room temperature. Use the first location as a reference point for rotation of the other two specimens. Rotate the second specimen 450 and the third specimen 900. Test each specimen in one position only. *(3)* The deflection indicator shall be readable and accurate to +0.001 in. (+0.02 mm). *(4)* The parallel plates must exceed the samples in length. *(5)* Cut test specimens from mid-valley to mid-valley.

NOTE 4—The 5% deflection criteria were arbitrarily selected for testing convenience and should not be considered as a limitation with respect to in-use deflection. The engineer is responsible for establishing the acceptable deflection limit.

8.7 *Impact*—Test pipe specimens in accordance with Test Method D2444, except six specimens shall be tested. Test specimens shall be at least one diameter or 24 in. (610 mm) in length, whichever is less. test shall be conducted using either a 20 lb(9kg) Tup B or 30 lb (15kg Tup B and a flat-plate Holder B. Condition the specimens for 24h at a temperature of 73 + 3.60°F (23 + 2.0°C). The center of the falling tup shall strike on a corrugation crown for three specimens and between crowns for three specimens. All specimens must pass.

8.8 *Flattening*—Flatten three specimens of pipe in a suitable press until the internal diameter has been reduced to 40% of the original inside diameter of the pipe. The rate of loading shall be uniform and at 2 in/min (50 mm/min.). The specimens shall pass if no splitting, cracking, breaking, or separation of ribs, seams, or corrugations is observed, when examined under normal light with the unaided eye.

NOTE 5—The flattening test may be run in conjunction with the pipe stiffness test in accordance with Test Method D2412.

8.9 *Joint Tightness*—Test pipe specimens in accordance with Specification D3212.

8.10 *Thermal Stability and Oxidative Induction Time (OIT)*—The oxidative induction time (OIT) shall be determined on pipe and fittings in accordance with Test Method D3895.

8.11 *Creep Rupture Strength*—Determine the creep rupture strength at 73°F (23°C) in accordance with the tensile creep test methods in Test Method D2990, except as follows. Test shall include an additional stress level selected so as to produce rupture at approximately 10,000 hours. Alternatively, use time-temperature superposition methods to determine the creep rupture strength.

8.12 *Creep Modulus*—Determine the creep modulus at 73°F (23°C) in accordance with the tensile creep test methods in Test Method D2990, except as follows. Test duration shall be 10,000 hours. Tests shall include a minimum of 5 stress levels that are selected in approximately even increments up to and including 500 psi (3.44 MPa). Alternatively, use time-temperature superposition methods to determine the creep modulus.

NOTE 6—The time-temperature superposition method in Test Method D6992 may be used to determine the tensile creep modulus and tensile

creep rupture strength. These tests are intended to validate a material's proof-of-performance qualification and are not standard quality assurance tests.

9. Certification

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

10. Marking

10.1 *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 each end of each length of pipe or spaced at intervals of not more than 10 ft. (3.0 m).

10.2 *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 F2736); the nominal pipe size, in inches; the legend "PP Corrugated Pipe;" the manufacturer's name; trade name, or trademark; and the manufacturer's production code, identifying plant location, machine, and date of manufacture.

11. Reporting

11.1 The report shall include the following:

11.2 Date or dates of tests,

11.3 Complete identification of the product tested, including size, nomenclature, manufacturer, lot number, previous history, if any, etc.,

11.4 Description of manufacturer's product marking,

11.5 Conditioning method,

11.6 Details of sampling,

11.7 Individual test results and average test results of manufacture,

11.8 Notation describing any retests due to previous test failure, and

11.9 Description of terms.

12. Packaging

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

13. Quality Assurance

13.1 When the product is market with the designation, F 2736, 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.

14. Keywords

14.1 corrugated; polypropylene; pipe

APPENDIXES

(Nonmandatory Information)

X1. COUPLINGS

X1.1 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. STRUCTURAL DESIGN

X2.1 AASHTO LRFD Section 12 is typically used for evaluation of structural design of corrugated polyethylene pipe. These structural design criteria are applicable to corrugated polypropylene pipe. After the design engineer satisfies project requirements, such as deflection, buckling, and bending stress, it is advisable to review conditions with particular respect to long-term strain.

X2.2 When the pipe is buried deeply, where hydrostatic conditions exist or when excessive pipe deformations or deflections, or both, might develop, it is advisable to evaluate the strain and environmental conditions as indicated in the following sections.

X2.3 The following discussion is about tensile and compressive strains. It is presented in general form. The owner is responsible for qualifying the pipe and after reviewing the proposed conditions and the qualities of the manufacturer's product.

X2.3.1 *Tensile Strain:*

$$\varepsilon_T = \varepsilon_B - (\varepsilon_S + \varepsilon_H) \quad \text{(X2.1)}$$

where:

ε_T = total tensile strain

ε_B = tensile strain from pipe bending in either diametric, axial, or combined situations,

ε_S = compressive strain induced into the pipe walls by the soil weight above the pipe, and
ε_H = external hydrostatic compressive strain.

X2.3.2 *Compressive Strain:*

$$\varepsilon_C = \varepsilon_B + \varepsilon_S + \varepsilon_H \quad \text{(X2.2)}$$

where:

ε_C = total compressive strain

X2.4 A modulus of elasticity and tensile strength for the material rated at 50 years is often used in the calculations leading to the determination of strain and thrust capacity. This value will vary directly in proportion to the stress level.

X2.4.1 The following long-term properties are recommended for design:

PP Engineering Properties	Short-Term Initial psi (N/mm^2)	Long-Term 50-year psi (N/mm^2)
Tensile Strength	3,500 (24.1)	1,000 (6.9)
Modulus of Elasticity	175,000 (1200)	27,000 (185)

X3. INSTALLATION

X3.1 *Installation Requirements* —Pipe shall be installed in accordance with Practice D2321. The pipe manufacturer shall provide the purchaser with the requirements for the proper installation of the pipe and the minimum and maximum allowable cover height for specific traffic and non-traffic loading conditions. The installation requirements shall be based on a design that satisfies the safety factors specified in the AASHTO LRFD Bridge Design Specifications, Section 12 for Thermoplastic Pipe for earth and live loads, with consideration for impact and multiple vehicle presences.

X4. STRUCTURAL DATA

X4.1 *Structural Data*—frequested by the purchaser, the pipe manufacturer shall provide data to enable verification of structural design safety factors, including pipe profile geometry, wall centroid, wall area, wall moment of inertia, and material strain limits.

X5. AUTHORITIES

X5.1 Since this product has a wide variety of uses in subsurface drainage systems, 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:

X5.1.1 *Subsurface Drainage*— Federal, state, county, or local highway authority.

X5.1.2 The pipe manufacturer(s) shall be able to provide proof of product acceptance by specific agencies, when appropriate.

SUMMARY OF CHANGES

Committee F17 has identified the location of selected changes to this standard since the last issue (F2736–12) that may impact the use of this standard.

(1) The revision to Specification F2736 only includes the addition of the new pipe nominal diameter, 21 in. (530 mm), with associated tolerances and minimum waterway wall thickness in Table 2. All other requirements remain the same.