



**Summary of Substantive Changes  
between the 2014e1 and the 2019 editions of  
ASTM F2306/F2306M “12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile  
Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and  
Subsurface Drainage Applications”**

**Presented to the IAPMO Standards Review Committee on May 6, 2019**

**General:** The changes to this standard should not have an impact on currently listed products. The changes are:

- Expanded the allowance of required materials to include recycled resin products and revised the standard accordingly (see Section 5)
- Added additional testing for the recycled resin materials that was included in the standard (see Sections 7.9, 7.10 and 7.11)
- Added the appropriate marking requirements for the recycled resin materials (see Section 11.2)

Section 2, Referenced Documents: Reference standards were added, revised or deleted as follows:

2.1 ASTM Standards:

[D638 Test Method for Tensile Properties of Plastics](#)

[D2444 ~~Test Method~~ Practice for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup \(Falling Weight\)](#)

[D4218 Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle- Furnace Technique](#)

[D4883 Test Method for Density of Polyethylene by the Ultrasound Technique](#)

[D5630 Test Method for Ash Content in Plastics](#)

[D7399 Test Method for Determination of the Amount of Polypropylene in Polypropylene/Low Density Polyethylene Mixtures Using Infrared Spectrophotometry](#)

[F3181 Test Method for The Un-notched, Constant Ligament Stress Crack Test \(UCLS\) for HDPE Materials Containing Post- Consumer Recycled HDPE](#)

[F3308 Practice for Sampling and Testing Frequency for Recycled Materials in Polyethylene \(PE\) Pipe for Non-Pressure Applications](#)

2.6 NCHRP (National Cooperative Highway Research Program) Report

[NCHRP Report 870 Performance of Corrugated Pipe Manufactured with Recycled Content](#)

2.7 ISO Standard:

[ISO 15270 Guidelines for the Recovery and Recycling of Plastic Waste](#)



Section 3, Terminology: Added a definition of service temperature as follows:

3.2 Definitions of Terms Specific to This Standard:

3.2.4 service temperature, n—the average ambient temperature of the insitu conditions at which the pipe will be operating for the life of the project.

Section 4, Ordering Information: Added a requirement to specify virgin or recycled resin as follows:

4.1 Orders for product made to this specification shall include the following information to adequately describe the desired product:

4.1.1 This ASTM designation and year of issue,

4.1.2 Perforations:

4.1.2.1 With perforations,

4.1.2.2 Without perforations,

4.1.3 Diameters,

4.1.4 Total footage of each pipe diameter involved,

4.1.5 Pipe laying length, and

4.1.6 Virgin or recycled resins.

Section 5, Materials and Manufacture: Clarified the carbon black content in virgin resin products and added the allowance and requirements of recycled resin products as follows:

5.1 ~~Basic Materials~~ Virgin Resin Products:

5.1.1 Pipe and Blow-Molded Fittings- The pipe and fittings shall be made of virgin PE plastic compound meeting the requirements of Specification D3350 cell classification 435400C or 435400E, except that carbon black content in compounds meeting cell classification 435400C shall be greater than 2% but not exceed 4 %. Compounds that have a higher cell classification in one or more properties shall be permitted provided the density of the base resin compound without pigment shall not exceed 0.955 g/cm<sup>3</sup> and all other product requirements are met. For slow crack-growth resistance, ~~resins~~ the plastic compound shall be evaluated using the notched constant ligament stress (NCLS) test according to the procedure described in 7.8. The average failure time of the five test specimens shall exceed 24 h with no single test specimen's failure time less than ~~17~~ 18 h.

5.1.2 Rotationally Molded Fittings and Couplings – Compounds used in the manufacture of rotationally molded fittings and couplings shall be virgin PE meeting the requirements of Specification D3350 and cell classification 213320C or 213320E, except that the carbon black content in compounds meeting cell classification 213320C shall be greater than 2% but not exceed 4%. Compounds that have a higher cell classification in one or more properties shall be permitted provided the density of the base resin shall not exceed 0.940 g/cm<sup>3</sup> and all other product requirements are met.

5.1.3 Injection-Molded Fittings and Couplings Compounds used in the manufacture of injection molded fittings and couplings shall be made of virgin PE meeting the requirements of Specification D3350 and cell classification 414420C or 414420E, except that the carbon black content in compounds meeting cell classification 213320C shall be greater than 2% but not exceed 4%. Compounds that have a higher cell classification in one or more properties shall be permitted provided all other product requirements are met.

~~5.2~~ 5.1.4 Rework Material-Clean rework material generated from the manufacture's own pipe and fittings production shall be permitted to be used by the same manufacturer, provided that the material meets the requirements of 5.1.1 or 5.1.2 as applicable for the intended part and pipe or fittings produced meet all the requirements of this specification.



5.2 Recycled Resin Products:

5.2.1 Recycled Resin Pipe-The pipe containing any postconsumer or post-industrial recycled materials shall be made of PE plastic compound recovered and recycled in accordance with Guide ISO 15270 such that the final blended compound meets the following requirements in accordance with Specification D3350:

5.2.1.1 Cell classification 435400C or 435400E in accordance with Specification D3350.

5.2.1.2 The carbon black content in compounds meeting cell classification 435400C shall be equal to or greater than 2 % but not exceed 4 % when tested in accordance with Test Method D4218. Compounds that have a higher cell classification in one or more properties shall be permitted provided the density of the compound shall not exceed 0.955 g/cm<sup>3</sup> as tested in accordance with Test Method D4883 and all other product requirements are met.

5.2.1.3 For slow crack growth resistance, extruded pipe shall be evaluated using the notched constant ligament stress (NCLS) test according to the procedure described in 7.8. The average failure time of the five test specimens shall exceed 24 h with no single test specimen's failure time less than 18 h.

5.2.1.4 Crack initiation shall be tested in accordance with the procedures in 7.11. The average failure time of five test specimens shall exceed the minimum required for the applied tensile stress, service temperature and required service life required for the application.

5.2.1.5 Maximum level of polypropylene present by volume shall not be greater than 5 percent when tested in accordance with the procedures in 7.9.

5.2.1.6 Maximum ash content shall not be more than 2 % in accordance with the procedures in 7.10.

5.2.1.7 Samples taken from the extruded pipe supplied to the project shall have a minimum Oxidative-Induction-Time of 20 min when tested in accordance with Test Method D3895 and break strain of 150 % when tested in accordance with Test Method D638.

5.2.1.8 Service life prediction shall be done in accordance with 7.11. The predicted service life shall meet or exceed 100 years.

5.2.1.9 All sampling and testing frequency for recycled resin pipe shall be in accordance with Practice F3308.

5.2.2 Recycled Resin Fittings-Fittings made from recycled resins are not permitted under this standard.

Note 2-Post-consumer recycled materials contain a wide assortment of polyethylene compounds. which may have a combination of high and low environmental stress crack resistance. Post-industrial recycled materials will have much more consistent quality of compounds, but they will be of the same stress-crack resistance. They may, therefore, have higher or lower environmental stress crack resistance than post-consumer materials. The F3181 test method will, however, provide predictable and reproducible results for either material.

Section 6.6, Fittings and Joining Systems: Removed redundant information as follows:

6.6.3.1 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 Specifications for Highway Bridges, Division II, Section 26, "Metal Culverts."**



Section 7, Test Methods: Added additional testing for recycled resin products as follows:

*7.9 Determination of Percent Polypropylene for Recycled Resin Compounds—Test samples of the recycled resin compound in accordance with Test Method D7399.*

*7.10 Determination of Ash Content in Recycled Compounds—Test a two gram sample at 1472 °F [800 °C] in accordance with Test Method D5630.*

*7.11 Determination of Crack Initiation and Service Life Prediction of Pipes Manufactured with Recycled Compounds:*

*7.11.1 Crack initiation shall be tested in accordance with the un-notched, constant ligament stress (UCLS) crack test per Test Method F3181 at a condition of 650 psi [4 482 kPa] stress and 176 °F [80 °C].*

*7.11.2 For a service life of 100 years in service conditions where the tensile wall stress is 500 psi (3 447 kPa) and the service temperature is 73.4 °F [23 °C], the average failure time of five specimens shall be greater than or equal to 34 h and no specimen shall fail in less than 18 h.*

*7.11.3 For service conditions other than stated in 7.11.2, see Table X2.1.*

*7.11.4 An example calculation providing the basis for these average and minimum UCLS failure times is provided in Appendix X2.*

*NOTE 8—The UCLS test method and results are based on NCHRP Research Report 870.*

Section 11, Markings: Marking requirements were added for recycled resin pipe as follows:

*11.2 Recycled Resin Pipe—Each length of pipe in compliance with this specification shall be clearly marked with the following information: this designation “ASTM F2306/F2306M”; the nominal pipe size in inches [mm]; the Specification D3350 cell classification per 5.2.1 followed by the statement “contains recycled resin”, the manufacturer’s name, trade name or trademark, plant location, and date of manufacture.*

*The marking shall be applied to the pipe in such a manner that it remains legible 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].*