Designation: F405 – 13

Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings[1]

This standard is issued under the fixed designation F405; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification covers requirements and test methods for materials, marking dimensions, workmanship, elongation, brittleness, pipe stiffness, and perforations for corrugated polyethylene (PE) pipe and fittings in nominal sizes of 3 to 6 in., inclusive.

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..

NOTE 1—Along with sizes 3 to 6 in. covered in this specification, sizes 4 to 24 in. are described in Specification F667.

1.3 The text of this specification references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the specification.

1.4 The following precautionary caveat pertains only to the test methods portion, Section 8, of this specification: *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]

D618 Practice for Conditioning Plastics for Testing

D1600 Terminology for Abbreviated Terms Relating to Plastics

D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

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

D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials

F412 Terminology Relating to Plastic Piping Systems

F667 Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology F412, and abbreviations are in accordance with Terminology D1600, unless otherwise specified. The abbreviation for polyethylene is PE.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *crack*—any break or split that extends through the wall.

3.2.2 *crease*—a deformation that cannot be removed like a dent; generally associated with wall buckling.

4. Significance and Use

4.1 Corrugated PE pipe and fittings are intended for underground applications where soil support is given to the flexible walls. Their major uses are in soil drainage and septic field leach beds (see appendix for installation guidelines).

4.2 Corrugated fittings complying with the requirements of this specification may be used with either standard or heavy-duty pipe as defined by the requirements of Table 1.

5. Materials

5.1 *General*—Compounds used in the manufacture of corrugated PE drainage pipe and fittings shall have a minimum cell classification of 323410C or 333410C as defined and described in Specification D3350. Compounds that have a higher cell classification in one or more properties are acceptable, provided the product requirements are met.

NOTE 2—Class B pigments may be substituted for Class C provided that ultraviolet protection is acceptable to the purchaser as satisfactory for the intended use.

5.2 *Rework Material*—The manufacturer shall use only his own clean pipe or fitting rework material; the pipe and fittings produced shall meet all the requirements of this specification.

[1] This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.65 on Land Drainage.

Current edition approved Aug. 1, 2013. Published August 2013. Originally approved in 1974. Last previous edition approved in 2005 as F405 – 05. DOI: 10.1520/F0405-13.

[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.

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

TABLE 1 Physical Test Requirements for Corrugated Plastic Pipe

Physical Property Specified	Standard Pipe	Heavy-Duty Pipe
Pipe stiffness at 5 % deflection, min, MPa (psi)	0.17 (24)	0.21 (30)
Pipe stiffness at 10 % deflection, min, MPa (psi)	0.13 (19)	0.175 (25)
Elongation, max, %	10	5

6. Requirements

6.1 The pipe and fittings shall be homogeneous throughout and free of foreign inclusions or visible defects. The pipe and fittings shall be as uniform as commercially practicable in color, opacity, density, and other physical properties. The ends shall be cut squarely and cleanly. They shall be free of internal obstructions, including defective seams or mold registration lines. The product function shall be considered when judging external defects.

6.1.1 *Visible Defects*—Cracks, creases, splits, obstructions to flow in perforations or in pipe, uncolored or "pale" pipe, and obvious thin spots are not permissible.

NOTE 3—Wall thickness may vary within each corrugation. This variation is acceptable provided that the pipe meets all physical requirements.

NOTE 4—Defective sections may be removed and the line spliced in the field, where practical.

6.2 *Dimensions:*

6.2.1 *Nominal Size*—The nominal size for pipe and fittings shall be the inside diameter. Nominal diameters shall be sized in 1-in. increments beginning at 3 in.

6.2.2 *Inside Diameter*—The tolerance on the specified inside diameter shall be ±3 % when measured in accordance with 8.7.1.

6.2.3 *Length*—Corrugated PE pipe is an extruded product and may be sold in any length agreeable to the user. Length shall not be less than 99 % of stated quantity when measured in accordance with 8.7.

6.2.4 *Perforations*—Perforations shall be cleanly cut and uniformly spaced along the length of the pipe, in a size, shape, and pattern to suit the needs of the specifier. Unless otherwise specified, leach bed pipe shall have at least two rows of holes nominally ¼ to ¾ in. in diameter at a maximum of 5-in. (125-mm) centers, when measured in accordance with 8.7.3. Pipe shall be clearly marked with a locating stripe or embossment.

6.2.5 The actual inside diameter of a fitting will normally exceed the nominal diameter to permit the connection to be external to the pipe.

6.2.6 The maximum allowable gap between fitting and pipe shall not exceed the pipe perforation width unless otherwise specified.

6.2.7 All fittings shall be within an overall length dimension tolerance ± ½ in. (12.7 mm) of the manufacturer's specified dimensions.

6.3 *Pipe Requirements:*

6.3.1 *Pipe Stiffness*—Corrugated PE pipe shall have a minimum pipe stiffness as described in Table 1 when tested in accordance with 8.3. Pipe tested shall contain perforations if applicable.

NOTE 5—The 5 and 10 % deflection criteria, which were arbitrarily selected for testing convenience, should not be considered as limitations with respect to in-use deflection. The engineer is responsible for establishing the acceptable deflection limit.

NOTE 6—The strength and load carrying capabilities of plastic drain and sewer pipe are measured and reported as pipe stiffness which is determined in accordance with Test Method D2412. The term "crush strength" is not applicable to plastic piping because (*1*) the values obtained can be significantly different, depending on the bedding, loading, or testing technique used; and (*2*) the term derives from rigid pipe and refers to its ultimate strength at rupture.

6.3.2 *Elongation:*

6.3.2.1 The pipe shall be tested in accordance with 8.4. The test specimens shall contain perforations if applicable. Three specimens shall be tested and the average elongation calculated.

6.3.2.2 This test is intended for continuously extruded pipe only. Individually blown molded pipe, due to its short length, is exempted from the test unless installed in tension.

6.3.2.3 The average elongation shall meet the requirements of Table 1. For pipe having a higher elongation, the specimens shall meet the requirements of 6.3.3.

6.3.3 *Pipe Stiffness While Elongated*— Pipe having an elongation greater than permitted by Table 1 shall be further tested in accordance with 8.5. Three specimens shall be tested; the average value shall meet the pipe stiffness requirements of Table 1 in the stretched condition in order to be considered acceptable under this specification.

6.4 *Fitting Requirements:*

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

6.4.2 Common corrugated fittings include in-line joint fittings, such as couplings and reducers, and branch or complementary assembly fittings, such as tees, Y's, downspout adapters, and end caps. These fittings are installed by various methods, such as snap-on, screw-on, or wrap around.

NOTE 7—Some corrugated fittings will not fit all pipes. Only pipe supplied or recommended by the pipe manufacturer should be used.

6.4.3 Fittings shall not reduce the waterway of the pipe being joined. Reducer fittings shall not reduce the cross-sectional area of the smaller size.

6.4.4 Pipe and joint fittings shall not separate when tested in accordance with 8.8.

6.4.5 The fitting shall not crack, split, or crease when tested in accordance with 8.9.

6.4.6 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 8.10.

6.5 *Brittleness*—There shall be no cracking of the pipe wall when tested in accordance with 8.6, except as specified in 6.5.1 and 6.5.2.

6.5.1 Cracks with a maximum chord length of 10 mm that originate at a perforation or at either end of the sample shall not be cause for rejection.

6.5.2 Splitting along a pipe seam or mold parting line is not caused by brittleness and should be evaluated as a workmanship defect as described in 6.1, if no split exceeds 50 mm in chord length.

7. Sampling and Retest

7.1 *Sampling*—Representative samples of pipe and fittings sufficient to determine conformance with this specification shall be taken at random from stock by the testing agency.

7.2 *Retest and Rejection*—If the results of any test(s) do not meet the requirements of this specification, the test(s) shall be conducted again only by agreement between the purchaser and seller. Under such agreement, minumum requirements shall not be lowered, changed, or modified, nor shall specification limits be changed. If, upon retest, failure occurs, the quantity of product represented by the test(s) shall be rejected.

8. Test Methods

8.1 *Conditioning*—Condition the specimen prior to test at 70 to 77°F (23 ± 2°C) for not less than 40 h in accordance with Procedure A in Practice D618, for those tests where conditioning is required and in all cases of disagreement.

8.2 *Test Conditions*—Conduct the test in a laboratory temperature of 23 ± 2°C unless otherwise specified.

8.3 *Pipe Stiffness*—Weigh a minimum of three pipe specimens and test for pipe stiffness, $F/\Delta y$, as described in Test Method D2412, except for the following: (*1*) The test specimens shall be 12 ± ⅛ in. (305 ± 3 mm) long. (2) Locate the first specimens in loading machine with the imaginary line between the two corrugator seams (end view) parallel to the loading plates. The specimen must lie flat on the plate within ⅛ in. (3 mm). If necessary, straighten specimen 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 ±0.001 in. (±0.02 mm). (*4*) The residual curvature found in corrugated pipe 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 % deflection until it intersects the deflection axis. This point shall be considered as the origin of the load/deflection curve.

NOTE 8—The parallel plates must exceed the samples in length.

8.4 *Elongation*—Each specimen shall be 50 in. (1.27 m) long and shall be tested with the axis vertical. Apply the load by hanging a mass at the bottom end of the specimen. The initial load shall not exceed one *D* lb; the test load shall be five *D* lb, where *D* is the nominal inside diameter of the specimen. Apply the initial load to straighten the specimen and mark the gage length. The gage length shall be the middle 30 in. (0.76 m) of the specimen. Apply the test weight gently and, after 3 min, remeasure the gage length to the nearest 0.125 in. (3 mm). Calculate the elongation, *E*, in percent, as follows:

$$E = (\text{in. of stretch} \times 100)/30 \text{ in.}$$

NOTE 9—The test load is additional to the initial (tare) load.

8.5 *Pipe Stiffness While Elongated*— Test the 30-in. (0.76-m) gage length cut from the center of the 50-in. (1.27 m) specimen for pipe stiffness at 5 and 10 % deflection as described in Test Method D2412, except for the following conditions: (*1*) Stretch the test specimen as shown in Fig. 1 to the same percent elongation as measured in 8.4 and test in this condition; (*2*) support it on a rigid base plate 12 in. (305 mm) in length, and (*3*) apply a load plate 12 in. (305 mm) in length, to the center portion of the 30-in. (762-mm) specimen.

8.6 *Brittleness*—Test three samples of frozen pipe at an impact of 35 ft·lbf (47 J) between two flat parallel plates. See Fig. 2.

8.6.1 Cut sample specimens 6 in. (152 mm) long from one continuous length.

8.6.2 Condition specimens at −10 ± 5°F (−23 ± 3°C) for a minimum of 30 min.

8.6.3 Set the 21-lb (9.5-kg) top plate for a free fall of 20 in. (508 mm) to the uppermost surface of the specimen.

8.6.4 Locate the specimen to be tested on the bottom plate with the plane of the corrugator seams parallel to the plate.

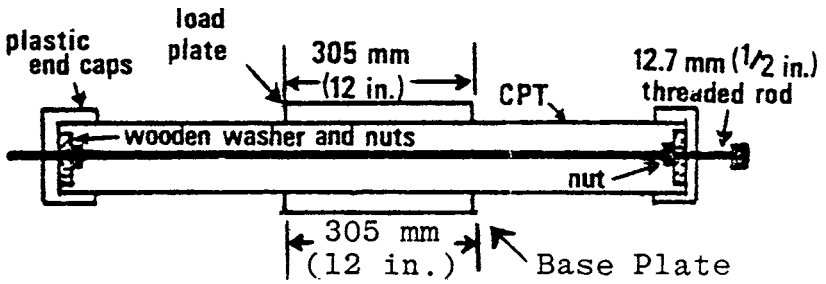
8.6.5 Drop the upper plate and impact test the pipe specimen within 30 s of removal of specimen from conditioning environment.

8.6.6 Remove and inspect in accordance with the requirements of 6.5. Repeat for each specimen.

NOTE 10—Brittleness cracking will normally occur in the areas of direct plate contact and will be quite audible.

8.7 *Measurement:*

8.7.1 *Inside Diameter*—Measure the inside diameter of the pipe with a tapered plug in accordance with Test Method D2122.



NOTE 1—Use any fabricated fitting that provides contact around the circumference of the corrugation in place of the end cap. On one end of the rod use a double nut (locked together) and on the other end attach the nut to the end cap.

FIG. 1 Test Rig for Determining Stiffness When Elongated

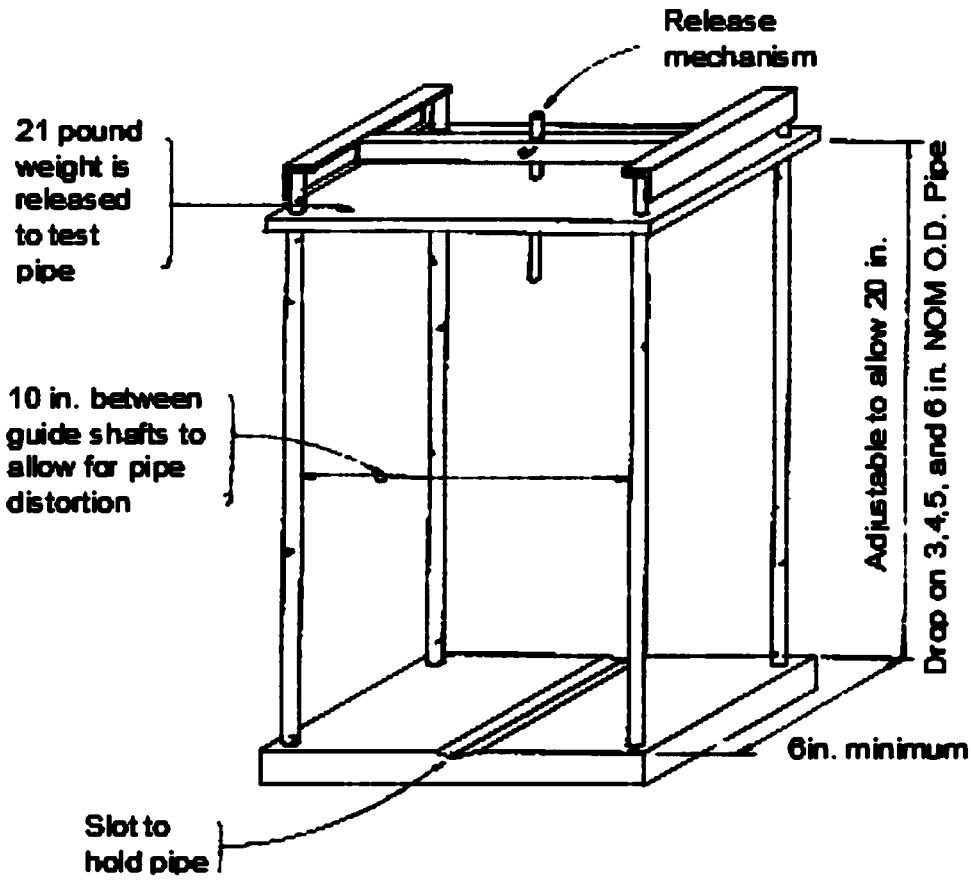


FIG. 2 Brittleness Test Device

8.7.2 *Length*—Measure pipe with any suitable device accurate to ±¼ in. (±6 mm) in 10 ft (3 m) (0.2 %). Make all measurements on the tubing while it is resting on a relatively flat surface in a straight line, with no external forces of tension or compression exerted on the pipe.

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

8.8 *Joint Integrity*—Assemble joint fittings to the appropriate pipe in accordance with manufacturer's instructions. Use pipe samples at least 6 in. (150 mm) in length. Use the hanging weight test procedure described in 8.4. Verify that the joint will withstand a pull in pounds force along the pipe axis equal to five times the nominal inside diameter in inches without separating. Test three fittings of each type.

8.9 *Strength*—Assemble each fitting to the appropriate pipe in accordance with manufacturer's instructions. Use pipe samples at least 6 in. (150 mm) in length. Load the connected pipe and fitting between parallel plates at the rate of ½ in. (12.7 mm)/min until the vertical inside diameter is reduced by at least 20 % of the nominal diameter of the fitting. Remove and inspect for damage. Test three specimens of each type.

8.10 *Alignment*—Ensure that the assembly or joint is correct and complete. If pipe is bent, straighten it by hand before performing this test. Lay the assembly or joint on a flat surface and verify that it will accommodate straight-line flow.

9. Report

9.1 Report the following information:

9.1.1 Date or dates of tests,

9.1.2 Complete identification of product tested, including nomenclature, manufacturer, source, previous history, if any, etc.,

9.1.3 Description of manufacturer's product marking,

9.1.4 Notation describing any retest due to previous test failure,

9.1.5 Conditioning method,

9.1.6 Details of sampling,

9.1.7 Individual and average test results,

9.1.8 Weight per foot of each test specimen and the average, and

9.1.9 Description of any failures.

NOTE 11—It is recommended that heavy-duty pipe be used in leach beds.

10. Certification

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

11. Marking

11.1 Corrugated polyethylene drainage pipe complying with this specification shall be marked with the designation number, "ASTM F405," the designation of standard or heavy duty as in Table 1, and with the manufacturer's identification symbol, regularly spaced at intervals not exceeding 10 ft (3 m).

11.1.1 *Dating*—Each role or bundle shall bear the day, month, and year of manufacture embossed on the product or added on a tag.

11.2 Fittings for corrugated polyethylene pipe complying with this specification shall be marked with the designation number, "ASTM F405," and with the manufacturer's identification symbol.

12. Quality Assurance

12.1 When the product is marked with this designation, "ASTM F405", 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. When specified in the purchase order or contract, a report of the test results shall be furnished.

APPENDIX

(Nonmandatory Information)

X1. INSTALLATION

X1.1 Authorities

X1.1.1 Since this product has a wide variety of uses, approval for its use rests with various agencies. The installer must contact the relevant authority to obtain local installation guidelines. Some such authorities are listed by product usage as follows:

X1.1.1.1 *Farm Drainage*— U.S. Department of Agriculture Soil Conservation Service, local office. Reference, Engineering Standard 606.

X1.1.1.2 *Leach Bed, Septic Fields*—The local Health Department and Federal Housing Authority (FHA) offices.

X1.1.1.3 *Construction Uses, Building Perimeter Drains*—The local Building Department, FHA, or the local PlumbingAuthority, or all three.

X1.1.1.4 *Roadway Drainage*—State, county, or local Highway Authority.

X1.1.2 The pipe manufacturer should be able to provide proof of product acceptance by specific agencies.

X1.2 Caution

X1.2.1 The user should be aware that the use of this pipe is not recommended where:

X1.2.1.1 It is exposed to flame at any time.

X1.2.1.2 It is permanently exposed to sunlight or weathering, or both.

X1.2.1.3 It is exposed to chemicals other than those normally found in groundwater or septic tank effluents.

SUMMARY OF CHANGES

Committee F17 has identified the location of selected changes to this standard since the last issue (F405–05) that may impact the use of this standard.

(1) Sections 2 and 5.1 were revised.