

IAPMO IGC 354-2022



Industry Standard for

Expandable Pressure Pipe Renewal Systems Employing Polyethylene Terephthalate (PET)



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Preface

This is the fifth edition of IAPMO IGC 354, Expandable Pressure Pipe Renewal Systems Employing Polyethylene Terephthalate (PET). This Standard supersedes IAPMO IGC 354-2021, Expandable Pressure Pipe Renewal Systems Employing Polyethylene Terephthalate (PET). The previous editions of this standard are: October 2021, October 2020, August 2019, and January 2020

This Standard was developed by the IAPMO Standards Review Committee (SRC) in accordance with the policies and procedures regulating IAPMO industry standards development, Policy S-001, Standards Development Process. This Standard was approved as an IAPMO Industry Standard on February 7, 2022.

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and
 - (d) *rationale for the change.*
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IAPMO IGC 354-2022

Expandable Pressure Pipe Renewal Systems Employing Polyethylene Terephthalate (PET)

1 Scope

1.1 General

- 1.1.1** This Standard covers expandable pressure pipe renewal systems employing polyethylene terephthalate (PET) intended for use in water supply pipes ranging from DN 15 to 50 (1/2 to 2 NPS) and specifies requirements for materials, physical characteristics, performance testing, and markings.
- 1.1.2** Polyethylene terephthalate (PET) pipe renewal systems covered by this standard are intended for application in various pipe materials including but not limited to lead, copper, galvanized iron, steel, and plastic.
- 1.1.3** The pipe renewal is achieved by forming a thin-walled layer close-fitting to the interior of the existing pipe.
***Note:** Information on the pipe renewal system, the installation of the pipe and the manufacture and quality assurance of the pipe, is provided in the Informative Appendices A, B and C respectively.*
- 1.1.4** This Standard covers expandable pressure pipe renewal systems employing polyethylene terephthalate (PET) and does not cover cured in place, pulled in place, pipe bursting, internal pipe epoxy lining or any other pipe lining systems.

1.2 Alternative Materials

The requirements of this Standard are not intended to prevent the use of alternative materials or methods of construction provided such alternatives meet the intent and requirements of this Standard.

1.3 Terminology

In this Standard,

- (a) “shall” is used to express a requirement, i.e., a provision that the user is obliged to satisfy to comply with the Standard;
- (b) “should” is used to express a recommendation, but not a requirement;
- (c) “may” is used to express an option or something permissible within the scope of the Standard; and
- (d) “can” is used to express a possibility or a capability.

Notes accompanying sections of the Standard do not specify requirements or alternative requirements; their purpose is to separate explanatory or informative material from the text. Notes to tables and figures are considered part of the table or figure and can be written as requirements.

1.4 Units of Measurement

SI units are the primary units of record in global commerce. In this Standard, the inch/pound units are shown in parentheses. The values stated in each measurement system are equivalent in application, but each unit system is to be used independently. All references to gallons are to U.S. gallons.

2 Reference Publications

This Standard refers to the following publications and, where such reference is made, it shall be to the current edition of those publications, including all amendments published thereto.

ASTM International

ASTM D1599

Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings

ASTM D7091

Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals

ASTM E376

Standard Practice for Measuring Coating Thickness by Magnetic-Field or Eddy Current (Electromagnetic) Testing Methods

ASTM E797/E797M

Standard Practice for Measuring Thickness by Manual Ultrasonic Pulse-Echo Contact Method

AWWA (American Water Works Association)

AWWA M28

Rehabilitation of Water Mains, Third Edition

ISO (International Standards Organization)

ISO 11295

Classification and Information on Design and Applications of Plastics Piping Systems Used for Renovation and Replacement

ISO 11298-3

Plastics Piping Systems for Renovation of Underground Water Supply Networks - Part 3: Lining with Close-Fit Pipes

NSF International

NSF/ANSI/CAN 61

Drinking Water System Components - Health Effects

3 Definitions and Abbreviations

3.1 Definitions

The following definitions shall apply in this Standard:

Batch Release Test — A test performed by the manufacturer on a batch of component which has to be satisfactorily completed before the batch can be released

Close-Fit — Situation of the outside of the inside expandable pressure pipe relative to the inside of the existing pipeline, which may either be an interference fit or include a small annular gap resulting from shrinking and tolerances only

Expandable Pressure Pipe (EPP) — Rehabilitated pipe after installation

Interactive Expandable Pressure Pipe — Expandable pressure pipe which relies on the existing pipeline for some measure of radial support in order to resist without failure all applicable internal loads throughout its design life

Nominal Size — Numerical designation of the size of a component which is a convenient round number - approximately equal to the manufacturing dimension in millimeters - and is related to the outside diameter.

Renewal with Close-Fit Pipes — Renewal with a continuous pipe for which the cross section is reduced to facilitate installation and reverted after installation to provide a close-fit to the existing pipe

Renovation — Work incorporating all or part of the original fabric of the pipeline by means of which its current performance is improved

Type Test — Test performed to prove that the material, component, joint or assembly is capable of conforming to the requirements given in a specification

3.2 Abbreviations

The following abbreviations apply in this Standard:

DN	—	Nominal size based on outside diameter (in mm)
NPS	—	Nominal pipe size (in inches)
PET	—	Polyethylene terephthalate

4 General Requirements

4.1 Materials

PET pipe renewal systems covered by this Standard shall be made of Polyethylene Terephthalate (PET) that complies with or exceeds the minimum requirements of this Standard.

4.2 PET Expandable Pressure Pipe Characteristics

4.2.1 Stages

The PET expandable pressure pipe characteristics are considered in two stages:

- (a) The manufactured stage (the manufactured pipe) or the “M” stage
- (b) The installed stage (the installed expandable pressure pipe) or the “I” stage”

4.2.1.1 The “M” stage is the condition of the pipes as supplied by the manufacturer and before any further installation process has taken place.

4.2.1.2 The “I” stage is the condition of the expandable pressure pipe after the installation process has taken place.

4.2.1.3 The assessment of conformity (type testing, batch release testing) covered in Appendix C is conducted on pipe samples both in the “M” stage and the “I” stage.

4.2.2 Capabilities

4.2.2.1 The PET expandable pressure pipe shall have the capability to span holes and gaps when tested in accordance with Section 5.3.

4.2.2.2 The PET expandable pressure pipe system shall be capable of expansion from the “M” stage to the “I” stage with a rate between 1.6 and 2.5.

4.2.2.3 The PET expandable pressure pipe shall create a continuous protective barrier, separating the potable water from the existing host pipe.

4.3 Toxicity

Materials and components of the PET expandable pressure pipe intended to convey or dispense water for human consumption through drinking or cooking shall comply with the applicable requirements of NSF/ANSI/CAN 61.

4.4 Expandable Pressure Pipe Ratio

The ratio of the external diameter of the PET expandable pressure pipe in the “M” stage to the internal diameter of existing pipe shall be smaller than 0.6 and greater than 0.4.

4.5 Workmanship

After application (“I” stage) when viewed without magnification:

- (a) The color of the PET expandable pressure pipe shall be natural opaque; and,
- (b) The internal and external surfaces of the PET pipe liner:
 - (i) Shall be smooth, shiny, clean and free from scoring; and
 - (ii) There shall be no evidence of cavities or other defects, such as cracks, or significant amounts of waviness.

5 Testing Requirements

5.1 Bendability and Expandability Test

5.1.1 Test Procedure:

The bendability and expandability test shall be conducted as follows:

- (a) Prepare the host piping in accordance with Table 2 and with a minimum of 2 x long sweep 90-degree bends and a straight length of pipe as shown in Figure 3;
- (b) Install the expandable pressure pipe system in accordance with the manufacturer's installation instructions to have the product in the "I" stage;
- (c) Insert a cylindrical foam plug with a minimum diameter equal to the host pipe NPS and a minimum length of 31.8 mm (1.25 in) long;
- (d) Apply air pressure of 552 ± 34 kPa (80 ± 5 psi) to the test specimen on the same side the foam plug was inserted;
- (e) Maintain the pressure for 1 min; and
- (f) Observe the other side of the specimen for the foam plug.

5.1.2 Performance Requirements

The plug shall pass through the specimen and emerge from the other end successfully.

5.2 Expandable Pressure Pipe Thickness Test

5.2.1 Assembly and Preparation

Conduct the test with the same test assembly used in Section 5.1 after the bendability and expandability test has been conducted.

5.2.2 Test Procedure

The expandable pressure pipe thickness shall be measured in accordance with ASTM D7091, ASTM E376, ASTM E797/E797M or as follows:

- (a) Note the average wall thicknesses of the pipe and fittings before connection and assembly by measuring at least 5 locations, around the pipe and fitting openings and as far inside each as practical;
- (b) Install the PET expandable pressure pipe system in accordance with the manufacturer's installation instructions;
- (c) Remove and section the end fitting and at least one additional fitting from the assembly;
- (d) Cut the fittings to obtain a section for measurement of the PET expandable pressure pipe (e.g. Bisect axially, longitudinally, or laterally to expose the original fitting thickness and the PET expandable pressure pipe to measurement); and
- (e) Cut and remove at least six pipe specimens from various locations in the test assembly.
 - (i) Measure the external diameter of the ends of each test specimen (D1)
 - (ii) Measure the internal diameter of the ends of each test specimen (D3);
 - (iii) Measure the thickness of the pipe without the PET expandable pressure pipe (T1).
***Note:** If the thickness of the pipe without the PET expandable pressure pipe is not clear the average thickness of the pipe measured prior to specimen preparation may be used as (T1).*
 - (iv) Determine the thickness of the PET expandable pressure pipe (T3) in accordance with Figure 1 and Equation 1.

$$\text{Equation 1: } T3 = \frac{(D1-D3)}{2} - T1$$

5.2.3 Performance Requirements

The minimum thickness of the PET expandable pressure pipe in the "I" stage on the pipe and fittings shall be in accordance with this equation $0.01 D2 < T3 < 0.05 D2$ (see Figure 1 for demonstration).

5.3 Hole Span and Hydrostatic Burst Pressure Test

5.3.1 Test Procedure

The hole span test shall be conducted as follows:

- (a) Prepare the host pipe with a minimum length of 750 mm (29.5 in) with holes in accordance with Table 1 and equally distributed over the host pipe perimeter as shown in Figure 2;
- (b) Install the expandable pressure pipe system in accordance with the manufacturer's installation instructions to have the product in the "I" stage;
- (c) Fill the specimen with water and seal both ends with suitable end fittings; and
- (d) Apply pressure in increments of 500 kPa (72.5 psi) until the pressure reaches 2.5 MPa (363 psi).

5.3.2 Performance Requirements

The specimen shall withstand at least 2.5 MPa (363 psi) without leaking or failing.

6 Markings and Accompanying Literature

6.1 Marking and Tagging

6.1.1 The PET material shall not be marked under any circumstance; however, the packaging of the pipe in “M” stage is to be marked as instructed below. The “I” stage expandable pressure pipe must be tagged at entry of the structure and meter pit, if located outside of the structure.

6.1.2 Expandable pressure pipe renewal systems employing Polyethylene Terephthalate (PET) complying with this Standard shall be marked/tagged with at least the following information:

- (a) Manufacturer's name;
- (b) Trademark;
- (c) IAPMO IGC 354;
- (d) NSF/ANSI/CAN 61 for application in lining potable water services;
- (e) Length;
- (f) Internal diameter range host pipe;
- (g) Production date & maximum date of usage; and
- (h) Batch number.

6.2 Packaging

The PET expandable pressure pipe shall be:

- (a) Wound on coils and the coils of pipe shall be strapped at regular intervals; and
- (b) Packaged in the “M” stage and boxed or otherwise covered sufficiently to protect against UV exposure prior to use.

6.3 Accompanying Literature

Expandable pressure pipe renewal systems employing Polyethylene Terephthalate (PET) complying with this Standard shall be accompanied by instructions for their installation, care and maintenance, and repair, specifying at least the following:

- (a) Requirements for the installation company, including:
 - (i) The qualification for working in the respective application; and
 - (ii) Work carried out by installation personnel certified by the pipe lining system owner;
- (b) Requirements for the installation equipment, for a quality and environmentally compatible execution of the installation, including/respecting:
 - (i) The national regulations regarding
 - 1. safety;
 - 2. noise protection; and
 - 3. preservation of clean of air, ground and water.
 - (ii) The technical requirements set by the expandable pressure pipe system owner; and
 - (iii) Checks and controls of the equipment a regular time base and documented.
- (c) Requirements for the materials used, shall be in accordance with the specification of the expandable pressure pipe system owner;
- (d) Requirements for the existing pipe, including:
 - (i) It shall have sufficient rest strength (for the interactive expandable pressure pipe); and
 - (ii) It shall be accessible and cleanable to allow insertion of the PET expandable pressure pipe
- (e) Requirements for the installation process, where the content of the installation manual provided by the pipe lining system owner shall be respected.

Table 1
Host Pipe Requirements for Hole Spanning Test

(See Section 5.3.1)

Expandable pressure pipe size DN (NPS)	Diameter x wall thickness host pipe mm (in)	Hole size mm (in)
7 (3/16)	16.0 x 1.3 (0.63 x 0.05)	10.5 (0.4)
10 (3/8)	22.4 x 1.8 (0.88 x 0.07)	15 (0.6)
15 (1/2)	35.1x 1.8 (1.38 x 0.07)	23 (0.9)
20 (3/4)	54.1 x 2.0 (2.13 x 0.08)	30 (1.2)

Table 2
Host Pipe Requirements for Bendability and Expandability Test

(See Section 5.1.1)

Expandable pressure pipe size DN (NPS)	Diameter x wall thickness host pipe mm (in)	Approximate radius bends mm (in)	Length of straight pipes m (ft)
7 (3/16)	16.0 x 1.3 (0.63 x 0.05)	254 10	1.5 (5)
10 (3/8)	22.4 x 1.8 (0.88 x 0.07)	305 (12)	1.5 (5)
15 (1/2)	35.1x 1.8 (1.38 x 0.07)	381(15)	1.5 (5)
20 (3/4)	54.1 x 2.0 (2.13 x 0.08)	457 (18)	1.5 (5)