



Examination Standard for Polyethylene (PE) Pipe and Fittings for Underground Fire Protection Service

Class Number 1613

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Foreword

This standard is intended to verify that the products and services described will meet stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of this standard is to present the criteria for examination of various types of products and services.

Examination in accordance with this standard shall demonstrate compliance and verify that quality control in manufacturing shall ensure a consistent and reliable product.

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1. INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states testing and certification requirements for polyethylene (PE) pipe and fittings for underground fire service water mains.
- 1.1.2 Testing and certification criteria may include performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a surveillance program.

1.2 Scope

- 1.2.1 This standard encompasses the design and performance requirements for NPS (Nominal Pipe Size) 4 in. through 36 in. nominal size PE pipe and fittings for use in underground fire service mains. Other sizes may be considered for certification on a case-by-case basis.
- 1.2.2 In cases where metric sized PE pipe and fittings are to be examined for certification, test criteria comparable to the United States equivalent size shall be used.
- 1.2.3 The certification agency will consider PE pipe and fittings which are designed in accordance to national or international standards. Only after verification is made that the products to be reviewed are in conformance to ANSI/AWWA C906 or other nationally or internationally recognized standards will certification testing commence. All certification testing is to be conducted on production samples.

1.3 Basis for Requirements

- 1.3.1 The requirements of this standard are based on experience, research and testing, and/or the standards of other organizations. The advice of manufacturers, users, trade associations, jurisdictions and/or loss control specialists was also considered.
- 1.3.2 The requirements of this standard reflect tests and practices used to examine characteristics of PE pipe and fittings for the purpose of obtaining certification. PE pipe and fittings having characteristics not anticipated by this standard may be certified if performance equal, or superior, to that required by this standard is demonstrated.

1.4 Basis for Certification

Certification is based upon satisfactory evaluation of the product and the manufacturer in the following major areas:

- 1.4.1 Examination and tests on production samples shall be performed to evaluate:
 - the suitability of the product;
 - the performance of the product as specified by the manufacturer and required for certification;
 - the durability and reliability of the product.
- 1.4.2 An examination of the manufacturing facilities and audit of quality control procedures may be conducted to evaluate the manufacturer's ability to consistently produce the product which is examined and tested, and the marking procedures used to identify the product. Subsequent surveillance may be required by the certification agency in accordance with the certification scheme to ensure ongoing compliance.

1.5 Basis for Continued Certification

The basis for continual certification may include the following based upon the certification scheme and requirements of the certification agency:

- production or availability of the product as currently certified;
- the continued use of acceptable quality assurance procedures;
- satisfactory field experience;
- compliance with the terms stipulated by the certification;
- satisfactory re-examination of production samples for continued conformity to requirements; and
- satisfactory surveillance audits conducted as part of the certification agency's surveillance program.

1.6 Effective Date

The effective date of this examination standard mandates that all products tested for certification after the effective date shall satisfy the requirements of this standard.

The effective date of this standard is eighteen (18) months after the publication date of the standard for compliance with all requirements.

1.7 System of Units

Units of measurement used in this standard are United States (U.S.) customary units. These are followed by their arithmetic equivalents in International System (SI) units, enclosed in parentheses. The first value stated shall be regarded as the requirement. The converted equivalent value may be approximate. Conversion of U.S. customary units is in accordance with ANSI/IEEE/ASTM SI 10.

Two units (liter and bar), outside of but recognized by SI, are commonly used in international fire protection and are used in this standard.

1.8 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the cited edition applies:

ANSI A21.10, *American National Standard for Thickness Design of Cast Iron Pipe*

ANSI/IEEE/ASTM SI 10, *American National Standard for Metric Practice*

ANSI/AWWA C906, *Polyethylene (PE) Pressure Pipe and Fittings, 4 in. Through 65 in. (100 mm Through 1650 mm), for Waterworks*

ISO 6259:, *Thermoplastics pipes – Determination of tensile properties*

ASTM D638, *Standard Test Method for Tensile Properties of Plastics*

ASTM D883, *Standard Terminology Relating to Plastics*

ASTM D1238, *Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer*

ASTM D1598, *Standard Test Method for Time-to-Failure of Plastic Pipe under Constant Internal Pressure*

ASTM D1599, *Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing and Fittings*

ASTM D1603, *Standard Test Method for Carbon Black in Olefin Plastics*

ASTM D2290, *Standard Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe*

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

ASTM D2837, *Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products*

ASTM D2839, *Standard Practice for Use of a Melt Index Strand for Determining Density of Polyethylene*

ASTM D3350, *Standard Specification for Polyethylene Plastic Pipe and Fittings Materials*
ASTM D4218, *Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique*
ASTM F2620, *Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings* ASTM F2880-14, *Standard Specification for Lap-Joint Type Flange Adapters for Polyethylene Pressure Pipe in Nominal Pipe Sizes ¾ in. to 65 in.*
ASTM F412, *Standard Terminology Relating to Plastic Piping Systems*
ASTM F714, *Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter*
PPI TR-3, *Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB), Strength Design Basis (SDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe*
PPI TR-4, *PPI Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB) and Minimum Required Strength (MRS) Ratings For Thermoplastic Piping Materials or Pipe*
NSF/ANSI 61: *Drinking Water Systems Components - Health Effects*

1.9 Terms and Definitions

Generally, terminology relating to PE pipe and fittings shall be in accordance with ASTM D883, *Standard Terminology Relating to Plastics* and ASTM F412, *Standard Terminology Relating to Plastic Piping Systems*, respectively. Any terminology not included within, or in contradiction to, those documents will be separately defined where used in the certification examination of PE pipe and fittings. For purposes of this standard, the following terms apply:

Accepted

This term refers to installations acceptable to the authority enforcing the applicable installation rules (Authority Having Jurisdiction). Acceptance is based upon an overall evaluation of the installation. Acceptance is not a characteristic of a product. It is installation specific. A product accepted for one installation may not be acceptable elsewhere.

Design Factor (DF)

The design factor is used to reduce the hydrostatic design basis (HDB) determined according to ASTM D2837 and PPI TR-3 to arrive at the hydrostatic design stress (HDS) from which the pressure class (PC) is calculated. The design factor accounts for typical process variation, dimensional tolerances and other sources of variability that can impact the long-term performance of HDPE pipe. The design factor used in this standard for PE2708, PE3710 and PE4710 compounds is 0.63. The design factor used in this standard for PE2606, PE2706, PE3608, PE3708, PE4608 and PE4708 is 0.50.

NOTE: The design factor is not the inverse of the safety factor. The time to failure of HDPE at a particular temperature is related to stress through a power law relationship i.e. time to failure increases dramatically with a small reduction in stress.

Dimension Ratio (DR)

The ratio of the average outside diameter of outside diameter-controlled plastic pipe to the minimum specified wall thickness of the pipe, rounded to the nearest tenth (eg. DR 13.5).

Electrofusion Joints

A joint where the mating surfaces, typically a pipe outside diameter and the inside diameter of a coupler, are first mated and then brought to the material melt temperature by means of heating elements embedded in the socket. Once cooled, the result is an electrofused joint.

Hydrostatic Design Basis (HDB)

The categorized long-term hydrostatic strength in the circumferential or hoop direction established in accordance with ASTM D2837 and PPI TR-3. The HDB is established at a specific reference temperature, usually 73°F and 140°F and represents the constant hoop stress that induces ductile rupture

in the pipe in 100,000 hours (~11.4 years) at the specified reference temperature.

Hydrostatic Design Stress (HDS)

The maximum allowable hoop stress in the pipe wall for pipe that is subjected to sustained long-term hydrostatic pressure. The hydrostatic design stress is determined by multiplying the hydrostatic design basis by the design factor for water service. HDS ratings for PE materials are published in PPI TR-4.

Long Term Hydrostatic Strength (LTHS)

Plastic materials exhibit a time-dependent response to stress. This occurs in a predictable fashion. If samples of plastic pipe are pressurized to various levels, they will fail after periods of time proportional to those pressures. The specific relationship is that the logarithm of the time to failure is negatively proportional to the logarithm of the stress.

$$\log T = a - b \log S$$

Where a and b are constants.

This stress, S , is the hoop stress in the material due to internal pressure at a constant temperature. ASTM D2837, *Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products*, details test procedures for obtaining this relationship. The relationship is then used to determine a particular maximum S that should not cause failure until at least after a minimum desired life. That S is termed the Long Term Hydrostatic Stress (LTHS) for the material in question.

Polyethylene (PE)

A polymer prepared by the polymerization of no less than 85 percent ethylene and no less than 95 percent of total olefins by weight, plus compounding ingredients.

Pressure Class

For polyethylene pipe or tubing, the PC is a numerical classification for maximum sustained internal water pressure water at 80°F (27°C) and lower service temperature with specified maximum allowances for pressure surges. Pressure Class is defined as:

$$PC = \frac{2}{DR - 1} \times HDB \times DF$$

Where:

- PC - Pressure Class
- DR - Dimension Ratio = D_o/t
- HDB - Hydrostatic Design Basis for water, as determined in AWWA C906.
- DF - Typical Design Factor. For example, 0.63 for PE4710.
- t - Minimum Pipe Wall Thickness
- D_o - Average Outside Diameter for IPS and DI sizes; minimum outside diameter for ISO sizes.

Pressure Pipe for Water Distribution and Transmission

Underground pipe used to carry water from a source of supply and distribute it throughout a distribution system or a service area. For the purposes of this standard, distribution and transmission pipe is limited to nominal sizes 4 inches through 36 inches; other sizes will be evaluated on a case-by-case basis.

Production Run

The length of time a particular piece of extrusion equipment is set up to produce a certain size and class of pipe.

Safety Factor (SF)

The safety factor in this standard is the ratio of the actual hoop stress at the allowed operating pressure and temperature to the hoop stress that will cause a ductile failure at the operating temperature.

For example, PE 4710 Safety factor is greater than 2 relative to the allowed operating stress.

Working Pressure (WP)

The maximum anticipated, sustained operating pressure applied to the pipe exclusive of hydraulic transient pressures.

2. GENERAL INFORMATION

2.1 Product Information

- 2.1.1 Nominal sizes of PE pipe and fittings for underground fire protection service addressed in this standard are limited to sizes 4 in. through 36 in. Other sizes shall be evaluated on a case-by-case basis.
- 2.1.2 PE pipe and fittings are manufactured from materials with specific properties. They are thermoplastic compounds prepared by combining the base polymer, polyethylene or a copolymer of ethylene and higher olefins, with stabilizers, colorants, anti-oxidants and ultra-violet (UV) screens for processing, property control, and coloring.
- 2.1.3 PE resin is usually either extruded (pipes) or fabricated or molded (fittings) of specific thermoplastic formulations, in conformance to nationally or internationally recognized standards.
- 2.1.4 In order to meet the intent of this standard, PE pipe and fittings must be examined on a model-by-model, type-by-type, manufacturer-by manufacturer, and plant-by-plant basis. This is predicated on the basis that identical designs, fabricated in identical materials by different manufacturers or, even by different plants of the same manufacturer, have been seen to perform differently in testing. Sample PE pipe and fittings, selected in conformance to this criterion, shall satisfy all of the requirements of this standard.

2.2 Certification Application Requirements

The manufacturer shall provide the following preliminary information with any request for certification consideration:

- a complete list of all models, types, sizes, and options for the products or services being submitted for certification consideration;
- general assembly drawings, one complete set of manufacturing drawings, hydrostatic design basis (HDB) calculations, anticipated marking format, brochures, sales literature, specification sheets, installation, operation and maintenance procedures, and
- number and location of manufacturing facilities making the products submitted for certification.

All documents shall identify the manufacturer's name, document number or other form of reference, title, date of last revision, and revision level. All documents shall be provided with English translation.

2.3 Requirements for Samples for Examination

- 2.3.1 Following authorization of a certification examination, the manufacturer shall submit samples for examination and testing based on the following:
 - Sample requirements to be determined by the certification agency
- 2.3.2 Requirements for samples may vary depending on design features, results of prior or similar testing, and results of any foregoing tests.
- 2.3.3 The manufacturer shall submit samples representative of production. Any decision to use data generated using prototypes is at the discretion of the certification agency.
- 2.3.2 It is the manufacturer's responsibility to provide any special test fixtures which may be required to evaluate the PE pipe and fittings.