



Examination Standard for Fiber Reinforced Composite (FRC) Pipe and Fittings for Underground Fire Protection Service

Class Number 1614

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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 fiber reinforced composite (FRC) pipe and fittings for underground fire service water mains.
- 1.1.2 Testing and certification requirements 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 inch through 36 inch nominal size FRC pipe and fittings for use in underground fire service mains. Other sizes may be evaluated on a case-by-case basis.
- 1.2.2 In cases where metric sized FRC 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 FRC pipe and fittings which are designed in accordance to national or international standards, such as the American Water Works Association (AWWA) C-950 for *Fiberglass Pressure Pipe*. Pipe manufactured in accordance with other nationally or internationally recognized standards will be considered on a case-by-case basis. All certification testing is to be conducted on production samples.
- 1.2.4 This standard is primarily intended for use in certifying fiberglass pipe and fittings. Other fiber reinforced composite materials can be certified under this standard and will be evaluated on a case-by-case basis.

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 FRC pipe and fittings for the purpose of obtaining certification. FRC pipe and fittings having characteristics not anticipated by this standard may be certified if performance equal to, 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 A21.1, *American National Standard for Thickness Design of Cast Iron Pipe*
ANSI/AWWA C950, *Fiberglass Pressure Pipe*
ANSI/IEEE/ASTM SI 10, *American National Standard for Metric Practice*
ASTM D883, *Standard Terminology Relating to Plastics*
ASTM D1598, *Standard Test Method for Time-to-Failure of Plastic Pipe under Constant Internal Pressure*
ASTM D2412, *Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading*
ASTM D2444, *Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)*
ASTM D2837, *Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products*
ASTM D2992, *Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for 'Fiberglass' (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings*
ASTM D3517, *Standard Specification for 'Fiberglass' (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe*
ASTM D3567, *Standard Practice for Determining Dimensions of 'Fiberglass' (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe and Fittings*

ASTM F412, *Standard Terminology Relating to Plastic Piping Systems*
AWWA, M 45 *Fiberglass Pipe Design*
NSF/ANSI 61, *Standard for Drinking Water Systems Components - Health Effects*

1.9 Terms and Definitions

Generally, terminology relating to FRC pipe and fittings shall be in accordance with ANSI/ASTM D883, *Standard Definitions of Terms 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 FRC 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 factor that is used to reduce the Hydrostatic Design Basis (HDB) to arrive at the Hydrostatic Design Stress (HDS). The Design Factor is the inverse of the Safety Factor.

Hydrostatic Design Basis (HDB)

One of a series of established stress values obtained by categorizing the Long Term Hydrostatic Strength of the material as described in ASTM D2992, *Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for 'Fiberglass' (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe*.

Hydrostatic Design Stress (HDS)

The recommended maximum allowable hoop stress used in the design of plastic pipe of a given material. It is obtained by dividing the Hydrostatic Design Basis (HDB) by a safety factor.

$$HDS = \frac{HDB}{SF}$$

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 that depends on these 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 material constants.

This stress, S , is the hoop stress in the material due to internal pressure at a constant temperature. ASTM D2992, *Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for 'Fiberglass' (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe*, 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.

Pressure Class

The pressure class is the design capacity to resist working pressure at 73.4°F (23°C) with specified maximum allowances for recurring positive pressure surges above the working pressure. Pressure Class is defined in AWWA *Fiberglass Pipe Design (M45)*, as:

For stress basis HDB:

$$P_c < \left(\frac{HDB}{FS} \right) \left(\frac{2t}{D} \right)$$

For strain basis HDB:

$$P_c < \left(\frac{HDB}{FS} \right) \left(\frac{2tE_H}{D} \right)$$

Where:

- P_c - Pressure Class, in psi_g (kPa_g)
- HDB - Hydrostatic Design Basis for water, in psi, (kPa) as determined in ASTM D2992.
- FS - Typical Design Factor; Includes Consideration of Degree of Safety and all the variables, including limited surge pressure effects, in the end application
- t - Thickness of the pipe wall, in. (mm) as defined in ASTM D3567
- D - Mean Pipe Diameter, in. (mm)
- E_H - hoop tensile modulus of elasticity, lb/in² (kPa)

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)

A number, typically greater than or equal to 1.8, by which the Hydrostatic Design Basis (HDB) is divided to obtain the Hydrostatic Design Stress (HDS). This SF is used to account for variations in conditions from those contemplated in the design of an installation, rough handling of piping, and manufacturing variations.

Surge Pressure (P_s)

The maximum transient pressure increase in excess of the operating pressure that is anticipated in the system as a result of changes in velocity. For the purposes of FRC piping product selection and system design two types of surge are considered:

Occasional Surge Pressure (P_{os})

Occasional surge pressure is the result of an infrequent event and is usually the result of a malfunction, such as a power failure or system component failure (such as pump seize-up, valve-stem failure or pressure relief valve failure).

Recurring Surge Pressure (P_r)

Recurring surge pressures occur frequently and are inherent in the design and operation of the piping system (such as normal pump startup or shutdown and normal valve opening and closing).

Working Pressure (WP)

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