



Approval Standard for Underground Pipe Rehabilitation Systems

Class Number 1616

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Foreword

The FM Approvals certification mark is intended to verify that the products and services described will meet FM Approvals' stated conditions of performance, safety and quality useful to the ends of property conservation. The purpose of Approval Standards is to present the criteria for FM Approval of various types of products and services, as guidance for FM Approvals personnel, manufacturers, users and authorities having jurisdiction.

Products submitted for certification by FM Approvals shall demonstrate that they meet the intent of the Approval Standard, and that quality control in manufacturing shall ensure a consistently uniform and reliable product. Approval Standards strive to be performance-oriented. They are intended to facilitate technological development.

For examining equipment, materials and services, Approval Standards:

- a) must be useful to the ends of property conservation by preventing, limiting or not causing damage under the conditions stated by the Approval listing; and
- b) must be readily identifiable.

Continuance of Approval and listing depends on compliance with the Approval Agreement, satisfactory performance in the field, on successful re-examinations of equipment, materials, and services as appropriate, and on periodic follow-up audits of the manufacturing facility.

FM Approvals LLC reserves the right in its sole judgment to change or revise its standards, criteria, methods, or procedures.

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1 INTRODUCTION

1.1 Purpose

- 1.1.1 This standard states Approval criteria for pipe rehabilitation systems for use in underground fire service water mains. Rehabilitation of already installed underground pipe lengths / sections is a means to extend the useful life of existing fire service water mains.
- 1.1.2 Approval criteria may include, but are not limited to, performance requirements, marking requirements, examination of manufacturing facility(ies), audit of quality assurance procedures, and a follow-up program.

1.2 Scope

- 1.2.1 This standard encompasses the design and performance requirements for pipe rehabilitation systems for use in underground fire service water mains. Rehabilitation may be considered for all pipe sizes within the size ranges addressed in the FM Approval Standards outlined in Section 1.2.2. Rehabilitation of pipe outside the allowed size ranges is outside the scope of this standard. In cases where metric sized are to be examined for Approval, test criteria comparable to the United States equivalent size shall be used.
- 1.2.2 Requirements for the pipe rehabilitation systems addressed in this standard are for use in the rehabilitation of existing underground piping systems for fire protection service. FM Approval of new underground pipe is addressed in the following Approval Standards:

<i>Class</i>	<i>Underground Pipe</i>
1610	Ductile Iron Pipe and Fittings
1612	Polyvinyl Chloride (PVC) Pipe and Fittings
1613	Polyethylene (PE) Pipe and Fittings
1614	Fiber Reinforced Composite (FRC) Pipe and Fittings

- 1.2.3 Approval is limited to rehabilitation systems / sizes which have a rated working pressure of at least 150 psi (1035 kPa).
- 1.2.4 This Approval standard is intended to verify that the product described will meet stated conditions of performance, safety, and quality useful to the ends of property conservation.
- 1.2.5 Non-Structural pipe-lining systems are not addressed in this standard.

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 underground pipe rehabilitation systems for the purpose of obtaining Approval. Underground pipe rehabilitation systems having characteristics not anticipated by this Standard may be FM Approved if performance equal, or superior, to that required by this standard is demonstrated, or if the intent of the standard is met. Alternatively, underground pipe rehabilitation systems which meet all of the requirements identified in this standard may not be FM Approved if other conditions which adversely affect performance exist or if the intent of this standard is not met.

1.4 Basis for FM Approval

FM Approval 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 by FM Approvals; and as far as practical,
- the durability and reliability of the product.

1.4.2 An examination of the manufacturer's manufacturing facilities and audit of their quality control procedures shall be made to evaluate the manufacturer's ability to consistently produce the product that was examined and tested as part of the Approval examination. The audit shall review the facility and in-place quality control procedures used in the manufacturing of the product. Typically, areas of review are incoming inspection, work in progress, production testing, final quality control, marking, calibration of equipment, shipping procedures and document and drawing control. These audits are repeated quarterly as part of FM Approvals' Surveillance Audit Program. (Refer to Section 5.2)

1.5 Basis for Continued FM Approval

1.5.1 Continued Approval is based upon:

- Production or availability of the product as currently FM Approved;
- Continued use of acceptable quality assurance procedures;
- Satisfactory field experience;
- Compliance with the terms stipulated in the Master Agreement;
- Satisfactory re-examination of production samples for continued conformity to requirements; and
- Satisfactory Surveillance Audits conducted as part of FM Approvals' product surveillance audit program.

1.5.2 Also, as a condition of retaining Approval, manufacturers may not change an FM Approved product or service without prior authorization by FM Approvals. (Refer to Section 5.1.3 for further details regarding changes.)

1.6 Effective Date

The effective date of an Approval standard mandates that all products tested for Approval after the effective date shall satisfy the requirements of that standard. Products FM Approved under a previous edition shall comply with the new version by the effective date or forfeit Approval.

The effective date of this standard is the date of publication for full 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 the Institute of Electrical and Electronics Engineers (IEEE) / American Society for Testing Materials (ASTM) SI 10-2010, *American National Standard for Metric Practice*.

1.8 Normative References

The following documents are referred to in the text in such a way that some or all of their contents constitutes requirements of this document. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document (including any amendments) applies:

AWWA Standard C900, *Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 60 in. (100 mm through 1500 mm)*

ASTM International (ASTM) D638 – *Standard Test Method for Tensile Properties of Plastics*

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

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

ASTM D2990 – *Standard Test Methods for Tensile, Compressive and Flexural Creep and Creep-Rupture of Plastics*

ASTM D3039 – *Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials*

ASTM F2994-18, *Standard Practice for Utilization of Mobile, Automated Cured-in-Place (CIPP) Impregnation Systems*

IEEE/ASTM SI 10-2010, *American National Standard for Metric Practice*

International Standards Organization (ISO) 17025, *General Requirements for the Competence of Testing and Calibration Laboratories*

NSF International (NSF) / American National Standards Institute (ANSI) Standard 61, *Standard for Drinking Water Systems Components – Health Effects*

1.9 Definitions

For purposes of this standard, the following terms apply:

Accepted

This term refers to installations acceptable to the authority enforcing the applicable installation rules. When the authority is FM Global, such locations are termed “FM Global Accepted.” Acceptance is based upon an overall evaluation of the installation. Factors other than the use of FM Approved equipment impact upon the decision to accept, or not to accept. Acceptance is not a characteristic of a product. A product accepted for one installation may not be acceptable elsewhere. (Contrast with FM Approved.)

Close-Fit Lining (CFL)

A pipe rehabilitation system where the circular shape of the lining is temporarily modified to reduce the cross-section to enable insertion of the continuous lining into a deteriorated or damaged pipe after which a reversion process is performed to re-round the lining to its original design size and then expanded using heat and pressure to fit snugly onto the inner surface of the host pipe. These pipe relining systems have sufficient ring stiffness to be self-supporting when subjected to all hydrostatic and vacuum conditions, external buckling forces, internal pressures, and meet long-term design objectives for hole spanning applications.

Cured In-Place Pipe (CIPP) Lining

A pipe rehabilitation system where a resin saturated tube is inverted or pulled into a deteriorated or damaged host pipe, and then subjected to heat from the circulation of hot water or introduction of air/steam which cures the tube and forms a tight fit to the inner surface of the host pipe. CIPP rehabilitation systems are further discussed in ASTM International (ASTM) F1216, *Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube*, ASTM F1743, *Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in Place Installation or Cured-in-Place Thermosetting Resin Pipe (CIPP)*; ASTM F2019, *Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP)* and ASTM F2994, *Standard Practice for Utilization of Mobile, Automated, Cured-in-Place (CIPP) Impregnations Systems*.

FM Approvals Certification Mark

Product markings, applied by the manufacturer, that identify the product as FM Approved. Their use is mandatory on all pipe rehabilitation systems. These registered marks cannot be used except as authorized by FM Approvals via the granting of Approval to a specific product.

FM Approved

This term refers to products FM Approved by FM Approvals. Such products are listed in the Approval Guide, an on-line resource of FM Approvals. All products so listed have been successfully examined by FM Approvals, and their manufacturers have signed and returned a Master Agreement to FM Approvals. These forms obligate the manufacturer to allow re-examination of the product and audit of facilities and procedures at FM Approval's discretion. It further requires the manufacturer not to deviate from the FM Approved configuration of the product without review by and agreement of FM Approvals.

Host Pipe

Installed underground pipe that will be rehabilitated. Rehabilitation of water mains is typically performed to address water quality issues as well as hydraulic and structural improvement as a result of leakage, corrosion build up or structural defects in the installed pipe.

Maximum Allowable Operating Pressure (MAOP)

See Rated Working Pressure.

Pipe Bursting

A pipe replacement system that requires special equipment to break down or "burst" the host pipe while simultaneously pulling a new replacement pipe, which may be larger than the host pipe into place.

Pipe Rehabilitation

This term refers to a variety of processes by which an installed pipe can be refreshed to extend its useful service life. Depending on the condition of the host pipe, the configuration of the pipe network, and the conditions at the site, different options for rehabilitation may or may not be possible or practical. Where possible, internal examination of the host pipe should be conducted in order to assess its condition so that a plan for rehabilitation can be determined.