Designation: F2019 – 11

Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP)[1]

This standard is issued under the fixed designation F2019; 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.

1. Scope*

1.1 This practice covers the procedures for the reconstruction of pipelines and conduits (4 to 60 in. (100 to 1500 mm) diameter) by the pulled-in place installation of a resin-impregnated, flexible fabric tube into an existing conduit followed by inflation with compressed air (see Fig. 1). The resin/fabric tube can be cured by either the flow through the fabric tube of mixed air and steam or hot water or by use of ultraviolet light. When cured, the finished cured-in-place pipe will be continuous and tight fitting. This reconstruction process can be used in a variety of gravity flow applications such as sanitary sewers, storm sewers, process piping, electrical conduits, ventilation systems, and pressure applications.

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.

1.3 *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]

D543 Practices for Evaluating the Resistance of Plastics to Chemical Reagents

D578 Specification for Glass Fiber Strands

D638 Test Method for Tensile Properties of Plastics

D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D1600 Terminology for Abbreviated Terms Relating to Plastics

D3039/D3039M Test Method for Tensile Properties of Polymer Matrix Composite Materials

D3567 Practice for Determining Dimensions of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings

D5813 Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems

F412 Terminology Relating to Plastic Piping Systems

F1216 Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube

F1417 Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air

2.2 *AWWA Standard:*

Manual on Cleaning and Lining Water Mains, M28[3]

2.3 *NASSCO Standard:*

Recommended Specifications for Sewer Collection System Rehabilitation[4]

3. Terminology

3.1 *General:*

3.1.1 Definitions are in accordance with Terminology F412. Abbreviations are in accordance with Abbreviations D1600, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calibration hose*—an impermeable bladder installed inside the fabric tube, and inflated with air or steam, or both to press the tube firmly against the wall of the existing pipe until the resin is cured with air and steam or ultraviolet light. The calibration hose shall be removed when the installation is finished.

[1] This practice is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.67 on Trenchless Plastic Pipeline Technology.

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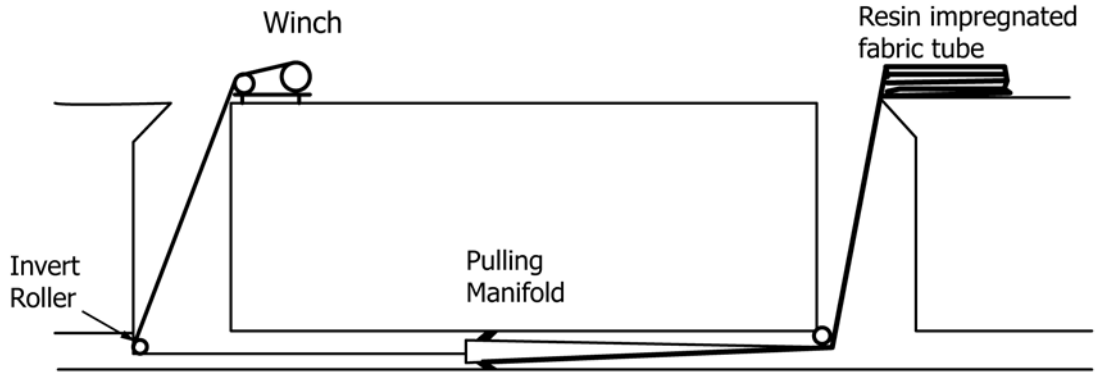
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

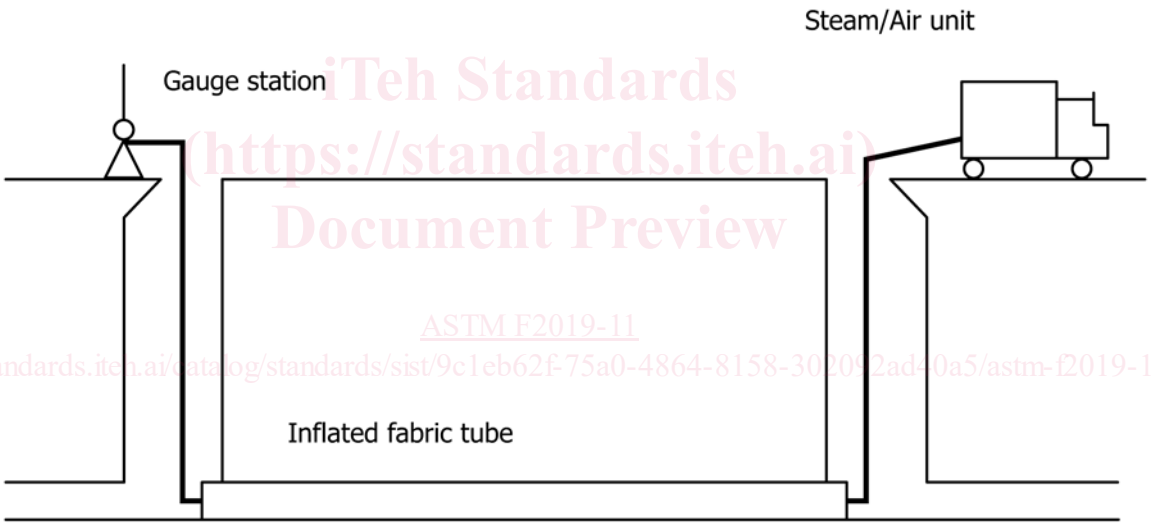
[3] Available from American Water Works Association (AWWA), 6666 W. Quincy Ave., Denver, CO 80235, http://www.awwa.org.

[4] Available from National Association of Sewer Service Companies, 423 W. King Street, Suite 3000, Chambersburg, PA 17201.

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



Step 1 - Pulling resin impregnated fabric tube in place



Step 2 Inflated resin impregnated fabric tube

FIG. 1 Cured-In-Place Pipe Installation Method (Air/Steam)

3.2.2 *cured-in-place pipe (CIPP)*—a hollow cylinder consisting of a glass reinforced plastic (GRP) fabric tube with cured thermosetting resin. External foils are included. The CIPP is formed within an existing pipe and takes the shape of the pipe.

3.2.3 *delamination*—separation of the layers in the sandwich constructed CIPP

3.2.4 *dry spot*—an area of the fabric tube, where the finished CIPP is deficient or devoid of resin.

3.2.5 *fiberglass composite*—a material that is resistant to normal sewer effluents as tested in accordance with 6.4.1 and 6.4.2 of Specification D5813.

3.2.6 *fabric tube*—flexible fiberglass materials formed into a tubular shape which is saturated with resin prior to installation and holds the resin in place as a permanent part of the installed cured-in-place pipe as further described in 5.2.1.

3.2.7 *lift*—a portion of the CIPP that is a departure from the existing conduit wall forming a section of reverse curvature in the CIPP.

3.2.8 *sliding foil*—a plastic foil installed prior to the fabric tube covering the lower of the circumference of the existing pipe to reduce friction and to protect the soft fabric tube while being drawn into the host pipe.

4. Significance and Use

4.1 This practice is for use by designers and specifiers, regulatory agencies, owners and inspection organizations who are involved in the rehabilitation of conduits through the use of a resin-impregnated fabric tube, pulled in place through an existing conduit and subsequently inflated and cured. As for any standard practice, modifications may be required for specific job conditions.

5. Recommended Materials and Manufacture

5.1 *General*—The fabric tube, resin and external preliners shall produce a CIPP that meets the requirements of these specifications.

5.2 *CIPP Wall Composition*—The wall shall consist of a corrosion resistant fiberglass fabric tube (Fig. 2) saturated with a thermosetting (cross-linked) resin, and if used a filler material.

5.2.1 *Fabric Tube*—The fabric tube shall consist of at least two separate tubes made of corrosion resistant (E-CR or equivalent) glass fibers in accordance with Specification D578. Where a removable calibration hose is used, the internal surface shall consist of a resin rich layer for high chemical and abrasion resistance. The fabric tube shall further be constructed with longitudinal unidirectional glass roving of sufficient strength to negotiate a pulling force at least equal to the weight of the liner. The fabric tube shall tolerate circumferential changes in the existing conduit. In order to allow a close fit installation in deformed host pipes, as well as to avoid wrinkles in the final CIPP product, the fabric tube shall be produced with an under measurement of at least 1 % of the host pipe's nominal diameter, and the ability to be over-expanded by at least 1 % of the host pipe's nominal diameter. The ability to over-expand is essential to avoid annular spaces or cavities between the host pipe and the liner and thereby to guarantee the conditions assumed in the static calculation of the CIPP and to avoid or reduce the infiltration of ground water into manholes alongside the outer surface of the liner.

5.2.2 *External Foils*—The external foils (Layer 1 and 2 in Fig. 2 and Fig. 3) shall consist of one combined or more layers of tube-shaped plastic foils which are resistant and impermeable to moisture, in cases where styrene based resin is used, impermeable to styrene and, in cases where a UV cure reins is used, light proof.

5.2.3 *Calibration hose*—The calibration hose (Layer 6 in Fig. 2 and Layer 5 in Fig. 3) which is installed during the construction of the fabric tube, shall consist of a tube shaped plastic foil or resin-saturated coated felt tube resistant and impermeable to moisture and, in case a styrene based resin is used, styrene and able to resist temperatures up to 260°F (126°C) while exposed to the installation pressure sufficient to keep the fabric tube tight against the pipe wall. It shall further release easily from the inside wall for removal, when the installation is finished.

5.2.4 *Resin*—The resin system shall consist of a chemically resistant polyester or vinyl ester thermoset (Heat or UV-light-cured) resin and catalyst system or an epoxy resin and hardener that is compatible to the installation process. Heat cured resin systems shall have an initiating temperature less than 180°F (82°C). For UV-light cured systems a photo-initiator system must be added to the resin prior to the impregnation. The photo-initiator system shall be tuned to the UV-curing equipment used or vice-versa.

5.2.5 *Properties*—The cured CIPP product shall at least have the initial structural properties given in Table 1. These physical properties should be determined in accordance with Section 7 of this practice.

5.2.6 *Chemical Resistance*—The inner surface of the cured resin/fabric matrix shall be evaluated in a laminate for qualification testing of long term chemical exposure to a variety of chemical effluents and should be evaluated in a manner consistent with 6.4.1 and 6.4.2 of Specifications D5813. The edges of the test coupons shall be sealed.

6. Installation Recommendations

6.1 *Cleaning and Pre-Inspection:*

6.1.1 *Safety*—Prior to entering access areas such as manholes, and performing inspection and cleaning operations, an evaluation of the atmosphere to determine the presence of toxic or flammable vapors or lack of oxygen shall be undertaken in accordance with local, state or federal safety regulations.

6.1.2 *Cleaning the Pipeline*—All internal debris shall be removed from the original pipeline. Gravity pipes shall be cleaned with hydraulically powered equipment, high velocity jet cleaners, or mechanically powered equipment in accordance with NASSCO Recommended Specifications for Sewer Collection System Rehabilitation. Pressure pipelines shall be cleaned with cable attached devices or fluid propelled devices in accordance with AWWA Manual on Cleaning and Lining Water Mains, M28.

6.1.3 *Line Obstructions*—The original pipeline should be clear of obstructions such as solids, dropped joints, protruding service connections, collapsed pipe, and reductions in the cross-sectional area that may hinder or prevent the installation and curing of the resin impregnated fabric tube. Where the inspection reveals an obstruction that cannot be removed by conventional sewer cleaning equipment, then a robot with a cutter or other suitable tool should be used to remove the obstruction.

6.1.4 *Inspection of Pipelines*—Inspection of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles and service connections by closed circuit television or man entry. The interior of the pipeline shall be carefully inspected to determine the location of any conditions that prevent proper installation of the impregnated tube, such as protruding service taps, collapsed or crushed pipe, and

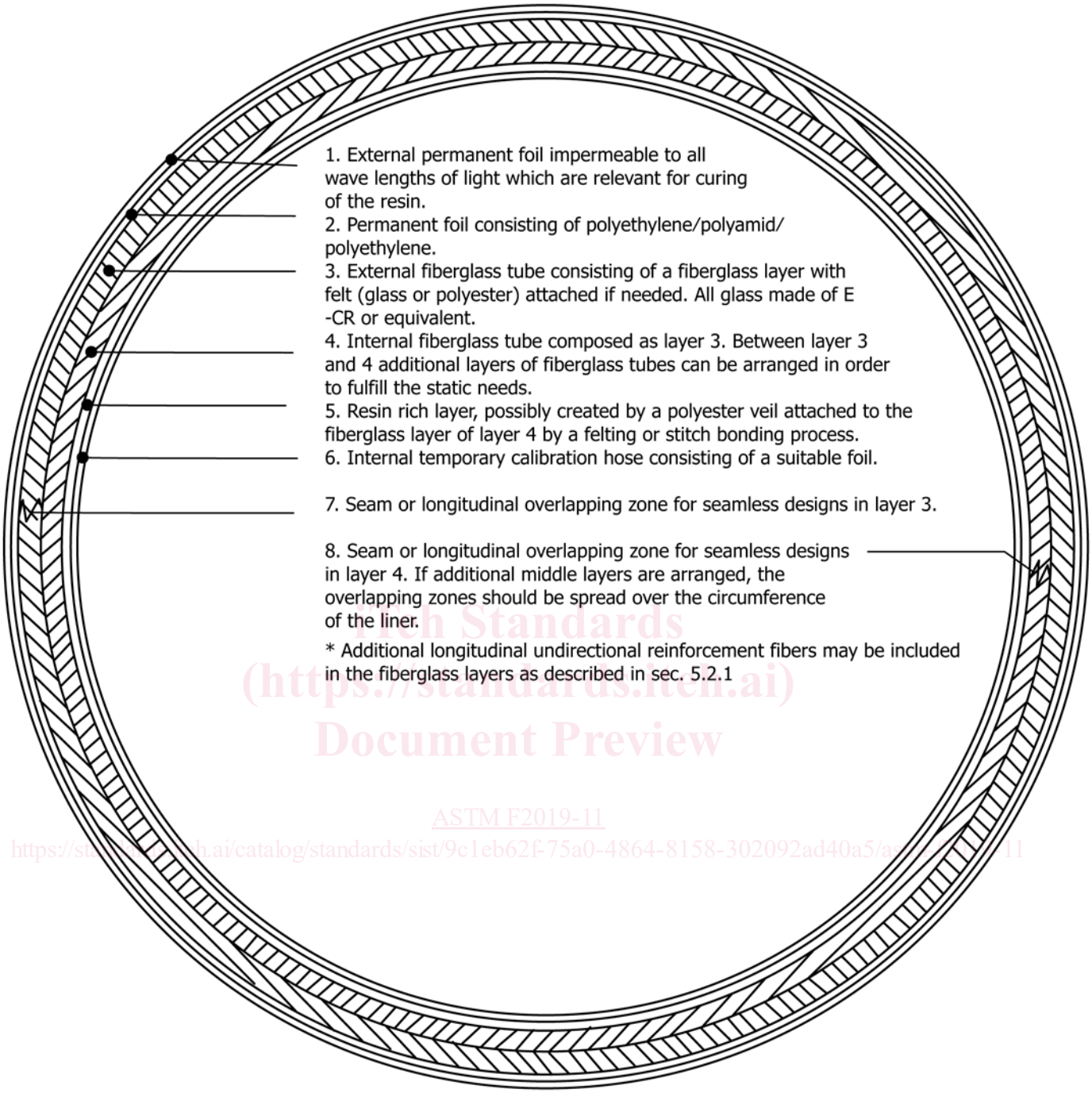


FIG. 2 Composition of Fabric Tube (UV cure)

reductions in the cross-sectional area. These conditions shall be noted and corrected prior to the installation.

6.1.5 *Pre-Measurement of Service Connections:*

6.1.5.1 A pre-measuring of all service locations shall be performed by experienced personnel. Visible indentations by the lateral connections may not be readily identified.

6.1.5.2 The measurements shall be noted in a log also containing information about the clockwise position of the opening.

6.1.6 *Bypassing:*

6.1.6.1 Where bypassing the flow is required around the sections of pipe designated for reconstruction, the bypass shall be made by plugging the line at the up-stream end of the pipe to be reconstructed and pumping the flow to a downstream point or adjacent system.

6.1.6.2 The pump and bypass lines shall be of adequate capacity and size to handle the flow. Services within the reach shall be temporarily out of service.