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An American National Standard

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 ~~48~~60 in. (100 to ~~1200~~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
~~D1682Methods of Test for Breaking Load and Elongation of Textile Fabrics~~
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~~
~~F1743Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)~~ 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]

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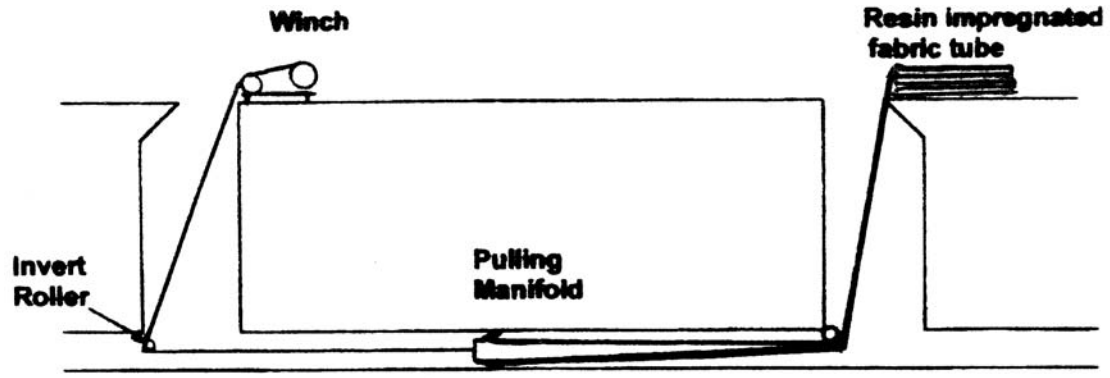
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] ~~Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.~~

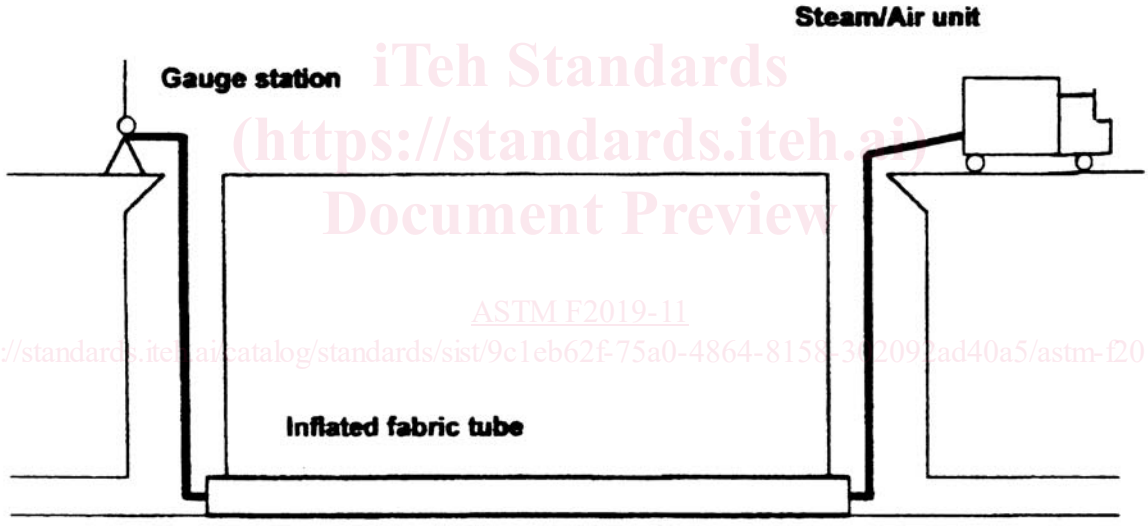
[3] Available from American Water Works Association (AWWA), 6666 W. Quincy Ave., Denver, CO 80235, http://www.awwa.org.

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

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



Step1 - 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. 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 ~~is~~shall be removed when the installation is finished.

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

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

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 ~~well~~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 third of the circumference of the existing pipe to reduce friction.~~ —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~~. The internal surface shall consist of a veil preferably made of polyester. 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 up to 10% circumferential changes in the existing conduit.~~

~~5.2.2~~ *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 in Figs. 2 and~~ —The external foils (Layer 1 and 2 in Fig. 2 and Fig. 3~~3) shall consist of one or more layers of styrene resistant or light proof, or both, tube-shaped plastic foils.~~

~~5.2.3~~*) 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 ~~resist~~ 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 isophthalic polyester or vinyl ester thermoset resin and catalyst system or an epoxy resin and hardener that is compatible to the installation process. The resin system shall have an initiating temperature less than 180°F (82°C).~~ —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 ~~cured resin/fabric matrix shall after~~ inner surface of the ~~calibration hose is removed~~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.

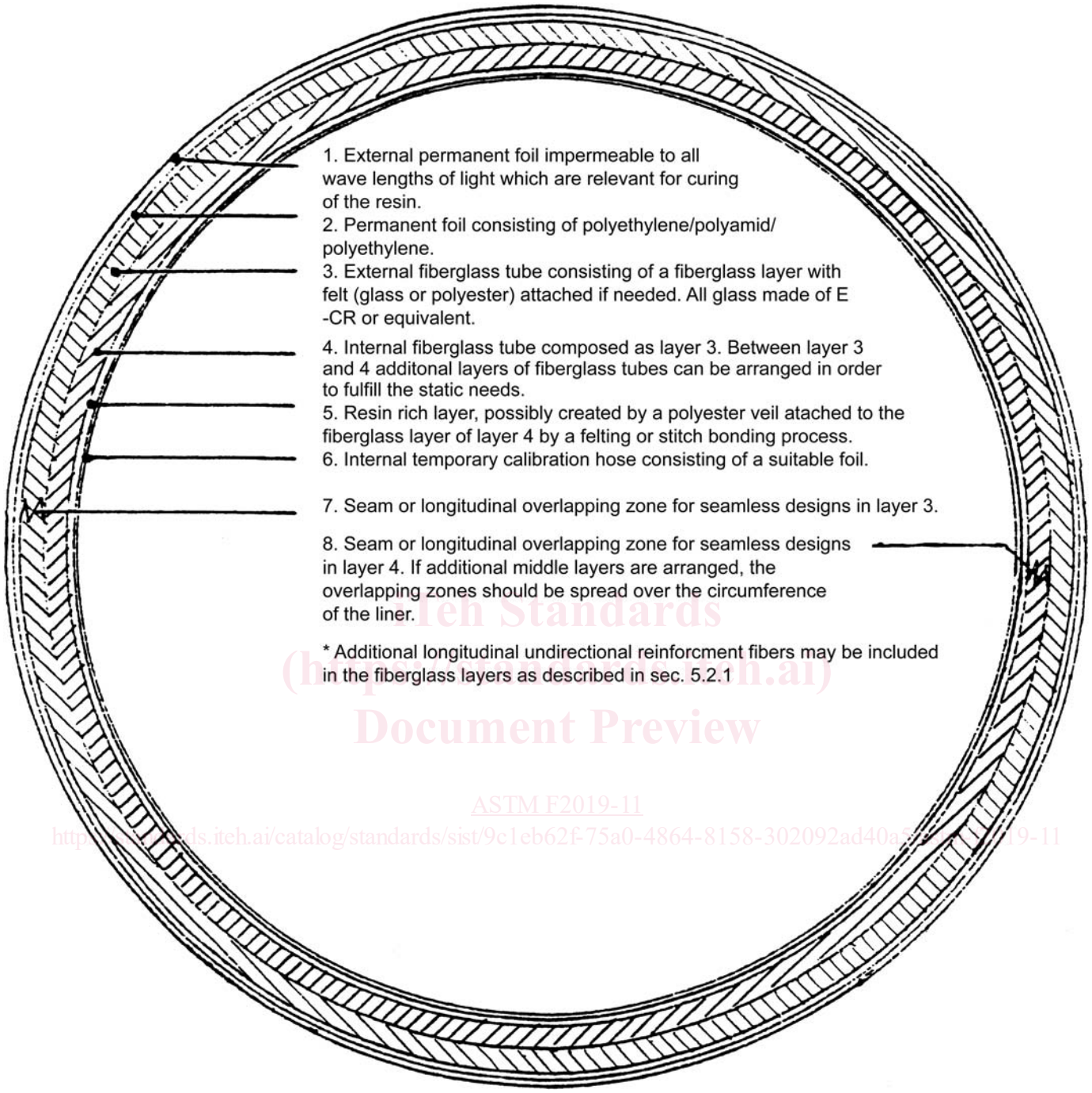


FIG. 2 Composition of Fabric Tube (UV cure)

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 ~~of more than 40%~~ that may hinder or prevent the installation

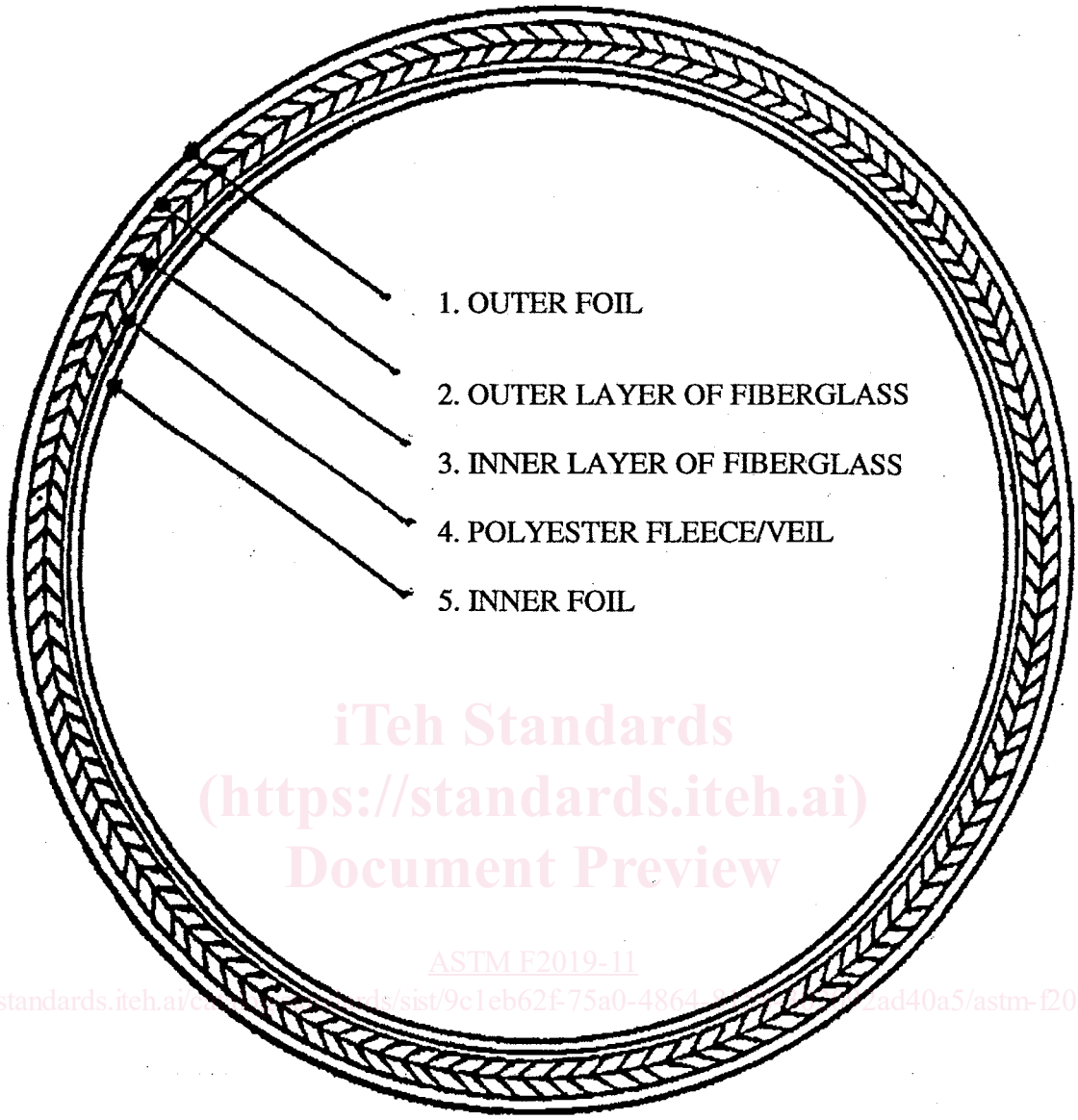


FIG. 3 Composition of Alternative Fabric Tube

TABLE 1 CIPP Initial Structural Properties[A]

Property	Test Method	Minimum value, psi	(MPA)
Flexural Strength	D790	6500[B]	45
Flexural Modulus	D790	725 000	5000
Tensile Strength	D3039/D3039M	9000	62
	D638	9000	62

[A]The values in Table 1 are for test results on field specimens. The purchaser shall consult the manufacturer for the long-term structural properties.

[B]The value indicates minimum strength both in the circumferential and longitudinal direction

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 ~~point repair shall~~ robot with a cutter or other suitable tool should be ~~made~~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 reductions in the cross-sectional ~~area of more than 40%.~~area. These conditions shall be noted and corrected prior to the installation.

6.1.5 *Pre-Measurement of Service Connections*:

~~6.1.5.1A pre-measuring of all service locations shall be performed by experienced personnel. Due to the reinforcement of the fabric tube visible indentations by the lateral connections may not be readily identified.~~

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.

6.1.7 Public advisory services shall be required to notify all parties whose service laterals are out of commission and to advise against water usage until the lateral line is back in service.

6.2 *Installation Methods*:

6.2.1 *Sliding Foil and Winch Cable*—~~Upon verification of the removal of all debris and protrusions a sliding foil and a winch cable is pulled through the line. The sliding foil shall cover approximately the lower third of the circumference of the pipe. At the upstream end it is locked in place by being inserted underneath the plug used to block the flow in the manhole.~~

~~6.2.2*Invert Roller and Pulling Manifold*—An invert guide roller is placed in the winch manhole. The invert roller shall allow the pulling manifold to enter the manhole before the pulling is terminated. The pulling manifold is attached to the end of the liner with sufficient strength to transfer the pulling force. It contains a mounting point for the air/stream hose. During the mounting of the pulling manifold care shall be taken to provide an airtight fit of the calibration hose to the manifold.~~ —Upon verification of the removal of all debris and protrusions a sliding foil and a winch cable may be pulled through the line. The sliding foil shall cover approximately the lower third or up to half of the circumference of the pipe, as recommended by the manufacturer. At the upstream end it is locked in place by being inserted underneath the plug used to block the flow in the manhole.

6.2.2 *Pulling Head or Pulling Manifold and Invert Roller*—The liner is connected to the winch cable by forming a pulling head or using a pulling manifold. A pulling head can be made by turning the end of the liner over into a loop. If a pulling manifold is used it shall be attached to the end of the liner with sufficient strength to transfer the pulling force. It contains a mounting point for the air/stream hose. During the mounting of the pulling manifold care shall be taken to provide an airtight fit of the calibration hose to the manifold. If a pulling head has been used it shall be dismantled after pulling in the liner. Then a manifold is mounted airtight into the calibration hose. An invert guide roller is placed in the winch manhole. The invert roller shall allow the pulling head or manifold to enter the manhole before the pulling is terminated. A swivel connection to the pulling cable may be added to avoid twisting the liner.

6.3 *Resin Impregnation*:

~~6.3.1The fabric tube shall be totally impregnated with resin (wet-out). The impregnation can either take place before the external foils are mounted or with a light penetrable foil mounted. The impregnation equipment shall contain devices to secure a proper distribution of the resin. Following the impregnation, the fabric tube shall be exposed to a resin thickening procedure. Certification documentation concerning date, type of resin (manufacturer, trade name and lot number) resin calculation and volume of resin used shall be attached to the impregnated fabric tube.~~

~~6.3.2~~

6.3.1 *Resin Impregnation*—The fabric tube shall be totally impregnated with resin (wet-out) in the manufacturer's plant under quality controlled conditions, on-site or in a mobile wet out unit. The impregnation equipment shall contain devices to secure a proper distribution of the resin. Certification documentation concerning date, type of resin, resin volume, mixing ratio, liner thickness, temperature, type of glass fiber, liner type, manufacturing date and last installation date shall be attached to the impregnated fabric tube or provided by the CIPP manufacturer.

6.4 *Storage and Transportation* —~~The impregnated liner shall be stored in an area where the temperature is controlled to 70°F (21°C) or less. When the resin impregnated fabric tube is transported to a job site it shall be shipped with a data logger inside each container. The data logger shall record exposure temperatures and time the impregnated tube experiences.~~

~~6.4~~:

6.4.1 *Termocurring CIPP*—The impregnated liner shall be stored in an area where the temperature is maintained within an acceptable range per the manufacturer's recommendations. When the resin impregnated fabric tube is transported to a job site it shall be shipped with a data logger inside each container. The data logger shall record exposure temperatures and time the impregnated tube experiences.

6.4.2 *UV-cured CIPP*—The impregnated liner shall be stored, transported, and installed inside maximum and minimum temperatures not less than 45°F (7°C) or higher than 95°F (35°C) when being installed on site. UV cured CIPP shall be stored in accordance with the manufacturer's recommendations.