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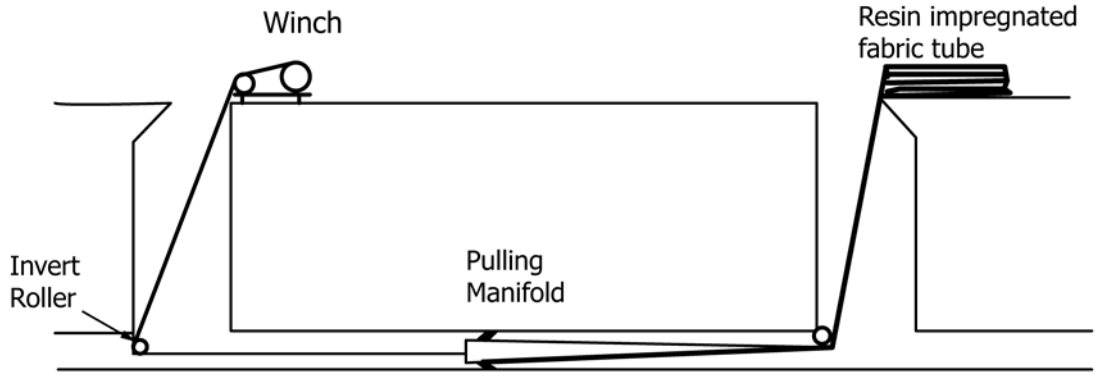
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

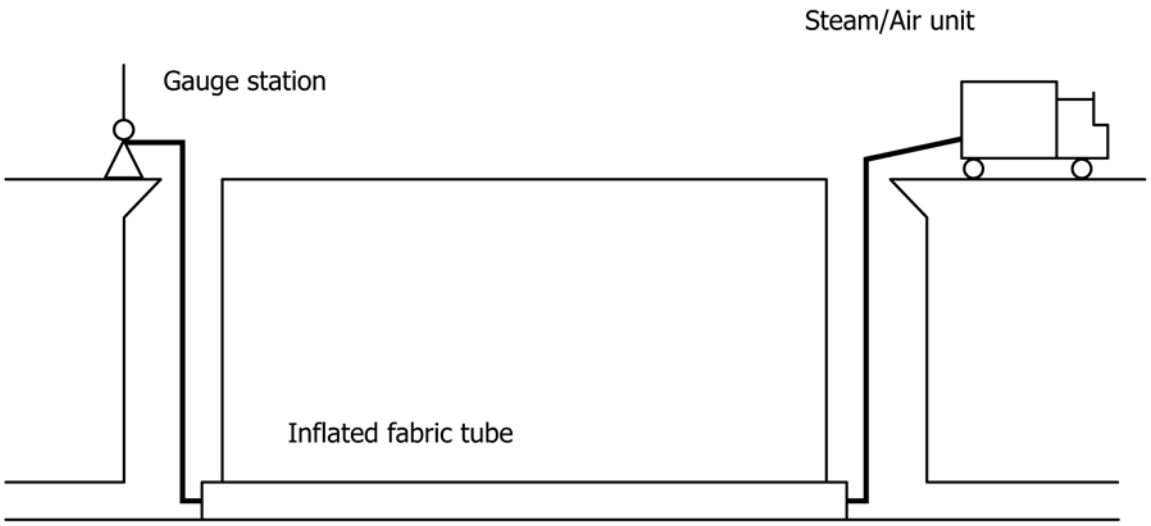
[3] Available from American Water Works Association (AWWA), 6666 W. Quincy Ave., Denver, CO 80235, http://www.awwa.org.

[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

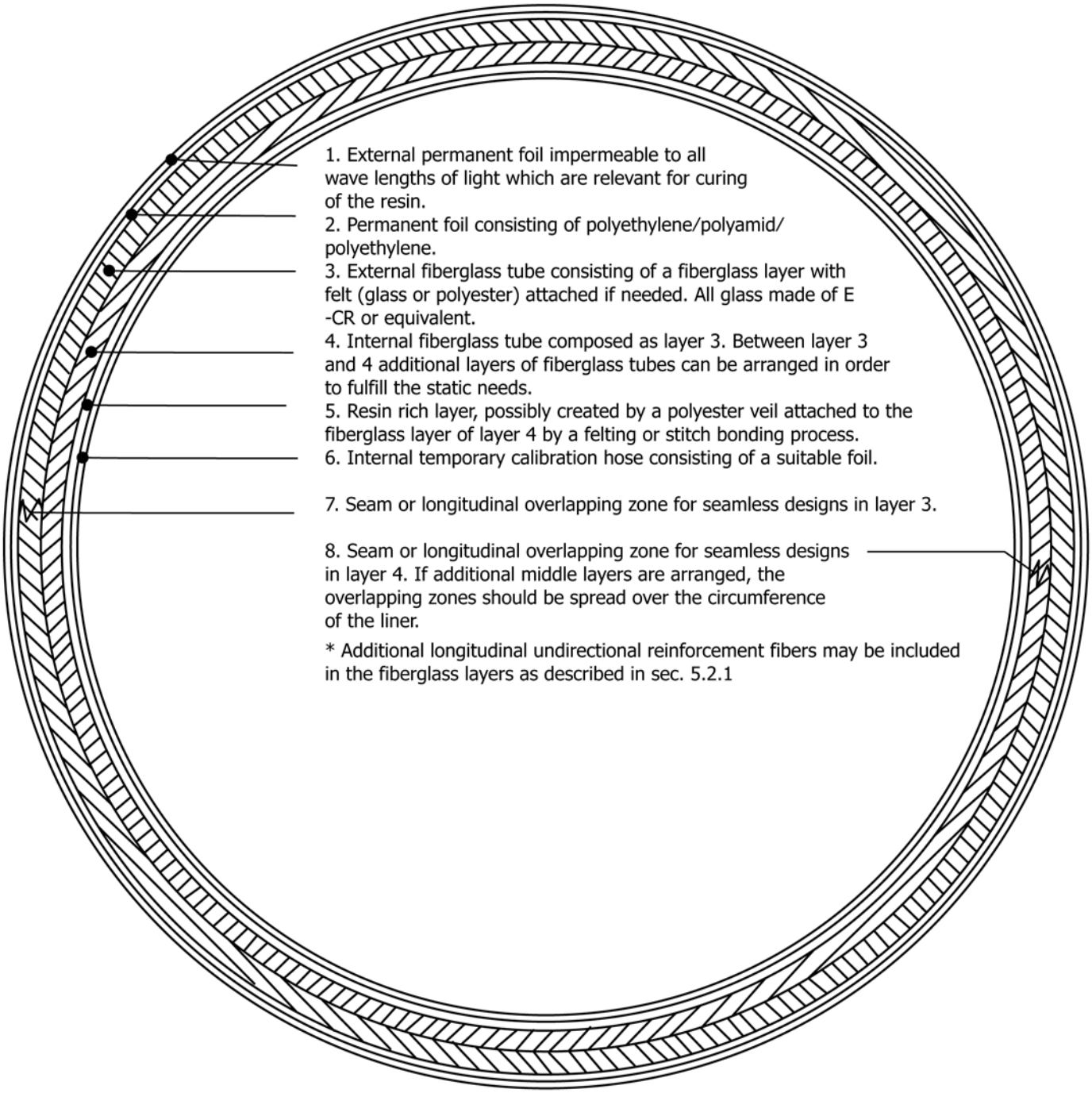


FIG. 2 Composition of Fabric Tube (UV cure)

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.

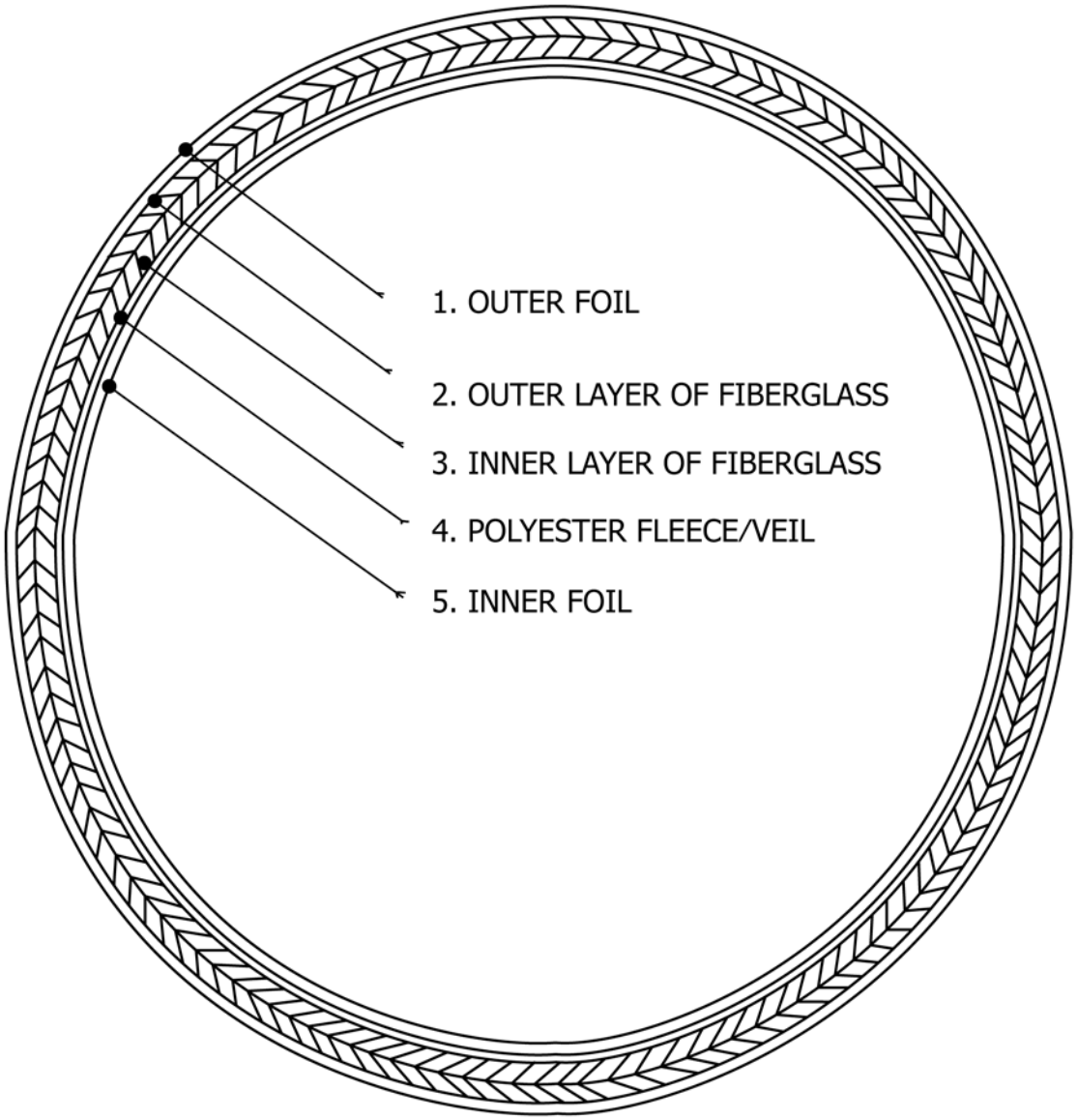


FIG. 3 Composition of Alternative Fabric Tube

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

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 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:*

6.3.1 *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:*

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.

6.5 *Pulling Resin Impregnated Tube into Position*—The wet-out fabric tube shall be pulled in place using a power winch. The fabric tube shall be pulled into place through an existing manhole or other approved access point to fully extend to the designated manhole or termination point. If the product is sensitive to pulling speed, the pulling speed should be monitored and not exceed the manufacturers specification. When entered into the access point the fabric tube shall be folded in half and placed on top of the sliding foil. Care shall be exercised not to damage the tube during the pulling phase, especially where curved alignments, multilinear alignments, multiple off-sets, protruding elements and other friction producing pipe conditions are present. Where applicable, when entered into the access point, the pulling shall be considered completed when the pulling head or manifold and 1 to 2 ft (0.3 to 0.6m) of impregnated tube has entered the termination point. If the product is sensitive to elongation then measure the overall elongation of the fabric tube after the pull-in completion. The acceptable longitudinal elongation shall be less than 2% of the overall length specified by the manufacturer. Next the length of the fabric tube shall be adjusted to extend 1 to 2 ft into the access point and mounted with an inlet manifold. For steam curing systems the manifolds shall be connected to inlet- and outlet air/steam hoses and the inlet manifold shall be mounted with temperature and pressure sensors. Temperature sensors shall be further mounted approximately 1 ft into the existing pipe on the outside of the fabric tube from the access and termination point.

6.6 *Curing Methods-Steam Curing:*

6.6.1 *Installation Set-Up:*

6.6.1.1 The inlet air/steam hose shall be connected to the installation equipment, which shall be equipped with an air compressor and a steam source or sufficient capacity. It is further equipped with monitoring and control equipment for adjustment of air/steam temperature and pressure in accordance with the manufacturer's instructions for the curing process (Fig. 1).

6.6.1.2 The outlet air/steam hose shall be mounted to a gauge station, equipped with a pressure adjustment valve and temperature and pressure gauge.

6.6.2 *Processing:*

6.6.2.1 The fabric tube shall be inflated with air until it is fitting tight against the wall of the existing pipe. The air pressure shall be adjusted to be of sufficient pressure to hold the impregnated fabric tube tight to the pipe wall. The desired pressure shall be maintained by adjustment of the outlet valve.

6.6.2.2 The temperature in the airflow shall now be adjusted to follow the manufacturer's (installer's) instructions for the curing temperature.

6.6.2.3 When a temperature, as recommended by the manufacturer (installer), has been reached at the sensor placed at the bottom of the fabric tube, a post curing with steam at 260°F (126°C), or as recommended by the manufacturer may take place to provide the full development of chemical resistance and resin strength. Following the post curing the steam shall be gradually replaced with air and the cured fabric tube shall be cooled down to 90°F (32°C), or as recommended by the manufacturer, measured at the outside sensors. This cooling can be assisted by mixing water into the air flow.

6.6.2.4 Finally the manifolds and then the calibration hose shall be removed.

6.6.3 *Curing Control*—A full protocol for time, temperatures and pressures shall be maintained as documentation for the correct curing of the fabric tube.

6.7 *Curing Methods-Ultraviolet Light Curing:*

6.7.1 *Installation Set-Up:*

6.7.1.1 The inlet air hose shall be connected to the installation equipment and shall be equipped with an air compressor of sufficient capacity to expand the impregnated fabric tube. While the tube expands under pressure, a multi-lamp ultraviolet curing assembly shall be drawn through the pipe.

6.7.1.2 The ultraviolet curing lights shall be tuned or optimized to the photo initiator system of the resin or the initiator systems of the resin shall be optimized to the output of the ultraviolet curing lights.

6.7.2 *Processing*—Travel through the pipe shall be at a pre-determined speed which allows for cross-linking/polymerization of the CIPP resin. Air pressure shall be adjusted to sufficient pressure to hold the impregnated fabric tube tight to the pipe wall. The desired pressure shall be maintained by adjustment of the outlet valve.

6.7.3 *Curing Control*—A full protocol for time, rate of travel of the ultraviolet assembly, pressures, and amount of lamps in operation shall be maintained as documentation for the correct curing of the fabric tube. The protocol shall be recorded automatically from the beginning of inflation of the liner until the end of the curing. It shall also show the basic information

in a header, such as project name, address, section, and date, to clearly identify the renovated section.

6.8 *Workmanship*—The finished CIPP shall be continuous over the entire length of an installation and be free of dry spots, lifts, and delaminations. Where these conditions are present the CIPP shall be evaluated for its ability to meet the applicable requirements of Section 7. Where the CIPP does not meet the requirements of Section 7 or specifically stated requirements of the purchase agreement, or both, the affected portions of the CIPP shall be removed and replaced with an acceptable repair as specified in 6.2 of Specification D5813.

6.9 *Service Connections*—After the new CIPP has been installed, the existing service connections shall be reinstated. This shall be done without excavation and in cases of non man-entry pipes from the interior of the pipeline by the means of a television camera and a remotely controlled cutting device. Service connections shall be reinstated to at least 95 % of the original area as it enters the host pipe or conduit. All laterals where a plug by the end of the lateral was not visible by the pre-inspection, shall be reinstated, if the purchase agreement does not specify it differently.

NOTE 1—In many cases, a seal is provided between the existing pipe and the fabric tube at the service connections. If total elimination of infiltration and inflow is desired, other means, which are beyond the scope of this standard, may be necessary to seal service connections and to rehabilitate service lines and manholes.

7. Recommended Inspection Practices

7.1 For each installation length as designated by the purchaser in the purchase agreement, the preparation of CIPP samples shall be required from one of the following methods (7.1.1.1 and 7.1.1.2):

7.1.1 *Thermocuring systems:*

7.1.1.1 The samples shall be cut from a section of cured CIPP at an intermediate manhole or at the termination point that shall be installed through a like diameter section of conduit or other tubular restraining means which shall be held in place by a suitable heat sink such as sandbags.

7.1.1.2 The sample shall be fabricated from material taken from the fabric tube and the resin/catalyst system used, and cured in a clamped mold, placed in a designated chamber in the outlet gage station. This sampling method shall allow testing in the axial (along the length) and circumferential (that is, hoop) directions of the Fiberglass reinforcement in the CIPP. The sample shall be marked showing axial and circumferential directions.

7.1.2 *UV-cured systems*—The samples shall be cut from a section of cured CIPP at an intermediate manhole or at the termination point that shall be installed through a like diameter section of conduit or other tubular restraining means. The specimens shall allow circumferential (hoop) directions of the Fiberglass reinforcement in the CIPP. Each specimen shall be at least 2” wide (axial direction of the liner, along the length) to test a representative amount of fibers if glass roving mats have been used. The samples are to be tested in a curved beam configuration where the minimum beam width is 2.0 inches ((50mm).

7.1.3 The CIPP samples for each of these cases shall be large enough to provide a minimum of three specimens and recommended five specimens for flexural testing. The flexural specimens shall be prepared in a manner consistent with 8.3.1 of Specifications D5813. For flexural properties the structural wall thickness of the CIPP samples shall be tested. Layers 1 and 5 are not part of the structural wall thickness (Fig. 2). Where the sample is irregular or distorted in such a manner that the proper testing is inhibited, attempts shall be made to machine any wall thickness from the inside pipe face of the sample without cutting into the Fiberglass reinforcement. Any machining of the outside pipe face of the sample shall be done carefully so as to minimize the removal of material from the outer structural wall of the sample. Individual specimens shall be clearly marked for easy identification and retained until final disposition or CIPP acceptance, or both, has been given.

7.1.3.1 *Short Term Flexural Properties*—The initial tangent modulus of elasticity and flexural strength shall be measured for gravity pipe applications in accordance with Test Method D790, Test Method 1—Procedure A and shall meet the requirements of Table 1 within the 16:1 length to depth constraints. For specimens greater than 0.5 in. (12.7 mm) in depth, the width-to-depth ratio of the specimen shall be increased to a minimum of 1:1 and shall not exceed 4:1. Samples shall be prepared in accordance with 7.1.1.2, to determine the flexural properties in the hoop direction. Special consideration shall be given to the preparation of flexural specimens to provide the opposite sides that are parallel and adjacent edges are perpendicular. Flexural specimens shall be tested such that the inside pipe face is tested in tension and the outside face in compression. Each specimen shall be at least 2 in. wide (axial direction of the liner, along the length).

7.1.3.2 *Short-Term Tensile Properties*—The preferred test method is provided in Specification D5813 with reference to Test Method D3039/D3039M for tensile properties of fiber-resin composites and samples tested must meet the requirements of Table 1. The tensile strength may be measured for pressure pipe applications in accordance with Test Method D638 and must meet the requirements of Table 1.

7.1.4 *CIPP Wall Thickness*—The method of obtaining the CIPP wall thickness measurements shall be in a manner consistent with 8.1.2 of Specifications D5813. Thickness measurements shall only incorporate layers 2 to 4 (Fig. 2) and be in accordance with Practice D3567 for samples prepared in accordance with 7.1 and 7.2. Make a minimum of eight measurements at evenly spaced intervals around the circumference of the sample to provide the minimum and maximum thickness has been determined. The average thickness shall be calculated using all measured values and shall meet or exceed minimum design thickness as agreed between purchaser and seller. The minimum wall thickness at any point shall not be less than 87.5 % of the average specified design thickness as agreed between purchaser and seller.

NOTE 2—A local reduction in wall thickness may reduce the in service safety factor.

7.2 *Pipe Leakage Testing:*

7.2.1 *Gravity Pipe:*

7.2.1.1 If required by the owner in the contract documents or purchase order, gravity pipes shall be tested using an ex filtration test method where the CIPP, after it is cooled down to ambient temperature and the calibration hose is removed, but before the laterals are re-opened, is plugged in both ends. The testing shall be performed with either air or water

7.2.1.2 Air testing shall be in accordance with Test Method F1417.

NOTE 3—It is impractical to test pipes above 36 in. diameter for leakage due to the technology available in the pipeline rehabilitation industry. Man entry inspection of larger pipes shall detect major leaks.

NOTE 4—The allowable leakage for gravity pipe testing is a function of loss at end seals and by water testing of compression of air trapped in the pipe.

7.2.2 *Pressure Pipe Testing*—If required by the owner in the contract documents or purchase order, pressure pipes shall be subjected to a hydrostatic pressure test. A recommended pressure and leakage test at twice the working pressure or at the working pressure plus 50 psi, whichever is less. Hold this pressure for a period of 2 to 3 h for stabilization of the CIPP. After this period, the pressure test shall begin for a minimum of 1 h. The allowable leakage during the pressure test shall be 20 U.S. gal per inch of internal pipe diameter per mile per day, providing that all air has been evacuated from the line prior to testing and the CIPP has cooled down to ambient temperature.

7.3 *Inspection and Acceptance*—The installation shall be visually inspected to assure compliance with 6.8 or by closed circuit television where visual inspection cannot be accomplished. Variations from the true line and grade shall be inherent because of the condition of the original piping. No infiltration of ground water shall be observed through the CIPP. In cases of visible leakage repairs shall be made in accordance with agreement with the owner. All service openings shall be accounted for and be unobstructed.

8. Keywords

8.1 cured-in-place pipe (CIPP); glass reinforced plastic (GRP); rehabilitation; steam cured; UV-cured; UV-light-cured

APPENDIX

(Nonmandatory Information)

X1. DESIGN CONSIDERATIONS

X1.1 *General Guidelines*—The design thickness of the CIPP is a function of the resin, materials of construction of the fabric tube, and the condition of the existing pipe. In addition depending on the condition of the pipe, the design thickness of the CIPP may also be a function of groundwater, soil type and influence of live loading surrounding the host pipe. For guidance relating to terminology of piping conditions and related design equations see Appendix X1 of Practice F1216.

SUMMARY OF CHANGES

Committee F17 has identified the location of selected changes to this standard since the last issue (F2019–09) that may impact the use of this standard.

(1) Section 1.1– Change to scope to include higher maximum diameters and hot water cure.
(2) Section 2.1 –revised reference to ASTM standards – deleted space in title.
(3) Section 3.2.1 –Revised definition of Calibration hose.
(4) Section 3.2.5 –Revised definition of fiberglass composite.
(5) Section 3.2.8 –Revised definition of sliding foil.
(6) Section 3.2.7 –Correction of spelling of wall.
(7) Section 5.2.1 – revision of fabric tube requirements.
(8) Section 5.2.2 – revision of external foil requirements.
(9) Section 5.2.3 – revision of wording for clarification.
(10) Section 5.2.4– revision of wording to more clearly differentiate between hear cured and UV cured systems.
(11) Section 6.1.3 – revision of wording for further clarification.
(12) Section 6.1.4 – revision of wording on inspection and location of service connections.
(13) Section 6.1.5.1 – revision of wording for clarification.
(14) Section 6.2.1 – revision of sliding foil requirements.
(15) Section 6.2.2 – revision of wording and addition of new Note 5 containing some of the existing description.
(16) Section 6.3.1–revision to include new requirements.
(17) Renumbering of Section 6.3.2 to 6.4- rewording to differentiate UV Cured CIPP products.
(18) New Section 6.4.1–Thermocuring CIPP – describes storage conditions for Thermocuring CIPP products.
(19) New Section 6.4.2–UV Cured CIPP – describes storage conditions for UV cured CIPP products.
(20) Renumbering of Section 6.4 to 6.5–revision for clarification and differentiation of various products.
(21) Renumber Section 6.5 to 6.6 and revision to add specific requirements and clarification.
(22) Renumbered Section 6.5.1 to 6.6.1.
(23) Renumbered Section 6.5.1.1 to 6.6.1.1.
(24) Renumbered Section 6.5.1.2 to 6.6.1.2.
(25) Renumbered Section 6.5.2 to 6.6.2.

(26) Renumbered Section 6.5.2.1 to 6.6.2.1.
(27) Renumbered Section 6.5.2.2 to 6.6.2.4.
(28) Renumbered Section 6.5.2.3 to 6.6.2.3.
(29) Renumbered Section 6.5.2.4 to 6.6.2.2.
(30) Renumbered Section 6.5.3 to 6.6.3.
(31) Renumbered Section 6.6 to 6.7– and revision to add specific requirements for UV light curing.
(32) New section 6.7.1.
(33) Renumbered Section 6.6.1 to 6.7.1.1.
(34) Renumbered Section 6.6.2 to 6.7.1.2 and added wording for clarification.
(35) Renumbering Section 6.6.3 to 6.7.2.
(36) Renumbered Section 6.7 to 6.7.3 – addition of new wording for clarification.
(37) Addition of new Section title 7.1.1.
(38) Renumbered of Section 7.1.1 to 7.1.1.1.
(39) Renumbered of Section 7.1.2 to 7.1.1.2.
(40) New section 7.1.2– UV cured systems.
(41) 7.1.3.1– Additional wording on sample specimens.
(42) 7.1.4– Additional wording on sampling.
(43) Deletion of extra lines in Fig. 1.
(44) Changes to the Labels in Fig. 2 Composition of Fabric Tube.