



Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled- in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)¹

This standard is issued under the fixed designation F 1743; 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 describes the procedures for the reconstruction of pipelines and conduits (4 to 96 in. (10 to 244 cm) diameter) by the pulled-in-place installation of a resin-impregnated, flexible fabric tube into an existing conduit and secondarily inflated through the inversion of a calibration hose by the use of a hydrostatic head or air pressure (see Fig. 1). The resin is cured by circulating hot water or by the introduction of controlled steam into the tube. When cured, the finished cured-in-place pipe will be continuous and tight fitting. This reconstruction process may be used in a variety of gravity and pressure applications such as sanitary sewers, storm sewers, process piping, electrical conduits, and ventilation systems.

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NOTE 1—There are no ISO standards covering the primary subject matter of this practice.

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

~~D 543 Test Method of Resistance of Plastics to Chemical Reagents~~ Practices for Evaluating the Resistance of Plastics to Chemical Reagents

D 638 Test Method for Tensile Properties of Plastics

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D 903 Test Method for Peel or Stripping Strength of Adhesive Bonds

D 1600 Terminology for Abbreviated Terms Relating to Plastics

~~D 1682 Test Method~~ Methods of Test for Breaking Load and Elongation of Textile Fabrics³

D 3039/D 3039M Test Method for Tensile Properties of Polymer Matrix Composite Materials

~~D 3567 Practice for Determining Dimensions of Fiberglass (Glass-Fiber-Reinforced Thermosetting Resin) Pipe (RFRP) and Fittings~~

D 4814 Specification for Automotive Spark—Ignition Engine Fuel

~~D 5813 Specification for Cured-in-Place Thermosetting Resin Sewer Pipe⁶~~ Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems

E 797 Practice for Measuring Thickness by Manual Ultrasonic Pulse-Echo Contact Method

F 412 Terminology Relating to Plastic Piping Systems

F 1216 Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube

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 Annual Book of ASTM Standards, Vol 15.06.

⁶ Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

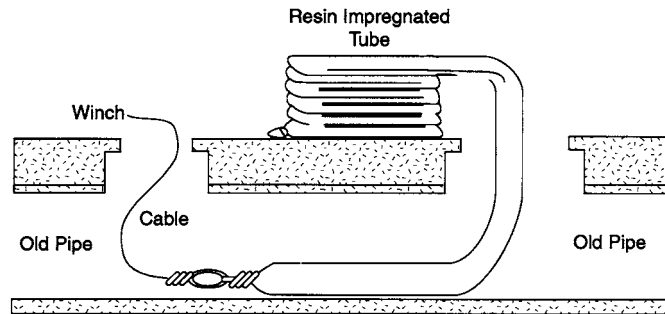
*A Summary of Changes section appears at the end of this standard.

- 2.2 AWWA Standard:⁴
M28 Manual on Cleaning and Lining Water Mains⁴
- 2.3 NASSCO Standard:
Recommended Specifications for Sewer Collection System Rehabilitation

NOTE 2—An ASTM specification for cured-in-place pipe materials appropriate for use in this practice is under preparation and will be referenced in this practice when published.⁵

Recommended Specifications for Sewer Collection System Rehabilitation

Step 1 – Pull resin-impregnated tube into existing pipe.



Step 2 – Calibration hose inversion

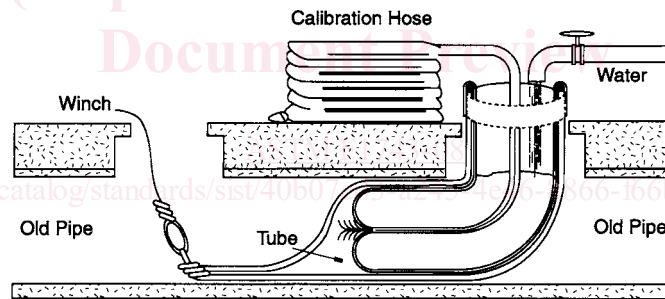


FIG. 1 Cured-in-Place Pipe Installation Methods

3. Terminology

3.1 *General*—Definitions are in accordance with Terminology F 412. Abbreviations are in accordance with Terminology D 1600, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *calibration hose*—an impermeable bladder which is inverted within the resin-impregnated fabric tube by hydrostatic head or air pressure and may optionally be removed or remain in place as a permanent part of the installed cured-in-place pipe as described in 5.2.2.

3.2.2 *cured-in-place pipe (CIPP)*—a hollow cylinder consisting of a fabric tube with cured (cross-linked) thermosetting resin. Interior or exterior plastic coatings, or both, may be included. The CIPP is formed within an existing pipe and takes the shape of and fits tightly to the pipe.

3.2.3 *delamination*—separation of layers of the CIPP.

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

⁴Discontinued: See 1991 Annual Book of ASTM Standards, Vol 07.01.

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

⁵Annual Book of ASTM Standards, Vol 15.03.

⁵ Available from the National Association of Sewer Service Companies, NASSCO 11521 Cronridge Drive, Suite J Owings Mills, MD 21117, <http://www.nassco.org>.

3.2.5 *fabric tube*—flexible needled felt, or equivalent, woven or nonwoven material(s), or both, formed into a tubular shape which during the installation process is saturated with resin and holds the resin in place during the installation and curing process.

3.2.6 *inversion*—the process of turning the calibration hose inside out by the use of water pressure or air pressure.

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.

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 secondarily inflated through the inversion of a calibration hose. Modifications may be required for specific job conditions.

5. Recommended Materials and Manufacture

5.1 *General*—The resins, fabric tube, tube coatings, or other materials, such as the permanent calibration hose when combined as a composite structure, shall produce CIPP that meets the requirements of this specification.

5.2 *CIPP Wall Composition*—The wall shall consist of a plastic coated fabric tube filled with a thermosetting (cross-linked) resin, and if used, a filler.

5.2.1 *Fabric Tube*—The fabric tube should consist of one or more layers of flexible needled felt, or equivalent, woven or nonwoven material(s), or both, capable of carrying resin, withstanding installation pressures, and curing temperatures. The material(s) of construction should be able to stretch to fit irregular pipe sections and negotiate bends. Longitudinal and circumferential joints between multiple layers of fabric should be staggered so as not to overlap. The outside layer of the fabric tube should have an impermeable flexible coating(s) whose function is to contain the resin during and after fabric tube impregnation. The outer coating(s) must facilitate monitoring of resin saturation of the material(s) of construction of the fabric tube. The fabric tube should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the original conduit. Allowance should be made for circumferential and longitudinal stretching of the fabric tube during installation. As required, the fabric tube should meet minimum tensile strength requirements in the longitudinal and transverse directions as specified in 7.1. All the material(s) of construction for the fabric tube should be compatible with the resin system used.

5.2.2 Calibration Hose:

5.2.2.1 *Removable Calibration Hose*—The removable calibration hose should consist of an impermeable plastic, or impermeable plastic coating(s) on flexible woven or nonwoven material(s), or both, that do not absorb resin and are capable of being removed from the CIPP.

5.2.2.2 *Permanent Calibration Hose*—The permanent calibration hose should consist of an impermeable plastic coating on a flexible needled felt or equivalent woven or nonwoven material(s), or both, that are capable of absorbing resin and are of a thickness to become fully saturated with resin. The calibration hose should be translucent to facilitate post-installation inspection. The calibration hose should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the resin saturated fabric tube. Once inverted, the calibration hose becomes part of the fabric tube, and once properly cured, should bond permanently with the fabric tube. The properties of the calibration hose should meet minimum tensile strength requirements in the longitudinal and transverse directions as specified in 7.1. All the material(s) of construction for the calibration hose should be compatible with the resin system used.

5.2.3 *Resin*—A chemically resistant isophthalic based polyester, or vinyl ester thermoset resin and catalyst system or an epoxy resin and hardener that is compatible with the installation process should be used. The resin should be able to cure in the presence of water and the initiation temperature for cure should be less than 180°F (82.2°C). The cured resin/fabric tube system, with or without the calibration hose, shall be expected to have as a minimum the initial structural properties given in Table 1. These physical properties should be determined in accordance with Section 8. The cured resin/fabric tube system, with or without the calibration hose, should meet the minimum chemical resistance requirements as specified in 7.2.

6. Installation Recommendations

6.1 Cleaning and Pre-Inspection:

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

TABLE 1 CIPP Initial Structural Properties^A

Property	Test Method	Minimum Value	
		psi	(MPa)
Flexural strength	D 790	4 500	(31)
Flexural modulus	D 790	250 000	(1724)
Tensile strength (for pressure pipes only)	D 638	3 000	(21)

^AThe values in Table 1 are for field inspection. The purchaser should consult the manufacturer for the long-term structural properties.

6.1.2 *Cleaning of Pipeline*—All internal debris should be removed from the original pipeline. Gravity pipes should 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 should be cleaned with cable attached devices or fluid propelled devices in accordance with AWWA M28.

6.1.3 *Inspection of Pipelines*—Inspection of pipelines should 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 should be carefully inspected to determine the location of any conditions that may 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 %. These conditions should be noted so that they can be corrected.

6.1.4 *Line Obstructions*—The original pipeline should be clear of obstructions such as solids, dropped joints, protruding service connections, crushed or collapsed pipe, and reductions in the cross-sectional area of more than 40 % that may hinder or prevent the installation of the resin-impregnated fabric tube. If inspection reveals an obstruction that cannot be removed by conventional sewer-cleaning equipment, then a point-repair excavation should be made to uncover and remove or repair the obstruction.

6.2 *Resin Impregnation*—The fabric tube should be totally impregnated with resin (wet-out) and run through a set of rollers separated by a space, calibrated under controlled conditions to ensure proper distribution of resin. The volume of resin used should be sufficient to fully saturate all the voids of the fabric tube material, as well as all resin-absorbing material of the calibration hose at nominal thickness and diameter. The volume should be adjusted by adding 3 to 15 % excess resin to allow for the change in resin volume due to polymerization, the change in resin volume due to thermal expansion or contraction, and resin migration through the perforations of the fabric tube and out onto the host pipe.

6.3 *Bypassing*—If bypassing of the flow is required around the sections of pipe designated for reconstruction, the bypass should be made by plugging the line at a point upstream of the pipe to be reconstructed and pumping the flow to a downstream point or adjacent system. The pump and bypass lines should be of adequate capacity and size to handle the flow. Services within this reach will be temporarily out of service.

6.3.1 Public advisory services shall notify all parties whose service laterals will be out of commission and advise against water usage until the main line is back in service.

6.4 *Installation Methods:*

6.4.1 *Perforation of Resin-Impregnated Tube*—Prior to pulling the resin-impregnated fabric tube in place, the outer impermeable plastic coating may optionally be perforated. When the resin-impregnated fabric tube is perforated, this should allow resin to be forced through the perforations and out against the existing conduit by the force of the hydrostatic head or air pressure against the inner wall of the calibration hose. The perforation should be done after fabric tube impregnation with a perforating roller device at the point of manufacture or at the jobsite. Perforations should be made on both sides of the lay-flat fabric tube covering the full circumference with a spacing no less than 1.5 in. (38.1 mm) apart. Perforating slits should be a minimum of 0.25 in. (6.4 mm) long.

6.4.2 *Pulling Resin-Impregnated Tube into Position*—The wet-out fabric tube should be pulled into place using a power winch. The saturated fabric tube should be pulled through an existing manhole or other approved access to fully extend to the next designated manhole or termination point. Care should be exercised not to damage the tube as a result of friction during pull-in, especially where curvilinear alignments, multilinear alignments, multiple offsets, protruding services, and other friction-producing host pipe conditions are present. Once the fabric tube is in place, it should be attached to a vertical standpipe so that the calibration hose can invert into the center of the resin-impregnated fabric tube. The vertical standpipe should be of sufficient height of water head to hold the fabric tube tight to the existing pipe wall, producing dimples at side connections. A device such as a dynamometer or load cell should be provided on the winch or cable to monitor the pulling force. Measure the overall elongation of the fabric tube after pull-in completion. The acceptable longitudinal elongation shall not be more than 5 % of the overall length measured after the calibration hose has been installed, or exceed the recommended pulling force.

6.4.3 *Hydrostatic Head Calibration Hose Inversion*—The calibration hose should be inserted into the vertical inversion standpipe, with the impermeable plastic membrane side out. At the lower end of the inversion standpipe, the calibration hose should be turned inside out and attached to the standpipe so that a leakproof seal is created. The resin-impregnated fabric tube should also be attached to the standpipe so that the calibration hose can invert into the center of the resin-impregnated tube. The inversion head should be adjusted to be of sufficient height of water head to cause the calibration hose to invert from the initial point of inversion to the point of termination and hold the resin-impregnated fabric tube tight to the pipe wall, producing dimples at side connections. Care should be taken during the inversion so as not to overstress the felt fiber. At the request of the purchaser, the fabric tube manufacturer should provide information on the maximum allowable axial and longitudinal tensile stress for the fabric tube.

6.4.3.1 An alternative method of installation is top inversion. In this case, the calibration hose and resin-impregnated fabric tube are attached to a top ring. In this case, the tube itself forms the standpipe for generation of the hydrostatic head. Other methods of installation are also available and should be submitted for acceptance by the purchaser.

6.4.4 *Using Air Pressure*—The resin-impregnated fabric tube should be perforated as described in 6.4.1. Once perforated, the wet-out fabric tube should be pulled into place using a power winch as described in 6.4.2. The calibration hose should be inserted through the guide chute or tube of the pressure containment device in which the calibration hose has been loaded, with the impermeable plastic membrane side out. At the end of the guide chute, the calibration hose should be turned inside out and attached