Designation: F2599 – 16

Standard Practice for The Sectional Repair of Damaged Pipe By Means of An Inverted Cured-In-Place Liner[1,2]

This standard is issued under the fixed designation F2599; 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 requirements and test methods for the sectional cured-in-place lining (SCIPL) repair of a pipe line (4 in. through 60 in. (10.2 cm through 152 cm)) by the installation of a continuous resin-impregnated-textile tube into an existing host pipe by means of air or water inversion and inflation. The tube is pressed against the host pipe by air or water pressure and held in place until the thermoset resins have cured. When cured, the sectional liner shall extend over a predetermined length of the host pipe as a continuous, one piece, tight fitting, corrosion resistant, and verifiable non-leaking cured-in-place pipe.

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 There is no similar or equivalent ISO Standard.

1.4 *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. Particular attention is drawn to those safety regulations and requirements involving entering into and working in confined spaces.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

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

D1600 Terminology for Abbreviated Terms Relating to Plastics

D3681 Test Method for Chemical Resistance of "Fiberglass" (Glass–Fiber–Reinforced Thermosetting-Resin) Pipe in a Deflected Condition

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

2.2 *NASSCO Guidelines:*[4]

Recommended Specifications for Sewer Collection System Rehabilitation.

3. Terminology

3.1 *Definitions:*

3.1.1 Unless otherwise indicated, definitions are in accordance with Terminology F412, and abbreviations are in accordance with Terminology D1600.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *access point, n*—upstream or downstream manholes, that serve as the point of entrance or exit for the liner assembly into the existing pipe.

[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] The sectional repair of damaged pipe by means of inversion of a cured in place liner is covered by patents (LMK Enterprises, Inc. 1779 Chessie Lane, Ottawa, IL 61350). Interested parties are invited to submit information regarding the identification of acceptable alternatives to this patented item to the Committee on Standards, ASTM Headquarters, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. Your comments will receive careful consideration at a meeting of the responsible technical committee which you may attend.

[3] 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.

[4] NASSCO, Inc. 11521 Cronridge Drive, Suite J, Owings Mills, MD 21117. http://www.nassco.org.

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

3.2.2 *bladder, n*—a translucent plastic apparatus that when pressurized, causes the tube to be inverted through the damaged pipe section and pressed against the pipe walls. The bladder joined with the tube creates a liner/bladder assembly.

3.2.3 *frangible connection, n*—a joining or combining of two objects that can be easily disconnected or separated by means of force.

3.2.4 *hydrophilic O-ring, n*—a neoprene O-ring that is moisture activated with expansion characteristics of 5-8 times its original thickness, producing a compression gasket seal between the cured liner tube and the host pipe.

3.2.5 *inversion, n*—the process of turning the resin-impregnated tube inside out by the use of air or water pressure.

3.2.6 *launcher, n*—an elongated flexible pressure vessel (hose apparatus) with one open end and one closed end, capable of receiving air pressure to cause a liner/bladder assembly to invert forward out from the launcher.

3.2.7 *lift, n*—a portion of the cured liner that has cured in a position such that it has pulled away from the existing pipe wall.

3.2.8 *liner/bladder assembly, n*—a combination of a tube and bladder that are frangibley connected.

3.2.9 *nominal thickness, n*—the finished liner thickness after curing.

3.2.10 *resin, n*—polyester, vinyl ester, epoxy or silicate resin systems being ambient or steam cured.

3.2.11 *sectional cured-in-place lining (SCIPL), n*—a textile tube impregnated by a thermosetting resin, which is formed within a portion of the existing pipe, thereby taking the shape of, and fitting tightly to the existing pipe.

3.2.12 *tube, n*—a textile tube capable of absorbing a thermoset resin.

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 pipes through the use of a resin-impregnated tube installed within a damaged existing host pipe. As for any practice, modifications may be required for specific job conditions.

5. Materials

5.1 *Tube:*

5.1.1 The textile tube shall consist of one or more layers of absorbent textile, for example, needle punched felt or circular knit, fiberglass or similar textile materials that meet the requirements of Practice F1216 and the Requirements and Test Methods sections of Specification D5813. The tube shall be constructed to withstand installation pressures and to have sufficient strength to bridge missing pipe segments and flexibility to fit irregular pipe sections. The wet-out tube shall meet the Resin Impregnation Requirements of Practice F1216, and shall have a uniform thickness with excess resin distribution that when compressed at installation will meet or exceed the design thickness after cure.

5.1.2 The tube shall be surrounded by an impermeable flexible translucent bladder that will contain the resin and facilitate visual monitoring of the vacuum impregnation (wet-out) procedure.

5.1.3 The tube shall be continuous. No intermediate or encapsulated elastomeric layers shall be in the textile that may cause delamination in the finished cured-in-place pipe. The tube shall be sized accordingly to create a circular lining equal to the inside of the host pipe.

5.1.4 The tube shall be fabricated with a 2 in. (5.1 cm) ring of compressible textile material at the upstream and downstream ends, to create a smooth transition. The compressible textile material will compress to meet the host pipe at its leading end and match the nominal thickness of the tube at its opposite end.

5.1.5 The tube shall be fabricated to include a hydrophilic neoprene rubber O-ring at each end of the tube. The O-ring shall be attached to the inner side of the liner tube prior to resin impregnation.

5.2 *Resin:*

5.2.1 The resin/liner system shall conform to the Test Methods section of Specification D5813- 10,000-hour test and the Test Method D3681 using a 10,000 hour test period.

5.2.2 The resin shall be a corrosion resistant polyester, vinyl ester, epoxy resin, or silicate and catalyst system that when properly cured within the composite liner assembly, meets the requirements of Practice F1216, the physical properties herein, and those, which are to be utilized in the design of the SCIPL for this project.

5.2.3 The resin shall produce a SCIPL, which will comply with the structural and chemical resistance requirements of Practice F1216.

6. Design Considerations

6.1 The SCIPL shall be designed in accordance with Practice F1216, Appendix X1, Section X1.1.2.

6.2 The SCIPL design for the sectional liner shall assume no bonding to the original host pipe.

7. Installation Recommendations

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

7.1.1 *Cleaning and Inspection*—in accordance with NASSCO Guidelines.

7.1.2 *Inspection of Pipelines*—The interior of the pipeline shall be carefully inspected to determine the location of any condition that shall prevent proper installation, such as roots and collapsed or crushed pipe. These conditions shall be noted so that they can be corrected before installation of the SCIPL. Experienced personnel trained in locating breaks, obstacles, and service connections by closed circuit television shall perform inspection of pipelines.

7.1.3 *Line Obstructions*—The existing host pipe shall be clear of obstructions that prevent the proper insertion and

expansion of the lining system. Changes in pipe size shall be accommodated according to the pipe diameter and condition. Obstructions may include dropped or offset joints of more than 20 % of the inside pipe diameter.

7.2 *Resin Impregnation*—The tube encapsulated within the translucent bladder (liner/bladder assembly) shall be vacuum-impregnated with resin (wet-out) under controlled conditions. The volume of resin used shall be sufficient to fill all voids in the tube material at nominal thickness and diameter. The volume shall be adjusted by adding excess resin for the change in resin volume due to polymerization and to allow for any migration of resin into the cracks and joints of the host pipe. No dry or unsaturated area in the main tube shall be acceptable upon visual inspection.

7.3 *Liner Insertion*—The bladder and tube (liner/bladder assembly) is drawn inside the launcher through the open end. The liner/bladder assembly is contained within the launcher, protecting the tube from resin loss. The launcher is inserted into the host pipe and towed to the beginning of the damaged section. After positioning, pressurized air is introduced causing the liner/bladder assembly to project out of the launcher simultaneously inverting and inflating the resin-impregnated tube against the host pipe. When fully inverted, the tube is continuous in length covering the damaged section and extending a minimum of 18 in. (45.7 cm) on each side of the damaged section of the host pipe, with the hydrophilic O-rings positioned between the liner tube and the host pipe.

7.4 *Curing*—After the liner tube placement is completed; pressure is maintained, pressing the liner firmly against the host pipe's inner wall. The liner is cured at ambient temperatures or by a suitable heat source. The heating equipment shall be capable of delivering a mixture of steam and air throughout the liner/bladder assembly to uniformly raise the temperature above the temperature required to cure the resin. The curing of the SCIPL shall take into account the existing host pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of the soil). The temperature shall be monitored and logged during the cure and cool down cycles.

7.5 *Curing Processing*—Curing shall be done without pressure interruption with air or a mixture of air and steam for the proper duration of time in accordance with the resin manufacturer's recommendations. When the heat source is removed and the temperature of the SCIPL reaches 100°F (37.8°C) or less, the processing shall be finished. For an ambient cured method, a coupon suspended in the manhole will determine curing time.

TABLE 1 SCIPL Initial Physical Properties

Property	ASTM Test	Minimum value	
		psi	(MPa)
Flexural strength	D790	4,500	(31)
Flexural modulus	D790	250,000	(1,724)

7.6 *Bladder Removal*—A visual inspection during bladder removal will verify the completion of the cure.

8. Finish

8.1 The finished SCIPL shall be continuous over the entire length of the rehabilitated section of the pipe. The SCIPL shall be free of dry spots, lifts, and delamination. The cured liner shall taper at each end so as to accept video equipment and maintain a proper flow. The hydrophilic O-ring shall be positioned between the liner tube and the host pipe producing a compression gasket seal that is compatible with all piping materials. After the work is completed, the installer will provide the owner with video footage documenting the completed work, in accordance with NASSCO Guidelines.

9. Recommended Inspection Practices

9.1 *Sampling*—As designated by the purchaser in the purchase agreement, the preparation of a SCIPL sample is required. The sample shall be of the same textile tube material and resin system as used for the rehabilitated pipe.

9.1.1 The minimum length of the sample must be able to produce at least five specimens for testing in accordance with Test Method D790.

9.2 *Short-Term Flexural (Bending) Properties*—The initial tangent flexural modulus of elasticity and flexural strength shall be measured for gravity pipe applications in accordance with Test Method D790 and shall meet the minimum requirements of Table 1.

10. Keywords

10.1 ambient cure; bladder; compression gasket; continuous; felt; hydrophilic O-ring; inflation; inversion; knit; launcher; liner/bladder assembly; resin; sectional cured-in-place lining; steam cure; textile; tube; vacuum impregnate

SUMMARY OF CHANGES

Committee F17 has identified the location of selected changes to this standard since the last issue (F2599–11) that may impact the use of this standard.

(1) Revised—1.1.
(2) Revised—4.1.
(3) Revised—5.1.1, 5.1.3, 5.1.4, and 5.1.5.
(4) Revised—6.2.
(5) Revised—7.1, 7.1.2, 7.3, 7.4, 7.5, and 7.6.
(6) Revised—8.1.
(7) Revised—Section 10.