



Designation: F2599 – 22

Standard Practice for 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recom-*

mendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ASTM Standards:³

[C1920 Practice for Cleaning of Vitrified Clay Sanitary Sewer Pipelines](#)

[D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials](#)

[D1149 Test Methods for Rubber Deterioration—Cracking in an Ozone Controlled Environment](#)

[D1600 Terminology for Abbreviated Terms Relating to Plastics](#)

[D2990 Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of 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](#)

[F3240 Practice for Installation of Seamless Molded Hydrophilic Gaskets \(SMHG\) for Long-Term Watertightness of Cured-in-Place Rehabilitation of Main and Lateral Pipelines](#)

2.2 NASSCO Guidelines:⁴

[Recommended Specifications for Sewer Collection System Rehabilitation.](#)

3. Terminology

3.1 Definitions:

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 Available from 5285 Westview Drive Suite 202 Frederick, MD 21703, <http://www.nassco.org>

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

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.

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 *SMHG O-ring, n*—a neoprene seamless molded hydrophilic 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 frangibly 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.

3.2.13 *warranty period*—the period of time that the manufacturer will guarantee the design life and service life of the properly installed product.

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.

5.2 Resin:

5.2.1 For design purposes a 50-year time-dependent flexural modulus shall be determined in accordance with Test Method **D2990** with a minimum test duration of 10 000 h.

5.2.2 Materials containing fiberglass shall meet the requirements of Specification **D5813** Section 8.2.2.

5.2.3 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.

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

5.3 Seamless Molded Hydrophilic Gaskets (SMHGs):

5.3.1 All of the SMHG's required for the SCIPL must conform to Practice **F3240**, Section 6.

5.3.2 The tube shall include two SMHG O-rings attached to the interior surface at each end. One O-ring shall be attached 4 in. from the end of the liner and the other shall be attached 6 in. from the end of the liner. The O-rings shall be attached to the liner in accordance with Practice **F3240** section 7.2.3.2. See **Fig. 1**.

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.



FIG. 1 SMHG O-rings on Tube at One End

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*—All internal debris shall be removed from the original pipeline. The pipes shall be cleaned with hydraulically powered equipment, high velocity jet cleaners, or mechanically powered equipment in accordance with manufacturers guidelines, Practice C1920 or NASSCO Guidelines as applicable.

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. The SCIPL shall be placed so that the intended rehabilitated area is contained within the SMHG. CCTV must verify the proper placement of the SMHG O-rings located near each end of the tube. 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 SMHG 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.

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. Inspection Practices

9.1 *Inspection and Acceptance*—The proper placement of the SMHG O-rings after installation shall be verified by visual inspection or by closed-circuit television (CCTV). The visual inspection of the finished rehabilitated SCIPL shall reveal a visual impression of the correctly positioned SMHGs. The SMHGs shall not be folded, torn, twisted or rolled. At the request of the owner a photo of the properly placed SMHGs shall be submitted. Once the SMHGs have been exposed to water for 72 h, no infiltration shall be observed through or around the installed Liner. Inspection to verify that the liner is not leaking through or around the liner shall take place during the period between 72 h after installation up until the end of the warranty period.

9.2 *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.

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

TABLE 1 SCIPL Initial Physical Properties

Property	ASTM Test	Minimum value	
		psi	(MPa)
Flexural strength	D790	4500	(31)
Flexural modulus	D790	250 000	(1724)

9.3 *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; seamless molded hydrophilic gasket (SMHG) -ring 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 (F2599–20) that may impact the use of this standard.

(1) Practice **C1920** was added to **2.1**.

(2) Section **7.1.1** was revised.

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