Designation: F3182 – 23

Standard Practice for the Application of Spray-Applied Polymeric Liners Inside Pipelines for Potable Water[1]

This standard is issued under the fixed designation F3182; 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 rehabilitation of potable water pipes using spray-applied polymeric coatings for pipelines constructed of iron, steel, or asbestos cement using resin materials that have been certified in accordance with NSF/ANSI 61 for the in-situ lining of potable water mains.

1.2 This practice applies to potable water pipelines constructed of metallic or non-metallic piping in the diameter ranges of 4 in. (10 cm) to 36 in. (90 cm). Specialist advice should be sought from the product manufacturer for polymeric linings applied to other nonmetallic surfaces and for applied linings outside of these diametric limitations.

1.3 This practice applies to in-situ pipes requiring AWWA Class I (nonstructural) linings through Class III (semi-structural) linings (see AWWA M28).

1.4 This practice does not address lining system design. Assistance with lining system design is available from lining system manufacturers and operators who have been professionally trained and experienced in polymeric liner design.

1.5 *Units*—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.

1.6 *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.*

1.7 *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 Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D883 Terminology Relating to Plastics

D1600 Terminology for Abbreviated Terms Relating to Plastics

D3359 Test Methods for Rating Adhesion by Tape Test

D4541 Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

D6677 Test Method for Evaluating Adhesion by Knife

D7091 Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals

F412 Terminology Relating to Plastic Piping Systems

2.2 *AWWA Documents:*[3]

AWWA C651 Disinfecting Water Mains

AWWA M28 Rehabilitation of Water Mains

AWWA C222 Polyurethane coatings for the Interior and Exterior of Steel Water Pipe and Fittings

2.3 *NSF Standards:*[4]

NSF/ANSI 61 Drinking Water System Components – Health Effects

NSF/ANSI 14 Plastic Piping System Components and Related Materials

NSF/ANSI 372 Drinking Water System Components – Lead Content

2.4 *Society of Protective Coating/NACE Standards:*[5,6]

SSPC-SP 6 /NACE NO. 3 Commercial Blast Cleaning

SSPC-SP 7 /NACE NO. 4 Brush-off Blast Cleaning

[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.

Current edition approved Feb. 15, 2023. Published March 2023. Originally approved in 2016. Last previous edition approved in 2016 as F3182–16. DOI: 10.1520/F3182–23

[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 NSF International, P.O. Box 130140, 789 N. Dixboro Rd., Ann Arbor, MI 48105, http://www.nsf.org.

[5] Available from The Society for Protective Coatings, 40 24th Street, Sixth Floor, Pittsburgh, PA 15222

[6] Available from NACE International (NACE), 15835 Park Ten Pl., Houston, TX 77084, http://www.nace.org.

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

3. Terminology

3.1 *Definitions:* Definitions are in accordance with Terminology F412 and abbreviations are in accordance with Terminology D883 and D1600, unless otherwise specified.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *accredited third party certification organizations, n*—agencies accredited by an independent and authoritative conformity assessment body (for example, International Laboratory Accreditation Cooperation) to operate a material and product testing, and listing (certification) system that is accepted by the Authority Having Jurisdiction.

3.2.2 *certified applicator*—any individual or firm who is certified by the manufacturer or his designated certifying representative to apply or supervise the application of the manufacturer's product or technology.

3.2.3 *metallic piping, n*—a tubular shape made of metal, intended to convey liquids or gases.

3.2.3.1 *Discussion*—Usually semi-rigid or rigid metal such as galvanized steel, galvanized wrought iron, black steel, stainless steel, copper, brass, cast iron, ductile iron or similar metal.

3.2.4 *non-metallic piping, n*—a tubular shape made of non-metallic materials, intended to convey liquids or gases.

3.2.4.1 *Discussion*—Non-metallic pipe materials include asbestos cement, concrete, thermoplastics such as HDPE and PVC, and composites such as fiberglass.

3.2.5 *non-structural lining, n*—a lining bonded to the host pipe internal diameter that can withstand abrasion and support limited specified loads including vacuum loads, but relies on the transfer of all other loads (internal and external) to the host pipe.

3.2.6 *owner's representative or designate*—The designated official who has the legal authority to act on behalf of the owner (for example, consultant).

3.2.7 *semi-structural lining, n*—an interactive lining bonded to the host pipe internal diameter whose hoop strength may be less than that required to support the maximum operating pressure (MOP) for the pressure pipe, but that can withstand abrasion and independently withstand vacuum, and pressure loads at holes or gaps.

3.2.7.1 *Discussion*—All other internal and external loads are sustained by the host pipe for the life of the liner.

3.2.8 *spray-in-place pipe, SIPP, n*—spray-applied polymeric (thermoset) lining for the interior of pipes that consists of a two-component system designed to provide a non-structural or semi-structural enhancement to pipes used for potable water conveyance.

4. Summary of Practice

4.1 This practice describes the procedures for the rehabilitation of potable water mains using spray-applied polymeric coatings for the inside of pipes. It includes material requirements, cleaning requirements, lining procedures, performance requirements (testing) and quality control provisions.

5. Significance and Use

5.1 This practice is for use by water utilities or other owners, contractors, specifiers, regulatory agencies, inspection organizations or other users who are involved in the rehabilitation of potable water pipelines and wish to specify or permit the use of spray-applied polymeric liners.

6. Material Requirements

6.1 The polymeric lining materials used for in-situ, spray-applied lining of water mains shall be evaluated, tested and certified for conformance with NSF/ANSI 61 or the health effects portion of NSF/ANSI 14 and NSF/ANSI 372 by an accredited third party certification organization when required by the regulatory authority having jurisdiction. These certification requirements relate to the effect of these materials on water quality and do not indicate fitness for use or purpose in terms of physical performance.

6.2 It shall be the manufacturer's responsibility to provide the owner or his designated representative with the physical performance and test data for the supplied polymeric lining materials (see 8.5). It shall be the manufacturer's further responsibility to ensure that testing and certification for these material and physical performance parameters is obtained using accredited third-party certification organizations' testing laboratories. These testing reports and certifications shall be made available to the owner's representative upon request.

7. Lining Procedures

7.1 *General*—The lining materials shall be applied in accordance with the manufacturer's recommendations using the means and methods specified by the manufacturer. All lining applications shall be completed by manufacturer-approved, certified applicators, using manufacturer-approved, calibrated equipment and written procedures. All material applications shall be pre-planned by a certified applicator in accordance with the manufacturer's recommendations and subject to the quality control requirements of Section 9 of this practice.

7.1.1 All lining equipment used in the lining process shall be sanitized for contact with potable water to the satisfaction of the contract provisions or owner. This includes cleaning equipment, spray rig including umbilical/tether, and CCTV equipment contacting the water pipe. Controls shall be put in place by the certified applicator to ensure that lining equipment does not bring contaminants into the pipe. The use of multiple application lining equipment for water pipe lining operations shall only be permitted when pre-authorized by the owner, and only after full sanitary cleaning measures imposed by the owner have been taken and proven.

7.2 *Preparatory Planning*—Comprehensive planning is required before the commencement of polymeric lining operations. The following list of considerations is provided to the user for guidance and is not exhaustive:

(1) Review and analysis of system architecture, surface and subsurface information,

(2) zoning restrictions and regulations,

(3) safety and health concerns and requirements,

(4) access and egress considerations,

(5) customer care planning,

(6) environmental concerns (weather, waste disposal),

(7) flow bypass requirements and arrangements,

(8) traffic control,

(9) availability of water and provisions for alternative supplies,

(10) discussions and meetings with other utilities, highway authorities and fire services, disinfection regulations and operations,

(11) permitted hours for lining operations, and

(12) bylaws/regulations affecting lining operations.

7.3 *Flow Bypass System*—Whenever the continuance water supply is required for customers connected to the pipelines being lined, the bypass shall be designed, installed and tested to meet the requirements of the contract documents and local health regulations. The bypass system shall receive the approval of the owner and local health officer prior to the commencement of lining operations. The bypass system shall be monitored and maintained for the full duration of lining operations. The bypass system must remain in service until the lined main has been fully returned to service.

7.4 *Pipeline Access:*

7.4.1 The main to be lined is isolated by closing all relevant supply valves and accessed at planned locations above ground or by localized removal of the surface pavement or concrete where the main is buried below ground.

7.4.2 For buried mains, pits are then excavated, followed by the cutting and removal of a section of pipeline, and draining it prior to cleaning. Access is preferably completed at a valve, bend, fitting, or other location wherever an excavation is needed for cleaning and lining operations. Piping components such as air valves, flow meters, butterfly valves, and pressure reducing valves (are generally) be removed prior to cleaning, and then replaced after lining.

7.4.3 Access pits are typically drained/dried for safety and health (personnel and contamination) and are suitably covered or barricaded when not in use. Care shall be taken by the applicator to erect proper barricades and signage around these excavations to prevent accidents or injuries.

7.5 Different producers, manufacturers and certified applicators will have different capabilities and configurations for their lining equipment, which impacts the nature and frequency of access required to accomplish the lining work. Users and owners are encouraged to check with the certified applicator in planning the access requirements for each project.

7.6 *Pipeline Cleaning and Preparation:*

7.6.1 The quality of cleaning and preparation is paramount if polymeric linings are to be applied successfully. The interior of metallic piping system surfaces shall be cleaned to achieve a clean metal surface conforming to the SSPC-SP 7/NACE NO. 4 standard for the pipeline and the SSPC-SP 6/NACE NO. 3 standard for service connections and terminations.[7] Service connections are often sites for dissimilar metal corrosion, and corrosion products must be fully removed around each service to ensure a leak-tight lining seal/bond at the service connections.

7.6.2 Any cleaning and preparation method used shall clean and prepare the pipe in order to meet the performance requirements of this section.

7.6.3 The cleaning method chosen shall achieve the removal of all foreign material on the pipe wall and around service connections, including sediment, corrosion, biofilm and graphite.

7.6.4 Previously-applied coatings are typically removed unless the residual coating is tightly-bonded, and the coating manufacturer has specified that the particular residual material can be over-coated.

7.6.5 When viewed without magnification, the cleaned, prepared surface shall be free of all visible contamination prior to coating.

7.6.6 The pipeline shall also be dried and left free of visible moisture (free standing water) in both the pipe and the pipe joints prior to lining.

7.6.7 The cleaning technology chosen shall consider and take precautions to minimize potential damage to service connections, appurtenances and the host pipe. All cleaning residue and contamination shall be disposed of in accordance with the owner's stipulations.

7.7 *Pre-Lining Inspection:*

7.7.1 A closed-circuit television (CCTV) inspection of the cleaned pipe must be carried out prior to lining to verify the quality of pipe cleaning, level of surface preparation, and pipe dryness, as well as the presence of unmapped fittings or bends, deep (protruding) ferrules, excessive lead jointing material or other flow restrictions, and to visually verify the integrity of the pipeline (for example, cracks, gaps, holes) prior to lining operations. This recorded inspection will examine service connections and joints for evidence of leakage or damage.

7.7.2 The inspection will ascertain the removal of piping components such as air valves, flow meters, butterfly valves, gate and pressure reducing valves. Only service connections (ferrules) are to be lined in place, except for deep-protruding or faulty/damaged ferrules, which are to be replaced prior to lining.

7.7.3 The inspection will also determine whether spot repairs (patches, clamps, seals, new valves) are needed before lining. Such decisions will also consider the gap and hole-spanning capabilities of the lining material as well as in-situ conditions (for example, surface and soil loads, groundwater, and soil conditions).

7.7.4 The applicator will provide a copy of the pre-lining inspection video to the owner or the owner's representative for review and approval prior to the commencement of lining operations.

7.7.5 Any cleaning defects found shall be rectified prior to lining. The lining material must be applied within six hours following cleaning and inspection. Delays greater than six hours shall require re-inspection prior to lining application to ascertain the absence of moisture and flash corrosion on the inner pipe surfaces.

[7] Conformance with SSPC/NACE standards apply for metal surface preparation only. A SSPC/NACE certified inspector is required only when specified by contract. Asbestos cement (AC) pipe shall require the removal of all loose deposits, loose fibers and debris, biofilm, and sediments, followed by complete surface drying prior to coating.

7.8 *Pipeline Lining:*

7.8.1 Once pipe temperature has been checked (9.6), the lining rig is fully prepared and checked for operation, and correctly heated, the lining material is at the correct temperature and any dehumidification equipment recommended by the manufacturer to facilitate the application has been put in place, lining can begin.

7.8.2 The lining may be applied in single or multiple passes using an application spray head connected to a lining rig through an umbilical hose. It shall be the lining manufacturer's responsibility to establish limitations on each coating application including: thickness of application per pass; resin cure times; and instructions or limitations for multiple coats and any re-coats.

7.8.3 The applicator shall then complete all manufacturer-mandated quality control checks and records for the rig and lining material.

7.8.4 Once the rig and material are fully prepared, and the pipe has been proved to ensure free passage of the lining application head, the hoses (umbilical) are winched fully through the pipe to be coated.

7.8.5 The application head shall be attached and resin shall be pumped through the head to waste until the correct mixture proportion is achieved and recorded by the applicator in accordance with the manufacturer's procedures. This process is frequently called "spin up".

7.8.6 Once the lining rig is ready, a dip card shall be used to sample the resin and be cured and retained as a record of the applied lining material condition.

7.8.7 Lining is then commenced to contract thickness by using the computer-controlled winch drum on the lining rig to withdraw the umbilical hoses and application head back through the pipe.

7.8.8 The applicator shall monitor the lining rig throughout the lining process. If a fault is suspected, the process shall be aborted and all lining equipment removed from the main.

7.8.9 Once lining is complete, a second dip card shall be used to sample resin condition and shall be kept by the applicator as a permanent record.

7.8.10 Immediately after lining, the applicator will review the lining printout in accordance with the manufacturer's procedures and provide a copy to the owner's representative to prove that all of the lining criteria have been met.

7.8.11 The cure period shall commence only when the lining head is removed.

7.8.12 The minimum coating thickness for polymeric linings is 0.04 in. (1 mm, 40 mils) throughout the lining.

7.8.13 The owner's representative shall have the final decision regarding whether there is a potential risk to water quality from improperly mixed, uncured polymer and whether rectification or rework is required.

7.9 *Post-Lining Inspection:*

7.9.1 Upon completion of lining operations and initial curing, a visual inspection at the entrance and exit points of the lined main shall be undertaken by the owner's representative to verify that the lining is cured in accordance with the manufacturer's instructions and there is no evidence of uncured product (see Section 9).

7.9.2 Once sufficient hardness of cure is achieved, in accordance with the manufacturer's instructions, a recorded CCTV inspection shall be completed by the applicator to evaluate the quality of the lining application and completeness of cure.

7.9.3 To avoid contamination of the pipe interior, CCTV equipment and cables shall be clean upon insertion in accordance with lining manufacturer's procedures.

7.9.4 The speed of travel of the camera shall allow the survey to be carried out effectively along the circumference and length of the lined pipe.

7.9.5 Careful attention shall be focused on ensuring fully-cured, bonded coverage including service connections, joints, and other anomalies.

7.9.6 The coating shall exhibit an even application on diameter with no signs of uncured product.

7.9.7 Lesser lining faults such as cracks, blisters, bubbles, sags, uncoated pipe, delamination, ringing, cuts, drips, holes, or service blockages shall be addressed in accordance with 9.7 of this practice.

7.9.8 In the event of such discrepancies, the contract documents and manufacturer's engineer shall be consulted to advise the owner regarding corrective action, as required.

7.9.9 The lining shall not be accepted for return to service without the review and approval of the owner's representative for each lined segment of potable water pipe.

7.10 *Return to Service:*

7.10.1 Following a successful visual inspection of the installed liner, and completion of the specified tests (Section 8), the lining is cured and flushed in accordance with the specific material certification requirements as specified in the material's NSF/ANSI 61 certification.

7.10.2 Depending on the requirements in the contract, the main line is then pressure tested, if required, and shall be disinfected and tested for bacteria in accordance with contract or owner-stipulated procedures and limits such as those found in AWWA C651.

7.10.3 Once these steps are successfully completed, the owner authorizes the main to be returned to service.

7.10.4 The bypass system can then be shut down and decommissioned, excavations can be backfilled and surface conditions restored.

7.10.5 Demobilization from site can follow a final owner-approved site inspection.

8. Performance Requirements and Test Methods

8.1 *Pipe Sampling:*

8.1.1 Pipe sampling shall be completed in accordance with the provisions of the contract. Certified applicators shall take pipe samples at a point in the lined main agreed to by the owner's representative or his designate, but avoiding pipe ends at lining entry and exit points.

8.1.2 Unless otherwise specified in the contract provisions, for diameters up to eight (8) in. (200 mm), a pipe sample of twelve (12) in. (300 mm) in length shall be taken for every 1650 ft (or 500 m) lined, and for diameters great than (8) in. (200 mm), a pipe sample of twelve (12) in. (300 mm) in length shall be taken for every 6500 ft (or 2 km) lined.