Designation: F2719 – 09 (Reapproved 2015)

Standard Practice for Installation of Polyethylene (PE) and Encapsulated Cement Mortar Formed in Place Lining System (FIPLS) for the Rehabilitation of Water Pipelines[1]

This standard is issued under the fixed designation F2719; 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 installation of a semi-structural polyethylene (PE) and encapsulated cement mortar formed-in-place lining system (FIPLS) intended for the rehabilitation of water pipelines from 4 in. to 12 in. This renewal process involves installing a folded PE liner with multiple hooks on the outside face into an existing water pipeline then pumping cement mortar into the annular space and progressively reforming the liner against the original pipe wall by means of forcing a reforming device through the pipeline.

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

1.4 This practice is to be used with the material specified in 4.2.1 of F2718 the Standard Specification for Polyethylene (PE) and Cement Materials for an Encapsulated Cement Mortar Formed in Place Lining System (FIPLS) for the Rehabilitation of Water Pipelines.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C109/C109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)

D1600 Terminology for Abbreviated Terms Relating to Plastics

F412 Terminology Relating to Plastic Piping Systems

F2718 Specification for Polyethylene (PE) and Cement Materials for an Encapsulated Cement Mortar Formed in Place Liner System (FIPLS) for the Rehabilitation of Water Pipelines

2.2 *AWWA/ANSI Standard:*[3]

C651 Disinfecting Water Mains

Manual M28 Rehabilitation of Water Mains

2.3 *NSF/ANSI Standards:*[4]

NSF/ANSI 14 for Plastic Ping Components and related Materials

NSF/ANSI 61 for Drinking Water Systems Components – Health Effects

3. Terminology

3.1 *Definitions*—Unless otherwise indicated, definitions are in accordance with Terminology F412, and abbreviations are in accordance with Terminology D1600. The abbreviation of polyethylene is PE.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *cement mortar, n*—a specially formulated cement based grout.

3.2.2 *formed-in-place-liner system (FIPLS), n*—after insertion of the liner and cement mortar, sequential insertion and reforming of the liner and cement mortar in the host pipe, a semi-structural composite lining of cement mortar with PE external surface is formed. See Fig. 1 and Fig. 2.

3.2.3 *liner, n*—a PE sheet with integral anchors extruded in a flat shape then formed with overlapping edges and fusion welded into a cylindrical shape. The collapsed liner or lay flat

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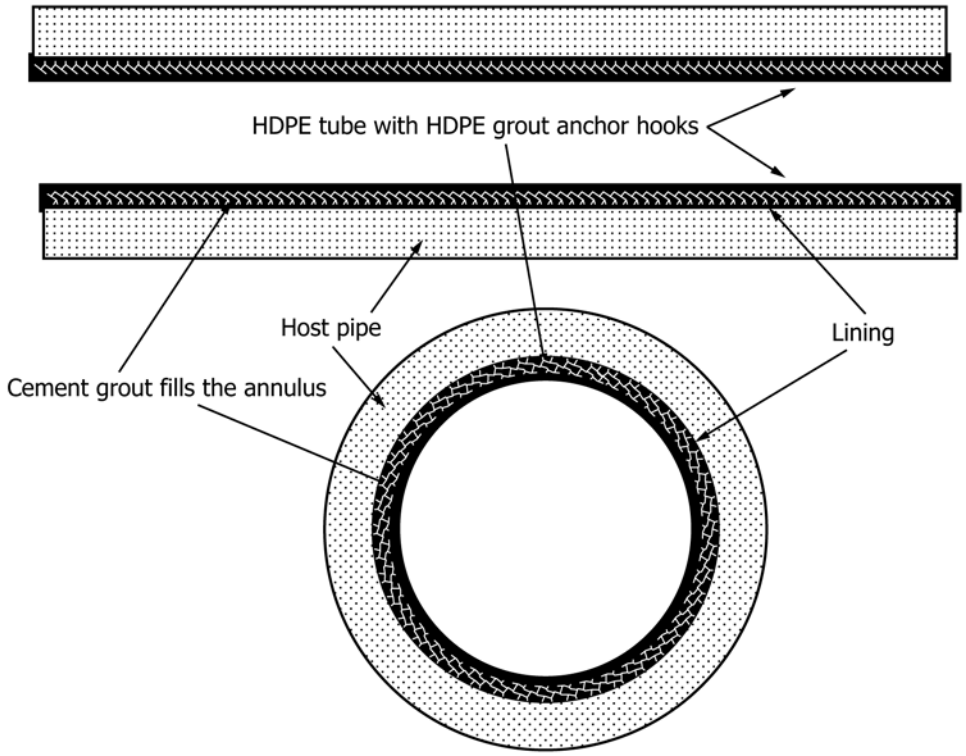
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

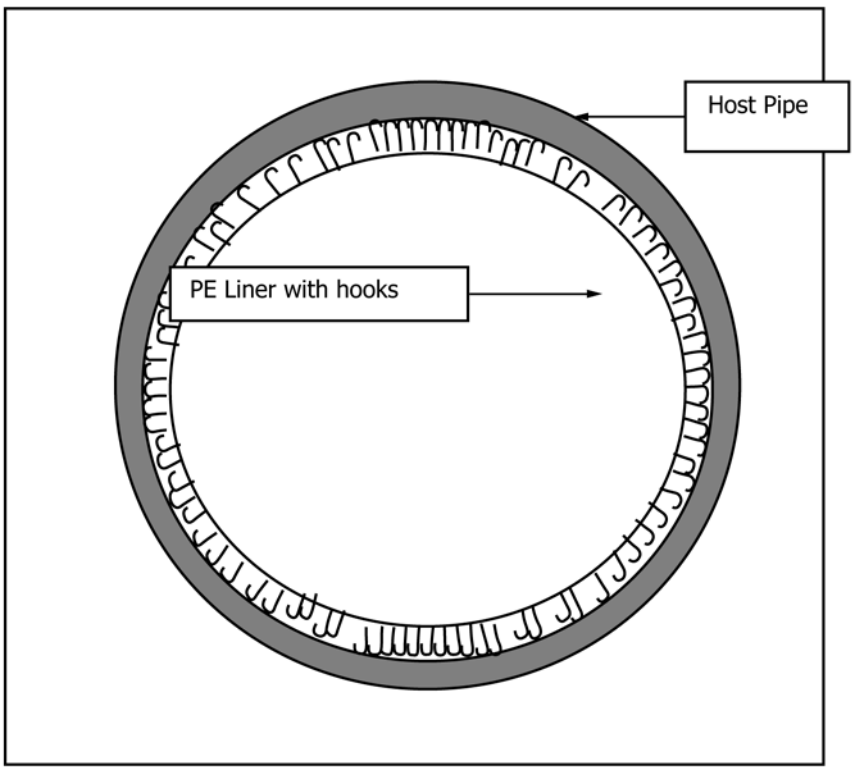
[3] Available from American Water Works Association (AWWA), 6666 W. Quincy Ave., Denver, CO 80235, http://www.awwa.org.

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



These figures are intended only for clarification of terms specific to this standard and show a representative Formed-In-Place Liner System.

FIG. 1 PE and Encapsulated Cement Mortar Formed-In-Place Liner System (FIPLS)



These figures are intended only for clarification of terms specific to this standard and show a representative Formed-In-Place Liner System.

FIG. 2 PE Liner with Protruding Hooks

tube is folded into a C configuration thereby reducing its area and pulled into the host pipe.

3.2.4 *semi-structural, adj*—lining systems designed to bridge small holes and gaps and seal leaking joints in the host pipe and having sufficient inherent stiffness to be self supporting without dependence on adhesion to the pipe wall.

3.2.4.1 *Discussion*—Appendix A of AWWA Manual M28 – "Structural Lining Design Issues," contains a more detailed discussion of structural classification of lining techniques. The following is taken from Manual M28: "Class II and Class III Linings are both interactive and semi-structural systems. Since the stiffness of such a lining is less than that of the host pipe, all internal pressure loads are transferred to the host pipe leading to their classification as interactive. Such a lining is required only to independently sustain internal pressure loads at discontinuities in the host pipe, such as corrosion holes or joint gaps, or if the host pipe is subject to structural failure."

4. Materials

4.1 *Basic Materials:*

4.2 The PE liner shall be made from PE material meeting all the minimum physical properties as listed in F2718, "Standard Specification for Polyethylene (PE) and Cement Materials for an Encapsulated Cement Mortar Lining System for the Rehabilitation (FIPLS) of Water Pipelines." In addition, the PE liner shall have the properties shown in Table 1.

4.3 The cement mortar is used to fill the annular space between outer surface of the liner and the host pipe. The cement mortar shall have the minimum physical properties as listed in F2718, " Standard Specification for Polyethylene (PE) and Cement Materials for an Encapsulated Cement Mortar Lining System for the Rehabilitation (FIPLS) of Water Pipelines."

4.4 The Polyethylene and cement mortar formed-in-place lining system (FIPLS) shall have the minimum properties as shown in Table 2.

NOTE 1—Samples will be taken of the cement mortar material and tested throughout the installation process to confirm its compliance to the properties listed in Table 2 and as specified in F2718, "Standard Specification for Polyethylene (PE) and Cement Materials for an Encapsulated Cement Mortar Lining System for the Rehabilitation (FIPLS) of Water Pipelines."

5. Significance and Use

5.1 This practice is for use by specifiers, regulatory agencies, owners and inspection organizations that are involved in the rehabilitation of pressure mains and conduits, and in particular potable water lines in the diameter range of 4 to 12 in. The supplier of the FIPLS lining system product should be consulted for design and installation information.

6. Installation Requirements

6.1 *Cleaning and Inspection:*

TABLE 1 Properties of the Polyethylene Liner

Property	ASTM Test Method	Minimum Value Hook
Concentration		105 /in.^{2} (16 /cm^2)

TABLE 2 Physical Properties of the Polyethylene and Cement Mortar Formed-in-Place Lining System

Property	ASTM Test Method	Minimum Value Hook
28 Day Compressive Strength	C109/C109M	7000 psi (55 MPa)
Resistance to pull out of the hooks		40 psi (0.28 MPa)

6.1.1 *Access Safety*—Prior to entering any confined space, 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.

6.1.2 *Cleaning of Pipeline*—Internal debris, including scaling and deposit buildups, shall be removed from the existing pipeline prior to installation of the product. Pipes should be cleaned with hydraulically powered equipment, or mechanically powered equipment. Any free standing water shall be removed from the pipe.

6.1.3 *Inspection of Pipelines*—The interior of the pipeline shall be carefully inspected to determine the location of any condition(s) that shall prevent proper installation. These conditions shall be noted and corrected prior to installation. Experienced personnel trained in locating breaks, obstacles, and service connections by closed circuit television (CCTV) shall perform inspection of pipelines. CCTV inspection shall be performed after cleaning to ensure the pipeline is ready for rehabilitation.

6.1.4 *Line Obstructions*—The existing pipeline shall be clear of obstructions that prevent the proper insertion and expansion of the lining system.

6.2 *Liner Insertion:*

6.2.1 The liner sections are positioned near their respective access points. A mechanical folding device may be positioned on the host pipe in order to fold the liner for winching through the host pipeline. A winch shall be placed at the opposite access, and the winch cable strung through the host pipe and then attached to the liner pulling head. Alternatively the liner may be pulled in by hand. The liner is winched through the folding device and along the length of main to be lined. Care must be taken to avoid any twisting of the liner as it travels through the main. When the liner reaches the winch end, the winch is stopped and an extra 2 yd (2 m) of liner are pulled through by hand. One yd (1 m) of the liner pulled out of the host pipe and is cut out and inspected for damage during insertion. If serious damage is observed, the liner should be removed and the cause of the damage located and rectified prior to the insertion of a new length of liner into the main. Damage will consist of tearing or cutting of the liner or serious abrasion and gouging of the surface of the liner extending to more than 20 % of the wall thickness.

6.3 *Grouting of the Annulus:*

6.3.1 *Protection of Service Connections*—Prior to the grouting operation service connections should be pre-plugged or corked to prevent ingress of the cement mortar.

6.3.2 Grouting operations shall be conducted from the downstream to the upstream access points. The grout fittings at the downstream end and the air release fittings at the upstream

end of the liner shall be inspected in accordance with the supplier's recommendations. A sufficient amount of grout shall be positioned at the downstream access point and the mixing equipment set-up and tested for proper operation in accordance with the supplier's recommendations. A quality control station shall be set-up adjacent to cement mortaring operation. The cement mortar machines shall be brought on line and the grout checked for temperature, viscosity, and water-cement ratio in accordance with the supplier's recommendations. When the recommended parameters have been achieved the grouting operation shall begin. Once grouting of the annulus has begun, the cementing operation shall not stop until completed.

6.4 *Introduction of the Rounding Device:*

6.4.1 After introduction of the grout, the rounding device (pig) is inserted into the launcher. Air is introduced behind the rounding device. The pressure should be increased until the rounding device starts to move. The pressure should be maintained as the rounding device travels through the section being lined.

6.5 *Hydration of the Cement Mortar:*

6.5.1 When the PE liner and grout have been installed, the fittings are sealed and the pressure in the liner increased. During hydration, the internal pressure on the lining may be maintained by use of compressed air only or by filling the liner with water and maintaining the desired pressure. Pressure should be maintained on the liner throughout hydration, until the cement has sufficiently hardened and the lining system is fully self-supporting and able to resist the short-term external hydrostatic loading. At this time the pressure may be relieved. The lining system must remain undisturbed until the cement has hardened, after which time, return to service procedures may commence. Once the cement has hardened the installation fitting may be removed, the inflation liner pulled out and discarded and the ends of the liner trimmed.

7. Post Lining Procedure

7.1 The cement mortar shall be cured for a period of time depending upon the ambient air temperature and flow conditions, but not less than 16 h. The cement mortar that remains in the cement liners and port shall be inspected to determine if the required amount of cure (16 h) has been achieved.

7.2 *Inspection*—A closed-circuit television (CCTV) inspection shall be carried out over the entire length of the installation to ensure that the lining conforms to the walls of the main and that the lining system is free from defects. The grout distribution is to be inspected using infra red thermography. Grout voids detected by the inspection should be repaired as recommended by the lining system manufacturer.

7.3 *Disinfection*—Before the lined section is reconnected to the main, the installation shall be disinfected (chlorinated). Any line cutouts and any fittings shall be disinfected using a hypochlorite solution as approved by the client engineer. After the specified time has elapsed, the main is flushed until the chlorine residual measured at the discharge point is equal to that of the water entering the main.

NOTE 2—The rehabilitated main is normally charged with suitably chlorinated water, the residual chlorine level and contact time being determined by the Client's Standard Practice for return to service procedures. In the US, the American Water Works Association Standard ANSI/AWWA C651 shall apply.

7.4 *Reconnecting to the Active Distribution System*—Reconnect the rehabilitated section to the active distribution system by installing spool pieces, couplings, ferrules and any other required fittings. Materials used for reconnection shall be sprayed with chlorine solution before incorporation into the works to prevent pollution from occurring. Service connections are to be reconnected by first removing the sealing plugs, then drilling a hole through the center of the taping. The PE liner and cement shall be milled from this central hole to the outside of the taping. A tap shall be run through the original taping to clean any residual cement from the threads. A new service ferule shall be screwed into the original taping for reconnection of the household supply. The ends of the lining shall be cut square and the propriety Top-Hat fitting pushed inside the liner. Spool pieces can be used to connect the lined section back into the network.

NOTE 3—Access holes are required to be backfilled and surface reinstatement carried out to the approval of the client. This work should ideally be carried out within 24 h of testing.

8. Keywords

8.1 cement mortar; encapsulated; FIPLS; formed-in-place liner system; grout; liner; main; pipelines; polyethylene; rehabilitation; water

SUPPLEMENTARY REQUIREMENTS

This requirement applies whenever a regulatory authority of user calls for the products to be used to convey or to be in contact with potable water.

S1 Potable Water Requirement

Products intended for contact with potable water shall be evaluated, tested, and certified for conformance with NSF/ANSI 61 or the health effects portion off NSF/ANSI 14 by an acceptable certifying organization when required by the regulatory authority having jurisdiction.