

Installation Practice – InnerSeal™

Rehabilitation of a Full-Length Sewer Service Lateral using One-Piece Main and Lateral Cured-In-Place Liner Assembly Installed By Means Of Air Inversion

1. Intent

This instruction details the material requirements, installation practices and test methods for the reconstruction of a sewer service lateral pipe and the main connection without the need for excavation. The lateral pipe is renovated remotely from the main pipe to a sewer cleanout located within the public right of way. The pipe renovation shall be accomplished by the inversion and inflation of a resin impregnated, single-piece lateral and main connection liner assembly. The liner assembly is pressed against the lined main pipe by inflation of a bladder and held under pressure until the thermo-set resin has cured. When cured, the liner shall extend over a predetermined length of the service lateral and the full circumference of the main pipe connection forming a continuous, single-piece, tight fitting, corrosion resistant and verifiable non-leaking cured in-place pipe (CIPP) inclusive with gasket seals. The Materials and Installation practices shall adhere to the minimum requirements of ASTM F2561-11 “Standard Practice for Rehabilitation of a Sewer Service Lateral and its Connection to the Main Using a One-Piece Main and Lateral Cured-in Place Liner”.

2. General

The rehabilitation is constructed using a resin absorbent Scrim Reinforced textile liner of particular measured length and a thermo-set resin with physical and chemical properties appropriate for the application. The lateral tube and main connection liner tube are assembled with a translucent inversion bladder and saturated under a controlled vacuum with a synthetic catalyzed resin. The liner and bladder form a liner/bladder assembly; the lateral tube is inserted inside of a protective launching hose, and the main connection liner is wrapped around a rigid launching device forming a main liner tube. The protective launching device is winched through the mainline and robotically positioned to be in alignment with a lateral service connection. The mainline bladder is inflated to press the connection liner against the main pipe; the lateral tube is inverted into the lateral pipe by the action of the inversion bladder. The resin-saturated liner assembly is cured; the inversion bladder and launching device are removed.

3. Material

3.1 **Liner Assembly** - The liner assembly shall be continuous in length and consist of one or more layers of absorbent Scrim Reinforced textile material i.e. needle punched felt, circular knit or circular braided tubes that meet the requirements of ASTM F1216 and ASTM D5813 Sections 6 and 8. No intermediate or encapsulated elastomeric layers shall be in the textile that may cause de-lamination in the cured in-place pipe. The textile tube and sheet shall be constructed of a non-stretch scrim reinforced lateral liner tube to withstand installation pressures, have sufficient strength to bridge missing pipe segments, and flexibility to fit irregular pipe sections. The wet-out textile tube and sheet shall meet ASTM F 1216, 7.2 as applicable, and shall have a uniform thickness and 5% to 10% excess resin distribution that when compressed at installation pressures will meet or exceed the design thickness after cure.

- 3.2 **Mainline Liner Tube** - The main sheet will be flat with one end overlapping the second end and sized accordingly to create a circular lining equal to the inner diameter of the main pipe. The interior of the textile sheet shall be laminated with an impermeable, translucent flexible membrane. The textile sheet before insertion shall be permanently marked on the membrane as a "Lateral Identification" correlating to the address of the building the lateral pipe provides service.
- 3.3 **Lateral Liner Tube** - The exterior of the lateral liner tube shall be laminated with an impermeable, translucent flexible membrane. Longitudinal seams in the tube shall be stitched and thermally sealed. The lateral tube will be continuous in length and the wall thickness shall be uniform. The lateral tube will be capable of conforming to offset joints, bells, disfigured pipe sections and pipe diameter transitions. The lateral tube must be made using a stretch resistant scrim reinforcement layered between the textile material and coating.
- 3.4 **Mainline Connection** - The main tube and lateral tube shall be formed as a one-piece assembly by stitching the lateral tube to the main sheet aperture. The connecting end of the lateral tube shall be shaped to match the aperture and curvature of the main tube. The lateral tube and main tube are connected by stitching and sealing the stitching using a flexible UV cured adhesive/sealant. The main and lateral tubes are assembled in the shape of a "T" or WYE with corresponding dimensions. Submittals for the liner assembly must include the manufacturers test protocol and tests data that certifies the connection between the liner tubes is leak-free, when subjected to a controlled vacuum leak test.
- 3.5 **Gasket Seals** - The mainline tube shall include (4) hydrophilic rubber gaskets attached to the main liner tube on each terminating end of the main liner tube, between the lateral connection and terminating main liner ends. The lateral tube shall also include a hydrophilic O-ring gasket attached six-inches from the upstream terminating end of the lateral tube.
- 3.6 **End Seal Test Data** - The hydrophilic gaskets must include test data that reports substantial water-tightness at the terminating ends of a CIPP when subjected to hydrostatic loading that simulates subterranean conditions. Gasket seal submittals must include tests data simulating hydration/ dehydration conditions for a period of 10,000-hours and the test results must successfully demonstrate and document long-term performance without deterioration, loss of material, flexibility, and expansion of the gasket during repeated cycles of hydration and dehydration.
- 3.7 **Bladder Assembly** - The liner assembly shall be surrounded by a second impermeable, inflatable, flexible translucent membrane (translucent bladder) that will contain the resin and facilitate vacuum impregnation while monitoring of the resin saturation during the resin impregnation (wet-out) procedure.

4. Resin System

- 4.1 **Resin / Liner System** - The resin/liner system shall conform to ASTM D5813 Section 8.2.2.
- 4.2 **Resin Selection** - The resin shall be a corrosion resistant polyester system that when properly cured within the composite liner assembly, meets the requirements of ASTM F1216, the physical properties herein, and those which are to be utilized in the design of the CIPP, for this project.

4.3 **Results** - The resin shall produce CIPP, which will comply with the structural and chemical resistance requirements of ASTM F1216.

Table 1 - CIPP Initial Structural Properties

<u>Property</u>	<u>ASTM Test</u>	<u>Min psi Value</u>	<u>Min Mpa Value</u>
Flexural Strength	D 790	4,500	(31)
Flexural Modulus	D 790	250,000	(1,724)

5. Design Considerations

5.1 The CIPP shall be designed per ASTM F1216, Appendix X1.

5.2 The CIPP design for the lateral tube and main connection shall assume no bonding to the original or host pipe.

5.3 Roughness Coefficient the liner must be smooth and have an average “n” factor of 0.013 or lower.

6. References

6.1 ASTM F2561 Standard Practice for Rehabilitation of a Sewer Service Lateral and Its Connection to the Main Using a One-Piece Main and Lateral Cured-In-Place Liner.

6.2 ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced

6.3 Plastics and Electrical Insulating Materials.

6.4 ASTM D792 Standard Test Methods for Density and Specific Gravity of Plastics by Displacement.

6.5 ASTM D2990 Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep

6.6 Rupture of Plastics.

6.7 ASTM D5813 Standard Specification for Cured-in Place Thermosetting Resin Sewer Pipe.

7. Installation Recommendations

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

7.2 **Cleaning and Inspection** – As per NASSCO Standards.

7.3 **Accessing the Lateral** – A cleanout is required to be located on the exterior of the building. The cleanout fitting must be either TEE shaped or a back-to-back WYE shaped. The cleanout shall be located no less than within two (2) feet of the finished liner.

7.4 **Plugging** – The upstream side of the cleanout shall be plugged during insertion and curing of the liner assembly ensuring no flows enter the pipe and no air, steam or odors will enter the building. When required, the main pipe flows will be by-passed. The pumping system shall be sized for normal to peak flow conditions. The upstream manhole shall be monitored at all times and an

emergency deflating system will be incorporated so that the plugs may be removed at any time without requiring confined space entry.

- 7.5 **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 sections. These conditions shall be noted. Experienced personnel trained in locating breaks, obstacles, and service connections by closed circuit television shall perform inspection of pipelines.
- 7.6 **Line Obstructions** – The existing service lateral shall be clear of obstructions that prevent the proper insertion and expansion of the lining system. Changes in pipe size shall be accommodated, if the lateral tube is sized according to the pipe diameter and condition. Obstructions may include dropped or offset joints of no more than 20% of inside pipe diameter.
- 7.7 **Resin Impregnation** – The liner assembly is encapsulated within the translucent bladder (liner/bladder assembly) shall be saturated with the resin system (wet-out) under controlled vacuum conditions. The volume of resin used shall be sufficient to fill all voids in the textile lining material at nominal thickness and diameter. The volume shall be adjusted by adding 5% to 10% excess resin for the change in resin volume due to polymerization and to allow for any migration of resin into the cracks and joints in the original pipe. No dry or unsaturated area in the mainline sheet or lateral tube shall be acceptable upon visual inspection.
- 7.8 **Liner Insertion** – The lateral tube and inversion bladder will be inserted into the carrying device. The main bladder and main flat sheet shall be wrapped around a launching device, formed into a tube and secured by use of hydrophilic o-rings. The mainline tube shall include (4) hydrophilic o-rings gaskets attached to the main liner tube, (2) on each terminating end of the main liner tube, between the lateral connection and terminating main liner ends. The four gaskets shall be installed at the main/lateral pipe interface by inserting the tube into the lateral pipe until the main sheet is firmly seated against the mainline pipe. A hydrophilic O-ring for lateral CIPP shall be installed 6- inches from the upstream terminating end of the lateral tube. The launching device is inserted into the pipe and pulled to the point of repair. The pull is complete when the lateral tube is aligned with the lateral pipe. The lateral tube is completely protected during the pull. The mainline liner is supported on a rigid launcher that is elevated above the pipe invert through the use of a rotating skid system. The liner assembly shall not be contaminated or diluted by exposure to dirt or debris during the pull.
- 7.9 **Bladder** – The main bladder shall be inflated causing the main sheet to unwrap and expand; pressing the main tube firmly into contact with the main pipe. The lateral tube is inverted through the main tube aperture by the action of the lateral bladder extending into the lateral pipe to a termination point that shall be no less than 2-feet from the exterior cleanout, or agreed terminating point. The bladder assembly shall extend beyond each end of the liner, so the liner remains open-ended and no cutting shall be required.

8. CIPP Processing

- 8.1 **Curing** – After the liner has been fully deployed into the lateral pipe, pressure is maintained pressing the liner firmly against the inner pipe wall until 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 a uniform raise the temperature above the temperature required to cure the resin. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions

(temperature, moisture level, and thermal conductivity of the soil). The heat source temperatures shall be monitored and logged during the cure and cool down cycles. The manufacturer's recommended cure schedule shall be submitted.

- 8.2 **CIPP Processing** – Curing shall be done without pressure interruption with air or a mixture of air and steam for the proper duration of time per the resin manufacturer's recommendations. The curing process is complete when the temperature of the CIPP reaches 100 degrees Fahrenheit or less, the processing shall be finished

9. Finish

- 9.1 **Completed CIPP** – CIPP Shall be a homogenous liner assembly located within a lateral service pipe for a specific length, and extending into the main pipe to renew 18-inches of the main pipe including the service connection). The CIPP shall be smooth with minimal wrinkling and increase flow rate. The CIPP shall be free of dry spots, lifts, and delaminated portions. The CIPP shall include an engineered taper at each end providing a smooth transition to the host pipe for accommodating video equipment and maintaining proper flow in the mainline. After the work is completed, the installer will provide the owner with video footage documenting the repair and the visual markings identifying the sewer lateral address as completed work. The finished product must provide an airtight/ watertight verifiable non-leaking connection between the main sewer and sewer service lateral.

10. Recommended Inspection and Testing Practices

- 10.1 **Sampling** – As designated by the purchaser in the purchase agreement, the preparation of a CIPP sample is required. The sample shall be prepared by securing a flat plate mold using the textile tube material and resin system as used for the rehabilitated pipe.
- 10.2 **Pressure** – The pressure applied on the plate sample will be equal to the highest pressure exerted on the lateral tube during the inversion process.
- 10.3 **Length** – The minimum length of the sample must be able to produce at least five specimens for testing in accordance with ASTM D790-03.
- 10.4 **Conditioning** – Condition the test specimens at $73.4 \pm 3.6^{\circ}$ F ($23 \pm 2^{\circ}$ C) and $50 \pm 5\%$ relative humidity for not less than 40 hour prior to test in accordance with Practice ASTM D 618, for those tests where conditioning is required.
- 10.5 **Short-Term Flexural (Bending) Properties** – The initial tangent flexural modulus of elasticity and flexural stress shall be measured for gravity and pressure pipe applications in accordance with Test Method D 790 and shall meet the minimum requirements of Table 1.
- 10.6 **CIPP Wall Thickness** – The minimum wall thickness at any point shall not be less than 87.5% of the specified design thickness as agreed upon between purchaser and seller.
- 10.7 **Gravity Pipe Leakage Testing** – If required by the owner in the contract documents or purchase order, gravity pipes should be tested using an air test method where a test plug is placed adjacent to the upstream and downstream ends of the main sheet CIPP and at the upper most end of the lateral tube. This test should take place after the CIPP has cooled down to ambient temperature. This test is limited to pipe lengths with no service connections. The test pressure shall be 4 PSI for a three-minute test time and during this time the pressure shall not drop below 3.5 PSI.

11. Design Considerations

General Guidelines – The design of the cured-in-place lateral liner system is largely a function of the condition of the existing pipeline and the loads stipulated by the customer's specification.

12. Payment

Price includes traffic control, permits, by pass pumping and video documentation. Unit prices shall be submitted for the following items:

- 12.1 Mobilization Lump Sum.
- 12.2 Lateral cleaning/ video inspection from cleanout to main per lineal foot.
- 12.3 Set-up for each manhole-to-manhole segment.
- 12.4 InnerSeal™ Main/Lateral connection and extending 15-feet up into the lateral.
- 12.5 Additional footage per lineal foot.

13. Warranty

- 13.1 All CIPP liners shall be certified by the manufacturer for specified material properties for a particular job. The manufacturer warrants the liner to be free from defects in raw materials for ten (10) years from the date of acceptance. The contractor guarantees the work to be free from defects caused by faulty workmanship and/or materials for a period of ten (10) Years. During the warranty period, any defects which affect the integrity, strength or water tightness of the pipe shall be repaired at the contractor's expense.
- 13.2 The contractor shall carry Professional Liability Coverage and provide proof of insurance during the term of the contract.

14. Qualified Bidder

A qualified bidder for installing a mainline/lateral connection and lateral repair system shall use a system that is manufactured in the United States by a Cured-In-Place-Pipe (CIPP) manufacturer with a minimum of a fifteen-year manufacturing history and proved with satisfactory performance. The Manufacturer shall have a minimum of 1 million feet of air inversion lateral lining as combined certified installer installations during this time period in the U.S.