

SECTION 02XXX
CURE IN PLACE PIPE (CIPP)

PART 1 GENERAL

1.01 SUMMARY

- A. This Section specifies rehabilitation of pipelines by the installation of a resin-impregnated flexible liner.

1.02 REFERENCES

- A. This Section incorporates by reference the latest revisions of the following documents. They are part of this section insofar as specified and modified herein. In case of conflict between the requirements of this Section and the listed documents, the requirements of this Section shall prevail.

<u>Reference</u>	<u>Title</u>
ASTM D543	Test methods for resistance of plastics to chemical reagents
ASTM D790	Test methods for flexural properties of non-reinforced plastics
ASTM D903	Test method for peel or stripping strength of adhesive bonds
ASTM D1600	Terminology for abbreviated terms relating to plastics
ASTM D2990	Test method for tensile, compressive and flexural creep and creep-rupture of plastics
ASTM D3839	Practice of underground installation of fiberglass (glass-fiber reinforced thermosetting resin) pipe
ASTM F412	Terminology relating to plastic piping systems
ASTM F1216	Standard Practice for Rehabilitation of existing pipelines and conduits by the inversion and curing of a resin-impregnated tube
ASTM F1743	Rehabilitation of pipelines by pulled-in-place installation of a cured-in-place thermosetting resin pipe
<u>ASTM F2019</u>	<u>Rehabilitation of existing pipelines and conduits by the Pulled in Place installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP)</u>

1.03 DEFINITIONS

- A. Definitions are in accordance with terminology of ASTM F412, unless otherwise specified.
- B. Abbreviations are in accordance with terminology of ASTM D1600, unless otherwise specified.

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01300:
1. Shop Drawings and equipment data.
 2. Certification showing that the CONTRACTOR is currently licensed by the appropriate licensor to perform CIPP installation. Certification shall be given to the PROJECT REPRESENTATIVE prior to deliver of material to the job site.
 3. Details on all lining materials and resins.
 4. Manufacturer certification that the liner materials are in compliance with the specifications, codes, and standards referenced herein.
 5. Manufacturer's recommendations for storage procedures and temperature control, handling and inserting the liner, curing details, service connection methods, and trimming and finishing.

6. Pipe sizing calculations that demonstrate that the liner has been properly undersized to avoid the creation of wrinkles or folds.
7. Bypass pumping and/or diversion plans for each section of work at least 10 working days prior to the work. Notify the ENGINEER 24 hours prior to commencing with the bypass pumping operation. Identify the liner insertion and bypass pumping locations and methods with sufficient detail to assure that the work can be accomplished without sewage spill. The bypass-pumping plan shall include an emergency response plan to be followed in the event of a failure of the bypass pumping system.
8. The resin manufacture's heating requirements, and conceptually discuss with the PROJECT REPRESENTATIVE the general curing guidelines.

1.05 QUALITY ASSURANCE

- A. Product, Manufacturer/Installer Qualification Requirements:
 1. Minimum of 1,000,000 linear feet of successful wastewater collection system installations ~~in the United States~~. Minimum of 50,000 linear feet of installations shall have been successfully in service for a minimum of five (5) years ~~in the United States~~.
 2. Installer shall have [a superintendent with](#) at least five (5) years of active experience with the commercial installations of the product bid. Installer's [superintendent](#) must have installed a minimum of 50,000 linear feet of product bid in wastewater collection systems ~~in the United States~~.
 3. Wastewater collection system rehabilitation products submitted for approval shall be provided with a Third Party Test Results supporting long-term performance and structural strength of the product. Third Party Test Result data shall be satisfactory to the OWNER. Test samples shall be prepared so as to simulate the installation methods and trauma of the product.
 4. Rehabilitation manufacturing and installation shall operate under a Third Party quality management system certified to ISO 9000 or other internationally recognized organizational standards. Proof of certification shall be required. [If the manufacturer and installer does not comply with this requirement, they have to be approved by the OWNER.](#)
- B. The finished CIPP shall be continuous over the entire length of an insertion run between two manholes or access points and shall be free from visual defects such as foreign inclusions, dry spots, pinholes, and delamination.
- C. Wrinkles in the finished CIPP that cause a backwater of five (5) percent of pipe diameter or more or reduce the hydraulic capacity of the pipe are unacceptable and shall be removed and repaired by the CONTRACTOR at the CONTRACTOR's expense. Methods of repair shall be proposed by CONTRACTOR and submitted to the PROJECT REPRESENTATIVE for review.
- D. Subject to these specifications, the following manufacturers are acceptable:
 1. Gelco Services Inc. (Salem, OR)
 2. IHC™ Rehabilitation Products (Pinehurst, TX) [\(Do they comply with 1.05 A 1 & A 4???\)](#)
 3. C.I.P.P. Corporation (Hudson, IA)
 4. Perma-Liner Industries, Inc. (Clearwater, FL) [\(Do they comply with 1.05 A 1 & A 4???\)](#)
 5. LMK Enterprises Inc. (Ottawa, IL)
 6. Insituform Technologies, Inc. (Chesterfield, MO)
 7. Inliner Technologies (Paoli, IN)
 8. [Pacific Multilining Inc. \(Abbotsford, BC\)](#)
 9. Or Equal

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1.06 WARRANTY

- A. Provide the OWNER with a warranty to be in force and effect a period of one year from the date of final acceptance of the project by the OWNER. The warranty shall cause the CONTRACTOR to repair or replace the liner should failure or damage result from materials or installation.

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PART 2 MATERIALS

2.01 CURE IN PLACE PIPE LINER

- A. The CIPP shall consist of one or more layers of flexible needled felt or an equivalent non-woven material, or a combination of non-woven and woven materials capable of carrying resin, withstanding installation pressures.
 - 1. The CIPP will be continuous in length and the wall thickness shall be uniform. No overlapping sections shall be allowed in the ~~circumference or the~~ length of the liner.
 - 2. The CIPP will be capable of conforming to offset joints, bells, and disfigured pipe sections. It shall be able to stretch to fit irregular pipe sections and negotiate bends.
 - 3. The CIPP shall be compatible with the resin system used.
 - 4. Seams in the CIPP shall be stronger than the non-seamed felt.
 - 5. The CIPP shall be marked at a distance of regular intervals along its entire length, not to exceed 5 feet. Markings shall include Manufacturer's name or identifying symbol.
- B. The CIPP shall be fabricated to a size that, when installed, will tightly fit the internal circumference and length of the original pipe.
 - 1. Allowance shall be made for circumferential stretching during the installation process.
 - 2. The hydraulic capacity of the CIPP shall be greater than or equal to the hydraulic capacity of the original host pipe, based on hydraulic calculations with standard engineering roughness coefficients.
- C. The liner thickness shall be designed based on the engineering formulas listed in ASTM F1216 for partially deteriorated pipes. The thickness shall be sufficient to prevent groundwater from entering the pipe, while maintaining the maximum cross-sectional pipe area possible. Liner thickness shall be determined at a minimum of three (3) locations on a cut section of the liner using a method of measurement accurate to the nearest 0.005 – inch.
- D. The CIPP shall be coated on one side with a translucent waterproof coating of:
 - 1. Polyvinyl chloride (PVC)
 - 2. Polyurethane
 - 3. Polyethylene
 - 4. Or approved by the PROJECT REPRESENTATIVE

2.02 RESIN

- A. A general purpose, unsaturated thermosetting, polyester, vinylester, or epoxy resin compatible with the liner material used.
- B. Resin shall meet or exceed the physical properties listed in Section 2.03.
- C. Resin shall form no excessive bubbling or wrinkling during lining.

2.03 PHYSICAL PROPERTIES

- A. The composite materials of the tube and resin shall, upon installation inside the host pipe, exceed the minimum test standards specified by the American Society for Testing Methods:

Physical Properties	
Flexural Strength (ASTM D790)	4,500 psi
Flexural Modulus (ASTM D790)	300,000 psi
Flexural Modulus (ASTM D2990) Long Term	150,000 psi

- B. The CIPP after installation shall be corrosion resistant to withstand exposure to sewage gases containing quantities of hydrogen sulfide, carbon monoxide, diluted sulfuric acid, and other

chemical reagents determined by the PROJECT REPRESENTATIVE. Chemical resistance of the installed CIPP shall meet the chemical resistance requirements of ASTM F1216.

- C. The wall color of the interior pipe surface of the CIPP after installation shall be a light reflective color.
- D. The hydraulic profile of the installed CIPP shall be maintained as large as possible. The CIPP shall have at a minimum the full flow capacity of the original pipe before rehabilitation. Calculated capacities may be derived using commonly accepted roughness coefficients for the existing pipe material taking into consideration its age and condition.

PART 3 EXECUTION

3.01 PREPARATION

- A. Safety
 - 1. Provide safety training and equipment for personnel. Training shall conform to the requirements of WISHA and OSHA. All activities shall be carried out in strict accordance with all applicable WISHA and OSHA Standards.
 - 2. The work provides the potential for confined space entry. Coordinate all confined space entries with PROJECT REPRESENTATIVE.
- B. Bypass Pumping
 - 1. Provide bypass pumping and/or diversion when required for acceptable completion of the CIPP installation. Bypass pumping shall consist of furnishing, installing, and maintaining all power, primary and standby pumps, appurtenances and bypass piping required to maintain existing flows and services. Bypass pumps and lines shall be of adequate capacity and size to handle the flow.
 - 2. Bypass pumping shall be done in such a manner as not to damage private or public property, or create a nuisance or public menace. The pumped sewage shall be in an enclosed hose or pipe that is adequately protected from traffic, and shall be redirected into the sanitary sewer system. Dumping or free flow of sewage on private property, gutters, streets, sidewalks, or into storm sewers is prohibited.
 - 3. Take all necessary precautions including constant monitoring of bypass pumping to ensure that no private residences or properties are subjected to a sewage backup or spill. The CONTRACTOR shall be liable for all cleanup, damages, and resultant fines in the event of a spill. After the work is completed, flow shall be restored to normal.
- C. Temporary Interruption of Service
 - 1. Provide notification to residences of services that will be temporarily out of service. Notification shall detail the time when service is to be interrupted, the time when service is to be restored, and an advisement against water usage until the mainline is back in service.
 - 2. Do not interrupt service for more than 8 hours without written consent from the homeowner of the service that is to be interrupted.
 - 3. Coordinate all service interruptions with the PROJECT REPRESENTATIVE.
- D. Cleaning
 - 1. Remove all internal debris from the original pipeline.
 - 2. Clean gravity sewers with hydraulically powered equipment, high-velocity jet cleaners, or mechanically powered equipment.
 - 3. Cleaning shall include removal of all roots from the inside of the pipeline.
- E. Point Repairs
 - 1. Apply an herbicide to all locations where roots were removed.
 - 2. Grout severe defects in the pipeline including, but not limited to open joints, fractures, cracks, and holes in the pipeline as follows:

- a. Grout severe defects, openings in the pipeline larger than 1-inch in any dimension.
 - b. Other defects, less than 1-inch in any dimension, the CONTRACTOR shall not be required to grout the void, unless in the CONTRACTOR's opinion, the defect will impede the performance of the liner.
 - 3. Make point repairs of any defect that cannot be removed by conventional sewer cleaning equipment or by remotely performed repair methods acceptable to the PROJECT REPRESENTATIVE. Point repairs shall be performed by excavating the defect and removing or repairing the obstruction.
 - 4. Remove protruding laterals internally with a hydrojet cutter. If approved by the PROJECT REPRESENTATIVE, protruding laterals may be removed by an external point repair method.
- F. Pre-CCTV Inspection
- 1. Perform a closed circuit television (CCTV) inspection of the pipeline prior to liner installation in accordance with Section XXXXX.
- G. Manholes
- 1. Protect all manholes to withstand forces generated by the equipment while installing the liner.

3.02 INSTALLATION

- A. Resin Impregnation
- 1. Vacuum impregnate the tube with resin under controlled conditions.
 - 2. Use a volume of resin sufficient to fill all voids in the tube material at nominal thickness and diameter. Volume should be adjusted by adding five (5) to ten (10) percent 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.
 - 3. The resin impregnated tube shall be stored in such a manner that it will not be damaged, exposed to direct sunlight, or result in a public safety hazard. All materials shall be subject to inspection and review prior to installation.
- B. Liner Installation
- 1. Inversion Method
 - a. The impregnated tube shall be inserted through an existing manhole or other access point approved by the PROJECT REPRESENTATIVE by means of the manufacturer's recommended installation process. The application of a hydrostatic head, compressed air, or other means shall fully extend the liner to the next designated manhole or termination point and inflate and firmly adhere the liner to the pipe wall.
 - b. The liner shall be installed at a rate less than 10 feet per minute at all times.
 - 2. Pull/Winch Method
 - a. The impregnated tube shall be pulled into place within the host pipe with the aid of a power winch that is equipped with a device to monitor the force and prevent excessive tension and tube elongation.
 - b. The maximum allowable longitudinal elongation, or stretch, of the material shall be one (1) percent. The longitudinal stretch of the tube shall be gauged by comparing marker on the fully inserted tube to the actual length of pipe being rehabilitated.
 - c. The CONTRACTOR shall use a flexible and impermeable calibration hose to inflate the tube. The calibration hose may or may not remain in the complete installation. Any dry tube or inflation hose material that enters the existing pipe that has not been previously vacuum impregnated with resin cannot be included in the structural wall of the CIPP. Hose materials remaining in the installation shall be compatible with the resin system used, shall bond permanently with the tube, and shall be translucent to facilitate post-installation inspection. Hose materials that are to be removed after curing shall be of non-bondable material.
- C. Curing
- 1. For Water, Air, or Steam Cure:

- a. After placement of the liner is complete, provide a suitable heat source and distribution equipment. The equipment shall be capable of circulating hot water, air, and/or steam throughout the section in accordance with the manufacturer's recommendations to raise the temperature uniformly above the temperature required to affect a resin cure. This temperature shall be determined by the manufacturer based on the resin/catalyst system employed.
 - b. The heat source shall be fitted with continuous monitoring thermocouples to gauge the temperature of the incoming and outgoing water, steam, and/or air supply. Water, steam, or air temperature during the cure period shall meet the requirements of the resin manufacturer as measured at the heat source inflow and outflow return lines.
 - c. Provide standby equipment to maintain the heat source supply. An additional continuous monitoring thermocouple shall be placed between the impregnated tube and the pipe invert at the remote manhole and at a point mid-way between the upstream and downstream manholes to determine the temperature during the cure. The temperature during the cure shall not be less than 130 degrees Fahrenheit at the boundary between the pipe wall and the liner unless otherwise directed by the manufacturer because of the resin system used.
 - d. Temperature shall be maintained during the curing period as recommended by the resin manufacturer, and shall follow the healing schedule supplied by the manufacturer.
2. For Conductive Element Cure:
- a. After placement of the liner is complete, provide a suitable power supply. The specified power supply shall be capable of heating the section evenly to affect the proper cure of the resin in accordance with the manufacturer's recommendations.
 - b. The power supply and termination point shall be fitted with continuous monitoring gauges to monitor the temperature and pressure during the curing process.
 - c. Provide standby equipment to maintain the power supply. An additional continuous monitoring thermocouple shall be placed between the impregnated tube and the pipe invert at the remote manhole and at a point mid-way between the upstream and downstream manholes to determine the temperature during the cure. The temperature during the cure shall not be less than 130 degrees Fahrenheit at the boundary between the pipe wall and the liner unless otherwise directed by the manufacturer because of the resin system used.
 - d. Temperature shall be maintained during the curing period as recommended by the resin manufacturer, and shall follow the healing schedule supplied by the manufacturer.
- D. Cool Down
1. Cool the liner down to below 100 degrees Fahrenheit following the cure period [or as described by the manufacturer](#), prior to relieving static head.
 2. Care shall be taken to ensure that a vacuum is not induced which could damage the new CIPP during the release of head on the new CIPP.
- E. Sealing at the Sewer Main and Manholes
1. Make a watertight seal between the CIPP and the host pipe. No water shall be able to migrate between the CIPP and the host pipe, otherwise the CIPP shall be considered defective and shall be repaired or replaced at the CONTRACTOR's expense.
 2. Make a watertight seal between the CIPP and the manhole seals. No water shall be able to migrate between the CIPP and the manhole, otherwise the CIPP shall be considered defective and shall be repaired or replaced at the CONTRACTOR's expense.

3.03 SERVICE RECONNECTION

- A. Reconnect service connections to the lined pipe. Reconnections of service connections shall be completed by one of the following methods:
1. Internally reconnected by using a pivot-headed CCTV camera and a remote cutting tool to locate the service connections from inside the lined pipe, cutting a hole matching the service connection diameter, and grouting the area where the service connection enters the lined

pipe to produce a water tight seal. Provide a nearly full-diameter hole, free from burrs or projections and with a smooth and crack-free edge. The hole shall be 95 percent minimum and 100 percent maximum of the original service connection diameter. The invert of the service connection shall match the bottom of the reinstated service opening.

2. By excavating by hand and/or mechanical equipment to the location of the service connections tie-in, cutting the existing pipe and liner material, and installing a saddle acceptable to the PROJECT REPRESENTATIVE.
3. Other remote methods as approved by the PROJECT REPRESENTATIVE.

3.04 TESTING

A. Material Testing

1. All material testing shall be performed by a registered independent, third-party laboratory.
2. Provide certified test results of the properties of the cured lining material from the actual installed CIPP at a minimum of one location per each liner insertion setup.
3. The cured CIPP shall be sampled and tested for flexural strength and flexural modulus. Flexural strength and modulus shall be tested in accordance with the requirements of ASTM D790. The CIPP shall be in compliance with the physical properties stated under Section 2.03 of this specification.
4. Corrosion resistance requirements shall be as stated in ASTM F 1216, Section X2, Chemical Resistance Tests. The chemical resistance tests shall be completed in accordance with ASTM D543. Exposure shall be for a minimum of one (1) month at 73.4 degrees Fahrenheit. During this period, the CIPP test specimens shall lose no more than twenty (20) percent of their initial flexural strength and flexural modulus when tested in accordance with ASTM F1216, Section 8.
 - a. The recommended minimum requirements for the chemical resistance properties of the CIPP in standard domestic sanitary sewer applications are as follows:

Chemical Solution	Concentration, percent
Tap Water (pH 6 - 9)	100
Nitric Acid	5
Phosphoric Acid	10
Sulfuric Acid	10
Gasoline	100
Vegetable Oil	100
Detergent	0.1
Soap	0.1

5. Delamination testing shall be in accordance with ASTM F1216, Section 8.4, if required by the PROJECT REPRESENTATIVE.
6. Wall thickness of samples shall be determined as described in ASTM F1743, Section 8.1.6. The minimum wall thickness at any point shall not be less than 87½ percent of the design thickness.

B. Field Testing

1. Test line for exfiltration in accordance with ASTM F1216, Section 8.2 prior to service line reconnections. Testing shall exclude maximum pressure limitation (4.3 psi) at lowest end. Leakage testing shall be performed after all dry and non-bondable hoses and tubes are completely removed from the pipe.
2. Visual inspection of the CIPP shall be in accordance with ASTM F1743, Section 8.6.
3. After completion of all CIPP insertions, service reconnections, and finish work at the manholes, the sewer shall be televised with a color CCTV tilt-head camera recorded in VHS format per Section XXXXX. The original tape shall be provided to the PROJECT REPRESENTATIVE.
4. No infiltration of groundwater should be observed.
5. All service connections shall be accounted for and be unobstructed.

3.05 CLEAN-UP

- A. Upon acceptance of the installed work and testing, the CONTRACTOR shall restore the project area affected by the operations to a condition at least equal to that existing prior to the work.

END OF SECTION

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