

**TECHNICAL SPECIFICATIONS
CURED-IN-PLACE PIPE (CIPP) FOR MAINLINE RENEWAL**

PART 1 - PRODUCTS

1.1 GENERAL

It is the intent of this specification to provide for the reconstruction of pipelines and conduits by the installation of a resin-impregnated flexible tube that is either inverted or pulled into the original pipeline/conduit and expanded to fit tightly against said pipeline by the use of water or air pressure. The resin system shall then be cured by elevating the temperature of the fluid (water/air) used for the inflation to a sufficient enough level for the initiators in the resin to effect a reaction. The finished pipe shall be such that when the thermosetting resin cures, the total wall thickness shall be a homogeneous and monolithic felt and resin composite matrix, chemically resistant to withstand internal exposure to domestic sewage or stormwater.

1.2 QUALIFICATIONS

Since sewer products are intended to have a 50-year design life, and in order to minimize the Owner's risk, only proven products with substantial successful installations and experience will be approved.

In order for the CIPP product and Installation Contractor to be deemed commercially acceptable and approved for this project, they must meet the following criteria:

A. CIPP Product

1. The CIPP product must have been installed in a minimum of 5,000,000 linear feet or 4,000 manhole to manhole line sections of successful wastewater collection systems in North America and must be documented to the satisfaction of the Owner.
2. The CIPP product shall comply with the latest versions of ASTM F1216 or ASTM F1743, including appendices.
3. For the CIPP to be considered Commercially Proven, it shall have been successfully in service in an application similar to this project for a minimum of 10 years and documented to the satisfaction of the Owner.
4. The lining tube manufacturer shall operate under a quality management system that is third party certified to ISO 9001 or other internationally recognized organization standards. Proof of certification shall be submitted with the Contractor's bid and required for approval.
5. Third-party test results supporting the structural properties and long-term performance of the CIPP product shall be submitted for approval, and such data shall be satisfactory to the Owner. No CIPP product will be approved without independent third party testing verification.

B. Installation Contractor

1. The Installation Contractor shall be certified by the CIPP product manufacturer to have had at least 5 years active experience in the installation of the proposed CIPP product.
2. The Installation Contractor shall satisfy all insurance, financial and bonding requirements of the Owner, and shall have installed within the United States a minimum of 1,000,000 lineal feet of the same CIPP product being represented by the bidder.
3. The Installation Contractor superintendent(s) designated for the project shall have installed a minimum of 100,000 lineal feet and shall have 5 years of installation experience of the same CIPP product being represented by the bidder. This shall be documented to the Owner's satisfaction in the form of a resume of work experience detailing scope of work (linear footage and pipe diameters), location of work, and reference contact information for each project listed.
4. The Installation Contractor shall operate under a quality management system that is third party certified to ISO 9001 or equivalent standards. Proof of certification or quality management system shall be submitted with the Installation Contractor's bid and required for approval.

1.3 STRUCTURAL REQUIREMENTS

- A. Each CIPP shall be designed to withstand internal and/or external loads as dictated by the site and pipe conditions. Unless specified differently by the Owner/Engineer in the contract documents, the design thickness of the CIPP shall be derived at using standard engineering methodology as found in ASTM F1216, Appendix X1. The long-term flexural modulus shall not exceed 50 percent of the short-term value for the CIPP resin system and shall be substantiated through third-party testing. The thickness calculations, signed and sealed by a registered professional engineer, shall be submitted to the Owner prior to CIPP installation.
- B. The layers of the finished CIPP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly or such that the knife blade moves freely between the layers. If separation of the layers occurs during testing of the field samples, new samples will be cut from the work. Any reoccurrence may be cause for rejection of the work.
- C. The Enhancement Factor 'K' to be used in the CIPP design shall be assigned a value of 7.
- D. Long-term testing in general accordance with ASTM D2990 must have been performed for flexural creep of the CIPP pipe material to be installed. Such testing results are to be used to determine the long-term, time dependent flexural modulus to be utilized in the product design. This is a performance test of the materials (CIPP Tube and Resin) and general workmanship of the installation and curing as defined within the relevant ASTM standard. A percentage of the instantaneous flexural modulus value (as measured by ASTM D790 testing) will be used in design calculations for external buckling. The percentage, or the long-term creep retention value utilized, will be verified by this testing. The materials utilized for the contracted project shall be of a quality equal to or better than the materials used in the long-term test with respect to the initial flexural modulus used in the CIPP design.

E. The CIPP shall meet the following minimum strength requirements:

MINIMUM PHYSICAL PROPERTIES				
Property	ASTM Test Method	Polyester System	Filled Polyester System	Vinyl Ester System
Flexural Strength	D790	4,500 psi	4,500 psi	5,000 psi
Flexural Modulus (initial)	D790	250,000 psi	400,000 psi	300,000 psi
Flexural Modulus (50-year)	D790	125,000 psi	200,000 psi	150,000 psi

F. The required CIPP wall thickness shall be based as a minimum on the physical properties in Section 1.3.E above, and in accordance with the design equations in the Appendix X1 of ASTM F1216, and the following design parameters:

Design Safety Factor (typically used value)	=	2.0
Retention Factor for Long-Term Flexural Modulus to be used in Design (As determined by long-term tests described in Section 1.3.D and approved by the Owner)	=	50% max
Ovality* (calculated from (X1.1 of ASTM F1216)	=	% ⁽¹⁾
Enhancement Factor, K	=	7.0
Groundwater Depth (above invert of pipe)	=	feet ⁽¹⁾
Soil Depth (above crown of pipe)	=	feet
Soil Modulus (only required for fully deteriorated design conditions)	=	psi ⁽¹⁾
Soil Density (only required for fully deteriorated design conditions)	=	lb/ft ³ (1)
Live Load (only required for fully deteriorated design conditions)	=	e.g. H20 Highway
Design Condition (partially or fully deteriorated)*	=	*

* Based on review of video logs, design conditions of pipeline can be fully or partially deteriorated (See ASTM F1216, Appendix X1). The Owner will be solely responsible for determining pipe conditions and parameters utilized in design.

⁽¹⁾ In the absence of other information and to ensure uniformity in bidding, the following assumptions shall be used: **Ovality** = 2%; **Groundwater Depth** at one half soil depth to invert; **Soil Modulus** = 1000 psi; **Soil Density** = 120 lb/ft³.

1.4 MATERIALS

A. CIPP Tube

1. The CIPP tube shall consist of one or more layers of a flexible needled felt or an equivalent nonwoven or woven material, or a combination of nonwoven and woven materials, capable of carrying resin, withstanding installation pressures and curing temperatures. The CIPP tube should be compatible with the resin system to be used on this project. The material should be able to stretch to fit irregular pipe sections and negotiate bends.
2. The CIPP tube should be fabricated under controlled conditions to a size that, when installed, will tightly fit the internal circumference and the length of the original conduit. Allowances should be made for the longitudinal and circumferential stretching that occurs during placement of the tube. Maximum stretching allowances shall be as defined in ASTM F1216 or ASTM F1743. The Installation Contractor shall verify the lengths in the field before cutting the liner to length. Continuous individual liners can be made over one or more manhole to manhole sections.

3. The CIPP tube shall be uniform in thickness and when subjected to the installation pressures shall meet or exceed the designed wall thickness.
4. Any plastic film applied to the tube on what will become the interior wall of the finished CIPP shall be compatible with the resin system used, translucent enough that the resin is clearly visible, and shall be firmly bonded to the felt material.
5. At time of manufacture, each lot of CIPP tube shall be inspected and certified to be free of defects. The tube shall be marked for distance at regular intervals along its entire length, not to exceed five feet. Such markings shall also include the CIPP tube Manufacturer's name or identifying symbol.
6. The CIPP tube may be made of single or multiple layer construction where any layer must not be less than 1.5 mm thick. A suitable mechanical strengthener membrane or strip may be placed in between layers where required to control longitudinal stretching.

B. Resin Components

1. The resin system shall be a corrosion resistant polyester or vinyl ester, along with a compatible catalyst system.
2. The resin used shall not contain non-strength enhancing fillers.
3. When combined with the CIPP tube, the resin system shall provide a CIPP that meets the structural requirements of ASTM F1216 or ASTM F1743, the minimum physical properties specified in Section 1.3.E, and those properties which are to be utilized in the design of the lining system for this project.
4. When combined with the CIPP tube, the resin system shall provide a CIPP that complies with the chemical resistance requirements specified in ASTM F1216 or ASTM F1743.

PART 2 - EXECUTION

2.1 GENERAL

- A. The Installation Contractor shall deliver the resin impregnated CIPP tube to the site and provide all equipment required to insert and cure the CIPP within the host pipe. The Installation Contractor shall designate a location where the tube will be vacuum impregnated with the resin prior to installation. If requested by the Owner, the Installation Contractor shall notify the Engineer at least 48 hours prior to wet out to allow the Owner's representative to observe the materials and wet out procedure. All procedures to prepare the CIPP for installation shall be in strict accordance with the Manufacturer's recommendations.
- B. The CIPP shall be vacuum impregnated with resin not more than 120 hours before the time of installation and stored out of direct sunlight at a temperature of less than 70° F.

2.2 NOTIFICATION AND PREPARATION

- A. The Installation Contractor shall notify all residents affected by this construction at least 24 hours prior to any service disruption affecting their service connection. The Installation Contractor shall make every effort to maintain service usage throughout the duration of the project.
- B. The Installation Contractor shall perform cleaning, video, and inspection prior to installation of the CIPP. The Installation Contractor, when required, shall remove all debris from within the pipe that will interfere with the installation of the CIPP. The Owner shall provide a dumpsite for such debris removed during the cleaning operations.
- C. It shall be the responsibility of the Installation Contractor to notify the Owner of line obstructions, offset joints or collapsed pipe that will prevent the insertion of the tube or significantly reduce the capacity of the sewer. The Owner, with input from the Installation Contractor shall determine the method of pipe repair required and shall address these concerns on a case-by-case basis.
- D. Protruding laterals or services shall be trimmed flush with the inside of the main sewer wall prior to installation of the CIPP. Trimming shall not cause damage to the lateral or service beyond the inside face of the main sewer.

2.3 BYPASS PUMPING

- A. The Installation Contractor, when required, shall provide for the flow of sewage around the section or sections of pipe designated for repair. When possible, the bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. The Installation Contractor shall furnish all necessary pumping equipment, conduit, etc. to adequately, safely, and environmentally divert sewage flow around the work.
- B. When requested by the Engineer, the Installation Contractor shall submit a general bypass plan.

2.4 TELEVISION INSPECTION

- A. The Installation Contractor shall provide video equipment capable of properly documenting the conditions as found within the pipe. Lighting for the video camera shall illuminate the entire periphery of the sewer. The camera shall be radial view type capable of viewing 360° within the pipe and shall provide an unobstructed view of the full pipe.
- B. The video shall begin with a clear identification of the pipeline location, upstream and downstream manhole designation, and pipe diameter. The video shall provide an accurate length measurement of the entire segment and of the distance to each lateral connection. The Installation Contractor shall pan all lateral connections on both the pre and post-videos.
- C. Reverse video set-ups shall be utilized when line obstructions prevent full segment televising from the initial set-up direction.
- D. Both a pre-lining and post-lining video shall be submitted to the Owner for approval. The discs shall be clearly and properly labeled.

2.5 INSTALLATION

- A. The CIPP shall be installed in accordance with the practices given in ASTM F1216 (for direct inversion installations) or ASTM F1743 (for pulled-in-place installations). The quantity of resin used for the tube's impregnation shall be sufficient to fill the volume of air voids in the CIPP tube with additional allowances being made for polymerization shrinkage and the loss of any resin through cracks and irregularities in the original pipe wall. A vacuum impregnation process shall be used in conjunction with a roller system to achieve a uniform distribution of the resin throughout the CIPP tube.
- B. The resin-impregnated CIPP tube shall be installed into the host pipe by methods specified in ASTM F1216 or ASTM F1743 and proven through previous successful installations. The insertion method shall not cause abrasion or scuffing of the CIPP tube. Hydrostatic or air pressure shall be used to inflate the CIPP tube and mold it against the walls of the host pipe. There will be no use of sewage in place of clean water for insertion of the tube, or for the curing of the liner.
- C. Temperature gauges shall be placed between the CIPP tube and the host pipe's invert position to monitor the temperatures during the cure cycle.

2.6 CURING

- A. After the CIPP tube installation is completed, the Installation Contractor shall supply a suitable heat source and recirculation equipment (if required). The equipment shall be capable of delivering hot water or steam throughout the section to uniformly raise the temperature above the temperature required to affect a cure of the resin.
- B. The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing heat supply (for water cure) and outgoing heat supply (for steam cure). Water or air temperature in the pipe during the cure period shall be as recommended by the resin Manufacturer.
- C. Initial cure shall be deemed to be completed when inspection of the exposed portions of the CIPP appears to be hard and sound and the remote temperature sensor(s) indicates that the temperature is of a magnitude to realize an exotherm. The cure period shall be of a duration recommended by the resin Manufacturer, as modified for the installation process, during which time the recirculation of the heat and/or cycling of the heat exchanger to maintain the temperature is continued.

2.7 COOL DOWN

- A. Cool down may be accomplished by the introduction of cool water or air to replace water or pressurized air being relieved. Care shall be taken in the release of the hydrostatic head so that a vacuum will not be developed.

2.8 FINISH

- A. The finished CIPP shall be continuous over the entire length of an insertion run and be as free as commercially practical from visual defects such as foreign inclusions, dry spots, pinholes, and delamination. The CIPP shall be homogeneous, and free of any leakage from the surrounding ground to the inside of the CIPP.

- B. Where the CIPP is installed through a manhole uninterrupted, the invert shall be maintained smooth within the manhole, with approximately the bottom half of the CIPP continuous through the length of the manhole. The invert of the manhole shall be shaped and grouted as necessary to support the liner. The cost of this work shall be included in the CIPP unit price.
- C. During the warranty period, any defects which will affect the integrity or strength of the CIPP, collect solids, or reduce hydraulic flow capabilities of the product shall be repaired at the Installation Contractor's expense in a manner mutually agreed upon by the Owner and the Installation Contractor.

2.9 REINSTATE LATERALS AND SERVICES

- A. Accurate location of the lateral and service connections shall be made by inspection of the pre-installation videotape or sewer walk.
- B. After the CIPP has been installed, all existing active lateral sewers and services shall be reinstated unless otherwise indicated by the Owner or on the plans. The reinstatement of laterals and services shall be done without excavation unless otherwise specified by the Engineer. Reinstatement of laterals and services will be accomplished from the interior of the CIPP by means of a video camera directed cutting device or by direct man entry when feasible.
- C. All cut lateral and service connections shall be free of burrs, frayed edges, or any restriction preventing free flow of wastewater. Laterals shall be reinstated to a minimum of 90% of their original diameter and no more than 100% of their minimum diameter. The CIPP shall be tightly sealed at the cut openings with no gaps.

2.10 QUALITY ASSURANCE PROCEDURES

- A. For every two thousand five hundred (2,500) lineal feet of CIPP installed, two (2) flat plate samples shall be processed and tested. For pipe diameters less than 18 inches, restrained end samples may also be utilized. The CIPP physical properties shall be tested in accordance with ASTM F1216, Section 8, using either allowed sampling method. The flexural properties must meet or exceed the values listed in Section 1.3.E of this specification and the values submitted to the Owner by the Installation Contractor for this project's CIPP wall design, whichever is greater.
- B. Testing shall be completed by an accredited, independent laboratory. Testing results shall be provided to the Owner within seven (7) days of receipt.
- C. Wall thickness of samples shall be determined in a manner consistent with paragraph 8.1.2 of ASTM D5813. The minimum wall thickness at any point shall not be less than 87.5% of the specified design thickness calculated in Section 1.3.F of this document.
- D. Flexural testing of the collected samples shall be conducted in accordance with ASTM D790, latest version, with only the structural portion of the CIPP being tested.
- E. CIPP installation shall be inspected by post-lining video inspection. Variations from true line and grade may be inherent because of the conditions of the original piping. No infiltration of groundwater should be observed. All service entrances should be unobstructed and accounted for.

PART 3 - PAYMENT

Payment for the work included in this section will be in accordance with the unit prices set forth in the proposal for the quantity of work performed. Progress payments will be made on the work performed during each monthly period.

When not defined, payment shall be broken down as follows:

- A. Mobilization and demobilization shall be paid for as one lump sum amount.
- B. Cleaning shall be paid for per lineal foot of line cleaned. Items for both light and heavy cleaning shall be designated as appropriate.
- C. Protruding laterals shall be paid for per each lateral removed.
- D. CIPP shall be paid per lineal foot of each diameter rehabilitated as measured from center of manhole to center of manhole.
- E. Lateral reinstatement shall be paid per each lateral reinstated.
- F. Bypass pumping shall be paid for as one lump sum and shall include all incidentals required for the bypass efforts.
- G. Traffic control shall be paid as one lump sum and shall include all incidentals required for traffic control.

All other incidental costs such as sample testing shall be included in the cost of these items.