

APPENDIX B - CURED-IN-PLACE PIPE (CIPP) TECHNICAL SPECIFICATIONS

A. GENERAL REQUIREMENTS

1. Scope. The work covered by this section of the Specifications shall consist of rehabilitating the existing vitrified clay and concrete sanitary sewer and storm drain lines as indicated on the Construction Drawings. Rehabilitation shall be accomplished by the use of Cured-In-Place Pipe (CIPP). The Contractor shall provide all materials, labor, equipment, services, and incidentals necessary to complete the work including but not limited to bypass pumping and/or diversion of sanitary and stormwater flows, cleaning and television inspection of pipe to be lined, liner installation, all quality controls, provision of samples for conformance testing, reestablishment and reconnection of service laterals, final television inspection, and all other related work.
2. Reference Specifications, Codes, and Standards. The following ASTM references are part of this Specification. In case of conflict between the requirements of this Specification and those of the listed documents, the requirements of this Specification shall prevail. The last edition of the following references shall be used:

ASTM F1216	Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
ASTM F1743	Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled-in-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP)
ASTM D790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
ASTM D543	Standard Practice for Evaluating the Resistance of Plastics to Chemical Reagents.
	ASTM D3567-97 (2002) Standard Practice for Determining Dimensions of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings.
ASTM D5813	Standard Specification for Cured-in-Place Thermosetting Resin Sewer Pipe.
ASTM D792	Standard Test Methods for Density and Specific Gravity of Plastics by displacement
ASTM F2019-03	Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled-in-Place installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP)
ASTM D2122-98 (2004)	Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
ASTM F2561-06	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
ASTM D2990	Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
ASTM D3681	Standard Test Method for Chemical Resistance of "Fiberglass" (Glass Fiber Reinforced Thermosetting Resin) Pipe and Fittings

B. CONTRACTOR SUBMITTALS

1. Data to be Submitted by Bidder with the Bid

a) Statement of Experience Requirements

This form shall be completed in its entirety. Failure to submit and meet the requirements outlined on the Statement of Experience forms for small CIPP installation and as listed below will be grounds for rejection of the bid. The form can be found in Appendix C.

- i. Contractor: The Contractor must have minimum of three (3) years of continuous experience installing CIPP liners in pipe of a similar size, length, and configuration as contained in this contract. A minimum of 12 lineal feet of 8-inch diameter mainline cured-in-place pipe spot repair installation using the proposed CIPP technology.
- ii. Field Personnel: The lead on-site personnel, including the superintendent and/or foreman as applicable, must have minimum supervisory field experience for cured-in-place pipe installation of three (3) successfully completed projects totaling a minimum of 12 lineal feet of 8-inch diameter mainline cured-in-place pipe spot repair installation using the proposed CIPP technology.
- iii. Include a separate form for each lead individual performing work on this contract.
- iv. CCTV Operator: The CCTV operator must have a minimum of three (3) years experience in CCTV pipeline inspection and assessment as well as a valid NASSCO PACP certification. The CCTV software used must be NASSCO PACP compliant.

b) Licensed Installing Documentation

Failure to submit documentation meeting the following requirements included in this paragraph will be grounds for rejection of the bid. The Contractor shall be certified, authorized, or licensed by the manufacturer or licensor of the cured-in-place method that the Contractor will use or employ on this project. The Contractor shall provide proof of the license or deliberation documentation to the Engineer to substantiate the above with his bid. The Contractor shall defend, indemnify and hold harmless the City and the Engineer from and against any and all liability, loss, damage claims, suits, judgments, or costs arising, in whole or in part, from any allegation of patent infringement by the City or the Contractor on account of the use or employment of the cured-in-place pipe method on this project by the Contractor. In the event that the method used or employed on this project is determined to infringe upon the patent rights of another, then the Contractor either shall secure for the City and Engineer approval or the method, as modified, so that the alleged patent infringement ceases, or pay any and all liability, loss, damage, claims, suits, judgments, or costs attributed to the use or employment of the infringing cured-in-place pipe method plus any costs incurred by the City and Engineer in connection therewith. The unit price for cured-in-place pipe shall include the cost of any fees and royalties due to the patent holder of the cured-in-place pipe method.

2. Data to be Submitted After Notice of Award

The following data is to be submitted after the Notice of Award and a minimum of one week prior to the preconstruction meeting. The Contractor shall not start work until all submittals are turned in.

- a) Performance Work Statement (PWS): The Contractor shall submit a PWS that clearly defines the CIPP product is in conformance with the requirements of these Contract Documents. The PWS shall, at a minimum, contain the following: a detailed installation plan describing all preparation work, cleaning operations, pre-CCTV inspections, bypass pumping, traffic control, installation procedure, method of curing, service reconnection, quality control, testing to be performed, final CCTV inspection, warranties furnished, and further requirements as listed below.
 - i. Proposed CIPP Detailed Plan: Contractor shall submit a description of the proposed CIPP lining technology, including a detailed plan for identifying all active service connections, maintaining service during mainline installation for each home/business served by the segment of pipe being lined, including temporary service if required by the Contract.
 - ii. Engineering Design Calculations: In accordance with the Appendix of ASTM F-1216, engineering design calculations shall be submitted for each length of liner to be installed including the thickness of each proposed CIPP. It will be acceptable for the Contractor to submit a design for the most severe line condition and apply that design to all of the line sections. These calculations shall be performed

- and certified by a qualified Professional Engineer registered in the State of Oregon. All calculations shall include data that conforms to the requirements of these specifications or has been pre-approved in writing by the Engineer.
- iii. Manufacturers Technology Data: Proposed manufacturers technology data shall be submitted for all CIPP products and all associated technologies to be furnished.
 - iv. Tools and Equipment: Submittals for the proposed cured-in-place pipe shall include a description of all tools and equipment required for a complete installation as well as which tools and equipment will be redundant on the job site in the event of an equipment failure or breakdown. All equipment to be furnished for the project, including proposed back-up equipment, shall be clearly described. The Contractor shall outline the mitigation procedure to be implemented in the event of key equipment failure during the installation process.
 - v. Removal of Pipeline Blockages: A detailed description of the Contractor's proposed procedures for removal of any existing blockages in the pipeline that may be encountered during the cleaning process.
 - vi. Public Notice: A detailed public notification plan shall be submitted that includes detailed staged notification to residences affected by the CIPP installation.
- b) Odor Control Plan: A detailed odor control plan shall be submitted ensuring project specific odors will be minimized at the project site and surrounding areas.
 - c) Cured-in-Place Pipe Literature: The Contractor shall submit shop drawings, catalog data, manufacturer's technical data, dimensioned drawings, and installation details/sketches and other pertinent information for the cured-in-place pipe installation work. All materials provided shall be fully in accordance with the requirements of the reference specifications listed.
 - d) Project Schedule: The Contractor shall submit a schedule identifying proposed work hours and dates for each installation.
 - e) Affidavit of Compliance: The Contractor shall submit a certified affidavit of compliance for all cured-in-place pipe furnished confirming that the materials fully conform to the requirements specified herein.
 - f) Bypass Pumping Plan: The Contractor shall submit a bypass-pumping plan for review by the Engineer. The plan shall include proposed methods and equipment for stormwater and sewage control in accordance with the Special Provisions. This submittal shall include methods of controlling main pipeline flow, including location where stormwater and sewage is to be diverted, type of pipe to be used for bypass, and the method of service lateral flow control. The plan shall include methods for employing standby equipment when required during an emergency, including the use of a second pumping unit on standby or two pumps alternating.
 - g) Thickness Calculations: The Contractor shall submit detailed calculations confirming the liner thickness for the proposed resin system. List all assumptions, design criteria, and material characteristics.
 - h) Resin Calculations: The Contractor shall submit calculations for the volume of resin to be used for each segment including the calculated amount of excess resin necessary to account for liner material properties, changes in the resin's physical and chemical characteristics due to polymerization and the structural condition of the sewer. The Contractor shall provide a log of the actual volume of resin used during installation.
 - i) Cured-in-Place Process: The Contractor shall provide a detailed description of the cured-in-place installation process, including the wet-out process, manhole preparation, existing pipe preparation and manufacturer's liner installation procedure. This description shall include tube and resin manufacturers wet-out recommendations including the roller gap, material feed speed and vacuum requirements for each liner size and thickness. If wet out occurs off-site, provide certification by the person-in-charge that the entire wet out process including handling and delivery to the site followed the defined procedures.
 - j) Quality Control Plan (QCP): The Contractor shall submit a detailed quality control plan (QCP) that fully represents and conforms to the requirements of these specifications. At a minimum the QCP shall include:
 - i. Detailed discussion of the proposed quality controls to be performed by the Contractor.

- ii. Proposed procedures for quality control, product sampling and testing shall be defined and submitted as part of the plan. Proposed methods for product performance controls, including method of and frequency of product sampling and testing both in raw material form and cured product form. The system manufacturer shall furnish a checklist containing key elements of the CIPP installation criteria that is important for the Engineer to ensure that quality control and testing requirements are performed in accordance with the Contract Documents.

C. MATERIALS

CIPP Liner Physical Properties: The cured resin/fabric tube CIPP system shall conform to the minimum structural standards defined in ASTM F1216 and ASTM F1743 and found in Table 1.

Property	Test Method	Cured Composite Per ASTM F1216	Cured Composite Per Design
Flexural Modulus of Elasticity (Short Term) (Felt Tubes)	ASTM D790	250,000 psi	Contractor Value
Flexural Strength (Short Term) (Felt Tubes) Felt/Fiberglass as recommended by the Manufacturer	ASTM D790	4,500 psi	Contractor Value

D. DESIGN PARAMETERS

The proposed CIPP liner shall be designed for the following parameters:

Service Life	Greater than 50 years
Pipe Conditions	Fully-deteriorated
Load Conditions	Continuous
Soil	135-pounds/cubic foot
Groundwater	Groundwater to finished grade
Pipe Ovality	2% or as measured by field inspection
Modulus of Soil Reaction	1,000 psi
Long-term Flexural Strength	50% of initial (ASTM D790)
Modulus of Elasticity	50% of initial (ASTM D790)
Enhancement Factor (K)	7
Maximum Deflection	5%
Minimum Factor of Safety	2.0
Resin Migration Allowance	10 % maximum
Creep Retention Factor	50%

The liner shall have sufficient wall thickness to withstand all anticipated internal and external pressures and loads that may be imposed after installation. The design of the CIPP shall include considerations for ring bending, deflection, combined loading buckling and ovality. A Professional Engineer licensed by the State of Oregon shall check and approve the liner design calculations. Calculations shall be submitted to the Engineer for approval prior to fabrication of the tube.

Hydraulic Capacity: The overall hydraulic capacity shall, at a minimum, be maintained after installation of the CIPP. The installed CIPP shall, at a minimum, be equal to the full flow capacity of the original pipe before rehabilitation. In those cases where full capacity cannot be achieved after liner installation, the Contractor shall submit a request

to waive this requirement, together with the reasons for the waiver request. Calculated capacities may be derived using a commonly accepted roughness coefficient for the existing pipe material taking into consideration its age and condition.

The required structural CIPP wall thickness shall be based as a minimum, on the physical properties above or greater values if substantiated by independent lab testing and in accordance with the design equations in Appendix X1 of ASTM F1216, and the above design parameters.

E. PRODUCTS

Materials: All materials shipped to the project site shall be accompanied by test reports certifying that the material conforms to the ASTM standards listed herein. Materials shall be shipped, stored, and handled in a manner consistent with written recommendations of the CIPP system manufacturer to avoid damage. Damage includes, but is not limited to gouging, abrasion, flattening, cutting, puncturing, or ultra-violet (UV) degradation. On-site storage locations shall be approved by the Engineer. All damaged materials shall be promptly removed from the project site at the Contractor's expense and disposed of in accordance with all current applicable agency regulations.

1. Fabric Tube: The fabric tube shall consist of one or more layers of absorbent non-woven felt fabric, felt/fiberglass or fiberglass and meet the requirements of ASTM F1216, ASTM F1743, ASTM D5813 and ASTM F2019. The fabric tube shall be capable of absorbing and carrying resins, construction to withstand installation pressures and curing temperatures and have sufficient strength to bridge missing pipe segments and stretch to fit irregular pipe sections. The Contractor shall submit certified information from the felt manufacturer on the nominal void volume in the felt fabric that will be filled with resin.
 - a) The wet-out fabric tube shall have a uniform thickness and excess resin distribution that when compressed at installation, pressures will meet or exceed the design thickness after cure.
 - b) The fabric tube shall be manufactured to a size and length that, when installed, will tightly fit the internal circumference, meeting applicable ASTM standards or better, of the original pipe. Allowance shall be made for circumferential stretching during installation. The tube shall be properly sized to the diameter of the existing pipe and length to be rehabilitated and be able to stretch to fit irregular pipe sections and negotiate bends. The Contractor shall determine the minimum tube length necessary to effectively span the designated run between manholes. The Contractor shall verify the lengths in the field prior to ordering and prior to impregnation of the tube with resin to ensure the tube will have sufficient length to extend the entire length of the run. The Contractor shall also measure the inside diameter of the existing pipelines in the field prior to ordering liner to ensure that the liner can be installed in a tight-fitted condition.
 - c) The outside and/or inside layer of the fabric tube (before inversion/pull-in as applicable) shall be coated with an impermeable, flexible membrane that will contain the resin and facilitate, if applicable, vacuum impregnation and monitoring of the resin saturation during the resin impregnation (wet out) procedure.
 - d) No material shall be included in the fabric tube that may cause de-lamination in the CIPP. No dry or unsaturated layers shall be acceptable upon visual inspection as evident by color contrast between tube fabric and the activated resin containing a colorant. Colorant shall be green unless otherwise approved by the Engineer.
 - e) The wall color of the interior pipe surface of CIPP after installation shall be a light reflective color so that a clear detailed examination with closed circuit television inspection equipment may be made. The hue of the color shall be dark enough to distinguish a contrast between the fully resin saturated felt fabric and dry or resin-lean areas.
 - f) Seams in the fabric tube, if applicable, shall meet the requirements of ASTM D5813.
 - g) The outside of the fabric tube shall be marked every 5 feet with the name of the manufacturer or CIPP system, manufacturing lot, and production footage.
 - h) The minimum length of the fabric tube shall be determined by the installer and shall effectively span the distance from the starting manhole to the terminating manhole or access point, plus that amount required to run-in and run-out for the installation process.
 - i) The nominal fabric tube wall thickness shall be constructed, as minimum, to the nearest 0.5mm increment, rounded up from the design thickness for that section of installed CIPP. Wall thickness transitions, in

0.5mm increments or greater as appropriate, may be fabricated into the fabric tube between installation entrance and exit access points. The quantity of resin used in the impregnation shall be sufficient to fill all of the felt voids for the nominal felt thickness.

2. Resin: The resin shall be a corrosion-resistant polyester or vinyl-ester resin and catalyst system or epoxy and hardener system that when properly cured within the tube composite meets the requirements of ASTM F1216, ASTM F1743 or F2019, the physical properties herein, and those that are to be utilized in the design of the CIPP for this project. The resin shall produce CIPP which will comply with or exceed the structural and chemical resistance requirements of this specification.
3. Hydrophilic End Seals: Full-circle hydrophilic compression seals shall be properly sized according to the segment of the pipe to be lined. Product shall be Insignia™ End Seal Sleeve by LMK Technologies or approved equal.

F. INSTALLATION

Wet Out:

- a) Thoroughly saturate flexible tube prior to installation. Catalyst system or additives compatible with the resin and flexible tube shall be as recommended by the manufacturer.
- b) Handle the resin impregnated flexible tube to retard or prevent resin setting until it is ready for insertion.

2. Insertion:

- a) The wet-out tube shall be positioned in the pipeline using the method specified by the manufacturer. Care should be exercised not to damage the tube as a result of installation. The tube should be pulled-in or inverted through an existing manhole or approved access point and fully extended to the next manhole or termination point.
- b) Prior to installation, and as recommended by the manufacturer, remote temperature gauges or sensors shall be placed inside the host pipe to monitor the temperatures during the cure cycle. Liner and/or host pipe interface temperature shall be monitored and logged during curing of the liner.
- c) To monitor the temperature of the liner wall and to verify correct curing temperature, sensors shall be placed between the host pipe and the liner in the bottom of the host pipe (invert) throughout its length to monitor the temperature on the outside of the liner during the curing process. The temperature sensors shall be placed where significant heat sinks are likely or anticipated. The sensors must be monitored by the computer using a tamper proof database that is capable of recording temperatures at the interface of the liner and the host pipe.
- d) The addition of water, air, or steam pressure shall be adjusted to cause the impregnated flexible tube to invert from manhole to manhole, holding the tube tight against the host sewer pipe.

3. Curing:

- a) Curing shall be accomplished by utilizing the appropriate medium in accordance with the manufacturer's recommended cure schedule. The curing source or in and output temperatures shall be monitored and logged during the cure cycles, if applicable. The manufacturer's recommended cure method and schedule shall be used for each line segment installed, and the liner wall thickness and the existing ground conditions with regard to temperature, moisture level, and thermal conductivity or soil, per ASTM as applicable, shall be taken into account by the Contractor.
- b) For heat cured liners, if any temperature sensors do not reach the temperature as specified by the manufacturer to achieve proper curing and cooling, the installer can be make necessary adjustments to comply with the manufacturer's recommendations. The system computer should have an output report that specifically identifies each installed sensor station in the length of the pipe, indicates the maximum temperature achieved and the sustained temperature time. Each sensor should record both the maximum temperature and the minimum cool down temperature and comply with the manufacturer's recommendations.
- c) For UV Cured Liners, all light train sensor reading, recorded by the tamper proof computer, shall provide output documenting the cure along the entire length of the installed liner. The cure procedure shall be in accordance with the manufacturer's recommendation as included in the PWS submission by the Contractor.

4. Cool Down: Cool the CIPP in accordance with the manufacturer's instructions. Do not release internal pressure in a way that can create vacuum and damage the CIPP.
5. Finished Pipe:
 - a) The finished CIPP shall be continuous over the entire length of the sewer line section and be free from visual defects such as foreign inclusions, dry spots, pinholes, delamination, and wrinkles larger than 2 percent of the diameter. The CIPP shall be impervious and free of any leakage from the pipe to the surrounding ground or from the ground to inside the lined pipe.
 - b) Any defect, which will or could affect the structural integrity or strength of the linings, shall be repaired at the Contractor's expense in accordance with the procedures as detailed in these Special Provisions.
 - c) The ends of the CIPP shall be sealed to the existing host pipe. The sealing material shall be Insignia™ End Seal Sleeve by LMK Technologies or approved equal.
 - d) If the wall of the CIPP leaks, it shall be repaired or removed and replaced with a watertight pipe as recommended by the manufacturer of the CIPP system.

G. CONNECTION TO MANHOLES

The CIPP shall make a tight seal at the manhole opening with no annular gaps. Seal shall be a hydrophilic seal compatible with installed CIPP, applied at the manhole/wall interface in accordance with the CIPP system manufacturer's recommendation. The sealing material shall be Insignia™ End Seal Sleeve by LMK Technologies or approved equal.

H. TEMPORARY SEWAGE BYPASS

Unless specified otherwise in the Contract Documents, the work specified in this section includes all costs for labor, materials, accessories, equipment, and tools for performing all operations required to bypass pump sewage around a manhole or sewer section in which work is to be performed. This work shall be consistent with the temporary sewage bypass pumping guidelines as stated in the Special Provisions.

I. FINAL ACCEPTANCE

All CIPP sample testing and repairs to the installed CIPP as applicable shall be completed before final acceptance, meeting the requirements of these specifications, and documented in written form.

1. The Contractor shall perform a detailed closed-circuit television inspection in accordance with ASTM standards. All CCTV inspections shall be performed by a certified and trained PACP operator, using NASSCO compliant software.
2. Post-lining CCTV inspection shall be completed after installation of the CIPP liner and reconnection of the side sewers. A radial view (pan and tilt) TV camera shall be used. The finished liner shall be continuous over the entire length of the installation and shall be free of significant visual defects, damage, deflection, holes, leaks, and other defects. Unedited digital documentation of the inspection shall be provided to the Engineer within ten (10) working days of the liner installation. The data shall note the inspection date, location of all reconnected service laterals, debris, as well as any other defects in the liner. Immediately prior to conducting the closed-circuit television inspection, the Contractor shall thoroughly clean the newly installed liner, removing all debris and build-up that may have accumulated.
3. Bypass pumping or plugging from the upstream manhole shall be utilized to minimize sewage from entering the line during the inspection. In the case of bellies in the line, the pipe shall be cleared of any standing water to provide continuous visibility during the inspection.