

Board of Water and Sewer Commissioners
of the
City of Mobile, Alabama

Update of Standard Specifications
Section 18

Rehabilitation of Sanitary Sewer Mains
by
The Cured-In-Place (CIPP) Method

Updated May 2021

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PART 1 GENERAL

18.1.01 DESCRIPTION

- A. It is the intent of this specification to define the approved methods and materials for the trenchless rehabilitation of existing sanitary sewer mainlines and lateral lines by the Cured-In-Place Pipe (CIPP) method.
- B. The work covered in this section includes the furnishing of all plant, labor, equipment, appliances and materials and performing all operations in connection with the complete rehabilitation of the existing deteriorated sanitary sewer system piping.
- C. The sewer main and lateral CIPP process shall consist of inserting a resin-impregnated flexible tube into an existing sewer, expanding the tube out against the sewer pipe, and curing the tube to form a pipe liner. For mainline CIPP, curing shall be accomplished by circulating heated water or steam to affect the desired cure throughout the tube extending full length from manhole to manhole. For lateral CIPP, curing shall be accomplished by circulating heated water or steam to affect the desired cure throughout the tube extending full length from mainline connection to within 18” of cleanout or property line.
- D. The CIPP liner shall cure into a watertight, impermeable liner pipe of the specified thickness and form a structurally sound liner pipe with a uniformly smooth and jointless interior.

18.1.02 REFERENCED SECTIONS

- A. Section 12 – Sanitary Sewer Standard Specifications

18.1.03 REFERENCED CODES AND STANDARDS

- A. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- B. ASTM D2990 - Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
- C. ASTM D5813 – Standard Specification for Cured-In-Place Thermosetting Resin Sewer Pipe
- D. ASTM F1216 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube

18.1.04 QUALIFICATIONS

- A. Mainline CIPP:
 - 1. The CONTRACTOR shall provide evidence and references for successfully installing a minimum of 500,000 linear feet of CIPP in the United States of America.
 - 2. The CONTRACTOR shall also provide documentation that the specified material to be used has been successfully installed in a minimum of 1,000,000 linear feet of pipe in the United States of America and has been in place for a minimum of five (5) years.

B. Lateral CIPP:

1. The employees of the CONTRACTOR performing the work of this section shall be of the company installing the CIPP lateral lining system components or shall be licensed by the system manufacturer.
2. The manufactured system must have a minimum of a five (5) year history of satisfactory performance with a minimum of 25,000 CIPP lateral installations.
3. The CONTRACTOR contracted to perform the work shall have a minimum of five (5) years of continuous experience installing CIPP lateral lining in pipe of similar size, length and configuration as proposed in this project.
4. The CONTRACTOR contracted to perform the work shall have successfully installed 15,000 CIPP laterals as the contractor of record for a given project in a wastewater collection system application.
5. The on-site Superintendent of the lateral lining CONTRACTOR contracted to perform the work shall have installed a minimum of 5,000 CIPP laterals of like condition for this geographic area and have a minimum of five (5) years of CIPP industry experience.
6. If the CONTRACTOR cannot satisfy the number of lateral liner installations requirement as stated above, the manufacturer must provide a manufacturer's representative that has a minimum of 2-years' experience installing the manufacturer's system and certifications that the CONTRACTOR is current with the manufacturer's installation requirements and protocols.
 - a. The experience of the manufacturer's representative and current CONTRACTOR certification must be provided with the bid documents.
 - b. The manufacturer's representative must be on-site during any work by the CONTRACTOR or sub-contractor. Daily reports by the manufacturer's representative will be provided to the MAWSS representative at the completion of the daily works. The manufacturer's daily report shall include readily apparent locations of the work performed and confirmation of compliance with the manufacturer's QA/QC protocols. The manufacturer's representative and the above-mentioned qualifications will be required until the CONTRACTOR has successfully completed 200 lateral liner installations for the OWNER.

18.1.05 DELIVERY, STORAGE, AND HANDLING

- A. Care shall be taken in shipping, handling, and storage to avoid damaging the liner. Extra care shall be taken during warm weather construction. Any liner damaged in shipment shall be replaced as directed by the OWNER at no additional cost to OWNER.
- B. The CIPP shall be adequately supported and protected while stored. The CIPP shall be stored in a manner as recommended by the manufacturer and as approved by the ENGINEER.

18.1.06 QUALITY CONTROL

- A. No change of material, design values, or procedures may be made during the course of the Work without the prior written approval of the ENGINEER.
- B. All liners to be installed under this Work may be inspected at the manufacturer's plant(s) and wet-out facility for compliance with these Specifications by the OWNER or ENGINEER. The CONTRACTOR shall require the wet-out facility's cooperation in these inspections. The cost of inspection will be the responsibility of the OWNER.
- C. The CONTRACTOR shall inspect each lot of liner for defects at the time of manufacture. The CONTRACTOR shall inspect each liner at delivery to assure the liner is homogeneous throughout, uniform in color, free of cracks, holes, foreign materials, blisters, or deleterious faults.
- D. The CONTRACTOR shall have a Quality Control Plan or Procedure in place that will allow the ENGINEER to monitor the resin impregnation process.

18.1.07 WARRANTY

- A. All liner installations shall be warranted to be free from defects in materials and workmanship for a period of five (5) years from the date of project acceptance. The required five (5) year guarantee covers all workmanship and construction and shall warranty that the liner shall not:
 - 1. Impede flow and cause backups to the customer;
 - 2. Collapse or separate from the wall;
 - 3. Allow groundwater infiltration;
 - 4. Allow root intrusion;
 - 5. Allow soil migration into the main;
 - 6. Experience material degradation;
 - 7. Exhibit properties of improper curing;
 - 8. Become unsealed at mainline to lateral connection; or
 - 9. Any other defect inhibiting proper performance of the mainline or lateral.
- B. Any defect discovered during this five (5) year period shall be repaired within four (4) weeks for from the date of defect notification to the CONTRACTOR at no additional cost to the OWNER. When the OWNER determines that the defect must be addressed immediately to prevent an overflow or backup the OWNER may require the CONTRACTOR to repair or replace the section immediately at no additional cost to the OWNER. The OWNER will begin bypass procedures immediately until the CONTRACTOR can arrive with the appropriate liner section for repair. The CONTRACTOR shall be responsible for all costs including bypassing.

- C. The CONTRACTOR shall be responsible for all required repair costs associated with a liner failure during the warranty period including all required permit costs, restoration, pavement repairs, all cost associated with lateral backups into buildings and all other property damage resulting from failure of the liner.
- D. The five (5) year warranty shall be backed by a two (2) year warranty bond and a five (5) year Manufacturer's warranty letter. The five (5) year Manufacturer's warranty letter shall be supplied on the Manufacturer's letterhead and specifically state the project name and OWNER's name and shall not contain any exclusion of activities in the manhole or sanitary sewer system.

18.1.08 SUBMITTALS

- A. The following submittals shall be submitted prior to beginning work:
 - 1. Independent third-party certified laboratory test reports showing that the resin/liner combination to be used for this project meets the requirements for initial structural properties and chemical resistance in accordance with ASTM F1216 and ASTM D790.
 - 2. Independent third-party certified laboratory test reports showing the resin/liner combination long term flexural modulus and long-term flexural strength test results for ASTM D2990.
 - 3. Structural design calculations certified by a professional engineer in the State of Alabama in accordance with ASTM F1216 for the deepest length of liner to be installed.
 - 4. MSDS sheets for all materials to be provided for this project.
 - 5. Fabric tube manufacturer and product components description.
 - 6. Flexible membrane coating material data sheet including repair recommendations.
 - 7. Raw resin manufacturer and product components description.
 - 8. Manufacturer's shipping, storage and handling recommendations for all components of the CIPP system.
 - 9. Description of the proposed wet-out procedure.
 - 10. Manufacturer's recommended cure method for each diameter and thickness to be used in the project which shall include a detailed curing schedule for each segment.
 - 11. CONTRACTOR'S proposed installation schedule.
 - 12. CONTRACTOR'S public notification door hanger.
 - 13. CONTRACTOR'S detailed proposed method and procedures for installation.
 - 14. CONTRACTOR'S contingency plan for performing repairs of defects.
- B. The following documentation shall be submitted during construction:
 - 1. Pre and Post Video Inspection

2. Homeowner Notification Delivery Form
3. Liner/Delivery Inspection Form
4. Wet-Out Report
5. Pre-Installation Pipe Inspection Form
6. Curing Log
7. CIPP Test Sample Form
8. Service Connection Documentation Form
9. Defect Documentation Form

PART 2 PRODUCTS

18.2.01 DESIGN REQUIREMENTS

- A. The CIPP liner shall form a continuous, tight fitting, hard, impermeable liner that is chemically resistant to chemicals found in both domestic sewage and seawater.
- B. The CIPP liner shall have the minimum physical characteristics listed below:

| Physical Characteristic | Minimum Values | Test Method |
|--------------------------------|-----------------------|--------------------|
| Flexural Strength | 4500 psi | ASTM D 790 |
| Modulus of Elasticity | 250,000 psi | ASTM D 790 |

- C. Mainline CIPP Thickness:
 1. The required structural mainline CIPP wall thickness shall be based, at a minimum on the criteria below:
 - a. In accordance with ASTM F1216, Appendix X1, Design Considerations for a fully deteriorated host pipe.
 - b. A safety factor of 2.
 - c. A minimum service life of 50 years under continuous service.
 - d. Creep Retention Factor of 50%.
 - e. A soil density of 120 lbs./ft³.
 - f. Constrained Soil Modulus of 1,000 psi.
 - g. The groundwater elevation shall be assumed at grade for each pipe segment.
 - h. Ovality for each segment shall be a minimum of 2%.

- i. Live loads for each segment shall be HS-20 unless otherwise noted on the drawings.
- j. Soil depth for each segment to be lined will be based on the max distance in feet measured between the crown of the pipe and the highest point of soil cover over the length of the pipe.

D. Lateral CIPP Thickness

- 1. The required structural lateral CIPP wall thickness shall be based, at a minimum on the criteria below:
 - a. 4” thru 6” diameter lateral liner assuming fully deteriorated condition.

E. Mainline pipe liner assuming partially deteriorated conditions when the mainline pipe is lined. Mainline pipe liner assuming fully deteriorated conditions when the mainline pipe is NOT lined. The minimum CIPP finished thicknesses for the physical characteristics required above are listed in Table 18-1 below:

| TABLE 18-1 Minimum Finished Liner Thickness | | | |
|--|-----------------------------|--------------------------|--------------------------------|
| SEWER DIAMETER | PIPE INVERT DEPTH UP TO 10' | PIPE INVERT DEPTH 10-15' | PIPE INVERT DEPTH 15' AND OVER |
| 6" | 4.5 mm | 4.5 mm | 4.5 mm |
| 8" | 6.0 mm | 6.0 mm | 6.0 mm |
| 10" | 6.0 mm | 6.0 mm | 7.5 mm |
| 12" | 7.5 mm | 7.5 mm | 9.0 mm |
| 15" | 7.5 mm | 9.0 mm | 10.5 mm |
| 18" | 9.0 mm | 12.0 mm | 13.5 mm |
| 21" | 10.5 mm | 13.5 mm | 15.0 mm |
| 24" | 12.0 mm | 15.0 mm | 16.5 mm |
| 30" | 15.0 mm | 18.0 mm | 21.0 mm |
| 36" | 16.5 mm | 21.0 mm | 24.0 mm |
| 42" | 19.5 mm | 24.5 mm | 28.5 mm |
| 48" | 22.5 mm | 28.5 mm | 33.0 mm |
| 54" | 24.5 mm | 33.0 mm | 39.0 mm |

F. The CONTRACTOR shall verify the liner thicknesses included in Table 18-1 for accuracy and advise of any variations required to accommodate the selected process and structural requirements. No additional compensation will be allowed for these variations. Any

proposed adjustments to the liner wall thickness or installation procedures shall be submitted by the CONTRACOR to the ENGINEER for approval including design criteria, calculations, and information required to ensure the structural integrity and hydraulic capacity of the proposed liner materials.

- G. The CONTRACTOR shall field verify all lengths and diameters prior to construction.

18.2.02 FABRIC TUBE

A. Mainline CIPP

1. The fabric tube shall consist of one or more layers of absorbent non-woven felt fabric that meets the requirements of ASTM F1216, Section 5.1 or ASTM F1743, Section 5.2.1 or ASTM D5813, Sections 5 and 6.
2. The fabric tube shall be capable of absorbing and carrying resins, constructed to withstand installation pressures and curing temperatures and have sufficient strength to bridge missing pipe segments, and stretch to fit irregular pipe sections.
3. The wet-out fabric tube shall have a uniform thickness and excess resin distribution that when compressed at installation pressure will meet or exceed the calculated minimum design thickness after cure.
4. No material shall be included in the tube that may cause delamination in the CIPP. No dry or unsaturated layers shall be evident.
5. The inside layer of the fabric tube shall be coated with an impermeable, flexible membrane that will contain and protect the resin during installation and curing.
6. Seams in the tube shall be stronger than the non-seamed felt material.
7. 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.
8. The fabric tube shall be manufactured to a size and length that when installed will tightly fit the internal circumference of the existing pipe. Allowance shall be made for circumferential stretching during installation. The tube shall be properly sized to the diameter of the existing pipe and the 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 including obtaining the required samples for testing. The CONTRACTOR shall verify the lengths in the field prior to ordering and prior to impregnation of the tube with resin, to ensure that 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 pipe in the field prior to ordering the liner so that the liner can be installed in a tight-fitted condition.

B. Lateral CIPP

1. The liner shall be fabricated to a size that when installed will neatly fit the internal circumference of the conduit specified by the OWNER. Allowance shall be made for

circumferential stretching during insertion. The liner shall be a joint-less polyester felt “tube” that will create a watertight seal at the mainline pipe interface.

2. The length shall be a distance to effectively span from the lateral connection at the mainline pipe to the desired termination location in the service lateral pipe. The CONTRACTOR shall verify the lengths in the field before impregnation of the resin.

18.2.03 RESIN

A. Mainline & Lateral CIPP:

1. The resin shall be corrosion resistant polyester or vinyl ester resin and compatible catalyst system and when properly cured meets the requirements of ASTM F1216, ASTM D5813, ASTM F1743, and the requirements specified in this section.
2. The resin shall be a liquid thermosetting resin and shall be suitable for the design conditions as well as the curing process.

B. Short Liner:

1. The resin shall be a two-part, ambient cure 100% solid epoxy vinyl ester or polyester resin and a compatible catalyst system to accommodate the environment of the existing sanitary sewer with multiple temperature range hardeners suitable for ambient conditions at the time of installation and when properly cured meets the requirements of ASTM F1216 and the requirements specified in this section.
2. Resins shall be non-volatile and safe for use in the interior of sanitary sewer pipe. Resins shall have a maximum shelf life of six (6) months. The CONTRACTOR shall not use any resin that has exceeded its shelf life or expiration date.

C. The resin shall saturate the tube and produce a properly cured liner which is resistant to abrasion due to solids, grit, and sand.

D. The resin to tube ratio, by volume, shall be furnish as recommended by the manufacturer.

18.2.04 HYDROPHILIC SEALS

A. Hydrophilic seals shall be installed between the pipe and liner inside the pipe near each manhole prior to installation of the liner.

B. The hydrophilic waterstop end seals shall be bands that are 20 mm wide and 5 mm thick and shall be installed at every entrance to a manhole.

C. Manufacturer: GreenStreak Hydrotite Style RS-0520-3.51, or an ENGINEER approved equal.

18.2.05 CIPP END SEAL

A. Install cured-in-place pipe (CIPP) end seals to seal the end of the CIPP where it enters the manhole.

B. The CONTRACTOR shall use the LeakMaster product manufacturer: GreenStreak or an ENGINEER approved equal.

18.2.06 PRE-LINERS

- A. Pre-liners shall be a thin, fully circumferential, plastic liner sized to nominal host pipe inside diameter.
- B. Manufacturer: Griffolyn TX 1200 or an ENGINEER approved equal.

18.2.07 SHORT LINERS

- A. Short liners, when required, shall be of the same material as described above for a full length CIPP liner except for the resin which shall be as described above for short liners.

18.2.08 MAINLINE/LATERAL CONNECTION FOR LATERAL CIPP

- A. The mainline tube and lateral tube shall form a one-piece assembly by stitching the lateral tube to the mainsheet aperture. The connecting end of the lateral tube shall be shaped to match the aperture and curvature of the mainline tube. The lateral tube and mainline tube shall be sealed by use of a flexible UV cured adhesive/sealant applied in a factory-controlled setting. The main/lateral tube assembly shall take the shape of a “TEE” or “WYE” with corresponding dimensions such as a curved circle or a curved elliptical opening in the pipefitting.

PART 3 EXECUTION

18.3.01 PREPARATION

- A. Mainline CIPP
 1. Review OWNER’s television inspection logs of the pipes when available to plan rehabilitation work. Inspect and confirm the inside diameter, alignment and condition of each pipe segment to be lined.
 2. Provide notification to all homeowners affected by the rehabilitation process including the CONTRACTOR’s contact information.
 3. The OWNER or CONTRACTOR shall determine the location of all active service connections prior to lining. Dye test to verify all active service connections, if necessary, or otherwise required by the Contract Documents. Do not reopen taps that are not active. The CONTRACTOR shall submit a Lateral Reinstatement Plan.
 4. Hydraulically clean the pipe to be rehabilitated in accordance with Section 12.1.35 Cleaning of Sewer Mains prior to performing pre-rehabilitation video inspection.
 5. Remove intruding taps, debris, and obstructions prior to pre-rehabilitation video inspection. When an obstruction requires removal by open cut methods, the CONTRACTOR shall notify the OWNER immediately.
 6. Flow bypassing required to perform the rehabilitation shall be performed in accordance with Section 12.1.26 Pumping and By-Passing.
 7. Remove pockets of water from the pipe.

8. In the presence of the OWNER or ENGINEER, perform a pre-lining video inspection immediately prior to CIPP lining to demonstrate that the pipe is clean and free of roots, grease, sand, rocks, sludge, PACP Runners or Gushers, pockets of water, or structural impediments that would affect long-term viability of the pipe liner. Obtain ENGINEER's verbal approval of the acceptability of the existing pipe condition prior to installation of the CIPP.
9. When approved by the OWNER or ENGINEER, a pre-liner may be installed to protect the CIPP liner from existing infiltration.

B. Lateral CIPP

1. Access – If a cleanout already exists or is required by the OWNER, it shall be constructed of materials which provide a four-inch minimum diameter opening if the service lateral is four inches (4"). A six-inch minimum diameter opening is required if the service lateral is six inches (6"). If a clean out does not exist and the OWNER does not require a clean out, any cost associated with a clean out/access point to facilitate lateral rehabilitation will be considered incidental to the rehabilitation of the lateral. There will be no direct pay for this access point.
2. Safety – The CONTRACTOR shall carry out his operations in strict accordance with all applicable OSHA standards. Particular attention is drawn to those safety requirements involving entrance into confined spaces.
3. Cleaning of Sewer Line – The intent of this specification is for cleaning of the lateral to be accomplished from the mainline pipe via lateral launching equipment. If the lateral cannot be cleaned using industry standard cleaning heads that can be launched from the mainline pipe, then a cleanout or access point will be required. The laterals shall be cleaned a sufficient length to ensure the specified length of sewer is ready for lining. It shall be the responsibility of the CONTRACTOR to verify, prior to installation, that all internal debris has been removed from the sewer line. Internal debris consists of broken pipe sections, roots, loose gravel, etc.
4. It is the intent of this specification for inspection of the lateral to be accomplished from the mainline pipe via lateral launching equipment. If the lateral cannot be inspected using industry standard inspection equipment that can be launched from the mainline pipe, then a cleanout or access point will be required. Inspection of pipelines shall be performed by experienced personnel trained (PACP Certification) in locating breaks and obstacles by closed circuit television (CCTV). The interior of the pipeline shall be carefully inspected to determine the location of any conditions which may prevent proper installation of the lateral liner into the pipelines, and it shall be noted so that these conditions can be corrected.
5. The CONTRACTOR, when required, shall provide for the flow of sewage around the section(s) of mainline pipe where the service lateral designated for lining is located. 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. It is assumed that flows in the lateral specified for lining will not require bypass pumping.
6. It is required that the service lateral be inactive during the time of installation. This is normally accomplished by turning off the homeowner's services or requesting that the homeowner relinquish using their services during the period of installation. Notification

will be distributed to impacted residents 24 hours in advance of the lateral liner installation.

7. Line Obstructions – If inspection reveals an obstruction that cannot be removed by conventional sewer cleaning equipment, as in solids, dropped joints or collapsed pipe, then the CONTRACTOR shall make a point repair excavation to uncover and remove or repair the obstruction. Such excavation shall be approved in writing by the OWNER'S representative prior to the commencement of the work and shall be considered as a separate pay item.
8. In case of lined mainline pipes, the lateral connection specified for rehabilitation shall be reinstated to 100% of its original size.

18.3.02 MAINLINE CIPP INSTALLATION

- A. The CONTRACTOR shall submit a detailed description of the proposed techniques and procedures for rehabilitating the existing piping. The CONTRACTOR shall submit details to the OWNER for approval prior to beginning work.
- B. Resin Impregnation (Wet Out):
 1. The CONTRACTOR shall designate a location where the flexible tube will be impregnated with resin using distribution rollers and vacuum to thoroughly saturate the flexible tube prior to installation.
 2. A catalyst system, or additive compatible with the resin and flexible tube, may be used as recommended by the manufacturer and with approval of the ENGINEER provided they will not impair or reduce the resin's quality to withstand the minimum chemical resistance criteria.
 3. The CONTRACTOR shall take care in handling the resin-impregnated flexible tube to retard or prevent resin setting until it is ready for insertion.
- C. Insertion:
 1. The resin impregnated tube shall be transported and kept in a refrigerated truck until it is inserted through an existing manhole by manufacturer's techniques/process. The insertion area, equipment platform, etc., shall be securely protected.
 2. When required by the OWNER, Prior to insertion the CONTRACTOR shall install temperature sensors between the host pipe and the liner in the bottom of the host pipe throughout its length to monitor the temperature on the outside of the liner during the curing process. The temperature sensors can be placed at ten-foot intervals. The sensor should be monitored by a computer using a tamper proof database that is capable of recording temperatures at the interface of the liner and the host pipe. The output report stating the maximum temperature and the minimum cool down temperature for each sensor shall be provided to the OWNER.
 3. The liner material shall be inserted through a manhole by means and methods required by the manufacturer and shall be fully extended to the downstream manhole.
- D. Insert continuous or properly trimmed hydrophilic waterstops at each manhole opening, centered within the intersection of the host pipe and the manhole wall. Trimmed waterstop

edges shall be butted up against each other at the crown of the pipe using a 45° miter cut. Waterstops with any gap between the ends will not be accepted. For manholes with outside drops, install two hydrophilic waterstops, one approximately one inch inside the manhole wall and another approximately nine inches upstream of the outside drop and reinstate the drop opening through the CIPP. If defects in the host pipe near the manhole are such that the end seal will not form a watertight seal between the liner and host pipe, apply hydraulic cement to the defects in the host pipe to provide a smooth surface to receive the end seal.

- E. The pressure head used during the installation process shall be sufficient to hold the liner tight to the pipe wall, produce dimples at all service connections and the two access manholes, and prevent wrinkles in the cured liner. The same head shall be great enough to prevent infiltration from entering the pipeline during the curing process. Pressure head shall be maintained sufficiently long enough to allow pockets of water to exfiltrate through the host pipe and prevent lifts in the liner and resin washout.
- F. Curing:
 - 1. Curing shall be accomplished by the use of water or steam in accordance with the manufacturer's recommended cure schedule. The curing source temperatures shall be monitored and logged during the cure cycles. The manufacturer's recommended cure method and schedule shall be used for the size, thickness, and conditions of the liner being installed.
 - 2. Maintain the curing temperature as recommended by the liner system manufacturer. Prevent excessive temperatures that could scald or bubble the liner. Scalded or blistered liner shall be rejected if, in the opinion of the ENGINEER, the performance of the liner is compromised.
 - 3. Fit suitable monitors to any heat source to gauge the temperature of incoming and outgoing water or steam supply.
 - 4. Monitor temperatures through thermal couplings at each end of the liner or by temperature strips described above when required by the OWNER.
 - 5. Continue uninterrupted curing until the desired product is achieved.
 - 6. Provide for vapor tight connections in the downstream manhole such that no vapors enter downstream pipes or provide styrene odor reducing agents, venting, and downstream plugs sufficient to prevent steam, styrene, or other odors from entering downstream buildings.
- G. Cool Down: Initiate a controlled cool-down to cool the hardened liner to a temperature below 100°F, in accordance with the cure schedule. Care shall be taken in the release of the pressure column so that a vacuum will not develop that could damage the newly installed liner. Cooling/Curing water shall only be discharged into the sanitary sewer. Discharging of cooling/curing water to the ground or storm water system is not permitted. Temperatures shall be recorded by the CONTRACTOR and provided to the OWNER.
- H. Finished Pipe: The finished CIPP liner shall be continuous over the entire length and be free from visual defects such as foreign inclusions, dry spots, pinholes, delamination, and major wrinkles. The CIPP liner shall be impervious and free from any leaks through the CIPP wall. Any defect which will affect the integrity of the pipe or hinder the flow of the sanitary sewer shall be repaired at the CONTRACTOR's expense.

- I. Short Liners shall meet the specifications for design, preparation, installation, inspection, and testing as required for full length mainline CIPP except for the method of installation and the resin material.
 1. The short liner shall be wrenched into place on a carrier train/plug assembly and positioned by a closed-circuit TV camera. The short liner shall overlap the area to be repaired by a minimum of one foot on each side.
 2. The CONTRACTOR shall furnish a two-part, ambient cure 100% solid epoxy vinyl ester or polyester resin and a compatible catalyst system to accommodate the environment of the existing sanitary sewer with multiple temperature range hardeners suitable for ambient conditions at the time of installation. Resins shall be non-volatile and safe for use in the interior of sanitary sewer pipe. Resins shall have a maximum shelf life of six (6) months. The CONTRACTOR shall not use any resin that has exceeded its shelf life or expiration date.

18.3.03 LATERAL CIPP INSTALLATION

- A. The CONTRACTOR shall designate a location where the liner will be vacuum impregnated prior to installation. The CONTRACTOR shall allow the OWNER to inspect the materials and resin saturation (wet-out) procedure. A catalyst system compatible with the resin and liner shall be used.
- B. The wet-out liner shall be loaded inside a pressure apparatus above ground, utilizing a hydrophilic sealant (or equivalent) on the backside of the connection to enhance a watertight seal. Also, a silicate resin or a two-part 100% solid epoxy (reference ASTM C-881) shall be applied to the lateral interface to enhance adhesion against the host pipe. The pressure apparatus, with an end attached to a robotic device, shall be winched through the mainline pipe to the service connection. The robotic device, together with a television camera, will be used to position the pressure apparatus' inversion elbow at the service connection opening. Air pressure, supplied to the pressure apparatus through an inversion hose, shall be used to invert the wet-out liner through the lateral pipe to the cleanout/access point or "Right of Way" point. The inversion head will be adjusted to be of sufficient pressure to cause the impregnated liner to invert completely in the lateral pipe and hold the liner tight to the pipe wall. Care shall be taken during the curing process so as not to overstress the liner.
- C. Curing – In most circumstances, an ambient-temperature curing resin system will be utilized. **No UV cure systems will be allowed.**
- D. Initial cure shall be deemed to be complete when inspection of the exposed portions of the CIPP appear to be hard and sound. The cure period shall be of a duration recommended by the resin manufacturer, as modified for the installation process.
- E. Cool-down – The CONTRACTOR shall cool the hardened CIPP to a temperature to approximately 100⁰ F before relieving the pressure in the pressure apparatus. Care shall be taken to maintain proper pressure throughout the cure and cool-down period.
- F. Finish – The finished CIPP shall be a watertight connection seal at the mainline pipe and extend continuous over the entire length of the service lateral and be free of dry spots, lifts, and delamination. This continuous one-piece structural pipe-within-a-pipe shall not inhibit the closed-circuit television (CCTV) post video inspection of the mainline or service lateral pipes.

18.3.04 RECONNECTION OF EXISTING LATERAL SERVICES

- A. The CONTRACTOR shall maintain two working lateral reinstatement cutters at the job site at all times. Lining work shall not commence if the CONTRACTOR does not have the required number of working cutters on site. No additional time or compensation shall be awarded to the CONTRACTOR in the event that work is stopped due to the CONTRACTOR'S failure to comply with this requirement.
- B. The CONTRACTOR shall reopen all existing active lateral service connections, as submitted in the Lateral Reinstatement Plan, in each length of sewer immediately following installation of the liner.
- C. The CONTRACTOR shall reopen active service connections from inside the sewer by means of a remote controlled, video assisted cutting device appropriate for the liner material and the rehabilitated sewer pipe. Each active service connection shall be cut completely open at a minimum of 95% of the service pipe diameter and shall have smooth edges with no protruding material capable of hindering flow or catching and holding solids contained in the flow stream. The CONTRACTOR shall not overcut the lateral connection. Excess resin shall be removed from the lateral. Any damage to the saddle or tee caused from cutting out the coupon shall require replacement of the connection by excavation or a CIPP "Service Connection Seal" at the CONTRACTOR'S expense.
- D. When the lateral connection reinstatement exceeds 100% of the lateral opening, the CONTRACTOR shall install a CIPP repair to cover the over-cut at no additional cost to the OWNER.
- E. The CONTRACTOR shall not reopen capped or inactive lateral connections as determined by Section 18.3.01.B above. The CONTRACTOR shall confirm the locations of all capped or inactive laterals during pre-construction video inspections.
- F. All coupons from lateral reinstatement shall be removed at the downstream manhole and shall not be allowed to enter the sanitary sewer system.
- G. Lateral reinstatement by excavation shall be in accordance with Section 12.1.06.G. Lateral Services and Connections.
- H. The CONTRACTOR shall be responsible for restoring/correcting, without any delay, all omitted or faulty reconnections, as well as for any damage caused to the property for not reconnecting the services soon enough or for not giving notice to the property's owners.

18.3.05 TRIMMING AT MANHOLES

- A. Delay final trimming and sealing of the liner at manholes according to Manufacturer's guidelines.
- B. Seal the manhole/wall to CIPP interface with GreenStreak LeakMaster or an ENGINEER approved product in accordance with the manufacturer's recommendation.
- C. Neatly and smoothly trim the finished ends of the liner to within four inches of host pipe end. Do not leave any rough edges that may catch debris. Do not leave any portion of CIPP within the manhole channel unless directed by the OWNER to remain. The channel shall allow for ease of access by a remote camera.

- D. Provide a smooth transition between the existing manhole channel invert and the effluent liner using cementitious or other approved material to prevent settling of sediments or debris from catching on the liner.

18.3.06 POST-CONSTRUCTION VIDEO INSPECTION OF COMPLETED WORK

- A. Provide post-construction video inspection documentation showing completed work in accordance with Section 12.1.34 Internal Video Inspection.

18.3.07 FINAL CLEANUP

- A. Upon completion of rehabilitation work and testing, clean and restore project area affected by the Work.

18.3.08 TESTING

- A. Physical Properties and Thickness Test: The CONTRACTOR shall collect a restrained pipe sample by placing a section of PVC pipe in the adjacent manhole. Samples shall be collected every 1,000' for pipe diameters less than 15"; collected at each installed segment for pipe diameters 15" and greater; and collected from lateral CIPP for every 50 laterals installed. Select PVC material and size to match the inside diameter of the sewer being lined as closely as practical. Run the impregnated tube through the pipe and cure the CIPP under restrained conditions. Cut a cylindrical sample from the center of the restrained pipe sample. The sample shall be sized to allow for all applicable ASTM test methods to confirm compliance with these specifications. Label samples with the contract number, date of installation, street location, segment number(s), and specified thickness. Deliver the sample to the OWNER for testing of the physical properties and thickness. The CONTRACTOR shall coordinate with the ENGINEER to be present for obtaining the sample.

18.3.09 FORMS

- A. The CONTRACTOR shall utilize and complete the required forms for quality assurance. The following forms are provided as samples. The CONTRACTOR may elect to utilize these forms or provide forms of similar nature.

END OF SECTION