



REGIONAL CONSTRUCTION **STANDARDS**

FIFTH EDITION

Publication Update #3

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As Publication Update #3)

November 23, 2012

Face of DVD

Manhole No. From	Manhole No. To	Pipe Diameter	Pipe Length	Street

B. Pipe Rehabilitation by Cured-In-Place Pipe Method

1. The product proposed for the cured-in-place rehabilitation of sewers must have been in use in the United States for at least three years with a minimum of 50,000 linear feet of the product installed to date in this country.
2. The liner shall generally consist of corrosion resistant polyester, vinyl ester, or epoxy thermosetting resin, or approved equal, impregnated flexible polyester felt or fiberglass fiber.
3. The wall color of the interior pipe surface of the cured-in-place pipe after installation shall be a light reflective color so that a clear detail examination with closed circuit television inspection equipment may be made.
4. Water or Steam Cured Liners
 - a. The liner shall meet the requirements of ASTM F 1216 and shall be constructed to withstand inversion pressures, have sufficient strength to bridge missing pipe, stretch to fit irregular pipe sections, and shall invert smoothly around bends. The liner shall fit tightly to the internal circumference of the existing pipe, and a membrane integrally bonded to the internal circumference of the felt, thus forming a smooth, chemically inert internal flow surface. The membrane shall be a minimum of 0.25 mm +5% and shall not be considered to impart any structural strength of the liner. The liner shall be fabricated to a size that when installed will neatly fit the internal circumference of the pipe to be lined. Allowance for longitudinal and circumferential stretching of the liner during installation shall be made by the Contractor.
 - b. The CIPP liner shall be composed of tubing material consisting of one or more layers of a flexible non-woven polyester felt with or without additives such as woven fiberglass or other fibers and meet the requirements of ASTM F 1216, ASTM F 1743, and ASTM D 5813. The felt content of the CIPP liner shall be determined by the Contractor, but shall not exceed 25 percent of the total impregnated liner volume. 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.

- c. The CIPP liner tube may be made of single or multiple layer construction, with any layer not less than 1.5 mm thick. 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.
- d. The exterior of the manufactured tube shall have distance markings along its length at regular intervals not to exceed 5 feet. Contractor shall use these marks as a gauge to measure elongation during insertion. Should the overall elongation of a reach exceed 5 percent, the liner tube shall be rejected and replaced. The Contractor shall identify the wet-out facility where all CIPP liner under this Contract will be manufactured. All CIPP liner shall be manufactured from this designated wet-out facility throughout the entire Contract unless specifically approved otherwise by the Owner in writing. Multiple wet-out facilities shall not be allowed. The application of the resin to the felt tubing (wet-out) shall be conducted under factory conditions and the materials shall be fully protected against UV light, excessive heat and contamination at all times.
- e. The resin volume shall be adjusted by adding 5 to 10% excess resin for the change in resin volume due to polymerization and to allow for any migration of resin into the cracks and joints in the original pipe. The resin used shall not contain fillers, except those required for viscosity control, fire retardance, or as required to obtain the necessary pot life. Thixotropic agents which will not interfere with visual inspection may be added for viscosity control. Resins may contain pigments, dyes or colors that will not interfere with visual inspection of the cured liner. However, the types and quantities of fillers and pigments added shall have prior approval of the Owner. The resin content of the liner shall be 10-15% by volume greater than the volume of felt in the liner bag. The felt resin tubing shall be vacuum impregnated with a thermosetting polyester resin and catalyst, vinyl ester resin and catalyst, or epoxy resin and hardener.

5. Ultra Violet Light Cured Liners (Flexible Fiberglass)

- a. The materials used for the flexible fiberglass tubes using ultra violet (UV) light curing process shall have the following additional properties:
- b. The fiberglass within the liner shall be non-corrosion material and shall be free from tears, holes, cuts, foreign materials and other surface defects. Its glass fibers must extend in a longitudinal direction to insure no longitudinal stretching during the pull-in process. The tube shall consist of a seamless, flexible, glass fiber with no longitudinal seams.
- c. Interior and exterior plastics shall be styrene resistant to protect and contain the resin used in the liner.
- d. The exterior plastic shall be UV light resistant and translucent to allow visual inspection of the impregnation of the resin within the glass fibers.
- e. The resin shall be a chemically resistant UV cured isophthalic polyester resin or vinyl ester resin. When cured the resin/liner system shall meet the structural and chemical resistance requirements of ASTM F 2019.

6. Liner Wall Thickness

- a. Liner thicknesses shall be submitted for all pipe sections for Owner approval.
- b. The required structural CIPP wall thickness shall be designed in accordance with the guidelines in Appendix X1 of ASTM F 1216 98. In cases where ovality exceeds 10%, or where pipes are egg or oval shaped, alternative methods of design may be considered by the Owner. The categories of design parameters noted in Tables 200-5.21.1, 200-5.21.2, and 200-5.21.3 shall be used, unless otherwise directed by the Owner.
- c. Liner thicknesses may be modified with the Owner's approval of supporting calculations by the Contractor's Professional Engineer. The Owner reserves the right to change specified thickness based on new information. The bid prices will be adjusted to increase or decrease unit price as liners are thickened or thinned at the Owner's direction.
- d. Maintenance of flow capacity of existing pipes is essential. Rehabilitated pipe shall have minimum or no change in capacity. An increase in flow capacity following rehabilitation is preferred, and in no case shall the flow capacity of rehabilitated pipes be reduced.
- e. Verify that installed thickness of the CIPP is within minus 5 % and plus 10 % of the specified thickness. The Contractor shall collect samples per Section 813.2.6 Testing. The results of the liner thickness measurements and structural analysis shall be submitted to the Owner within 14 Days and prior to payment.
- f. For water or steam cured applications, minimum liner thickness for nominal pipe diameters of 6 inches shall be 4.5 mm. Minimum liner thickness for nominal pipe diameters of 8 to 12 inches shall be 6 mm. Minimum liner thickness for nominal pipe diameters of 14 to 16 inches shall be 8 mm. Minimum liner thickness for nominal pipe diameters of 18 inches shall be 9 mm.
- g. For UV cured applications, minimum fiberglass liner thickness shall be 4.5 mm and in accordance with the Bid form requirements.

SECTION 813

PIPE REHABILITATION BY CURED-IN-PLACE PIPE METHOD

I. GENERAL

1.1. DESCRIPTION OF WORK

- A. All applicable requirements of other portions of the Contract Documents apply to the Work of this Section.
- B. Related Documents.
 - 1. ASTM F 1216 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
 - 2. ASTM D 543 – Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents
 - 3. ASTM D 618-61 – Standard Practice for Conditioning Plastics for Testing
 - 4. ASTM F 1743 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)
 - 5. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics
 - 6. ASTM D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
 - 7. ASTM D 792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
 - 8. ASTM D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
 - 9. ASTM D 2990 - Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
 - 10. ASTM D 5813 - Standard Specification for Cured-in-Place Thermosetting Resin Sewer Piping Systems
 - 11. ASTM F 2019 - Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Resin Pipe (CIPP)
- C. Products shall conform to Section 200.

D. The Contractor shall perform all required permanent landscape restoration of disturbed areas on private property and within the locality or VDOT right-of-way upon completion of the Work to the satisfaction of the Owner.

E. These specifications include requirements for all design, materials, transportation, equipment and labor necessary to rehabilitate deteriorated sections of sewer listed in the contract documents by means of cured-in-place pipe (CIPP) liner. This specification is intended to identify the minimum requirements of the Owner.

F. General Requirements:

1. The Contractor shall furnish all material, labor and special equipment required to accomplish the Work in accordance with these specifications. The installation shall affect the complete interior relining of the existing sanitary sewer piping and shall result in a smooth, hard, strong and chemically inert interior finish, and closely following the contours of the existing piping. The Contractor shall provide a watertight completed system with mainline sewer and all lateral connections in operational condition.
2. The Contractor shall comply with erosion and sediment control and other applicable requirements to protect drainage structures, systems, and waters of the Commonwealth.
3. Potable water usage shall be in accordance with Section 810 - Sewer Line Cleaning.
4. The Contractor shall remove obstructions and protruding service connections into the mainline or any protrusion that could cause installation problems of the CIPP liner as required to complete the CIPP rehabilitation prior to initiating liner insertion procedures. Protrusions shall be ground smooth with no intrusion into the mainline.
5. Lining Contractor Experience.
 - a. The Contractor for the cured-in-place rehabilitation of sewers must have a minimum of 3 years experience using the proposed product and have installed at least 50,000 linear feet of the proposed product for collection system. All contractor employees and/or subcontractors performing Work on the cured-in-place rehabilitation of sewer must be certified by the cured-in-place rehabilitation system manufacturer/supplier as qualified to perform Work with the proposed product.
 - b. The superintendent for the job must have supervised jobs in which at least 50,000 linear feet of collection system pipe has been rehabilitated using the product proposed in the bid. The superintendent for the job shall be on-site during all phases of the Work involving the insertion and processing of the liner pipe. The superintendent must be an employee of the lining contractor.
 - c. The Contractor shall be licensed by the liner process manufacturer/supplier.

1.2. SUBMITTALS

Submittals shall be made by the Contractor in accordance with the procedures set forth in Section 105 - Control of Work, and as described below.

A. After notification of award of a specific project, the Contractor shall provide the following information for review and approval.

1. Name of the CIPP lining supplier and a list of materials to be furnished.
2. Shop drawings and product data to demonstrate compliance with these specifications and identify materials of construction (including resins, catalysts, felt, etc.), felt manufacturer, location of the felt manufacturing facility, location of the wet-out facility, etc.
3. Manufacturers' shipping, storage and handling recommendations for all components of the CIPP System.
4. MSDS sheets for all materials to be furnished for the project.
5. Detailed installation procedures, including CIPP lining production schedule, acceptable inversion heads and pressures, inversion procedures, curing and cool-down procedures and temperatures, and times for each stage of the process.
6. Detailed testing and quality control procedures, including schedule and shipping and storage requirements.
7. An odor control plan that will ensure that project specific odors will be minimized at the project site and surrounding area.
8. A description of the proposed wet-out procedure for the proposed technology and the wet-out report for each liner.
9. Manufacturer's recommended cure method for each diameter and thickness of CIPP liner to be installed. Include detailed curing procedures detailing the curing medium and the method of application.
10. CIPP liner curing reports documenting the liner installation for all sewer segments. The CIPP liner reports shall document all details of liner installation, including manhole numbers, street names/sewer location, project number, date, time, outdoor ambient temperature, start to finish temperatures, curing time, CIPP liner thickness, rate of travel of UV light train assembly for UV cured applications, etc. A sample report shall be submitted to the Owner for approval prior to the installation of any CIPP lining.
11. Quality assurance and quality control information from product manufacturer including recommended heating and cooling procedures (including temperatures) from the rehabilitation system supplier.
12. Provide data on the maximum allowable stresses and elongation of the tube during

installation and the means in which the Contractor will monitor stress and elongation.

13. The Contractor shall submit a proposed Safety Plan to the Owner, prior to beginning any work, identifying all competent persons, a description of a daily safety program for the job site and all emergency procedures to be implemented in the event of a safety incident. All work shall be conducted in accordance with the Contractor's submitted Safety Plan.
14. A comprehensive construction sequencing plan. At minimum the plan shall include the following:
 - a. A proposed schedule.
 - b. Identification of all proposed access routes.
 - c. Identification of set-up locations for lining installation.
 - d. Lining procedures.
 - e. Bypass Pumping Plan in accordance with Section 812 – Bypass Pumping.
 - f. Traffic Control Plan in accordance with VDOT or locality requirements.
15. Letter identifying the crew members performing the lining. If any of the crew members are not identified on the original certification letter received during the pre-qualification process, then a new certification letter listing the crew member(s) must be received from the rehabilitated system manufacturer/supplier prior to initiation of the specific project.
16. Calculations supporting recommended liner thicknesses. Design data and specification data sheets listing all parameters used in the CIPP liner design and thickness calculations based on ASTM F1216 for "fully deteriorated gravity pipe conditions." The data shall include both the sealed calculated thicknesses and the thicknesses proposed to be installed. A registered Professional Engineer shall seal the calculations and provide an executed copy of the following form:

Professional Engineer Certification Form

The undersigned hereby certifies that he/she is a Professional Engineer registered in the State of Virginia and that he/she is employed by:

*(Name of Contractor)
to design cured in place liner segments. The undersigned further certifies that he/she has performed the design of the specified liner diameters and thicknesses and that the design is in conformance with all applicable local, state, and federal codes, rules, and regulations. It is further certified that the signature and Professional Engineer stamp will be affixed to all calculations and drawings used in, and resulting from the design.*

The undersigned hereby agrees to make all original design drawings and calculations available to the Owner within seven (7) Days following the Owner's request.

Professional Engineer Stamp _____

By _____

B. Prior to initiation of the Work the Contractor shall submit the following information for review and approval. These items may be submitted prior to the notice to proceed for review and approval.

1. Shop drawings and product data for the rehabilitation method including a report outlining the process to be used in the rehabilitation of the sewer line. The report shall also include information specific to the job, such as coordination issues, access, timing, and manufacturer's installation instructions and bypass pumping.
2. Infrared spectrum analysis for proposed resin and confirmation of the resins meeting ASTM D 5813.
3. Detailed description of lubricant proposed for inversion process. Lubricant shall be compatible with the Hampton Roads Sanitation District's wastewater treatment plant operations and pretreatment program.
4. Certification from resin manufacturer regarding approval of resin dye quantity and type.
5. Information on the maximum allowable tensile stress for the tube from the felt manufacturer.
6. Prior to each shipment of CIPP lining, submit certified test reports that the CIPP

lining for this Contract was manufactured and tested in accordance with all ASTM Standards specified and referenced herein.

7. One complete set of CDs/DVDs/external hard drive from each of the television inspections performed (Pre-Installation TV Inspection), as specified in Section 811 - Television Inspection. The Owner shall specify the storage media. The Pre-Installation CCTV inspection shall be performed after any protruding services have been removed.
- C. At least 7 working days prior to initiation of construction, the following information shall be provided for Owner review and approval:
 1. All measurements made by the Contractor to verify length, ovality, and diameter of pipe prior to ordering of material.
 2. Procedure for disposal of superheated water.
- D. Wet-out report with detailed information including but not limited to: volumes and/or weights of resin, length of CIPP liner, roller gap settings, start times, finish times, gel times, resin injection locations and any other pertinent data documenting the wet-out for each section of CIPP liner manufactured. The wet out report shall document and certify that the actual resin volume or weight used for each liner was between 5% to 10% additional volume or weight. A copy of these forms shall be delivered each week to the Owner with the wet out CIPP liners.
- E. The following information shall be submitted after the Work has been performed and along with the next application for payment:
 1. A specification sheet for each liner delivered. The sheet shall include, at minimum, the liner length, thickness, diameter, batch number, and resin volume.
 2. The curing log of temperatures at the upstream and downstream manholes during the curing process.
 3. Results of testing for materials provided for this job, as specified in this Specification.
 4. One complete set of CDs/DVDs/external hard drive from each of the television inspections performed (Post-Installation TV Inspection), as specified in Section 811 - Television Inspection. The Owner shall specify the storage media.

II. EXECUTION

2.1. GENERAL

A. Inspections:

1. Prior to beginning insertion of the liner bag, the Contractor shall inspect the cleaned line by use of closed-circuit TV cameras (in accordance with Section 811 -

Television Inspection), and shall confirm to his own satisfaction that the lines are adequately cleaned. Insertion of the bag by the Contractor shall serve as evidence of his acceptance of the condition of the piping and the suitability of the liner insertion within the host pipe. Failure of the liner system due to inadequately cleaned host pipes shall be repaired by the Contractor at no cost to the Owner.

2. During the process of manufacture and impregnation, the Owner shall have the reasonable opportunity to examine all operations where the manufacture and impregnation (when applicable) of the liner is being carried out. The Contractor shall give appropriate prior notice in order that the Owner's inspector may be on hand to observe the various processes.
3. No Work shall be performed by the Contractor except in the presence of the Owner's inspection personnel, unless otherwise approved. The Contractor shall coordinate his work schedule and give 48 hours (2 working days) prior notice regarding his intentions to perform any and/or all parts of the Work, in order that the Owner's inspector may be on hand. Any Work performed in the absence of the Owner's inspector is subject to removal and replacement at the Contractor's expense.
4. The Contractor shall, in the presence of the Owner's inspector, inspect the line using closed-circuit television equipment.
5. The video thus produced shall be accompanied by a simultaneously produced, narrated sound CD/DVD/external hard drive. The sound narration shall draw attention to all recognizable defects, imperfections, etc., and the location along the length of the piping shall be accurately noted. Also, the locations and all pertinent details regarding the entrance of service laterals into the main trunk sewer shall be accurately noted on the sound CD/DVD/external hard drive. One copy of the sound and video CDs/DVDs/external hard drive shall become the property of the Owner. Televising shall be performed as specified in Section 811 - Television Inspection.

B. Preparatory Procedures:

1. Prior to initiation of a specific project, it is the responsibility of the Contractor to notify all residents that could be affected by the lining process. This notification shall consist of written information and verbal communication that outlines the CIPP process and timing of the project. The written information shall be delivered to each home or business at least 48 hours prior to the start of insertion, and at minimum shall describe the Work, schedule, how it affects the home/business, the project manager's name, crew foreman's name, emergency contact number, and details how to identify crew members/vehicle.
2. The Contractor shall provide water and sewer to affected property owners in the event of service interruption, at no additional cost to the Owner.
3. The Contractor shall be responsible for the construction layout at the beginning of the project. The Contractor shall take all precautions to protect all stakes, hubs, control points, etc. If the stakes, hubs, control points, etc. are disturbed during construction, the Contractor shall re-stake at his expense. The Contractor is

responsible for the accuracy of the re-staking in accordance with Section 105 - Control of Work.

4. All utilities must be marked by "Miss Utility" prior to construction layout.
5. The actual sizes, lengths and materials of the pipes to be lined shall be indicated on the Contract Documents, but shall be verified by the Contractor prior to commencing with the Work.
6. Cleaning of sewer lines and manholes shall be performed as specified in Section 810 – Sewer Line Cleaning.
7. When required for acceptable completion of an insertion process, the Contractor shall provide for adequate flow control including but not limited to required pumping and bypassing as stipulated in Section 812 – Bypass Pumping.
8. The line shall be cleared of obstructions such as solids, or intruding service connections that may prevent liner installation. If the inspection reveals an obstruction that cannot be removed by conventional remote sewer equipment, then a point repair excavation shall be made to remove or repair the obstruction. NOTE: Point repairs shall be made only after cleaning methods were performed and shall be approved in advance by the Owner. Such point repairs shall be reimbursed per agreed upon unit prices as indicated on the Bid form.
9. Roots shall be removed in the designated sections where root intrusion is a problem. Special attention should be used during the cleaning operation to assure a clear opening of at least 95% of the pipe area with only a minimal amount of fine roots from the joints. Procedures may include the use of mechanical equipment such as rodding machines, bucket machines and winches using root cutters and porcupines, and equipment such as high-velocity jet cleaners in accordance with Section 810 - Sewer Line Cleaning.
10. The Contractor shall seal all leaks and infiltration identified in the Bid Documents that will prevent the liner from curing properly. Infiltration control is considered incidental and shall be included in the cost of the project. If, in the opinion of the CIPP liner manufacturer, the rate of infiltration in the sewer segment is high enough to risk washout of the resin, then the Contractor shall perform measures (such as chemical grouting), as required, to minimize infiltration prior to installation. If during the pre-CCTV inspection, any infiltration runners or gushers are observed, the Contractor shall submit, in writing for approval by the Owner, the methods and materials for mitigating any adverse impacts from the infiltration.
11. All protruding service lateral connections shall be internally cut or ground down flush with the pipe wall with a robotic cutter specifically designed for this purpose. The internal cutter shall be capable of cutting cast iron, PVC, vitrified clay pipe, and ductile iron pipe. All materials / cuttings shall be removed from the sewer and properly disposed of.
12. For steam or water cured applications, fit the heat source with monitors to accurately gauge the temperature of the incoming and outgoing water supply. Place another

such gauge between the CIPP liner and the pipe invert at the removal end to determine the temperature during the curing process. The temperature in the CIPP-lined host conduit during the curing process shall be as recommended by the resin manufacturer. The length of time for allowing the curing process to be completed shall be of the duration recommended by the manufacturer, during which time the Contractor shall maintain the required temperature throughout the CIPP-lined host conduit. Provide a written temperature data chart to the Owner for review to ensure that curing temperatures for the resin meet the manufacturer's recommendations.

13. When indicated on the Bid form, for steam or water cured applications, temperature monitoring systems are required for all 18-inch or larger sewer, or any sized sewer in locations with significant known groundwater infiltration, or if the pipe is within 50 feet of stream, river or lake. This system shall be installed at the invert of the pipe and be installed per the manufacturers recommended procedures. The temperature sensors shall be placed at intervals as recommended by the sensor manufacturer. Additional sensors shall be placed where significant heat sinks are likely or anticipated. The sensors, if installed, shall be monitored by a computer using a tamper proof data base that is capable of recording temperatures at the interface of the liner and the host pipe. Temperature monitoring systems shall be Zia Systems, Vericure by Pipeline Renewal Technologies, or approved equal.
14. The discharge location of the water within the CIPP liner after curing must be approved by the Owner or his designated representative.

2.2. LINER INSTALLATION

A. General Procedures:

1. Conduct operations in accordance with applicable OSHA standards, including those safety requirements involving Work on an elevated platform and entry into a confined space. Take suitable precautions to eliminate hazards to personnel near construction activities when pressurized air is being used.
2. The curing period shall be carried out under an inversion head to maintain a minimum hoop tension in the liner felt of 1 lb/in².
3. Vent and/or exhaust noxious fumes or odors generated during and remaining after the curing process is completed. This process shall remain in place at all manholes, laterals, etc., until noxious odors have dissipated to an acceptable level in accordance with OSHA requirements for the materials used and there is no more air pollution or potential health hazard left to the general public or the construction workers.
4. Maintain a curing log of CIPP temperatures at the upstream and downstream manholes during the curing process to document that proper temperatures and cure times have been achieved.
5. Invert through manholes shall be continuous and smooth through all manholes. If a liner is installed through a manhole, the bottom portion of the liner shall remain and the bench of the manhole shall be grouted and shaped as necessary to support the liner. If the liner terminates on either side of a manhole, the invert shall be built up to

remove any flow restrictions and to form a continuous invert through the manhole. The cost of this Work shall be included in the price bid.

6. The finished pipelining shall be continuous over the entire length of an insertion run between two manholes or structures and be as free as commercially practicable from visual defects such as fins, foreign inclusions, dry spots, air bubbles, pinholes, dimples and delamination. The lining shall be impervious and free of any leakage from the pipe to the surrounding ground or from the ground to the inside of the lined pipe. Defects that will impede flow or maintenance equipment will not be permissible.
7. The inner surface shall be free of cracks and crazing with smooth finish and with an average of not over two pits per square foot, providing the pits are less than 0.12 inch in diameter and not over 0.04 inch deep and are covered with sufficient resin to avoid exposure of the inner fabric.
8. Some minor waviness, that in the Owner's opinion will not appreciably decrease the flow characteristics or be the cause of a possible blockage, shall be permissible.

B. Additional Steam or Water Cured Procedures:

1. The liner shall be installed in accordance with ASTM F 1216 or ASTM F 1743.
2. In the event of insertion being delayed after impregnation by unexpected site conditions but prior to the start of the insertion process, the Contractor shall store, at his own cost, the liner, at a temperature of less than 30° F for use when conditions allow.
3. The liner shall be installed via an inversion process or other process that has been approved by the Owner. The free open end of the liner bag shall be firmly secured to the platform and the folded liner passed down a suitably reinforced column to a chute or bend leading to the opening of the pipe to be lined. Potable water at ambient temperature shall be supplied to the platform at a rate sufficient to cause controlled installation of the liner into the pipeline. Use of non-potable water shall be used only upon approval from the Owner. Contractor shall assume potable water usage when developing unit pricing.
4. Liner inversion rate for water inversion installations shall not exceed 32 feet per minute and the tail of the liner or the tail tag rope shall be suitably restrained to prevent liner run away, if applicable.
5. The Contractor shall supply a suitable heat source and recirculation equipment capable of delivering required curing temperature to the far end of the liner to quickly and uniformly raise the water temperature in the entire liner, once inverted in the pipeline, above the temperature required to commence the exothermic reaction of the resin as determined by the catalyst system employed.
6. The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing water supply to determine when uniform temperature is achieved throughout the length of the liner. Another such gauge shall be placed between the impregnated tube and the pipe invert at the termination to determine the

temperatures during cure. Install thermocouples at the top and bottom (12- and 6-O'Clock positions) of the liner between the liner and host pipe. If the liner is installed through manhole structures, thermocouples shall also be placed at each structure.

7. Initial cure will occur during temperature heat-up and shall be completed when exposed portions of the new pipe appear to be hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize an exotherm or cure in the resin. After initial cure is reached, the temperature shall be raised to the post-cure temperature recommended by the resin manufacturer. The post-cure temperature shall be held for a period as recommended by the resin manufacturer, during which time the recirculation of the water and cycling of the boiler to maintain the temperature shall continue. The curing of the CIPP must take into account the existing pipe material, the resin system, and ground conditions (temperature, moisture level, and thermal conductivity of soil).
8. If cool-down is to be accomplished by the introduction of cool water into an inversion standpipe to replace the water being drained from a small hole made in the downstream end, cool the hardened pipe to a temperature below 100 degrees F (38 degrees C) before relieving static head in the inversion standpipe. Ensure that, in the release of static head, a vacuum will not be produced that could damage the newly installed CIPP liner.

C. Additional UV Cured Procedures:

Curing with UV light shall be in accordance with applicable ASTM F 2019, Section 6.6 and 6.7 with the following modifications:

1. The UV curing lamps shall operate in a sufficient frequency range to insure the curing of the resin.
2. A camera must be located on the UV light assembly to enable the video inspection of the liner and to insure that the liner has been properly inflated and any liner problems can be identified before curing begins.
3. The Contractor will submit a documented record of time, rate of travel of the UV light assembly, and the internal temperatures and pressures during the curing process to the Owner.

2.3. SEALING AT MANHOLES

A. Form a tight seal between the CIPP and the manhole wall at the pipe penetration. Do not leave any annular gaps. Contractor shall install hydrophilic end seals at all manhole penetrations prior to mainline rehabilitation. The end seals must be composed of hydrophilic rubber and molded as a one-piece, 3-inch wide cylinder which when installed will form a 360 degree seal between the host pipe and the newly installed liner. The use of caulking, rope or band type of an end seal will not be allowed. Acceptable End Seals are Insignia™ End Seals by LMK, or approved equal.

B. Reshape the manhole invert as specified in Section 822 – Manhole Rehabilitation. The Contractor shall repair any manhole benches and inverts that have been damaged during the liner installation.

2.4. SERVICE CONNECTIONS

Restore and install service reconnections as specified in Section 821 – Sanitary Sewer Service Reconnections.

2.5. DEFECTIVE WORK

Any defects which, in the judgment of the Owner, will affect the integrity or strength of the liner, shall be repaired or the liner replaced at the Contractor's expense. Obtain approval of the Owner for method of repair, which may require field or workshop demonstration.

2.6. TESTING

A. Field acceptance of the CIPP lining shall be based on the Owner's evaluation of the installation, including a review of the CIPP liner curing data, review of the post-rehabilitation CCTV inspection data, review of the certified test data for the installed CIPP liner, and review of CIPP air testing results. 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.

B. For every 1,000 linear feet of CIPP liner installed for the first 10,000 linear feet, the Contractor shall perform sampling and testing to determine the installed CIPP liner flexural properties and CIPP liner thickness. The frequency of testing may be reduced as approved by the Owner after sufficient tests are performed to verify the CIPP liner design, production and installation procedures. Likewise, the frequency of testing may be increased by the Owner and performed by the Contractor at no additional cost to the Owner when the required tests show that the installed CIPP liner does not meet the specifications. After the 10,000 feet of acceptable test results are received, the test sample frequency can be reduced to one sample every 2,000 feet as long as samples continue to meet all minimum standards and sampling results are received in a timely manner. A failed test may result in the Contractor removing and replacing the failed line segment at no additional cost to the Owner.

C. Testing shall be performed by an ASTM-certified independent testing laboratory. The Contractor shall submit to the Owner the name and location of the independent testing laboratory, a certified statement from the laboratory indicating that they are independent from and not associated with the Contractor in any way, and the ASTM certification for the independent testing laboratory.

D. All expenses for sampling and testing of the installed liner shall be paid for by the Contractor. The cost of all manufacturers testing to qualify products furnished to the project site shall be the responsibility of the Contractor.

E. Sampling and testing of the installed CIPP liner shall, at a minimum, conform to the following requirements:

1. Remove one restrained sample of the installed CIPP liner at least 18-inches in length. The sample shall be captured by installing the CIPP liner through a section of PVC

pipe (same diameter as the existing sewer diameter) within the most downstream manhole of the installation. The Contractor may elect to cut the sample longitudinally and provide ½ the sample to the Owner's representative or inspector for direct shipping to the laboratory and keep the other half of the sample for additional testing if necessary.

2. The CIPP liner thickness shall be measured in accordance with ASTM D5813. Flexural properties shall be determined in accordance with ASTM D790. The Contractor shall label and date all samples and provide to the inspector or Owner's representative the same day of the installation for shipping to the independent testing laboratory. The Owner shall be copied on all transmittals to the independent testing laboratory.
3. Any CIPP lining that does not meet the specified installed strength and/or thickness requirements, regardless of the amount below the specified requirements, shall be corrected by the Contractor in a manner approved by the Owner at no additional cost to the Owner. The Owner's decision on how to correct deficient CIPP liner installations shall be final. Options for correcting deficient CIPP liner installations that will be considered by the Owner include the following: removal of the existing CIPP liner and re-lining the sewer, open-cut replacement of the sewer from manhole to manhole, re-lining the sewer with the existing CIPP liner in place.

F. The Contractor shall collect representative sample coupons for testing as described herein this section. Coupons shall be taken from the lesser of either 10% of manholes in the project or a representative sample for each liner diameter installed in the project. The Contractor shall stamp or mark the test pieces with the date of manufacture and batch number. These samples shall be incidental to the price for the liner installation.

G. Should the Owner desire to make independent tests, the Contractor shall, upon request of the Owner, furnish any reasonable number of test pieces of raw material samples as the Owner may require, stamped or marked with the date of manufacture and batch number if applicable.

H. Tests shall be made on specimens of resin, catalyst and felt as supplied or pieces of cured liner cut from waste areas when possible. Otherwise, the specimens shall be cut from a piece of cured liner representative of the material inserted and prepared and cured in a similar technique to the process employed.

I. The test specimen shall be conditioned in accordance with procedure 'A' of ASTM D 618-61.

J. The test specimen shall be prepared and physical properties tested in accordance with ASTM F 1216. The properties shall meet or exceed the values identified in ASTM F 1216.

K. The Contractor shall, in preparation for insertion of the liner bag, and in placing of stops within the terminal manholes of an insertion run, allow sufficient length to facilitate the cutting out of one (1) full size cured liner section, for each thickness of liner installed, from the waste portion at the end of the insertion run. The lengths of the full size section thus provided shall be as practicable, in order to facilitate load testing if desired by the Owner.

2.7. FINAL ACCEPTANCE

Upon completion and before acceptance by the Owner, the Contractor will re-inspect the rehabilitated pipeline by the use of closed-circuit TV cameras and shall submit color CDs, DVDs or external hard drive of the rehabilitated pipeline to the Owner for approval/acceptance of the Work in accordance with Section 811 - Television Inspection.

2.8. WARRANTY INSPECTION

The contractor shall clean & TV the pipes at the end of the one year warranty period to assure quality. Contractor shall supply Owner with a copy of the television inspections in the same manner as specified for pre- and post CCTV inspections, as specified in this section.

III. MEASUREMENT FOR PAYMENT

A. Measurement for payment will be the actual distance measured along the centerline of the pipe from centerline to centerline for manholes, of each size pipe, excluding manhole diameter. Payment is based on the CIPP thickness required for the specified pipe diameter.

The price per linear foot shall include all:

1. Bypass pumping (up to 2 mgd),
2. Clearing and grubbing,
3. Cost of potable water from the Owner,
4. Debris collection and disposal,
5. Dewatering,
6. Erosion and sediment control,
7. Excavation pits,
8. Infiltration control,
9. Ingress and egress procedures,
10. Labor,
11. Manhole invert reshaping,
12. Materials,
13. Permits,
14. Pipeline cleaning,
15. Pre-, post-, and warranty television inspection,
16. Re-instatement of service connections,
17. Removal and replacement of manhole frames and covers as necessary,
18. Resident notification,
19. Sealing at manholes,
20. Sediment and root removal,
21. Site cleanup,
22. Site restoration,
23. Temporary service to affected properties,
24. Testing,
25. Traffic control,
26. Other Work, not included under other items, necessary to complete the rehabilitation per the Contract Documents.

B. Measurement for payment for removal of intruding service connections (ferrous or non-ferrous) shall be based on the actual number of removed intruding connections. Connections shall be classified as either ferrous or non-ferrous, as separate bid items.

Payment for removal of intruding service connections is made at the contract unit prices per each intruding connection removed. The price shall include all labor, incidentals, and materials to complete the Work. No payment shall be made for any incidentals that are required to complete the Work.

- C. Measurement for payment for a longitudinal temperature monitoring system per section 2.1 above, when indicated on the Bid form, shall be based on the number of pipe segments identified for monitoring. Payment shall be made at the unit contract price for each segment monitored. The price shall include all labor, equipment, sensors, computer usage, software, materials and incidentals necessary for accurate temperature monitoring of the curing process.

End of Section