

SPECIFICATIONS FOR INSTALLATION OF UV GRP CURED-IN-PLACE-PIPE (CIPP) (Reline America)

PART 1. GENERAL

1.01 INTENT

- A. It is the intent of this specification to provide for the reconstruction of pipelines and conduits by the installation of a resin-impregnated fiberglass material tube (“Liner”) which when cured shall extend the full length of the original pipe and provide a structurally sound, smooth, joint less and watertight pipe. The resin shall be cured using ultraviolet light within the tube. The Cured-In-Place Pipe (CIPP) will be continuous and tight fitting.

1.02 REFERENCED DOCUMENTS

- A. The following documents form a part of this specification to the extent stated herein:
 1. ASTM F2019 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)
 2. ASTM F1216 Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
 3. ASTM F1743 Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pull In and Inflate and Curing of a Resin-Impregnated Tube.
 4. ASTM D543 Test Method for Resistance of Plastics to Chemical Reagents
 5. ASTM D578 Standard Specification Glass Fiber Strands
 6. ASTM D638 Standard Test Method for Tensile Properties of Plastics
 7. ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
 8. ASTM D2122 Standard 1 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
 9. ASTM D3567 Standard Practice for Determining Dimensions of “Fiberglass” (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings
 10. ASTM D5813 Standard Specification for Cured-in Place Thermosetting Resin Sewer Pipe

1.03 PRODUCT, MANUFACTURER/INSTALLER QUALIFICATION REQUIREMENTS

- A. Since sewer products are intended to have a 50-year design life, and in order to minimize the Owner’s risk, only proven products with substantial successful long-term track records will be approved. Products and Installers must meet all of the following criteria to be deemed Commercially Acceptable:
 1. The “Manufacturer” must have a minimum 500,000 linear feet of successfully installed liner in the United States of America with the same product being used on this project . The installing contractor must be trained and certified by the UV GRP manufacturer and have documented experience with a fiberglass UV cured liner.
 2. For each method of installation and curing used on this project, the Cured-In-Place-Pipe Lining (CIPPL) work shall be supervised by a foreman having previously supervised a minimum of 50,000 linear feet of CIPPL using a similar resin and

flexible tube and using the specific method of installation and curing method proposed.

3. The manufacturer of the glass reinforced tube, including wet out, of the CIPPL shall have been performing this same type of work with ultra violet cured glass reinforced pipe (UV GRP) for a minimum of five years and previously wet-out at least 500,000 linear feet of this same technology. If the Contractor does not have 50,000 linear feet of CIPPL experience with the UV curing system being used, then a manufacturer's onsite representative must be present during installations of the CIPP system until such time the owner is confident in the contractor's ability. The Contractor is to provide the Engineer with the manufacturer representative's work experience for approval. Work shall not begin prior to the Engineer's approval of the manufacturer's onsite representative.
4. The Contractor shall provide five (5) references of completed projects of similar installations.

PART 2. PRODUCTS

2.01 MATERIALS

- A. Fiberglass liner – At the time of manufacture, each lot of glass fiber tube liner shall be inspected for defects. At the time of delivery, the liner shall be homogeneous throughout, uniform in color, free of cracks, holes, foreign materials, blisters, and deleterious faults.
 1. The ENGINEER may at any time direct the manufacturer to obtain compound samples and prepare test specimens in accordance with the latest applicable ASTM standards.
- B. Cured-in Place Pipe – The glass fiber tubing shall include an exterior and interior film that protects and contains the polyester, vinylester or ortho based resin used in the liner. The exterior film shall be provided with a UV light blocker foil.
- C. Tube
 1. The wet out Tube shall have a uniform thickness that when compressed at installation pressures will meet or exceed the Design thickness.
 2. The Tube shall be sized such that when installed, will tightly fit the internal circumference and length of the original pipe.
 3. The glass fiber Tube shall be saturated with the appropriate resin using a resin bath system to allow for the lowest possible amount of air entrapment. An inner and outer material will be added that are both impervious to airborne styrene, with the outer material also having UV blocking characteristics. If required by the liner manufacturer, the inner membrane will be removed after the installation and curing processes are completed.
 4. 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.
 5. The liner should be seamless in its cured state to ensure homogenous physical properties around the circumference of the cured liner.
- D. Resin
 1. The resin system shall be polyester, vinylester, or orthothalic (either ppg or npg grade) depending on the choice of the engineer, with a catalyst system that when properly cured within the tube composite meets the physical properties of:

- a. Flexural Modulus (minimum) 725,000 psi
 - b. Flexural Strength (minimum) 15,000 psi
 - c. Long term E-modulus 675,000 psi
 - d. Long term tensile bending strength 13,500 psi
2. The resin used with this product shall use UV light to cure the pipe. The liquid UV resin shall saturate the tube and produce a properly cured liner, which is resistant to abrasion due to solids, grit, and sand.
 3. Polyester, vinyl ester and catalyst system shall comply with the following requirements and when properly cured meet the requirements of ASTM F1216. Resins created from recycled materials are not allowed.
- E. Adheres to ASTM F 2019-11 (or latest edition)

2.02 GENERAL CORROSION REQUIREMENTS

- A. The UV GRP cured-in-place pipe system shall utilize resins which will withstand the corrosive effect of the existing residential, commercial, and industrial effluents, liquids and/or gases.

2.03 DELIVERY, STORAGE, AND HANDLING

- A. Care shall be taken in shipping, handling and storage to avoid damaging the liner. Any liner damaged in shipment shall be replaced as directed by the OWNER at no additional cost to OWNER.
- B. While stored, the CIPPL shall be adequately supported and protected. The UV Cure GRP CIPPL shall be stored in a manner as recommended by the manufacturer and as approved by the ENGINEER.

2.04 QUALITY CONTROL

- A. No change of material, design values, or procedures as developed before bidding the contract may be made during the course of the Work without the prior written approval of the ENGINEER.
- B. All liner 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 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. At the time of manufacture, inspect each lot of liner for defects. At the time of delivery, the liner shall be homogeneous throughout, uniform in color, free of cracks, holes, foreign materials, blisters, or deleterious faults.
- D. The liner manufacturer facility shall have a Quality Management System registered with the current ISO 9001 standard.
- E. The wet out of the liner must be done in an indoor environmentally controlled manufacturing setting. No onsite wet out will be allowed. OWNER or ENGINEER may inspect this facility at the manufacturer's plant(s) for compliance with these Specifications.

PART 3. EXECUTION

3.01 INSTALLATION OF GLASS FIBER TUBING

- A. The approved system must utilize an outer and inner film to ensure that the liner remains intact during the insertion process and to protect the resin at all times during the installation and curing process from water and debris contamination, and resin migration.
- B. A constant tension winch should be used, as specified by the liner manufacturer, to pull the glass fiber liner into position in the pipe. The liner shall have a longitudinal fiberglass reinforcement band which runs the entire length of the liner ensuring that the pulling force is transferred to the band and not the fiberglass liner. Once inserted, end plugs shall be used to cap each end of the glass fiber liner to prepare for pressurizing the liner. The end plugs shall be secured to prevent them from being expelled due to pressure. Liner restraints shall be used in manholes.
- C. A slip sheet shall be installed on the bottom one third to one half of the pipe prior to liner insertion (if it is not already part of the manufactured outer film of the liner), for the purpose of protecting the liner during insertion and reduce the drag, or as recommend by the liner manufacturer.
- D. The glass fiber liner shall be cured with UV light sources at a constant inner pressure. When inserting the curing equipment in the liner, care shall be taken to not damage the inner film material.
- E. The UV light sources shall be assembled according to the manufacturer's specifications for the liner diameter. For the liner to achieve the required water tightness and specified mechanical properties, the following parameters must be controlled during the entire curing process, giving the Engineer a record of the curing parameters over every segment of the entire length of the liner. This demonstrates that the entire liner is cured properly. The recording shall include:
 - 1. Curing speed
 - 2. Light source working & wattage
 - 3. Inner air pressure
 - 4. Curing temperatures
 - 5. Date and time
 - 6. Length of liner
- F. This shall be accomplished using a computer and database that are tamper proof. During the curing process, infrared sensors shall be used to record curing data that will be submitted to the Engineer with a post CCTV inspection.
- G. The optimal curing speed, or travel speed of the energized UV light sources, is determined for each length of liner based on liner diameter, liner thickness, and exothermic reaction temperature. Curing speed shall be as recommended by the manufacturer and determined by contractor based on various site specific field conditions.
- H. If the liner is manufactured with a removable inner film, the inner film material shall be removed and discarded after curing to provide optimal quality of the final product.

3.02 SUBMITTALS

- A. UV GRP Cured-In-Place Pipe - CONTRACTOR shall submit the following:
 - 1. Summary table of CIPP material properties, including short-term flexural modulus of elasticity, 50-year flexural modulus of elasticity, short-term flexural strength (bending stress), 50-year flexural strength (bending stress), and chemical resistance. Certified test reports shall be submitted verifying each value as described below.

2. Independent third party certified laboratory test reports demonstrating that the exact resin/liner combination to be used for this project meets the requirements for initial structural properties and chemical resistance (performed in accordance with ASTM F1216).
3. Independent third party certified laboratory test reports demonstrating that the exact resin and liner to be used for this project has been tested for long-term flexural modulus of elasticity and long-term flexural strength (i.e. 10,000 hour creep testing performed in accordance with ASTM 2990 or DIN 761 for design conditions applicable to this project). When filled resins are proposed, complementary data of the same data for unfilled resin shall also be provided. If the data submitted is not for the exact liner to be used on this project, submit a detailed description of the physical properties of both the liner used in the test and the liner to be used for this project to demonstrate that the two liners are comparable in terms of physical properties.
4. Test shall be performed for 10,000 hours under test conditions and loadings described below. The data points from 1,000 hours to 10,000 hours, or such other time period as determined by the ENGINEER based on the curve or slope of the plotted data, of the Long-term Flexural Modulus shall be extrapolated using a Microsoft Excel log-log scale linear regression analysis to determine the minimum service life performance of the resin-tube.
5. Testing shall be conducted at:
 - a. Temperature 21°C to 25°C
 - b. Relative humidity: 50% minimum
 - c. Load: Load shall be calculated at 0.25% of the short term E-modulus as tested per ASTM D790 or ISO 178, or as approved by ENGINEER.
6. The name of the liner and resin manufacturer, the location of the facility where each was manufactured, and a list of appurtenant materials and accessories to be furnished.
7. Structural design calculations and specification data sheets listing all parameters used in the liner design and thickness calculations based on Appendix X1 of ASTM F2019 for each pipe segment with less than 10% ovality. If the ovality is 10% or greater, use either the ASCE or the WRc Sewerage Rehabilitation Manual, Type II Design, Section 5.3.2.iii for non-round pipe.
8. The quality management system for the wet-out facility must be registered in accordance with and conform to the current ISO 9001 standard. It must ensure that proper materials and amounts are used in the resin saturation process and in liner shipping and storage. At a minimum, the quality control documentation shall include resin lot numbers, volumes of resin, catalyst, enhancers, date of wet-out, storage / transportation controls, and quality assurance procedures.
9. Installation quality control plan, including bypass pumping plans, mainline sewer cleaning plans, cleanliness requirements, liner shot plan and sequence, liner installation standard procedures (including, but not limited to, minimum / maximum allowable installation pressures and speeds certified by the liner manufacturer), intermediate manhole exposed liner restraining method, light train sizing, temperature monitoring plan, odor control procedure, and plan to manage flow to/from laterals during lining.
10. Curing schedule for each lining segment.
11. Available standard written warranty from the manufacturer.

12. The submittal of a Company's Health and Safety Program and all required documents to demonstrate and prove that all employees are Confined Space Entry trained and Rescue trained as well. A site specific Health and Safety Program will be created and submitted for review. All CONTRACTOR employees shall have all training documents submitted prior to work commencing for review.

3.03 WARRANTY

A. All lining work shall be fully guaranteed by the CONTRACTOR for a period of 1 year from the date of Final Acceptance unless otherwise stipulated in writing by the OWNER prior to the date of Conditional Acceptance. During this period, all serious defects discovered by the OWNER or ENGINEER shall be removed and replaced by the CONTRACTOR in a satisfactory manner at no cost to the OWNER. In addition, the OWNER may conduct independent television inspections, at its own expense, of the lining Work at any time prior to the completion of the guarantee period.

3.04 SAFETY

A. The Contractor shall carry out his operations in strict accordance with all applicable OSHA Standards. Particular attention is drawn to those safety requirements involving work on elevated platforms and entry into a confined space. It shall be the Contractor's responsibility to familiarize himself with OSHA Standards and Regulations pertaining to all aspects of this type of work. All equipment used on this project should be safe to operate and designed to eliminate manhole entry. If manhole entry is required, all OSHA guidelines for confined space entry shall be followed.

3.05 NOTIFICATION OF RESIDENTS

A. Prior to starting work, it is the responsibility of the Contractor to notify all residents that the lining process could affect. This notification shall consist of written information that outlines the CIPP process and timing of the project. This notification must be given a minimum of forty-eight (48) hours in advance of work in a given neighborhood.

3.06 BYPASS SEWAGE FLOW

A. Main lines shall be kept in service by bypassing sewage flow around the section or sections of sewer to be lined. The bypass shall be made by plugging the existing upstream manhole or adjacent sewer system. Pump and bypass lines shall be of adequate capacity and size to accommodate the flow without sewer backup. Sewer service connections within the section to be lined shall be temporarily taken out of service by the Contractor to permit relining. The operation of bypass pumping shall be considered incidental to the work. If sewage backup occurs and enters buildings, the Contractor shall be wholly responsible for cleanup, repair, and property damage costs and claims.

3.07 ACCESSIBILITY OF WATER FOR CLEANING

A. The Contractor is required to obtain a portable water meter from the local water department having jurisdiction in the area where lines are being cleaned/lined. All fresh water necessary for performance of work under this contract shall be obtained from approved fire hydrants and metered accordingly per the requirements of the local water department. Requirements of the local water department shall be strictly followed. The

water department may require an initial meter deposit. It is the responsibility of the Contractor to make these arrangements prior to start of this project.

3.08 CLEANING SEWERS

- A. Internal debris shall be removed from the existing pipeline. All roots, debris and protruding service connections shall be removed. Pipes shall be cleaned with hydraulically powered equipment, high-velocity jet cleaners, or mechanically powered equipment. This equipment shall be capable of sufficiently cleaning and clearing the existing pipe. During the sewer cleaning operations, satisfactory precautions shall be taken in the use of cleaning equipment to prevent additional damage to the existing pipe

3.09 TELEVISION INSPECTION

- A. After the sewer section to be lined is thoroughly cleaned, inspection shall be made with a color pan and tilt, 360° rotating head camera specifically designed and constructed for sewer inspection. Each sewer to be televised shall be field investigated to determine the need for plugging to eliminate flow from the line section. Lighting for the camera shall provide a clear picture of the entire periphery of the existing sewer. If the television inspection shows any areas where the sewer inside diameter may be deflected, decreased, or obstructed, the Engineer will coordinate a point repair. The Contractor shall carefully inspect the interior of the pipeline to determine the location of any conditions that may prevent proper installation of the impregnated tube. These conditions may include protruding service taps, collapsed or crushed pipe, and reductions in the cross-sectional area of more than 40%. The Contractor shall note these conditions so that they can be corrected. The original pipeline shall be cleared of these obstructions at the contracted unit price. Protruding taps or service connections which will obstruct or hinder the insertion of the liner, shall be removed to allow the liner to pass through. If inspection reveals an obstruction that cannot be removed by conventional sewer cleaning equipment, then a point repair excavation shall be recommended to remove or repair the obstruction. The Engineer shall be notified immediately when the Contractor has determined the need for a point repair.
- B. Upon completion of the liner installation the CONTRACTOR shall perform a television inspection to document the as-built condition. The CONTRACTOR shall provide two copies of as-built inspection to the OWNER in digital format for review and acceptance by the OWNER.

3.10 SERVICE CONNECTIONS

- A. Existing sewer service connections shall be reinstated through the use of a closed-circuit television camera and a remote-controlled (robotic) cutting device: Inactive sewer service connections shall not be cut. The exact location and number of service connections shall be determined from TV tapes and/or in the field. It shall be the Contractor's responsibility to accurately field locate all existing service connections. The Contractor shall reconnect all service connections to the lined pipe. Experienced operators shall make connections so that no blind attempts or holes are made in the liner pipe. The Contractor shall be responsible for restoring/correcting without any delay, all missed or faulty reconnections, as well as for any damage caused to property owners for not reconnecting the services soon enough or for not giving notice to the owners. All existing

service connections shall be reconnected by remote TV controlled cutting device. All service connections shall be fully opened (95% to 100%) within 24 hours. No partial cuts shall be permitted over a weekend or overnight. When the service connection is reestablished, the invert of the service connection shall match the bottom of the reinstated service opening. The service shall be reinstated from a minimum of 95 percent to a maximum of 100 percent of internal diameter of the original service connection. The sewer service connection cuts shall be uniform and brushed to remove burrs and sharp edges. After all service laterals have been cut, the line section shall be flushed and all coupons from the re-established laterals retrieved. These retrieved coupons shall be properly disposed and not washed down the line. The contractor shall be held responsible for service back-ups caused by accumulated coupons and liner material left in the sewer.

3.11 FIT AND FINISH

- A. The finished liner shall be continuous over the entire length of the sewer section. The finished liner shall tightly conform to the walls of the existing (host) sewer main; therefore, it is the Contractor's responsibility to verify the section lengths and pipe dimensions. No gap or annular space between the finished liner and the existing (host) sewer main shall be visible at the manhole, sewer service connection, or other exposed points within the finished lined section. The finished liner shall be homogeneous throughout and free of any wrinkles, protrusions, holes, cracks, foreign material, blisters, or other deleterious faults or defects, which in the opinion of the Engineer, will affect the liner's structural integrity, hydraulic performance, future maintenance access, and overall line performance.

PART 4. MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

- A. Measurement of CIPP liner shall be by the number of feet, measured from center-to-center of small drainage structures or between open ends including the length of pipe bends and branches. Deductions in length shall not be made for manholes where the distance measured in the direction of flow, including bends, is 6 feet or less.

4.02 PAYMENT

- A. Payment for all inspections is included with the contract unit price of the corresponding pay item.
- B. Payment for accepted quantities shall be made at the contract prices and paid in monthly progress payments for all work performed in that month.

CURED-IN-PLACE PIPE (CIPP) INSTALLATION

PERFORMANCE SPECIFICATION GUIDELINE (PSG)

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Disclaimer

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EFFECTIVE SPECIFICATIONS

Effective specifications should encourage the most innovative, efficient and experienced contractor to provide the level of quality required by the Owner at the best and lowest competitive price

The specification should not strive to encourage the contractor to seek the cheapest approach and product delivery available to provide the lowest price.

Effective specifications are critical for project success, which includes:

1. Product selection for the best solution.
2. Definition of project goals and requirements, both short and long term.
3. Construction means and methods as defined, in writing, by the contractor.
4. Product provided and installed as specified by the product manufacturer.
5. Product quality and quantity confirmed through inspection and testing.
6. Product design and service life verified through warranty inspection.

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PERFORMANCE SPECIFICATIONS

NASSCO recommends performance specifications that require the contractor to use superior skill, experience and innovative means available to deliver a specified product at a defined level of quality at a competitive price. This requires that the contractor, not the engineer, define the means and methods by submitting a detailed Performance Work Statement (PWS) before the project begins.

PART 1 - GENERAL

This performance specification guideline (PSG) is for the rehabilitation of gravity sewers, either sanitary or storm, by the installation of cured-in-place-pipe (CIPP).

- A. This PSG includes the minimum requirements for the rehabilitation of sanitary and storm sewer pipelines by the installation of Cured-In-Place Pipe (CIPP) within the existing, deteriorated pipe as shown on the plans included as part of these contract documents.
- B. The rehabilitation of pipelines shall be done by the installation of a resin-impregnated flexible tube which, when cured, shall be continuous and tight-fitting throughout the entire length of the original pipe. The CIPP shall extend the full length of the original pipe and provide a structurally sound, jointless and water-tight new pipe-within-a-pipe. The Contractor is responsible for proper, accurate and complete installation of the CIPP using the system selected by the Contractor meeting the Owners requirements.
- C. Neither the CIPP product, system, nor its installation, shall cause adverse effects to any of the Owner's processes or facilities. The installation pressure for the product shall not damage the system in any way, and the use of the product shall not result in the formation or production of any detrimental compounds or by-products at the wastewater treatment plant. The Contractor shall notify the Owner and identify any by-products produced as a result of the installation operations, test and monitor the levels, and comply with any and all local waste discharge requirements. The Contractor shall cleanup, restore existing surface conditions and structures, and repair any of the CIPP system determined to be defective. The Contractor shall conduct installation operations and schedule cleanup in a manner to cause the least possible obstruction and inconvenience to traffic, pedestrians, businesses and property owners or tenants.
- D. The prices submitted by the Contractor, shall include all costs of permits, labor, equipment and materials for the various bid items necessary for furnishing and installing, complete in place, CIPP in accordance with these specifications. All items of work not specifically mentioned herein which are required, by the contractor, to make the product perform as intended and deliver the final product as specified herein shall be included in the respective lump sum and unit prices bid.

1.1 DESCRIPTION OF WORK AND PRODUCT DELIVERY

The specifications must include a detailed description of the work required including all products that are to be included in the installation, and what is to be delivered by the contractor.

- A. This PSG covers all work necessary to furnish and install the CIPP. The Contractor shall provide all materials, labor, equipment, and services necessary for traffic control, bypass pumping and/or diversion of flows, cleaning and television inspection of sewers to be rehabilitated, liner installation, reconnection of service connections, all quality controls, provide samples for performance of required material tests, final television inspection, testing of the rehabilitated pipe system, warranty work and other work, all as specified herein.
- B. The product furnished shall be a complete CIPP system including specific materials, applicable equipment and installation procedures. The CIPP system manufacturer may submit, a minimum of 14 calendar days in advance of the bid date, required information to the Owner to obtain pre-approval status. Those CIPP systems that have been pre-approved will not be required to furnish information as required in the submittal section of these specifications unless specifically requested to do so by the Owner or if any of the CIPP system components have changed from those pre-approved by the Owner. All other CIPP systems or multi-component products will be required to meet the submittal requirements as contained herein.
- C. The CIPP shall be continuous and jointless from manhole to manhole or access point to access point and shall be free of all defects that will affect the long-term life and operation of the pipe.
- D. The CIPP shall fit sufficiently tight within the existing pipe so as to not leak at the manholes, at the service connections or through the wall of the installed pipe. If leakage occurs at the manholes or the service connections, the Contractor shall seal these areas to stop all leakage using a material compatible with the CIPP as directed by the Owner at the price bid in the Proposal. If leakage occurs through the wall of the pipe, the CIPP shall be repaired or removed as recommended by the CIPP manufacturer. Final approval of the CIPP will be based on a leak tight pipe.
- E. The CIPP shall be designed for a life of 50 years or greater and an equal service life unless specifically specified otherwise by the Owner.
- F. The CIPP may be designed to resist external groundwater pressures only or as a fully structural stand-alone pipe-within-a-pipe. If the design is for groundwater, only the design groundwater level is required for external loads. If specified in the contract documents, the installed CIPP shall be a structurally designed pipe-within-a-pipe, meet or exceed all contract specified physical properties, fitting tightly within the existing pipe all within the tolerances specified. The installed CIPP shall withstand all applicable surcharge loads (soil overburden, live loads, etc.) and external hydrostatic (groundwater) pressure, if present, for each specific installation location.

- G. The installed CIPP shall have a long term (50 year) corrosion resistance to the typical chemicals found in domestic sewage and defined in the referenced and applicable ASTM standards
- H. All existing and confirmed active service connections and any other service laterals to be reinstated, as directed by the Owner, shall be re-opened robotically or by hand in the case of man-entry size piping, to their original shape and to 90% - 95% of their original area. All over-cut or under-cut service connections will be properly repaired to meet the requirements of these specifications.
- I. All materials furnished, as part of this contract shall be marked with detailed product information, stored in a manner specified by the manufacturer and tested to the requirement of this contract.
- J. Testing and warranty inspections shall be executed by the Owner. Any defects found shall be repaired or replaced by the Contractor.
- K. The Contractor shall furnish, from the project installation, all samples for product testing at the request of the Owner. The Owner shall take possession of the samples for testing and shall maintain the chain of custody, deliver the samples to an approved laboratory and pay for all material and product testing performed under this contract.

1.2 REFERENCES

All applicable reference documents should be listed in this section. If a document does not apply, is not pertinent or has unknown content, it should not be included. Specific reference document requirements should be defined in the contract documents or by reference to a specific section of the document. Specific contractor requirements and/or test procedures contained in the references should be defined in detail in the contract documents

- A. The following documents form a part of this specification to the extent stated herein and shall be the latest editions thereof. Where differences exist between codes and standards, the requirements of these specifications shall apply. All references to codes and standards shall be to the latest revised version.

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 Pull in and Inflate and Curing of a Resin-Impregnated Tube

ASTM - D543 Standard and Practice for Evaluating the Resistance of Plastics to Chemical Reagents

ASTM - D638 Standard Test Method for Tensile Properties of Plastics

ASTM - D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

ASTM - D792 Standard Test Methods for Density and Specific Gravity of Plastics by Displacement.

ASTM - F2019 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 Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

ASTM F2561 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 - D3567 Standard Practice for Determining Dimensions of Fiberglass (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings

ASTM - D3681 Standard Test Method for Chemical Resistance of "Fiberglass (Glass Fiber Reinforced Thermosetting Resin) Pipe in a Deflected Condition

ASTM - D5813 Standard Specification for Cured-in Place Thermosetting Resin Sewer Pipe

1.3 PERFORMANCE WORK STATEMENT (PWS) SUBMITTAL

In place of the engineer defining the specific method for product installation, the contractor defines the installation means and methods through a written plan called the Performance Work Statement (PWS). During construction the PWS provides valuable information to the inspector so that the inspector can determine if the submitted means and methods are being followed by the contractor. The PWS also outlines the necessary quality checks to be performed and the installation crew qualifications.

- A. The Contractor shall submit, to the Owner a Performance Work Statement (PWS) which clearly defines the CIPP product delivery in conformance with the requirements of these contract documents. Unless otherwise directed by the Owner, the PWS shall at a minimum contain the following:
- B. Clearly indicate that the CIPP will conform to the project requirements as outlined in the Description of Work and as delineated in these specifications.
- C. Where the scope of work is specifically delineated in the contract documents, 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 all else necessary and appropriate for a complete liner installation. A detailed installation schedule shall be prepared, submitted and conform to the requirements of this contract.
- D. Contractor's description of the proposed CIPP technology, including a detailed plan for identifying all active service connections maintaining service, during mainline

installation, to each home connected to the section of pipe being lined, including temporary service for commercial, industrial and apartment complexes, if required by the contract.

- E. A description of the CIPP materials to be furnished for the project. Materials shall be fully detailed in the submittals and conform to these specifications and/or shall conform to the pre-approved product submission.

Crew experience is important, especially on difficult or large diameter projects. Resumes of lead personnel should be submitted, and the inspector should confirm that these individuals are on the project. If the contractor replaces personnel, resumes should be submitted for the new individuals to the inspector. The replacements should have experience equal to those originally submitted for the project.

- F. A statement of the Contractors experience. The Contractor shall have a minimum of three (3) years of continuous experience installing CIPP in pipe of a similar size, length and configuration as contained in this contract. A minimum of 150,000 linear feet of shop wet-out liner installation is required and minimum of 6 onsite wet-out installations are required as specifically applicable to this contract. The lead personnel including the superintendent, the foreman and the lead crew personnel for the CCTV inspection, resin wet-out, the liner installation, liner curing and the robotic service reconnections each must have a minimum of three (3) years of total experience with the CIPP technology proposed for this contract and must have demonstrated competency and experience to perform the scope of work contained in this contract. The name and experience of each lead individual performing work on this contract shall be submitted with the PWS. Personnel replaced by the contractor, on this contract, shall have similar, verifiable experience as the personnel originally submitted for the project

If the design calculations include physical properties greater than the minimum properties listed in these specifications, the physical properties included in the design calculations become the minimum acceptable values when testing field samples.

- G. Engineering design calculations, in accordance with the Appendix of ASTM F1216, 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. All calculations shall include data that conforms to the requirements of these specifications or has been pre-approved by the Owner.

- H. Proposed manufacturers technology data shall be submitted for all CIPP products and all associated technologies to be furnished.

Reinstating service laterals is a critical operation for completing small diameter CIPP installations. This specialty type equipment is not readily available for rent from local equipment rental companies. Because of this, often redundant robotic cutters are specified for small diameter projects with service laterals.

- I. Submittals shall include information on the cured-in-place pipe intended for installation and all tools and equipment required for a complete installation. The PWS shall identify which tools and equipment will be redundant on the job site in the event of equipment 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.

Non-specialty backup equipment should be identified and reserved by the contractor (on will call) from local rental companies in the event of equipment failure.

- J. 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.

Proper public notification can prevent many public relations issues during a project. If the residents know that there will be workers and equipment near their homes, that they should not use large volumes of water or that they may smell strange odors, many homeowner concerns and problems can be prevented.

- K. A detailed public notification plan shall be prepared and submitted including detailed staged notification to residences affected by the CIPP installation.

A CIPP installation typically includes the use of polyester resins. The resin emits a distinctive odor from the styrene component in the resin. Even though not harmful in small concentrations, it does emit an odor that is considered a nuisance. To minimize this nuisance odor the contractor should devise an odor control plan that will mitigate the nuisance effect to the general public and residents at the project site during the liner installation

- L. An odor control plan shall be submitted, by the contractor, that will ensure that project specific odors will be minimized at the project site and surrounding area.
- M. Compensation for all work required for the submittal of the PWS shall be included in the various pipelining items contained in the Proposal.

1.4 PRODUCT SUBMITTALS

Product submittals require the contractor to submit the materials to be incorporated in the installation. This also allows the contractor to submit alternative materials that may be equal or better than those specified. The engineer must be prepared to evaluate alternative materials through evaluation, certifications and third party testing to validate the alternative materials to meet the specified requirements of the contract.

This section includes a list of all significant CIPP products and procedures that should be included in the submittal package. These include the two principal products, the tube and the resin, in addition to handling and storing these items from the manufacturing plant to the wet-out facility. Also included are detailed procedures for wet-out, installation and curing.

- A. Fabric Tube – including the manufacturer and description of product components such as felts and reinforcing materials.
- B. Flexible membrane (coating) material – including materials specific to the proposed curing method and recommended repair (patching) procedure if applicable.
- C. Raw Resin Data - including the manufacturer and description of product components including the Spectroscopic Wavelength diagram for the resin being furnished
- D. Manufacturers' shipping, storage and handling recommendations for all components of the CIPP system.
- E. All Safety Data Sheets (SDS) for all materials to be furnished for the project.
- F. Tube wet-out & cure method including:
 - 1. A complete description of the proposed wet-out procedure for the proposed technology.
 - 2. The Manufacturer's recommended cure method for each diameter and thickness of liner to be installed. The PWS shall contain a detailed curing procedure outlining the curing medium, the method of application and how the curing temperatures will be monitored.
- G. Compensation for all work required for the submittal of product data shall be included in the Lump Sum price contained in the Proposal for Mobilization.

Worker safety should be the number one priority on a job site. No work should start until the contractor submits a safety plan, and all work should be conducted in accordance with the safety plan. The plan should be sufficiently detailed to describe daily safety meeting requirements, procedures and documentation. Emergency procedures and location of medical facilities should be identified

1.5 SAFETY

- A. The Contractor shall conform to all work safety requirements of pertinent regulatory agencies, and shall secure the site for the working conditions in compliance with the same. The Contractor shall erect such signs and other devices as are necessary for the safety of the work site.
- B. The Contractor shall perform all of the Work in accordance with applicable OSHA standards. Emphasis shall be placed upon the requirements for entering confined spaces and with the equipment being utilized for pipe renewal.
- C. The Contractor shall submit a proposed Safety Plan to the Owner, prior to beginning any work, identifying all competent persons. The plan shall include 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.
- D. Compensation for all work required for the submittal of the Safety Plan shall be included in the various pipelining items contained in the Proposal.

1.6 QUALITY CONTROL PLAN (QCP)

A detailed Quality Control Plan (QCP) should be submitted by the contractor. The QCP should include a discussion of the proposed quality controls to be performed by the contractor during installation including material protection and handling, equipment operation and documentation requirements. The contractor personnel, including names and cell phone numbers for those that are responsible for assuring that all quality requirements are met, should be identified and submitted

- A. A detailed quality control plan (QCP) shall be submitted to the Owner that fully represents and conforms to the requirements of these specifications. At a minimum the QCP shall include the following:
 - 1. A detailed discussion of the proposed quality controls to be performed by the Contractor.

2. Defined responsibilities, of the Contractor's personnel, for assuring that all quality requirements for this contract are met. These shall be assigned, by the Contractor, to specific personnel.
3. Proposed procedures for quality control, product sampling and testing shall be defined and submitted as part of the plan.
4. 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.
5. Scheduled performance and product test result reviews between the Contractor and the Owner at a regularly scheduled job meeting.
6. Inspection forms and guidelines for quality control inspections shall be prepared in accordance with the standards specified in this contract and submitted with the QCP.

Two very important aspects of a successful CIPP project are a well written and detailed performance specification and an educated inspector that understands the key aspects of CIPP and the quality control procedures required on a project. The inspector should be trained and knowledgeable in where the product is applicable, technology procedures, material wet-out, curing requirements, acceptability standards and required testing.

- B. Two (2) days of inspector training, by the CIPP system manufacture, for the Owners inspectors shall be provided. This training shall be prior to liner installation, include both technical and field training and include all key aspects of visual inspection and sampling procedures for testing requirements. On smaller projects having an estimated duration of less than two (2) weeks of installation work, the system manufacturer shall furnish a check list containing key elements of the CIPP installation criteria that are important for the Owners inspector to ensure that quality control and testing requirements are performed in accordance with the contract documents.
- C. Compensation for all work required for the submittal of the QCP shall be included in the various pipelining items contained in the Proposal. Compensation for inspector training shall be included in the price bid in the Proposal.

1.7 CIPP REPAIR/REPLACEMENT

As part of the PWS, the contractor should submit repair and replacement procedures for common CIPP defects. Defects should be categorized as those that need no repair, those that can be repaired and those that must be removed and replaced. Defects that affect the operation or longevity of the CIPP should be repaired or replaced.

- A. Occasionally installations will result in the need to repair or replace a defective CIPP. The Contractor shall outline specific repair or replacement procedures for potential defects that may occur in the installed CIPP. Repair/replacement procedures shall be as recommended by the CIPP system manufacturer and shall be submitted as part of the PWS.
- B. Defects in the installed CIPP that will not affect the operation and long term life of the product shall be identified and defined.
- C. Repairable defects that may occur in the installed CIPP shall be specifically defined by the Contractor based on manufacturer's recommendations, including a detailed step-by-step repair procedure, resulting in a finished product meeting the requirements of these contract specifications.
- D. Unrepairable defects that may occur to the CIPP shall be clearly defined by the Contractor based on the manufacturer's recommendations, including a recommended procedure for the removal and replacement of the CIPP.

1.8 AS-BUILT DRAWINGS/RECORDS

As-Built drawings/records include the identification of the work completed by the contractor and should include the pre and post inspection documentation. As-Built drawings /records should be kept current and should be available on the project site at all times. As-Built drawings/records can be in the form of actual drawings, either paper or electronic, spreadsheets or Word documents.

- A. As-Built drawings/records, pre & post inspection videotapes, CDs or other electronic media shall be submitted to the Owner, by the Contractor, within 2 weeks of final acceptance of said work or as specified by the Owner. As-Built drawings/records will include the identification of the work completed by the Contractor and shall be prepared on one set of Contract Drawings/Records provided to the Contractor at the onset of the project.
- B. As-Built drawings/records shall be kept on the project site at all times, shall include all necessary information as outlined in the PWS or as agreed to by the Owner and the Contractor at the start of the Contract, shall be updated as the work is being completed and shall be clearly legible.

- C. Compensation for all work required for the submittal and approval of As-Built drawings/records shall be included in the various pipelining items contained in the Proposal.

1.9 WARRRANTY

The contractor should warrant the CIPP material and installation for a period as specified. If required by the Owner, the contractor should warrant any defective work that has been repaired for an extended period as agreed. After completion of the work but before the warranty period has expired, the owner should inspect a portion of the rehabilitated system. Initial warranty inspection should include up to 15% of the completed work. The warranty inspection should be based on the recommendations documented by the project inspector during the execution of the project. Any defects found should be handled in accordance with the repair/replacement plan submitted in the PWS. Depending on the frequency of defects found, the Owner may require more installations inspections as necessary.

- A. The materials used for the project shall be certified by the manufacturer for the specified purpose. The Contractor shall warrant the CIPP material and installation for a period of one (1) year. During the Contractor warranty period, any defect which may materially affect the integrity, strength, function and/or operation of the pipe, shall be repaired at the Contractor's expense in accordance with procedures included in Section 1.7 CIPP Repair/Replacement and as recommended by the manufacturer.
- B. On any work completed by the contractor that is defective and/or has been repaired, the contractor shall warrant this work for (1) year in addition to the warrantee required by the contract.
- C. After a pipe section has been rehabilitated and for a period of time up to one (1) year following completion of the project, the Owner may inspect all or portions of the rehabilitated system. The specific locations will be selected at random by the Owner's inspector and should include all sizes of CIPP from this project. If it is found that any of the CIPP has developed abnormalities since the time of "Post Construction Television Inspection," the abnormalities shall be repaired and/or replaced as defined in Section 1.7 CIPP Repair/Replacement and as recommended by the manufacturer. If, after inspection of a portion of the rehabilitated system under the contract, problems are found, the Owner may televise all the CIPP installed on the contract. All verified defects shall be repaired and/or replaced by the Contractor and shall be performed in accordance with Section 1.7 CIPP Repair/Replacement and per the original specifications, all at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

The cured CIPP product must meet the chemical resistance requirements specified as referenced in ASTM F1216 and ASTM D5813. The tested product should be of the same type tube and resin used on the project. Chemical resistance testing is a qualification test that is typically completed by the resin manufacturer who then certifies that the product meets the specified requirement. This certification, which can be accompanied by the test report, is submitted by the contractor prior to the start of the project.

- A. The CIPP System must meet the chemical resistance requirements of these contract documents.
- B. 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 Owner. 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.

2.2 FABRIC TUBE

The fabric tube is the vehicle that carries the resin into the pipeline and holds the resin in place prior to and during cure. The thickness of the fabric tube will determine the finished thickness of the CIPP. A properly designed and specified fabric tube is critical to achieving the specified finished CIPP thickness.

- A. The fabric tube shall consist of one or more layers of absorbent non-woven felt fabric, felt/fiberglass, felt/carbon fiber, carbon fiber or fiberglass and meet the requirements of ASTM F 1216, ASTM F 1743, or ASTM F2019 and ASTM D5813. 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. 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.
- B. 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.

- C. 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 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. 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 pipelines in the field prior to ordering liner so that the liner can be installed in a tight-fitted condition.
- D. 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.
- E. No material shall be included in the fabric tube that may cause delamination in the cured CIPP. No dry or unsaturated layers shall be acceptable upon visual inspection as evident by color contrast between the tube fabric and the activated resin containing a colorant.
- F. 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.
- G. Seams in the fabric tube, if applicable, shall meet the requirements of ASTM D5813.
- H. The outside of the fabric tube shall be marked a maximum of every 5 feet with the name of the manufacturer or CIPP system, manufacturing lot and production footage.
- I. The minimum length of the fabric tube shall be that deemed necessary by the installer to 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.
- J. The nominal fabric tube wall thickness shall be constructed, as a minimum, to the nearest 0.5 mm increment, rounded up from the design thickness for that section of installed CIPP. Wall thickness transitions, in 0.5 mm 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.

2.3 RESIN

In felt tube CIPP the resin is the structural pipe. In reinforced tube CIPP, the resin is important in providing the structural matrix so that the reinforcing fibers can significantly increase the CIPP's physical properties. Thus, it is important that the applicable resin for the pipe's flow characteristics is specified and delivered to the wet-out facility. The engineer should verify that the resin specified or substituted by the contractor meets the contract specified requirements. The inspector should verify that the specified or approved resin is supplied by the contractor and correct amount of resin is added to the tube at the wet-out facility. This information can be verified from the Spectroscopic Wavelength Diagram of the resin, the tube wet-out report and standard resin saturation charts furnished from the suppliers of the resin and tube.

- A. 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 and ASTM D5813, the physical properties herein, and those which are to be utilized in the design of the CIPP for this project. The resin, specified for the specific application defined in the contract documents, shall produce CIPP which will comply with or exceed the structural and chemical resistance requirements of this specification.
- B. The resin to tube ratio, by volume, shall be furnished as recommended by the manufacturer.

2.4 STRUCTURAL REQUIREMENTS

Typically the minimum physical properties of the resin material are specified, and, with this data, the contractor submits a CIPP wall thickness design with the PWS submittal. If the physical properties used in the wall thickness design exceed the minimum properties specified, the contractor must meet the higher physical properties determined during CIPP sample testing.

- A. The physical properties and characteristics of the finished CIPP will vary considerably, depending on the types and mixing proportions of the materials used and the degree of cure executed. It shall be the responsibility of the Contractor to control these variables and to provide a CIPP system which meets or exceeds the minimum properties specified herein.
- B. The CIPP shall be designed as per ASTM F1216 Appendixes. The CIPP design shall assume no bonding to the original pipe wall.

- C. The design engineer shall set the long-term (50 year extrapolated) Creep Retention Factor at 50% of the initial design flexural modulus as determined by ASTM D790 test method. This value shall be used unless the Contractor submits long-term test data (ASTM D2990) to substantiate a higher retention factor.
- D. The cured pipe material (CIPP) shall, at a minimum, meet or exceed the structural properties, as listed below.

2.5 MINIMUM PHYSICAL PROPERTIES

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

- A. The required structural CIPP wall thickness shall be based, as a minimum, on the physical properties of the cured composite and per the design of the Professional Engineer (see section 1.3.G) and in accordance with the Design Equations contained in the appendix of ASTM F1216, and the following design parameters:

Design Safety Factor	2.0 (1.5 for pipes 36" or larger, if applicable)
Creep Retention Factor	50%
Ovality	2% or as measured by field inspection
Constrained Soil Modulus	Per AASHTO LRFD Section 12 and AWWA Manual M45
Groundwater Depth	As specified or indicated on the Plans
Soil Depth (above the crown)	As specified or indicated on the Plans
Live Load	Highway, railroad or airport as applicable
Soil Load (assumed)	120 lb./cu. ft.
Minimum Service Life	50 years

- B. The Contractor shall submit, prior to installation of the lining materials, certification of compliance with these specifications and/or the requirements of the pre-approved CIPP system. Certified material test results shall be included that confirm that all

materials conform to these specification and/or the pre-approved system. Materials not complying with these requirements will be rejected.

- C. The design soil modulus may be adjusted based on data, determined from detailed project soil testing results, as provided by the Owner in the contract documents.

PART 3 - INSTALLATION

3.1 CONSTRUCTION REQUIREMENTS

The construction requirements cover all on-site activities needed for a proper installation the CIPP product. All of these activities (cleaning, inspection, bypass, etc.) should have been explained in detail in the PWS submitted by the contractor. Inspection and testing requirements, during construction, should be clearly defined for the contractor and the inspector.

- A. Preparation, cleaning, inspection, flow bypassing and public notification. The Contractor shall clean the interior of the existing host pipe prior to installation of the liner. All debris and obstructions that will affect the installation and the final CIPP product delivery to the Owner shall be removed and disposed of.
- B. The liner shall be constructed of materials and methods that, when installed, shall provide a jointless and continuous structurally sound CIPP able to withstand all imposed static, and dynamic loads on a long-term basis.
- C. The Contractor may, under the direction of the Owner, utilize any of the existing manholes in the project area as installation access points. If a street must be closed to traffic because of the location of the sewer, the Contractor shall furnish a detailed traffic control plan and all labor and equipment necessary. The plan shall be in conformance with the requirements of the local agency having jurisdiction over traffic control.
- D. Cleaning of Pipe Lines – Before ordering liner materials for the project, the Contractor shall remove all internal debris from the pipe line that will interfere with the installation and the final product delivery of the CIPP, as required in these specifications, and accurately measure and document the exact size of the existing pipeline to be rehabilitated. Solid debris and deposits shall be removed from the system and disposed of properly by the Contractor. Moving material from manhole section to manhole section shall not be allowed. As applicable, the contractor shall either plug or install a flow bypass pumping system to properly clean the pipe lines. Precaution shall be taken by the Contractor in the use of cleaning equipment to avoid damage to the existing pipe. The repair of any damage, caused by the cleaning equipment, shall be the responsibility of the Contractor. The Owner will designate a site for the disposal of all debris removed from the Owner's sewer system as a direct result of the cleaning operation. Unless otherwise specified by the Owner, the Contractor shall dispose of

all debris at no charge. Should any dumping fees apply, the Contractor shall be compensated at the respective unit price bid in the Proposal for cleaning.

- E. Bypassing Existing Flows - The Contractor shall provide for the flow of existing mainline and service connection effluent around the section or sections of pipe designated for CIPP installation. With most small diameter pipelines, particularly on terminal sewers, plugging will be adequate but must be monitored on a regular basis to prevent backup of sewage into adjacent homes. Service connection effluent may be plugged only after proper notification to the affected residence and may not remain plugged overnight. Installation of the liner shall not begin until the Contractor has installed the required plugs or a sewage bypass system and all pumping facilities have been installed and tested under full operating conditions including the bypass of mainline and side sewer flows. Once the installation has begun, existing flows shall be maintained, until the resin/tube composite is fully cured, cooled down, full televised and the CIPP ends finished. The Contractor shall coordinate sewer bypass and flow interruptions with the Owner at least 14 days in advance and with the property owners and businesses at least 1 business day in advance. The pump and bypass lines shall be of adequate capacity and size to handle peak flows. The Contractor shall submit a detail of the bypass plan and design to the Owner before proceeding with any CIPP installation. Compensation for bypass pumping and all associated plans and approvals shall be at the price bid in the Proposal.
- F. Contractor shall perform post-cleaning video inspections of the pipelines. Only PACP certified personnel trained in locating breaks, obstacles and service connections by closed circuit television shall perform the inspection. The Contractor shall provide the Owner a copy of the pre-cleaning and post-cleaning video and suitable log, and/or in digital format, for review prior to installation of the CIPP and for later reference by the Owner.
- G. Line Obstructions - It shall be the responsibility of the Contractor to clear the line of obstructions that will interfere with the installation and long-term performance of the CIPP. If pre-installation inspection reveals an obstruction, misalignment, broken or collapsed section or sag that was not identified as part of the original scope of work and will prohibit proper installation of the CIPP, the Contractor may be directed by the Owner to correct the problem(s) prior to installation by utilizing open cut repair methods. The Contractor shall be compensated for this work under a contingency pay item designated for open cut point repairs. Removal of any previously unknown obstructions shall be considered as a changed condition. The cost of removal of obstructions that appeared on pre-bid video documentation and made available to the Contractor, prior to the bid opening, shall be compensated for on a unit price basis in accordance with the contract documents.
- H. The Contractor shall be responsible for confirming the locations of all branch service connections prior to installing the CIPP. If required in the contract documents, each

connection will be dye tested to determine whether or not the connection is live or abandoned. The cost for dye testing of existing service connections shall be compensated at the unit price bid in the Proposal for Dye Testing of Existing Service Connections. In the event the status of a service connection cannot be adequately defined, the Owner will make the final decision, prior to installation of the liner, as to the status. Typically only service connections deemed “active” shall be reopened by the Contractor.

- I. The Contractor shall be allowed use water from an owner-approved fire hydrant in the project vicinity. Use of an approved double check backflow assembly shall be required. Contractor shall provide his own approved assembly. Contractor shall pay current market price for all water usage.

3.2 INSTALLATION OF LINER

It is important that the CIPP be installed in accordance with the manufacturer’s recommendations. These procedures should have been outlined in detail in the PWS submitted by the contractor. Some key procedure that should be maintained include: Installation speed and pressure, the cure schedule and curing temperature monitoring must be maintained and documented, as recommended by the manufacturer. A pre-liner should be installed where the infiltration into the pipeline is excessive and may affect the cure and/or the final structure of the CIPP.

- A. The liner shall be installed and cured in the host pipe per the manufacturer’s specifications as described and submitted in the PWS.
- B. CIPP installation shall be in accordance with the applicable ASTM standards as modified in this section 3.2.
- C. If significant groundwater infiltration is present in the existing sewer such as heavy runners and gushers, the contractor shall install a pre-liner tube or perform chemical grouting to control resin loss and contamination, maintain CIPP thickness, prevent physical property reduction and prevent inadequate curing of the liner resulting from water or other contamination of the resin during installation. The pre-liner tube shall be a reinforced plastic tube to fit the existing pipeline and shall be continuous from manhole (access) to manhole (access).
- D. 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 liner should be pulled-in or inverted through an existing manhole or approved access point and fully extend to the next designated manhole or termination point.
- E. 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.

- F. To monitor the temperature of the liner wall and to verify correct curing, where specified by the contract documents, temperature monitors can be placed between the host pipe and the liner in the bottom of the host pipe (invert) at manholes or access points and/or throughout its entire length (continuous) to monitor the temperature on the outside of the liner during the curing process. For continuous temperature monitoring, a fiber optic cable is installed in the pipe invert prior to the liner installation. The fiber optic cable is monitored by a computer that is capable of recording temperatures at the interface of the liner and the host pipe continuously in time and location throughout the entire pipeline being rehabilitated.

Monitoring curing temperatures is important for verifying the correct cure of the resin. Temperatures can be monitored continuously in time and location throughout the pipeline being rehabilitated by using a fiber optic cable sensing system. Continuous monitoring systems are computer controlled with a real-time screen display, and can be monitored by any smart device. This is especially useful for critical sewers and medium to large diameter sewers. As a minimum, standard thermocouples, which measure temperatures at one point, should be used, typically at the pipe invert in the termination manhole. Often thermocouples are used in addition to continuous monitoring systems to verify proper cure of the CIPP

- G. Curing shall be accomplished by utilizing the appropriate medium or ultraviolet light in accordance with the manufacturer's recommended cure procedure and/or 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 & 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 of soil, per ASTM as applicable, shall be taken into account by the Contractor.
- H. For heat cured liners, if any temperature sensor, or continuous sensor location does not reach the temperature as specified by the manufacturer to achieve proper curing or cooling, the installer can make necessary adjustments to comply with the manufacturer's recommendations. For continuous temperature monitoring, the system computer should have an output report that specifically identifies stations along the length of pipe, indicates the maximum temperature achieved and the sustained temperature time at the stations. At each station along the length of the pipe, the computer should record both the maximum temperature and the minimum cool down temperature and comply with the manufacturers recommendations.
- I. For UV Cured Liners, all light train sensor readings, 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.

3.3 COOL DOWN

Proper cool down of CIPP is important to help minimize CIPP shrinkage and cracking. The temperature profile and times required should be provided as a part of the cure schedule. Short cuts that reduce the cool down time should not be allowed.

- A. The Contractor shall cool the CIPP in accordance with the approved CIPP manufacturer's recommendations as described and outlined in the PWS.
- B. Temperatures and curing data shall be monitored and recorded, by the Contractor, throughout the installation process to ensure that each phase of the process is achieved as approved in accordance with the CIPP System manufacturer's recommendations.

3.4 FINISH

Any defect which could affect the structural integrity or longevity of the CIPP should be repaired. Sealing the ends of the CIPP at manholes and at service connection openings is important in cases where the sewer is below the groundwater surface elevation. Leaks through the wall of the CIPP are considered a defect.

- A. The installed CIPP shall be continuous over the entire length of a sewer line section and be free from visual defects such as foreign inclusions, dry spots, pinholes, major wrinkles and delamination. The CIPP shall be impervious and free of any leakage through the CIPP wall.
- B. Any defect which will or could affect the structural integrity or strength of the CIPP shall be repaired at the Contractor's expense in accordance with the procedures submitted under Section 1.7 CIPP Repair/Replacement.
- C. The beginning and end of the CIPP shall be sealed to the existing host pipe. The sealing material shall be compatible with the pipe end and shall provide a watertight seal.

- D. If any of the service connections leak water between the host pipe and the installed CIPP, the connection mainline interface shall be sealed to provide a water tight connection.
- E. If the wall of the CIPP leaks, it shall be repaired or removed and replaced with a watertight pipe as recommended by the manufacture of the CIPP system.
- F. Compensation shall be at the actual length of cured-in-place pipe installed. The length shall be measured from center of manhole to center of manhole. The unit price per linear foot installed shall include all materials, labor, equipment and supplies necessary for the complete CIPP installation. Compensation for service connection sealing and pipe sealing at the manhole/wall interface shall be at the unit price bid in the Proposal.

The long-term structural capability of the existing underground pipeline is defined by the pipe design and the surrounding soil structure. When a CIPP is installed through an existing pipe that represents such defects as soil visible or soil missing, the engineer should consider that the soils be replaced using a flowable fill technique to provide soils support for the newly installed CIPP.

3.5 FLOWABLE FILL OF VOID AREAS

Where required by the owner, the contractor shall backfill voids that remain after installation of CIPP. The material shall be of the flowable fill type and shall be injected into the void while removing all trapped air from the void. The contractor shall submit the proposed method of placing the flowable fill, including pressures that will not collapse the CIPP and air release method to be employed, to the owner for review before any material is installed. The cost of this work shall be at the unit price bid for flowable fill complete and include all material, equipment and labor to complete the filling of the soil void.

3.6 MANHOLE CONNECTIONS AND RECONNECTIONS OF EXISTING SERVICES

The most common method of sealing the CIPP at manholes is to install a hydrophilic rubber seal prior to installing the CIPP. Sealing the CIPP at manholes after the CIPP has been installed is possible but less effective. Side connections should be cut open to at least 90%-95% of the original service connection opening area. In all cases, the invert of the lateral connection shall be cut flush with the invert entering the mainline to eliminate debris build-up.

- A. A seal, consisting of a resin mixture or hydrophilic seal compatible with the installed CIPP, shall be applied at manhole/wall interface in accordance with the CIPP System manufacturer's recommendations.
- B. Existing services shall be internally or externally reconnected unless indicated otherwise in the contract documents

- C. Reconnections of existing services shall be made after the CIPP has been installed, fully cured, and cooled down. It is the Contractor's responsibility to make sure that all active service connections are reconnected.
- D. External reconnections are to be made with a tee fitting in accordance with CIPP System manufacturer's recommendations. Saddle connections shall be seated and sealed to the new CIPP using grout or resin compatible with the CIPP.
- E. A CCTV camera and remote cutting tool shall be used for internal reconnections. The machined opening shall be at least 90 percent of the service connection opening area and the bottom of both openings must match. The opening shall not be more than 100 percent of the service connection opening. The edges of the opening shall not have pipe fragments or CIPP fragments which may obstruct flow or snag debris. In all cases the invert of the sewer connection shall be cut flush with the invert entering the mainline.
- F. In the event that service reinstatements result in openings that are greater than 100 percent of the service connection opening, the Contractor shall install a CIPP type repair, sufficiently in size to completely cover the over-cut service connection. No additional compensation will be paid for the repair of over-cut service connections.
- G. Coupons of pipe material resulting from service tap cutting shall be collected at the next manhole downstream of the pipe rehabilitation operation prior to leaving the site. Coupons may not be allowed to pass through the system.
- H. Compensation shall be at the actual number of services reconnected using either internal or external means as contained in the Proposal. The unit price bid per service line reconnected shall include all materials, labor, equipment and supplies necessary to complete the work as required in these specifications.

3.7 TESTING OF INSTALLED CIPP

CIPP physical properties should be verified through field sampling and independent testing. Samples shall be taken from the line section installed and should be properly marked and transmitted to an independent testing laboratory or obtained from the project site by a laboratory representing the Owner. Test results should be transmitted from the laboratory to the owner's representative. Sampling should be in accordance with ASTM F 1216, and a chain of custody should be strictly maintained. Restrained samples can be used for sewers of up to 18" in diameter or less. Plate samples are used for pipelines larger than 18" in diameter. A sample should be acquired for each section of CIPP installed.

- A. The physical properties of the installed CIPP shall be verified through field sampling and laboratory testing. All materials for testing shall be furnished by the Contractor to the Owner for testing. All materials testing shall be performed at the Owner's expense

by an independent third party laboratory selected by the Owner as recommended by the CIPP manufacturer. All tests shall be in accordance with applicable ASTM test methods to confirm compliance with the requirements specified in these contract documents.

- B. The Contractor shall provide samples for testing to the Owner from the actual installed CIPP. Samples shall be provided from each section of CIPP installed or as required by the Owner. The sample shall be cut from a section of cured CIPP that has been inverted or pulled through a like diameter pipe which has been held in place by a suitable heat sink, such as sandbags. All curing, cutting and identification of samples will be witnessed by the Owner and transmitted by the Owner's representative as specified, to the testing laboratory. On pipelines greater than 18 inches in diameter, the Owner may, at its discretion, require plate samples cured with the CIPP or designate a location in the newly installed CIPP where the Contractor shall take a sample. The Opening produced from the sample shall be repaired in accordance with manufacturer's recommended procedures.
- C. The laboratory results shall identify the test sample location as referenced to the nearest manhole and station. Final payment for the project shall be withheld pending receipt and approval of the test results. If properties tested do not meet the minimum physical and thickness requirements, the CIPP shall be repaired or replaced by the Contractor unless the actual physical properties and the thickness of the sample tested meet the design requirements as required in the contract.

Chemical resistance is a qualification test where CIPP samples tested should be of the fabric tube and resin proposed for the actual construction. For municipal applications a certification is typically submitted from the manufacturer verifying that the chemical resistance meets the contract requirements. For industrial installations, the chemical resistance of the resin installed must be tested and verified to meet the corrosion resistance requirements of the pipeline being rehabilitated.

- D. Chemical resistance - The CIPP system installed shall meet the chemical resistance requirements of ASTM F1216 and ASTM D5813. CIPP samples tested shall be of the fabric tube and the specific resin proposed for actual construction. It is required that CIPP samples without plastic coating meet these chemical testing requirements. A certification may be submitted, by the contractor, from the manufacturer verifying that the chemical resistance of the CIPP meets the contract requirements.
- E. Hydraulic Capacity - Overall, the hydraulic capacity shall be maintained as large as possible. 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 CIPP 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.

- F. The installed CIPP thickness shall be measured for each line section installed as per the ASTM requirements specified. If the CIPP thickness does not meet that specified in the contract and submitted as the approved design by the Contractor, then the CIPP shall be repaired or removed unless the tested physical properties and the thickness of the sample tested meet the design requirements as required in the contract. The CIPP thickness shall have tolerance of minus 5% - plus 10%. In worker-entry size piping, the Contractor shall remove a minimum of one sample every line section of installed CIPP to be used to check the CIPP thickness. The samples shall be taken by core drilling 2-inch diameter test plugs at random locations selected by the Owner. The openings produced from the samples shall be repaired in accordance with manufacturer's recommended procedures.

For small diameter CIPP of 18" inch diameter or less, the restrained sample can be measured for thickness. In sewers larger than 18 inch diameter where flat plate samples are collected and tested, 2 inch core samples must be removed from the CIPP at the 12:00 o'clock position to check thickness. The core hole shall be repaired as recommended by the manufacturer.

- G. All costs to the Contractor associated with providing cured CIPP samples for testing shall be included in the Lump Sum price bid for Mobilization. Payment for all testing by a laboratory will be paid for by the Owner directly to the laboratory under the lump sum Reserve for Testing item force bid in the Bid Proposal.

3.8 FINAL ACCEPTANCE

All sample testing and repairs to the CIPP should be completed. All test results must have been received from the independent laboratory and meet the contract specified requirements prior to final acceptance of the installed CIPP.

- A. 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.

Prior to conducting the final CCTV, the contractor should thoroughly clean the newly installed CIPP. Sewage flow in the line should be minimized, and any standing water in sags should be cleared. The CCTV visual quality of the final inspection shall be as specified in the contract. If the quality does not meet the specified requirements, the contractor shall re-CCTV those section that are unacceptable.

- B. The Contractor shall perform a detailed closed-circuit television inspection, in accordance with ASTM standards, in the presence of the Owner after installation of the CIPP and reconnection of the side sewers. A radial view (pan and tilt) TV camera shall be used. The finished CIPP 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 Owner within ten (10) working days of the CIPP installation. The data shall note the inspection date, location of all reconnected side sewers, debris, as well as any defects in the CIPP, including, but not limited to, gouges, cracks, bumps, or bulges. If post installation inspection documentation is not submitted within ten (10) working days of the CIPP installation, the Owner may at its discretion suspend any further installation of CIPP until the post-installation documentation is submitted. As a result of this suspension, no additional working days will be added to the contract, nor will any adjustment be made for increase in cost. Immediately prior to conducting the closed circuit television inspection, the Contractor shall thoroughly clean the newly installed CIPP removing all debris and build-up that may have accumulated at no additional cost to the Owner.

Final CCTV inspection should be performed using high pressure water to eliminate standing water in sags and bellies while the line is being televised.

Leakage can be determined through visual inspection (water or air installations), hydrostatic testing (water installations), air testing (air installations) or infiltration testing (water or air installations). For small diameter sewers installed with air pressure (UV cure or steam cure), it doesn't make sense to do hydrostatic (exfiltration) testing for leakage. This leaves visual inspection or air testing as viable alternatives. If any leakage is detected through visual inspection, further air testing can be performed to determine if the leakage rate is acceptable.

For large diameter sewers, visual inspection for leakage is the most common method. Air and hydrostatic testing should not be performed for sewers greater than 36" diameter because of worker safety. Any unacceptable leakage through the CIPP wall should be repaired as required in the contract documents or agreed to by the owner.

- C. 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.
- D. Where leakage is observed through the wall of the pipe, the contractor shall institute additional testing including, but not limited to, air testing, hydrostatic (exfiltration) testing, localized testing (such as a grout packer) or any other testing that will verify that the leakage rate of the installed CIPP does not exceed acceptable tolerances specified in the contract. As an alternative to further leakage testing, the contractor may choose to repair any observed leaks.

3.9 TYPICAL BID ITEMS

Additional items such as pre-liner and flowable backfill can be added to specific contracts requiring these items.

- A. Mobilization – Lump Sum - Includes all PWS information, submittals, safety plan, as-built drawings, testing samples, mobilization/demobilization of labor, equipment and materials to the project site. Generally limited to 5% of the total amount bid for the project.
- B. Pre-Installation CCTV Inspection – Per linear foot - Includes pre-cleaning and post cleaning CCTV for Owner review. Does not include CCTV inspection just prior to CIPP installation. All inspections will be performed by PACP trained and certified personnel.
- C. Dye Testing of Service Connections – Per each - Includes dye testing and documentation of existing service connection on each pipe length to be lined.
- D. Point Repairs – Per each or by Lump Sum Contingency - Includes excavation and restoration of a section or sections of pipe that are beyond rehabilitation using CIPP. Note: Point repair items shall be categorized by pipe size, a minimum length of excavation and depth category of excavation to be paid for in the Proposal. If point repairs are not identified in the contract documents, payment shall be on a contingency basis.
- E. Standard Pipe cleaning – Per linear foot for each pipe size category – including all labor, equipment, materials and cost of material disposal.
- F. Heavy Pipe Cleaning – Per linear foot for each pipe category – including all labor, equipment, materials and cost of material disposal.

- G. Inspector training – Lump Sum – includes all labor, equipment and materials required to train the Owner’s inspectors on the technology to be installed for a period of two days.
- H. Pre-liner Installation – per linear foot installed by size category. Includes all labor, equipment and materials required.
- I. Reinforced Pre-liner Installation - per linear foot installed by size category. Includes all labor, equipment and materials required.
- J. Liner Installation – Per linear foot for each pipe size category - Includes all labor, equipment and materials required for the complete installation of a CIPP.
- K. Flowable Fill – per cu. yd. of material installed and documented including all labor, equipment and materials required for the complete backfilling of soil voids.
- L. Traffic Control –Lump Sum – Includes all labor, equipment and materials required to implement a traffic control plan for the entire project and shall include all costs associated with sub-contracted traffic control specialists.
- M. Sewage Bypass – Lump Sum – Includes all labor, equipment and materials required to implement a flow bypass plan for the entire project, including the cost of all sub-contracted flow bypass specialists.
- N. Service Reconnections – Per each – Includes reconnecting existing live sewer service connections to the installed CIPP. Owner shall review and verify those connections that are not live and will be left unopened.
- O. Service connection sealing – Per each – Includes sealing the interface between the installed CIPP and the host pipe at the location of the service connection.
- P. Manhole/Wall Interface Sealing – Per each – Includes sealing the interface between the installed CIPP and the manhole wall
- Q. Post Construction CCTV Inspection - Per linear foot - Includes post lining CCTV for submission to the Owner. All inspections will be performed by PACP trained and certified personnel.
- R. Reserve for Testing – Lump Sum Reserve – For Owners use to include testing required as directed by the Owner, under this contract, by an independent laboratory. (The amount will be set by the Owner in the Bid Proposal)

****END OF SECTION****