5101.1 Description
This item shall govern approved methods and materials for the rehabilitation of deteriorated gravity sewer and storm water pipes by an Ultra-Violet Light Cured-In-Place Pipe (CIPP) lining method. This method of rehabilitation shall consist of installation of a resin-impregnated flexible liner into exiting 6-inch to 24-inch sewer pipe by the methods given in ASTM F2019, ASTM F1216, ASTM F1743 or by a comparable approved method.

5101.2 Product and Manufacturer Qualification Requirements
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 allowed. At a minimum, Products and Installers must meet all of the following criteria to be deemed commercially acceptable:

A. For a Product to be considered commercially acceptable, a minimum of 500,000 linear feet of successful wastewater collection system installation in the United States including 50,000 linear feet installed in the State of Texas, must be documented to assure commercial viability. In addition, it must have over 1,000,000 linear feet installed worldwide.

B. For an installing Contractor to be considered commercially acceptable, the installer must satisfy all insurance, financial, and bonding requirements of the Owner. The Contractor must have a certification from the manufacturer as a licensed and fully trained installer of the product.

C. Products must provide Third Party Test Results supporting the long-term performance and structural strength of the product and such data shall be satisfactory to the Owner. No product will be allowed without Independent Third Party Testing verification.

5101.3 References
This specification references the American Society for Testing and Materials (ASTM) standards and specifications, which are made a part hereof by such reference and shall be the latest edition and revision thereof.

E 1251 Standard Practice for General Techniques for Qualitative Infrared Analysis.
F-1216 Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.
F-1743 Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-In-Place Installation of Cured-in-Place Thermosetting Resin Pipe.

DIN-DN – 761--Creep Test to determine long term properties.
5101.4 Submittals
A. Resin
1. Submit technical data sheet showing physical and chemical properties.
2. Submit test results of chemical resistance testing performed by the resin manufacturer demonstrating compliance with testing requirements set forth in this specification.
3. Submit manufacturer certified infrared spectrum analysis per ASTM E1251 (chemical fingerprint) of proposed resin system.
4. The quality management system for the wet-out facility must be registered in accordance with ISO 9001:2008. It must ensure that proper materials and amounts are used in the resin saturation process and in liner shipping and storage.

B. Flexible Liner
1. Submit tabular summary by sewer segment noting required CIPP thickness as per section.
2. Provide certification from the manufacturer that the liner’s thickness is greater than or equal to the required cured laminate thickness. Thickness measurements shall be in accordance with ASTM D5199.

C. CIPP
1. Present calculations to support the design CIPP thickness, after curing. The design shall meet the minimum thickness based on equations X1.2 and X1.2.24 and the physical properties in Table X1.1 ASTM F1216. The criteria to be listed are as follows:
   a. Fully deteriorated “host pipe”
   b. Ground water table elevation (If unknown, assume within 2 feet of ground)
   c. Depth of cover at deepest manhole
   d. Unit weight of soil
   e. Modulus of soil stiffness
   f. Long term modulus of elasticity
   g. H-20 Live Load
   h. 2.0 Factor of Safety against buckling
   i. 2% Pipe Ovality

D. Though the process may be licensed, no change of material design values or procedures may be made during the course of the Work without the prior written approval of the Owner.

5101.5 Materials – Spiral Wound Fiberglass Liner
A. Liner
1. The liner shall consist of a seamless spirally wound glass fiber that is flexible and has strain values (expandable) of equal to eight (8) to ten (10) percent. The liner shall be constructed to withstand installation pressures and have sufficient strength to bridge missing pipe.
2. The liner will be manufactured to the length necessary to fully span the distance between manholes. Include sufficient amount of material for sealing at manholes and product sampling (when required).
3. The liner 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 will be provided with a UV light blocker foil.
4. The wet out liner shall have a uniform thickness that when compressed at installation pressures, will meet or exceed the design thickness.
5. The liner shall be sized such that when installed, it will tightly fit the internal circumference and length of the original pipe.

B. Resin
1. The resin used shall produce a properly cured-in-place pipe system, which will be resistant to abrasion caused by solids, grit, and/or sand. The cured-in-place pipe system shall also be resistant to corrosion due to acids and gases such as sulfuric acid, carbonic acid, hydrogen sulfide, methane, and carbon monoxide. The cured-in-place pipe system shall utilize thermosetting resins, which will withstand the corrosive effect of the existing residential, commercial, and industrial effluents, liquids and/or gases.
2. The resin system to be used shall be manufactured by an approved company selected by
the Cured-In-Place process manufacturer. Only corrosion resistant polyester npg, orthothalic, and vinylester resins complying with the requirements in section 5101.6.

C. Manufacturing Requirements for the Liner
1. At the time of manufacture, each lot of glass fiber liner shall be inspected for defects and tested in accordance with applicable ASTM standards (F2019-03). The manufacturer will test the raw materials and liner materials at various stages of manufacturing on every liner, including taking samples of every finished liner and conducting tests for e-modulus, tensile, wall thickness and porosity.
2. For testing purposes, a production lot shall consist of all liner having the same marking number. It shall include any and all items produced during any given work shift and must be so identified as opposed to previous or ensuing production.
3. The Owner may at any time direct the manufacturer to obtain compound samples and prepare test specimens in accordance with applicable ASTM standards.
4. The glass fiber liner shall be saturated with the appropriate resin using a resin bath to allow for the lowest possible amount of air entrapment. Vacuum-suction impregnation methods are not allowed due to the introduction of air using this method. The liner will then be formed into a spirally wound shape for the purpose of being seamless in its cured state. An inner and outer material will be added that are both impervious to airborne styrene, with the outer material also having UV blocking characteristics. The inner membrane will be removed after the installation and curing processes are completed.
5. All wet-out or impregnation of the liner must be done in a facility permitted by applicable State Department of Environmental Quality permits. Documentation of appropriate State permitting Agency must be submitted with all qualified bids. The manufacturing process shall be done under strict DIN ISO 9001 revision 2000 standards or equivalent, ensuring that the glass fiber composite liner is carefully impregnated with resin at the factory. No “over the hole” or “on-site” wet-out is allowed. All liners shall be packaged in special UV protection material and put into shipping containers that insure the liner can be stored for up to 6 months, with no need for refrigeration.
6. 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 liner should be seamless in its cured state to insure homogenous physical properties around the circumference of the cured liner.
7. fiberglass materials must be “direct sized” to enhance the fiberglass/resin bond. Certification of this coating and its compatibility with the resin system being used must be made available if requested by the Owner.
8. An “inner liner” and “outer liner” film must be used for resin control (to prevent resin migration and contamination). The “inner” and “outer” film must both be certified styrene gas barriers.

D. Structural Requirements for the Liner
1. The spiral wound fiberglass liner shall be designed for a minimum fifty-year service life under continuous loading conditions. The Long-Term E-Modulus to be used in design shall be verified by independent third party testing and shall exceed 600,000 psi. The short-term E-Modulus shall be in excess of 1,000,000 psi. Liner thickness shall not be less than that which is computed from the DR’s given in Table #1.
TABLE #1  
FIBERGLASS/UV CURE  
CIPP DESIGN THICKNESS  
BASED ON ASTM F1216 APPENDIX

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Existing Pipe Condition</th>
<th>Ovality</th>
<th>Pipe Depth (Ground Water Half)</th>
<th>Long Term Flex Modulus E= 617,977</th>
</tr>
</thead>
<tbody>
<tr>
<td>6&quot; ------ 24&quot;</td>
<td>FD</td>
<td>0-2%</td>
<td>4' -- 8'</td>
<td>100.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2-5%</td>
<td></td>
<td>84.37</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5-10%</td>
<td></td>
<td>62.88</td>
</tr>
</tbody>
</table>

FD - Fully Deteriorated, no strength to be assigned to existing pipe.

The following parameters were used for FD conditions:

- Soil Density – 120 lb/cu.ft
- Soil Modulus - 900 psi
- Live Load - 16000 lbs

(For parameters outside of Table 1, design thickness will be in accordance with manufacturer recommendations based on ASTM F1216 Appendix / Fully Deteriorated Only).

2. The minimum allowable wall thickness for a Seamless Spiral Wound Fiberglass CIPP products is 2.8 mm and can be increased as necessary to meet ASTM F1216 Design Formula rounded up to the nearest 0.7 mm increment.

3. PHYSICAL PROPERTIES: The cured pipe shall conform to the minimum structural standards, as follows:

- Tensile Strength ASTM D-638 20,000 psi
- Flexural Strength ASTM D-790 20,000 psi
- Short-Term E-Modulus ASTM D-790 1,000,000 psi
- Long-Term E-Modulus DIN - DN 761 600,000 psi
- *Porosity/Water Tightness test *pass/fail

* Determined via application of dyed water on the exterior surface of a liner sample and application of a partial vacuum of .5 bars on the opposite side (inner liner sample surface) for a period of 30 minutes. There can be no visible evidence of water droplets, foam or moisture on the interior sample surface.*
5101.6 Testing Requirements
A. Perform chemical resistance testing of the resin by the resin manufacturer in accordance with ASTM C581 or D543 as applicable and as modified herein. Testing shall be performed to successfully demonstrate the chemical resistance of the resin based on exposure to a solution with a pH of 0.5 and a solution with a pH of 10. Actual reagents or solutions utilized shall be as required to establish and maintain the minimum and maximum pH specified for the duration of the testing. The result of exposure to the minimum and maximum pH values shall produce an average loss of not more than 20 percent of the initial flexural properties for each test interval and an average loss of not more than 15 percent for a period of one year, as determined by ASTM D790. All testing shall be performed at a temperature of 73.4 degrees F (plus or minus 3.6 degrees F). Test specimens shall not have more than 1.5 percent gain or loss in weight over a period of one year. Test frequency and sample preparation shall be as per ASTM C581.

B. Certified copies of all test reports on the properties of the selected resin and on the initial structural properties of the CIPP system - and later, if required, on the field samples from designated inserted lengths shall be submitted to the Owner. All testing costs shall be paid by Owner.

C. Test reports on the structural properties of the CIPP field samples from designated inserted lengths shall be submitted to the Owner to demonstrate compliance with the above minimum values. All testing costs shall be paid by Owner.

D. Tests for compliance of the material with this specification shall be made according to the applicable ASTM specification. Upon request of the Owner, a certificate verifying the materials' compliance with this specification shall be provided by the manufacturer for all material furnished under this specification. In addition, Owner may, at his own expense, witness inspection and testing of the materials.

5101.7 Notification Procedures
A. to Contractor
1. The Contractor must perform an inspection of the work area prior to the arrival of his equipment. Existing damage to sidewalks; driveways and other structures must be documented. The Contractor should take identifiable pictures of all defects in the vicinity of the jobsite before the commencement of work. The use of a video and/or digital camera to record all conditions is recommended. The Contractor is urged to be very thorough with the accumulation of his photographs and its documentation. Authenticity of claims by area residents will be based upon this information.

2. The condition of all plant life in the area should be documented.

3. Photographs of the pre-existing conditions will be made available to the Owner upon request.

4. Inspect the jobsite for overhead electrical lines, or other utilities that may impact the safe installation of the liner.

B. to Residents
1. At least 24-hours prior to moving on to a job site, the Contractor must distribute door hangers describing the type of work being performed, when the work is scheduled and what inconveniences the residents should expect.

2. At the beginning of the Contract, a form door hanger will be provided to the Contractor by the Owner.

C. to the Owner
1. The Contractor will communicate with the Owner's representative with regards to remote facilities & lift stations to control any potential effects to pumping station operations during the work.

2. The Contractor must also coordinate its operations with other affected utilities through One Call. Contractor shall exercise caution in making any excavations to avoid damage to the existing gas mains, house service connections, underground telephone services and other utilities.
5101.8 Cleaning and TV Inspection
   A. The sewer mains selected for lining have previously been cleaned and televised, and were determined at that time to be restorable using this process.
   B. The Contractor shall be required to clean and CCTV these lines immediately prior to lining. If the Contractor feels that point repairs are required prior to lining, the contractor shall so notify the Owner’s Representative who will either authorize this work, or elect to repair the main using an alternate technique.
   C. Inspection of the pipeline by the Contractor shall be performed by experienced personnel trained in locating breaks, obstacles and service connections by CCTV. The interior of the pipe shall be carefully inspected to determine the location of any conditions that may prevent proper installation of the CIPP. A DVD and log shall be made by the Contractor (both before and after installation) and provided to the Owner’s Representative upon completion of the project. Cleaning and television inspection for small diameter pipes (6” to 12”) shall subsidiary to the lining pay items.

5101.9 Flow Control
   A. The Contractor will be responsible for establishing flow control, where required, in advance of all lining jobs, as well as for all inspections (i.e. pre and post videos). For small diameter pipes (6” to 12”), any and all cost for flow control shall be included in the price bid for the lining process.
   B. Plugging and Blocking
      1. A sewer line plug shall be inserted into the upstream manhole and downstream manhole as necessary.
      2. Upon completion of work, flows may be restored to not more than one half-pipe diameter in depth in order to avoid any damage downstream. Services within this reach will be temporarily out of service. The Contractor shall be held responsible for any damage caused by flooding and will take care to avoid this occurrence.
   C. By-Pass Pumping
      1. Where flow is large enough to require by-pass pumping, the Contractor will do so in accordance with current NASSCO Specifications. The Contractor shall prepare and submit one (1) Bypass Flow Control Plan that will be typically used for the project.
      2. The bypass pumping system (system) capacity must be sized to meet all potential flows (i.e. no overflows allowed). The Contractor will be held responsible for any damage caused by flooding and will take care to avoid this occurrence. The system must be kept in service for each section until that section is completed and ready to return to service. The Contractor is responsible for all installation, operation, and maintenance of the system. Manpower, fuel, and necessary utilities required by the systems must be provided by the Contractor. Ready-use, stand-by pumping must be available and achieved by backing up pumps size for size (100% back-up capacity) in case of emergency situations, equipment malfunction, or higher than anticipated flows. Contractor must make their own determination of flow quantities and characteristics. The Bypass Flow Control Plan and Bypass pumping operation for pipe sizes 15 through 24-inch will be paid under a separate pay item. Bypass pumping set up and tear down shall be subsidiary to the bypass pumping operation line items.

5101.10 Installation Procedures
   A. The Contractor will be expected to comply with all City, State and federal standards. Particular attention is drawn to those safety requirements involving entry into a confined space. The Contractor shall carry out its operations in strict accordance with all OSHA and manufacturer’s safety requirements.
   B. Pre-Installation
      1. Prior to installation of the liner, the following activities are required.
         a. Receipt and approval of pre-installation submittals.
b. Verification of line condition and any obstructions by video inspection.
c. Verification of existing taps in service by flowing water, dye test, or visually with a pan and tilt head camera or other means.
d. Cleaning of line (recorded on DVD).
e. Construct and complete Owner approved obstruction removals and point repairs deemed necessary.
f. All necessary traffic control measures shall be put into place and the diversion pumping system, including back-up pumps, shall be tested and running. Every effort should be made to protect the environment from any contamination from the sewer.

C. Liner Insertion
1. A plastic slip-sheet shall be installed in the bottom half of the pipe prior to liner insertion. The slip-sheet is used to protect the outer film from damage during insertion from offset joints, broken pipe, or slightly protruding taps. In addition, it will increase flow characteristics and reduce friction during the pull-in process.
2. Once the slip-sheet is in place, the shipping crate is opened and the spiral wound fiberglass liner is prepared for insertion into the host pipe following manufacturer procedures. Care should be taken to protect the ends of the liner from contaminates within the sewer such as moisture.
3. A double capstan, constant tension winch shall be used to pull the spiral wound fiberglass liner into position. The double capstan, constant tension winch must be capable of documenting the amount of tension used to pull the liner into the pipe. Maximum pulling forces established by the manufacturer will not be exceeded.
4. During the pull-in process, the liner is manually fed into the pipe by the install technician. Care should be taken during this process not to tear or damage the outer film, thus exposing the liner to contaminates within the pipe.

E. Curing the Spiral Wound Fiberglass Liner
1. Once the liner has been inserted into the host pipe, an end plug or packer is used to cap one end of the liner to prepare for initial pressurizing. The packer should be secured with a strap to prevent it from being expelled due to pressure. The other end of the liner is held closed manually by the technician. The liner is then pressurized using forced air to the initial pressure of one (1) psi.
2. The spiral wound fiberglass liner shall be cured with UV light sources (i.e. light train). The UV light train should be assembled according to the manufacturer’s specifications for the liner diameter.
3. Once initial air pressure is achieved, the technician shall insert the light train into the open end of the liner. When inserting the light train, care should be taken not to damage the inner film material or the light train. After the light train is inside the liner, a packer is used to cap the end of the liner to prepare for full inflation. Once the packer is secure, full liner inflation may begin.
4. The air pressure will be raised at one (1) psi increments and held for approximately ten (10) minutes before increasing the pressure to the next level. Typical optimum inner air pressure is between 6 psi and 8 psi. However, the Contractor shall follow the manufacturer’s recommendation for inner liner pressure according to the actual liner design used for the specific installation.
5. Once optimum inner air pressure is achieved, a visual “pre-curing” inspection of the liner will be done using CCTV. Once the “pre-cure” inspection is complete and the Owners representative gives approval, the actual curing of the liner can begin.
6. Curing of the spiral wound fiberglass liner is achieved through exposure to UV light. The lights are energized in sequence according to the manufacturer specifications.
7. 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 Owner a record of the curing process over every segment of the entire length of the liner. This demonstrates that the entire liner is cured properly and completely. The recording will include:
b. Curing speed

c. Light source working & wattage

d. inner air pressure

e. Exothermic (curing) temperatures

f. Date and time

g. Length of liner

9. Record of the curing parameters will be accomplished using a computer and database that are tamper proof. During the curing process, infrared sensors will be used to record exothermic curing temperature data.

10. The parameters for curing speed, inner air pressure and wattage are defined in the Quality Tracker UV curing protocol issued by the manufacturer. The optimal curing speed, or travel speed of the energized UV light train, is determined for each length of liner based on liner diameter, liner thickness, and exothermic reaction temperature.

11. The UV light train shall be capable of curing the fiberglass liner at a curing rate of up to 10 LF (liner feet) per minute. A video will be recorded using CCTV during the curing process. The liner is cured once the energized light train has traveled the entire length of the liner.

12. The outer film that has been manufactured to control resin loss, liner thickness, and contamination of the resin by water or other contaminants as well as a styrene barrier, shall remain in-place after UV curing of the liner has been completed. The inner film will be removed no sooner than 30 minutes after the curing of the liner is complete.

13. After the process is complete, all curing parameter data and the CCTV documentation taken during the cure shall be submitted to the Owner as an as-built.

5101.11 Service Connections

A. After the liner pipe has been cured in place, each existing service connection shall be opened to the lined main within 24 hours after the cured-in-place process is completed.

B. Service connections shall be reconnected by a remote-operated internal cutting device. Cutting devices utilizing high-pressure water shall not be utilized as they may cause damage to the existing lateral.

1. An internal tap cut shall be considered acceptable if the bottom third of the tap matches the invert of the wye or tee, there are no jagged edges and a minimum of 95% of the tap is restored.

2. Blind holes, over cutting, and holes that miss the tap must be repaired in a manner acceptable to the Owner at the Contractor’s expense.

C. If the method of tap cutting, as outlined above, does not prove satisfactory, the service connection will be restored by excavation and direct replacement by the Contractor.

1. The Contractor shall carefully break out the connection above the wye or tee, make the necessary cut in the lining and replace the segment of service pipe.

2. The service connections shall be installed at the existing elevation and locations indicated unless changed by the Owner.

3. The fitting to be utilized for all external connections for this project shall be Inserta Tee Lateral Fitting as manufactured by Fowler Manufacturing, QuikSeal manufactured by Fernco, Inc, or approved equal, and installed in accordance with the manufacturers written instructions.

4. There will be no direct pay for excavation and physical tie-in of house connections due to failure of internal tap cutting method.

5101.12 Pre and Post Videos

A. Prior to authorization by the Owner’s Representative to proceed with rehabilitation of a sewer main, a pre-lining television inspection video of the cleaned sewer will be given to the Owner’s Representative. The Owner’s Representative will review the video to confirm that the sewer was properly cleaned and that the intended method of rehabilitation is correct.

B. At the completion of the rehabilitation of the sewer main the Contractor shall give a post-lined televised inspection of the completed line segment to the Owner’s Representative, which will be
used to determine if this line has been restored in a satisfactory fashion.

C. This inspection shall be performed in accordance with Owner requirements. Location records shall be kept by the Contractor that will clearly show the exact location, in relation to adjacent manholes, of all service connections or defects discovered by the television inspection. A typed copy of the log shall be supplied to the Owner’s Representative along with a tape(s) and/or DVD’s of the pre and post video inspection.

D. If the camera or any other contractor tool becomes lodged in the pipe during any inspection, it is the Contractor’s responsibility to remove the camera or tool at his own expense.

5101.13 Final Cleanup
Upon completion of rehabilitation work and testing, clean and restore project area affected by the Work to a condition at least equal to that existing prior to work.

5101.14 Non-Conforming Work
A. All work required to remedy non-conforming work shall be at the sole cost of the Contractor.

5101.15 Traffic
A. Disruption to normal flow of traffic should be carried out in compliance with the Owner’s Specifications or the Texas Department of Transportation Manual on Uniform Traffic Control Devices. Prior to beginning any Work in that location, the Contractor shall submit a Traffic Control Plan to the Owner’s Representative for approval.

B. Maximum efforts must be made to maintain fifty percent (50%) of all roadways open to traffic at all time. In those instances, when a complete roadway must be closed, a Traffic Control Plan indicating in detail the location of signs, lights and barricades must be prepared by the Contractor in advance of starting work for approval by the Owner.

5101.16 Warranty
A. The warranty period for the liner, tap cuts, and all other work shall be one (1) year after substantial completion of the final work for the twelve (12) month agreement.

B. During this warranty period, any defects, which will affect the integrity or strength of the liner, shall be repaired at the Contractor’s expense, in a manner acceptable to the Owner.

5101.17 Payment
Measurement and payment for UV Cured In-Place Spiral Wound Fiberglass Pipe is on a linear foot basis measured according to camera footage measurements along the centerline of the pipe and shall be considered full compensation for all labor and materials required to install the liner to the specified requirements described in this specification.

A. Pay Item 5101- UV Cured In-Place Spiral Wound Fiberglass Pipe Lining for __” sewer line, all depths

End