SECTION 33 01 30.72
CURED-IN-PLACE PIPE LINING

PART 1 GENERAL

1.1 DESCRIPTION

A. Section includes requirements for reconstruction of storm water pipe by Cured in Place Pipe (CIPP) lining or installation of a resin-impregnated flexile tube.

1.2 DEFINITIONS

A. Mainline: storm water sewer pipe (SWSP).
B. CCTV: closed circuit television.
C. H₂S: hydrogen sulfide gas.
D. Ovality: pipe distortion, flattening or out-of-roundness cross-section from its round shape.
B. Inversion: the process of turning the resin-impregnated tube liner inside out by the use of water pressure or air pressure.
C. PACP: Pipeline Assessment Certification Program.

1.3 QUALITY ASSURANCE

A. Follow national standards and as specified herein.
B. Personnel Involved in Installation of Pipe Liner: PACP certified by liner manufacturer successfully completed training in handling, insertion, trimming, and finishing pipe liner.
C. Engineer:
   1. May inspect, test liner or its materials at factory, before delivery to site or while in storage.
   2. May inspect factory materials, wet-out procedure, and loading.
D. Internally inspect host pipe prior to lining and post-lining.
E. Commercially Proven Mainline Products Experience:
   1. The Contractor shall have a minimum of three (3) years of continuous experience installing CIPP liners in pipe of a similar size, length and configuration as contained in this contract. A minimum of 15,000 linear feet of shop wet-out liner installation and minimum of 6 onsite wetout installations are required. Each one of lead personnel including the superintendent, the foreman and the lead crew personnel for the CCTV inspection, resin wet-out, the CIPP liner installation, and liner curing each must have a minimum of three (3) years of 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.
1.4 SUBMITTALS

A. Submit following Section 01 33 00.
   1. Working drawings showing design calculations, soil impacts, live load, dead load, ground water impacts, materials selected, and thickness of liner.
   2. Catalog data showing manufacturer’s clarifications and updates, ASTM references, material composition, specifications, physical properties and chemical resistance of liner.
   3. Manufacturer's recommended procedures for handling, storing, repairing, and installing materials selected.
      a. Access manholes and site locations.
      b. Work dimensions.
      c. Existing utilities.
      d. Size of working area.
      e. Impacted portions of existing storm water sewer.
      f. Site access points.
   5. Emergency plan detailing procedures followed in event of health and safety emergency, overflows, backups, and spillage. Maintain copy on site for duration of project.
      a. Address dangers associated with rehabilitation work (i.e. working with large boiler trucks).
      b. Identify Health and Safety officer (i.e. crew chief)
      c. Designated Health and Safety officer:
         1) Responsible for providing health and safety oversight of personnel participating on project team.
         2) Perform and document routine work area inspections, conduct safety meetings, and provide safety orientations for team members.
         3) Have in easily accessible place following contact information;
            a) Non-emergency number.
            b) Contractor’s health and safety representative name and number.
            c) Occupational health clinic number(s).
      d. Submit for review the following;
         1) List of critical rehabilitation equipment, including boiler truck equipment, to be inspected on daily basis.
         2) Recently completed (previous month) monthly maintenance log.
         3) Annual third-party certified inspection for boiler truck(s) to be used on project.
         4) Certification of training for boiler truck operator.
   6. Certified statement from liner manufacturer approved installer of their system.
      a. Include certificates of training for each crewmember involved in installation process.
   7. Documentation for Products and Installers: Engineer’s approval required before installation of liner.
   8. ASTM certified lab test results for field installations in United States of same resin system and tube materials as proposed for actual installation.
      a. Test results must verify (CIPP) physical properties specified herein have been achieved in previous field applications.
      b. Third party is defined as ASTM or equivalent accredited materials testing firm with no financial or directorial link to manufacturer or Contractor.
   9. Video inspection reports shall include, at a minimum:
a. Date, time and inspection operator name;
b. Upstream and downstream manhole designations and heading direction;
c. Sewer reach designation identification;
d. Expected reach length;
e. Expected pipe type;
f. Fault areas listing footage, problem and/or audio description; and
g. Important or notable conditions.

10. A video capture on digital media and suitable log shall be supplied by the Contractor to the Owner. Video inspection reports shall be digital and submitted in color DVD (preferred) or USB thumb drive.

11. Curing logs: Include liner manufacturer recommended curing citations for each submittal. Store electronically on data logger. Submit printed copy with Post CCTV.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Protect, store, and handle materials during transportation and delivery, while stored on-site, and during installation following manufacturer's recommendations.

B. Continuously monitor liner materials during transport and storage with temperature recorder and data storage or strip printer.
   1. Furnish Engineer with recorder readings before installation.
   2. Material exposed to temperatures outside of manufacturer’s limits: Rejected.

C. Material found to be defective or damaged due to manufacture or shipment:
   1. When Engineer deems repairable: Repair following manufacturer’s recommendations.
   2. When Engineer deems not repairable: Rejected, removed from Contract site, and replaced under Engineer’s direction.
   3. All work required for repair or replacement of defective or damaged material will be at no additional cost to Owner.

1.6 CITY SUPPLIED VIDEO INFORMATION
A. City has made available video information that is included with the Contract Documents. The purpose of the video(s) is to provide rudimentary information for the contractor to aid in the bidding process. The City makes no warranty, neither implicit nor implied as to the validity of the video or the current state of the SWSP system. The video(s) were produced in 2015, 2016 and 2017.

1.7 WARRANTY
A. The liner shall be certified by the manufacturer for specified material properties. The liner material manufacturer shall warrant the liner to be free from defects in raw materials for five (5) years from the date of installation. The Contractor shall warrant the CIPP installation for a period of one (1) year. During the Contractor warranty period any defects which affect the integrity or strength of the pipe shall be repaired at the Contractor's expense in a manner mutually agreed to by the Owner and the Contractor.

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 warrantees required by the contract.
C. After a pipe section has been lined and for a period of time up to one (1) year following Project completion, the Owner may inspect all or portions of the lined system. 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 as recommended by the manufacturer.

1.8 PATENTS

A. The Contractor and the Contractor's supplier shall warrant and save harmless the City against any and all claims and potential litigation involving patent infringement and copyright violations and any loss thereof.

PART 2 PRODUCTS

2.1 MATERIALS

A. Mainline (CIPP): Use and follow ASTM D543, ASTM D790, ASTM D5813, ASTM F1216, ASTM F1743 and ASTM F2019 as appropriate for insertion method, liner tube material and resin material proposed for fully deteriorated pipe condition.
   1. Wet-out liner material in controlled factory environment.
   2. Resin-Catalyst-Colorant-Additive Mixture:
      a. Tested to certify liner material follows design standards before wet out.
      b. Quantity of resin used for tube impregnation: Sufficient to fill volume of air voids in felt tube with additional 10 to 15 percent allowances for polymerization shrinkage and loss of resin through cracks and irregularities in original pipe wall.
      c. Colorant: light color.
         1) Add to catalyst before mixing catalyst with resin.
         2) Pigmentation: Produces color that is clearly distinguishable from dry felt.
         3) 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.
      3. Additives for resin enhancement, viscosity control, safety, chemical resistance, physical resistance, or extending shelf life are permitted with Engineer’s approval.
   4. Liner Tube.
      a. Felt/Fabric Tubes.
         1) Seams shall meet the requirements of ASTM D5813.
            a) Liner to run continuously from manhole to manhole as required.
            b) Do not use overlapping section of liner felt tube or longitudinal seams that cause surface lumps.
         2) Impermeable, flexible membrane outside layer that will contain resin and monitor resin saturation at factory during resin impregnation procedure.
         3) The Tube shall be marked for distance at regular intervals along its entire length, not to exceed 5 feet. Such markings shall include the Manufacturers name or identifying symbol. The tubes must be manufactured in the USA.
a. Chemically resistant to internal exposure to water containing small quantities of hydrogen sulfide, carbon dioxide, methane, mercaptans, kerosene, moisture, and diluted sulfuric acid.
b. Chemically and physically resistant to external exposure of soil bacteria, moisture, roots, and chemical attack, that may be due to material in surrounding ground.

6. Approved Manufacturers:
   a. Inliner Technologies, LLC.
   b. Insituform Technologies Inc.
   c. National Liner.
   d. Premier Pipe.
   e. Or approved equal.

B. Miscellaneous Materials.
   1. Finishing material for transitioning, filling, and sealing liners entering manholes.
      a. Full-circle hydrophilic compression seals shall be properly sized according to the segment of the pipe to be lined. Product shall be Insignia™ End Seal Sleeve by LMK Technologies or approved equal.

C. Structural Requirements.
      a. Structural Properties: Use fully deteriorated gravity pipe condition, designed per ASTM F1216 Appendix X.1. Assume no bonding to the SWSP wall. If calculations provide less than 0.315-inch liner thickness, provide 0.315-inch minimum thickness.
   2. Basis of Design.
      a. Water table: At manhole rim
      b. Buckling resistance: AWWA M45, Appendix A
      c. Design Safety Factor: 2.0
      d. Ovality: 2 percent
      e. Live Load: HS-20 Highway
      f. Long term modulus: 175,000 psi
      g. Retention Factor for long-term modulus: 50% of initial per ASTM D790
      h. Groundwater depth: 7.1 feet
      i. Soil depth: 7.1 feet
      j. Soil density: 120 pcf
      k. Soil modulus: 500 psi
      l. Service life greater than 50 years

   3. Cured composite CIPP material shall meet or exceed following properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>ASTM F1216</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulus of Elasticity</td>
<td>ASTM D790</td>
<td>250,000 psi</td>
</tr>
<tr>
<td>Flexural Strength</td>
<td>ASTM D790</td>
<td>4,500 psi</td>
</tr>
</tbody>
</table>

2.2 SOURCE QUALITY CONTROL

A. Mainline Cured-In-Place Pipe (CIPP)
   1. Document installation procedure following ASTM F1216, ASTM F1743 or ASTM F2019, as appropriate to insertion method, liner tube material, resin material, curing method and installation procedures, as specified herein, for Engineer’s approval.
2. Submit lining coupon samples to independent third party laboratory for testing with verification following ASTM F1216, Section 8 Inspection Practices, or ASTM F2019, Table 1, as appropriate to liner tube and resin materials. Testing shall include:
   a. Short Term Flexural (Bend) Properties.
   b. Tensile Properties.
   c. CIPP Wall Thickness.
3. Submit results from independent third party laboratory for Engineer’s approval.
   a. Correct rejected deficiencies at no additional cost to the Owner.
4. Perform Post-inspection CCTV recording for Engineer’s approval.
   a. Liner Approved:
      1) Free of wrinkles, bubbles, and similar imperfections.
      2) Continuous liner over length of reconstructed SWSP.
      3) No visible leaks or leakage.
      4) Obstruction free.
   b. Rejected: Correct deficiencies at no additional cost to the Owner.

PART 3 EXECUTION

3.1 PUBLIC NOTIFICATION

A. Follow Section 01 11 00.

3.2 CLEANING OF MAINLINE

A. 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. 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 will not be allowed. Precaution shall be taken, by the Contractor, in the use of cleaning equipment to avoid damage to the existing SWSP. The repair of any damage to the SWSP, caused by the cleaning equipment or cleaning operation, shall be the responsibility of the Contractor.

B. The Contractor may be allowed to obtain water from an approved source in the project vicinity in accordance with the Reading Area Water Authority (RAWA) Rates, Rules, and Regulations. The RAWA may be contacted by phone at 610-406-6300 and by email info@readingareawater.com. The RAWA website is on the City’s website under Government/Authorities and includes rates for water usage and a FIRE HYDRANT Permit. Contractor shall be responsible to provide a supply of water for all construction activities at no cost to the City of Reading.

3.3 INSTALLATION TESTING

A. Follow as specified below and as directed by Engineer.
   1. Chemical Resistance - The CIPP shall meet the chemical resistance requirements of ASTM F1216, Appendix X2. CIPP samples for testing shall be of tube and resin system similar to that proposed for actual construction. It is required that CIPP samples with and without plastic coating meet the chemical-testing requirements.

   2. Hydraulic Capacity - Overall, the hydraulic cross-section shall be maintained as large as possible. The CIPP shall have a minimum of the full flow capacity of the original pipe
before rehabilitation. Calculated capacities shall be derived using ‘n’ = 0.023 for existing pipe and 0.013 for relined pipe.

3. CIPP Field Samples - The Contractor shall submit test results from field installations of the same resin system and tube materials as proposed for the actual installation. The submitted test results must verify that the CIPP physical properties specified in Section 2.1. were in previous field applications under similar conditions.

3.4 MAINLINE PREPARATION

A. Access: Through existing manholes 08MH1166, 08MH1229, 08MH1230, and if necessary 08MH1231. The Contractor shall protect existing manholes to withstand forces generated by equipment, water or air pressure, used while inserting the tube.

B. CCTV Internal Inspection after obstruction removal.
   1. Perform after cleaning pipe:
      a. Pre-lining recordings: Indicate mainline is ready for lining.
      b. Engineer approval of pre-lining recordings: Required prior to liner installation.
      c. Video inspection shall include: Color digital video showing significant conditions; lineal footage counter, accurate to 3 (three) feet and displayed continuously; upstream and downstream manhole designations and heading direction; mainline reach designation identification; fault areas listing footage, problem and/or audio description.

3.5 MAINLINE LINER INSTALLATION.

A. With Engineer’s approval, provide Public Notification: Follow Section 01 11 00.

B. Method of Lining.
   1. Invert tube by inversion: Follow ASTM F1216
      a. Erect scaffold or elevated platform at upstream or downstream access point.
      b. Invert pre-cured tube using inversion elbow at bottom of manhole or inversion ring above ground with water pressure.
         1) Ensure tube is;
            a) Fully extended to termination point and expanded to inside pipe diameter with no annular space between liner and host pipe.
            b) The wall color of the interior pipe surface of CIPP after installation shall be a relatively light reflective color so that a clear detailed examination with closed circuit television inspection equipment may be made.
            c) Seams in the Tube shall be stronger than the non-seamed felt material.

      a. Install slip sheet on bottom half of pipe prior to liner insertion. Pull liner into place with constant tension winch capable of recording strain used during insertion.
      b. Use end plugs to cap each end of liner. Both plugs and liner restrained during pressurization of line.
3. The CIPP shall make a tight seal at each manhole opening with no annular gaps. Seal shall be a hydrophilic seal compatible with installed CIPP, applied at the manhole/wall interface in accordance with the CIPP system manufacturer’s recommendation.
4. Other methods of installation of CIPP lining or curing maybe acceptable, provided manufacturer and installer demonstrate they meet Quality Assurance requirements specified herein and obtain Engineers approval following Substitution Procedures, Section 01 33 00.

C. Install and cure resin impregnated tube into liner: Follow manufacturer’s recommendations and as specified herein.
   1. Protect tube and lining material from damage during installation.
   2. Insert tube without twisting, cutting, tearing, separating, kinking, gouging, overstressing, resin loss, or double-ups.
   3. Engineer may request installed tube be retrieved for inspection.
   4. If tube is damaged during removal, repair tube to Engineer’s approval or replace damaged tube with new tube at no cost to the Owner.

D. Loss or discharge of resin, other lining materials, or by-products downstream is not permitted.
   1. Stop, collect, and remove at next downstream manhole.
   2. Transportation and disposal of debris: Follow jurisdiction requirements and as approved by Engineer.

E. Notify Engineer of any construction delay, problems, or contract deviations taking place during insertion before curing operations.
   1. Such delays or problems may require sampling and testing of portions of cured liner by independent laboratory at Engineer’s direction at no additional cost to the Owner.
   2. Sample test failures or lack of immediate notification of delay may result in rejection of that portion of work.
   3. Engineer has option to require removal of liner tube and reinstallation.
   4. If tube is damaged during removal, repair tube to Engineer’s approval or replace damaged tube with new tube at no cost to the Owner.

F. Cure.
   1. Liners cured with hot water or steam: Follow ASTM F1216 or ASTM F1743 as appropriate and specified.
      a. Recirculation Equipment: Capable of uniformly raising temperature of recirculated water, and maintaining recommended cure temperature for duration to produce cured resin.
      b. Temperature of water/steam in tube during cure period: Follow manufacturer’s guidelines and specified herein.
         1) Follow minimum and maximum standards for curing CIPP including temperature requirements determined by resin/catalyst system manufacturer recommendations.
         2) Bring temperature up slowly through stages until exothermic reaction is achieved and then maintain.
         3) Evidence of exothermic reaction: When exposed portions of the CIPP appear hard and sound and the remote temperature sensor indicates that the temperature is of a magnitude to realize cure in the resin. Method of delivery for hot water or steam shall be per manufacturer recommendations. All temperature conditions shall be based on the
resin/catalyst system employed and shall be per manufacturer’s recommendations.

c. Capture curing condensate and rinsewater and dispose of properly to prevent discharge to storm water system.

G. Process Monitoring Sensors.
1. Use to monitor and maintain curing temperature and internal pressure throughout length of liner following manufacturer’s recommendations.
2. Heat Source: Fitted with suitable monitors to gauge temperature of incoming and outgoing heat exchanger circulating water.
3. Placement: Between tube and host pipe in downstream manhole at or near bottom.
   a. Extra temperature gauges: Inside tube at invert level of each end
4. Electronically record continuous or specified pressure and temperature reading on printout.
   a. Start time.
   b. Gradual build up to curing period with maximum temperature and pressure.
   c. Time of gradual dropping of curing temperature.
   d. Cool down duration along with relaxing temperature and pressure.
   e. Start time of gradual release of curing pressure.
   f. Ending time.
5. If electronic recording fails, record temperature and pressure readings on log every 10 minutes starting before pressure is added to liner and ending 20 minutes after pressure is relieved.
6. Provide digital thermometer or other means of accurately and quickly checking temperature of exposed portions of liner.

H. Cooling and Relaxation of Liners:
1. Cool finished CIPP to temperature within 10 degrees of ambient temperature before relieving static head in inversion standpipe.
2. Cool-down may be accomplished by introduction of cool water into standpipe to replace water/steam being drained or vented from downstream end.
3. Caution is advised in release of static head so vacuum will not be developed with potential to damage newly installed liner.

I. Finished liner pipe:
1. The finished CIPP shall be continuous over the entire length of the mainline section and be free from visual defects such as foreign inclusions, dry spots, pinholes, and delamination. The CIPP shall be impervious and free of any leakage from the pipe to the surrounding ground or from the ground to inside the lined pipe.
2. Any defect, which will or could affect the structural integrity or strength of the linings, shall be repaired at the Contractor’s expense.
3. The ends of the CIPP shall be sealed to the existing host pipe. The sealing material shall be Insignia™ End Seal Sleeve by LMK Technologies or Hydrotite manufactured by Sika.
4. If the wall of the CIPP leaks, it shall be repaired as approved by the Engineer or as recommended by the manufacturer of the CIPP system.

3.6 TESTING AND INSPECTION

A. Follow as specified below:
1. CIPP samples shall be prepared for each section of SWSP liner installed. Pipe physical properties shall be tested in accordance with ASTM F1216 or ASTM F1743, Section 8, using either method proposed. The flexural properties must meet or exceed the values listed in Section 2.1C. or Table 1 of ASTM F1216 or the values submitted to the Owner/engineer by the Contractor for this project’s CIPP wall design, whichever is greater. The Contractor 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.

2. Wall thickness of samples shall be determined as described in paragraph 8.1.6 of ASTM F1743. The minimum wall thickness at any point shall not be less than 87½% of the submitted minimum design wall thickness as calculated in Section 2.1C.

3. Visual inspection of the CIPP shall be in accordance with ASTM F1743, Section 8.6.

3.7 ACCEPTANCE

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

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 liner. A radial view (pan and tilt) TV camera shall be used and travel up to 20 feet per minute. The finished liner shall be continuous over the entire length of the installation and shall be free of significant visual defects, damage, deflection, holes, leaks and other defects. Unedited digital documentation of the inspection shall be provided to the Owner within ten (10) working days of the liner installation. The data shall note the inspection date, location of all debris, as well as any other defects in the liner, including, but not limited to, gouges, cracks, bumps, or bulges. Immediately prior to conducting the closed circuit television inspection, the Contractor shall thoroughly clean the newly installed liner removing all debris and build-up that may have accumulated, at no additional cost to the Owner.

C. Infiltration of groundwater: None.

D. Defects Engineer Deems Repairable: Repair defect, replace liner, at no additional cost to the Owner.

3.8 ADDITIONAL WORK ORDERS

A. Additional Work Orders may be issued and may be designated as emergency.

PART 4 MEASUREMENT AND PAYMENT

4.1 MAINLINE PIPE LINER – BASE BID ITEM

A. Measurement: By linear foot measured horizontally along centerline of mainline lined.
B. Payment: Based on unit price listed in Bid Schedule.
   1. Payment includes Pre-Lining cleaning, Pre-Lining CCTV inspection, Pre-Lining tests, Post-Lining CCTV and visual inspection, restoration, labor, materials and equipment necessary to install liner as specified in Section 33 01 30.72.

4.2 MANHOLE/WALL INTERFACE SEALING – BASE BID ITEM

A. Measurement: By each completed interface sealing after lining of mainline is completed.

B. Payment: Based on unit price listed in Bid Schedule.
   1. Payment includes sealing the interface between the installed CIPP and the manhole wall and providing all labor, materials and equipment necessary as specified herein.

4.3 TRAFFIC CONTROL – BASE BID ITEM

A. Measurement: By lump sum.

B. Payment: At price listed in Bid Schedule.
   1. Payment includes all labor, equipment and materials to safely maintain traffic control throughout the project area at all times as specified herein and in accordance with PennDOT specifications.

4.4 GENERAL CONDITIONS – BASE BID ITEM

A. Measurement: By lump sum.

B. Payment: At price listed in Bid Schedule.
   1. Payment includes all performance of work information such as bonds and insurance, submittals, safety plan, record documents, testing samples and results, mobilization/demobilization of labor, equipment and materials to the project site.

END OF SECTION