SECTION 33 01 30.73

CURED-IN-PLACE LINER (CIPL) PIPE

PART 1 – GENERAL

1.1 CURED-IN-PLACE LINER (CIPL)

Under this process, a polyester fiber felt tube is coated on one side with impermeable material and impregnated with a liquid thermosetting resin. This Insitutube, tailored to the exact inner dimensions and length of the damaged sewer, is inverted into the wastewater sewer main through an existing manhole or other access point. When inverted, the liner presses firmly against the inner wall of the existing sewer through air or water pressure. The mixture of air and steam or heated water will cure the resin, and a structurally durable membrane is created within the existing sewer. The finished liner shall be continuous, watertight, and tightly and closely formed to the host sewer.

The calculated capacity of the rehabilitated sewer shall be equal to or greater than that of the host pipe based on a Manning's "n" roughness coefficient of 0.013 for the host sewer and no greater than 0.011 for the rehabilitated sewer. The roughness coefficient for the rehabilitated sewer shall be documented by hydraulic test data acceptable to the City Representative.

The Contractor shall provide materials, labor, equipments, services necessary for bypass pumping and/or diversion of sewage flows, CIPL installation, service connection reinstatement, initial and final cleaning, initial and final CCTV inspection, and final testing. The Contractor shall be responsible for proper and accurate installation of the CIPL regardless of the installation methods specified herein.

Since sewer and storm products are intended to have a 50 year design life, and in order to minimize the Owner's risk, only proven products and contractors with substantial successful long term track records will be approved. All trenchless rehabilitation products and installation contractors shall meet this specification prior to the bid date. Documentation of experience shall be verified by the Owner and no exceptions will be allowed.

Product manufacturers and Installation contractors seeking approval must meet all of the following criteria to be deemed Commercially Proven:

For a Product to be considered Commercially Proven, a minimum of 500,000 linear feet or 3,000 manhole-to-manhole line sections of the proposed tube and resin composite system shall have been successfully installed in wastewater or storm collection system installations in the U.S. At least 50,000 linear feet of the product shall have been in successful service within California for a minimum of five years.

For an Installation Contractor to be considered Commercially Proven, the Installation Contractor must possess and demonstrate the following experiences:

1. At least five (5) years active experience in the commercial installation of the product bid.

2. Successful installation of CIPL in wastewater or storm collection systems in the US must meet the following size and footage requirements:

Group	Largest CIPL Size in Contract Drawing	Minimum Size Installed	Minimum Installed Length (feet)
Circular System:			
1	18-inch Ø or Smaller	10-inch Ø	12,000

Experience of Installation Contractor's employees will not be considered or credited in evaluating whether the Installation Contractor meets the experience requirements specified above. Notwithstanding the restriction, the City may consider and credit the experience of an owner, partner or principal officers who is responsible for making significant administrative and business decisions on behalf of Installation Contractor toward the organizational experience requirements specified above.

The City will credit the experience of an Installation Contractor's owner, partner or principal officer toward the organizational experience requirements specified above only if each of the following requirements are satisfied:

1. The individual is not designated as a Key Team Member in responses to Paragraph 1.9.A.1 of Section 00 21 13 - Instructions to Bidders;

2. Installation Contractor demonstrates, to the City's satisfaction, that the individual's prior experience with another firm is predictive of Contractor's performance on this project based on the individual's present management/supervisory role with the firm or company and the individual's anticipated involvement and supervision of the Work to be performed; and

3. The individual has been employed by or associated with (i.e. as an owner or partner) with the firm or company for at least 2 years prior to the date of Bid Opening.

Sewer and storm rehabilitation products submitted for approval must provide Third Party Test Results performed by an independent lab supporting the long term performance, structural strength and corrosion resistance of the product. No product will be approved without independent third party testing verification. Minimum required third party test results to be submitted shall be per ASTM D2990 for 10,000 hours to establish the long term creep reduction factor to be used in the calculation of liner thickness, and ASTM D5813 for one year to determine acceptable corrosion resistance performance.

The owner authorizes the use of proven CIPL materials that serve to enhance the sewer performance specified herein. Proven materials have passed independent laboratory testing, not excluding long-term (10,000 hour) structural behavior testing, and have been successfully installed to repair failing host pipes in the U.S. for at least 4 years. In addition to the aforementioned, the owner may require that the contractor demonstrate that the enhancements proposed exceed the specifications herein, prior to the installation of the enhanced material systems. This section in no way shall be interpreted as authorization to deviate from the minimum standard practices set forth herein.

1.2 DESCRIPTION

A. Work Included: The work specified in this Section includes:

1. Confirm existing sewer size to be lined.

2. Cleaning, removing obstructions, televising existing sewer, and lining this sewer interior with cured-in-place liner.

3. Cutting segments of side sewers and culverts (if any) that protrude beyond the inner wall of the main sewer prior to the lining work.

4. Excavating pit and demolition sections of existing manhole if necessary for insertion of liner material.

5. Bypassing main sewer flow.

6. Side sewer and culvert flow diversion.

7. If necessary, excavating pits upon approval for accessing and diverting flows from side sewers that do not have air vents during the main sewer lining work. This work will be completed as incidental work.

8. Liner preparation.

9. Liner inversion.

10. Liner curing with air steam mixture or heated water.

11. Cured In-Place-Line Pipe Testing.

12. Reinstatement of active side sewers and culverts to newly lined main sewers.

13. In cases where liner is installed through an interior manhole, reinstated that manhole opening and other sewer connections within that manhole to the newly lined main sewers as incidental work.

14. After all work in this contract has been completed, the Contractor shall televise the entire lined sewer facility.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Other contract documents, including Drawings, Relevant Sections of the SFDPW Standard Specifications and these Specifications apply to work specified herein.

B. Division 1, General Requirements.

C. Sections 01 55 26, 31 23 19, 31 23 33, 32 12 16, 32 13 13 and 33 33 00.

1.4 REFERENCES

A. Department of Public Works Standard Specifications dated November 2000.

B. Standard Specifications for Public Works Construction - 1991 Edition (“Green Book”).

C. American Society of Testing and Materials (ASTM) Standards. (Latest Edition).

1.5 SUBMITTALS

A. The Contractor shall furnish six (6) copies of certified report of the actual test results for CIPL meeting the requirements of ASTM D790, D-5813, F1216 and F-1743 for approval by City Representative.

B. For review and evaluation by the City Representative, the Contractor shall furnish a side sewer diversion and main sewer flow bypassing plan for each individual sewer liner installation run.

C. The Contractor shall furnish logs of measurements of exact inside dimensions and length of sewers to be lined to City Representative for records. For every 50-foot length of sewer, at least one measurement shall be taken.

D. For review and evaluation by the City Representative, the Contractor shall furnish submittals that specify size of liners to be used for each sewer. Outside dimensions of CIPL shall be equal to inside dimension of existing sewer to be lined.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The thickness of the liner pipes and/or the modulus shall be submitted per specification for the City Representative's approval before manufacturing the liner.

B. The finished lining shall consist of a custom engineered nonwoven polyester fabric tube that is coated with plastic coating. The fabric matrix is vacuum impregnated with polyester, vinylester or epoxy resins to provide the necessary structural and chemical characteristics depending on the application to fit tight against the existing inside pipe wall. The liner shall be fabricated from materials which when cured, will be chemically resistant to withstand internal exposure to sewage gases containing quantities of hydrogen sulfide, carbon monoxide, methane, petroleum hydrocarbons, saturation with moisture and dilute sulfuric acid.

C. The lining shall be continuous and of sufficient length to extend the entire reach (entry to exit point) to be relined. The ends of the liner shall be trimmed neatly to within 2 inches of the lined section.

D. Felt shall be polyester tube of at least five (5) denier, with sufficient needling and crosslapping to yield burst strength of 1,000 pounds per square inch in transverse directions (hoop stress).

E. Inside liner coating shall be plastic coated non-woven polyester tube saturated with thermosetting resin bonded to the inside layer of felt at 400 grams/square meter forming a nominal (0.010 inch) pin hole free coating layer.

F. Resin shall be either polyester, vinylester or epoxy, depending on application, with sufficient thixotrophic properties to obtain non-draining characteristics when impregnated into the felt tubing.

G. Catalyst shall be compatible with the resin and other materials used in the manufacture of the liner. The non-promoted resin shall be catalyzed by the addition of sufficient catalyst to produce the physical properties of the cured polyester felt liner contained in the general physical properties listed in the Subsection of these Specifications.

H. Liner shall be free from visible tears, holes, cuts, foreign materials, and other defects.

I. **Liner resin shall include an odor neutralizing agent or additive that will mask the odor with a fruity scent.**

PART 3 - EXECUTION

3.1 PREPARATION

A. The Contractor shall remove all protruding connections, bricks, roots, grease and debris from existing sewers by any method necessary in order to adequately prepare the sewer for the televisions and proper installation of the liner.

3.2 TELEVISION INSPECTION OF EXISTING SEWERS BEFORE AND AFTER LINING

A. Television inspection of the existing sewers shall be performed by experienced personnel trained in locating breaks, obstacles and side sewer connections by closed circuit television. The television inspection shall be carefully done by experienced personnel to determine the location of any and all conditions which may prevent proper installation of

the liner into the existing sewer lines. Video DVDs and suitable logs shall be made of all television inspection. Contractor shall review the video tapes of the initial television inspection with the City Representative to determine actual number of side sewer connections, protruding side sewers, and the extent of cleaning operation needed to make the existing sewer line suitable for the installation of the liner. After all work in this contract is completed, Contractor will provide the City Representative with video tapes showing before and after conditions including restored service connections for City's file. Video inspections shall be formatted as indicated within Section 33 33 00 of the contract specifications.

3.3 HANDLING AND DISPOSAL OF SEEPAGE, STORM WATER AND SEWAGE

A. The Contractor shall protect the work from water damage, shall keep excavations dry, shall dispose of water from all sources, shall do all necessary pumping, and shall install suitable conduits to remove and divert all sanitary, ground water, tidewater, storm water flow and unforeseen sub-drain, so as to prevent back-up, by-passing to the Bay, flooding damage to property, and damage to City's Right Of Way in accordance with the requirements of Sections 301 and 700.08 of SFDPW Standard Specifications and the requirements as set forth in this Section.

B. The Contractor shall not impede or obstruct any wet weather flow anywhere in the sewer system. Backing up of flow is not allowed. The Contractor shall be cautioned that a sudden storm can cause heavy flow in the sewer system that could reach ground level. The bypassing sewer flow system shall be adequate to handle a 5-year storm routinely and heavy flow that could reach ground level during the period of construction.

C. The Contractor is hereby informed that the work inside existing sewers involves contact with raw sewage, sludge, grease and hydrogen sulfide may be present. The Contractor shall provide all safety equipment including gas-monitoring devices to detect the presence of toxic gases. OSHA health and safety requirements shall be strictly enforced.

D. The Contractor shall take adequate measures to prevent the impairment of the operation of the sewer system. The Contractor shall prevent construction material, pavement, concrete, earth, paints, thinner, solvents or other debris or toxic material from entering a sewer or sewer structure including surface flow collection system, like catch basin and culvert.

E. Contractor shall provide for the transfer and dispose of sanitary and storm flow around the section or sections of pipe that are to be rehabilitated. The bypass shall be made for diversion of the flow at an existing upstream access point and gravity or pumping the flow into a downstream access point of adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. The flow height shall not exceed one foot above the crown of any active sewer pipe access point.

F. The bypass pumping should be scheduled for 24-hour continuous duty from the start of the operation with backup equipment available for periods of maintenance and refueling. The Contractor shall obtain a night noise permit for any work between the hours of 8:00 PM and 7:00 AM, as specified in Section 2908 of the Police Code.

3.4 SIDE SEWER OR STORM DRAIN FLOW DIVERSION

A. The Contractor shall contact and notify the residents affected by this sewer work 72 hours in advance. The Contractor shall provide pumps and adequate drainage system at each side sewer locations as directed by the City Representative.

B. At locations where side sewers do not have air vents, excavate as needed in order to

access the side sewer for purposes of diverting the flow during the main sewer lining operation. These pits shall be excavated in advance and covered temporarily with steel plating or by other materials approved by the City Representative until such time that the side sewer needs to be accessed for flow diversion during the main sewer lining operation.

C. Failure to provide sufficient pumps will result in a liquidated damage of Five Hundred Dollars ($500.00) per occurrence per calendar day where flooding or overflowing occurs due to lack of side sewer flow diversion. Liquidated damages will not be assessed if the pumps are in operation at all times prior to flooding or overflowing. Mechanical breakdown will not be considered as valid cause for non-assessment.

3.5 LINER PREPARATION

An odor neutralizing agent or fruity scent additive shall be included in the liner preparation. This agent or additive shall have zero impact on the performance or life of the liner.

The Contractor shall designate a location where the uncured resin in the original containers and the unimpregnated liner will be vacuum impregnated prior to installation. Contractor shall allow the City Representative to inspect the materials and the "wet-out" procedure. A resin and catalyst system compatible with the requirements of this method shall be used. The quantities of the liquid thermosetting materials shall be per manufacturer's standards to provide the nominal liner thickness specified.

3.6 LINER INVERSION

The wet-out Liner shall be inserted through a manhole by means of an inversion process and the application of a hydrostatic head or any other adequate application sufficient to fully extend the Liner to the next designated access point. The impregnated Liner shall be inserted into the inversion tubes with the impermeable plastic membrane side out. At the lower end of the inversion of the inversion tube, the Liner shall be turned inside out and attached to the inversion tube so that a leak proof seal is created. The inversion head will be adjusted to the sufficient height to invert the Liner tube to the next access point designated and to hold the Insitupipe snug to the sewers wall and to produce dimples at side connections and flared ends at the entrance and exit access points. The use of a lubricant is recommended and, if used, such lubricant shall be as approved by manufacturer's standards. The manufacturer's standards shall be closely followed during the elevated curing temperature so as not to over stress the Liner and cause damage or failure of the Liner prior to cure. (In certain cases, the Contractor may elect to use a Top Inversion. In the Top Inversion method, the Liner is pre-inverted to a distance that corresponds to the minimum inversion head and instead of attaching to an elbow at the base of the inversion tube the Liner is attached to a top ring.).

3.7 LINER CURING

A. After inversion is completed, Contractor shall supply a suitable heat source and water recirculation equipment. The equipment shall be capable of delivering hot water to the far end of the Liner tube through a hose, per manufacturer's recommendations, to uniformly raise the water temperature in the entire Liner tube above the temperature required to effect a cure of the resin. The temperature shall be determined by the resin/catalyst system employed.

B. The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing heat exchanger circulating water. Thermocouples shall be placed between the Liner tube and the invert at near and far access to determine the temperature of the Liner tube and time of exotherm. Water temperature in the line during cure period shall not be less than 150^{O}F or more than 180^{O}F as measured at the heat

exchanger return line.

C. Initial cure shall be deemed to be completed when inspection of the exposed portion of the Liner appears to be hard and the thermocouples indicate that an exotherm has occurred. The cure period shall be of a duration recommended by the resin manufacturer, as modified for this process, during which time the recirculation of the water and cycling of the heat exchanger to maintain the temperature in the Liner continues.

3.8 COOL DOWN

The Contractor shall cool the hardened Liner tube to a temperature below 100^{O}F before relieving the static head in the inversion tube. Cool down may be accomplished by the introduction of cool water into the inversion tube to replace water being drained from a small hole made in the end of the Cured-In-Place Pipe at the downstream end. Care shall be taken in the release of the static head such that a vacuum will not be developed that could damage the newly installed Liner.

3.9 FINISHED CURED-IN-PLACE LINER

A. The finished Cured-In-Place Liner shall be continuous over the entire length of an insertion run and be as free as commercially practicable from visual defects such as foreign inclusions, dry spots, pinholes, and delamination. The Liner shall be impervious and free of any leakage from the pipe to the surrounding ground and from the surrounding ground to the inside of the Liner.

B. Any defects which will affect, in the warranty period the integrity or strength of the Liner, shall be repaired at the Contractor's expense in a manner mutually agreed upon by the City and Contractor.

C. Physical Strength of Cured-In-Place Pipe

The Cured-In-Place Liner Membrane shall conform to and shall be designed as per ASTM F1216, Appendix X.1. meeting the minimum standards as listed below:

Cured Insituform	Standard	Results
Flexural Strength	ASTM D-790	4,500 psi
Flexural Modulus & Elasticity	ASTM D-790	400,000 psi

The required structural CIPL wall thickness shall be based as a minimum, on the physical properties in the above table and in accordance with the Design Equations in Appendix X1 of ASTM F 1216, and the following design parameters:

Design Safety Factor = 2.0

Retention Factor for Long-Term Flexural Modulus to be used in Design = 50% (max)

(*as determined by Long-Term tests described in paragraph 5.2*)

Ovality* = 2%

Groundwater Depth (above invert) = 2+/- ft.

Soil Depth (above crown) = 10+/- ft.

Soil Modulus = 1,000 psi

Soil Density = 120 pcf

Live Load (use AASHTO 20 if in public right of way) = H20

Design Condition = fully deteriorated

D. Chemical Resistance

Chemical resistance must meet requirements of ASTM D-5813 and F-1216.

E. Sealing Liner at the Ends

If, due to broken or misaligned sewer at the access point, the Liner fails to make a tight seal, the Contractor shall apply a seal at those locations. The seal shall be of a resin mixture compatible with the Liner.

3.10 CURED IN PLACE LINER TESTING

A. The water tightness of the liner shall be gauged while the liner tube is curing and under positive head.

B. The Contractor shall bear all costs incurred in correcting any deficiencies found during the final television inspection.

C. CIPL Field Samples - The Contractor shall submit test results from field installations in the USA of the same resin system and tube materials as proposed for the actual installation. These test results must verify that the CIPL physical properties specified in Section 3.09 have been achieved in previous field applications. Samples for this project shall be made and tested as described in Sections 7 and 8 of ASTM D 5813.

3.11 CLEAN UP

Upon completion of the installation work and after required testing indicates the liner is acceptable, Contractor shall restore the project area affected by his operation.

3.12 SPECIAL INSTRUCTION TO THE CONTRACTOR

The Contractor shall video inspect the sewer to find out the condition prior to lining work.

It is the responsibility of the Contractor to verify in field the exact inner dimensions and length of the existing main sewer to be lined prior to manufacturing the liner.

A. Contractor shall submit a “Styrene Mitigation Plan” with designs to reduce, shield, control and direct the emission of styrene emissions and/or other potentially harmful gases and meet the requirements and guidelines of agencies having jurisdiction over this work, including but not limited to California Occupational Safety and Health Administration (CAL/OSHA) requirements, State of California Division of Industrial Safety, U.S. National Institute of Occupational Safety and Health (NIOSH), and the project action levels (both Tiers I and II) listed below. The Contractor is directed to the table below regarding project action levels and maximum allowable levels, which shall be used when developing the Styrene Mitigation Plan submittal.

	Maximum Allowable Level
California Occupational Safety and Health Administration (CAL/OSHA)	
PERMISSIBLE EXPOSURE LIMIT Permissible exposure limit expressed as a time-weighted average; the concentration of a substance to which most workers can be exposed without adverse effect averaged over a normal 8-hour workday or a 40-hour workweek (PEL-TWA)	50 ppm

SHORT-TERM EXPOSURE LIMIT Short-term exposure limit expressed as a 15- minute time weighted average exposure which should not be exceeded at any time during a workday (STEL)	100 ppm
National Institute of Occupational Safety and Health (NIOSH)	
Recommended exposure limit for an 8- or 10-hour timeweighted-average exposure and/or ceiling (REL-TWA)	50 ppm
Recommended short-term exposure limit; a 15-minute TWA exposure which should not be exceeded at any time during a workday (STEL)	100 ppm
PROJECT ACTION LEVEL TIER I, (INSIDE WORK AREA)	10 ppm
PROJECT ACTION LEVEL TIER II (CLOSEST TO COMMUNITY RECEPTORS)	4.9 ppm

1. The Styrene Mitigation Plan:
    a. shall be reviewed and approved by a Certified Industrial Hygienist (CIH).
    b. shall provide sufficient details on how to reduce the emission of styrene at the project location and throughout the CIPL installation process to meet the requirements in the table above, particularly: when opening the storage unit and on preventing styrene odor; from travelling up sewer laterals and into private properties, and from being released into the environment.
    c. may include engineering measures, such as: airtight barriers or containment, use of local exhaust ventilation or similar controls for a minimum of 24 hours.
    d. shall include additional mitigation measures that the Contractor shall implement within 1 hour if either the Project Action Level Tier I or Tier II are exceeded.
    e. shall be provided as a submittal per Section 01 33 00 - Submittal Procedures.
2. If styrene emission level exceeds the Project Action Level, Tier I or Tier II, as shown in the table above, Contractor shall implement additional mitigation measures approved in the Contractor's Styrene Mitigation Plan as soon as possible, but within 1 hour or less of being notified of the exceedance. If the additional mitigation measures are not successful in reducing the styrene emission levels within 2 consecutive calendar days, the City may issue a stop work notice immediately and/or suspend the future CIPL work until the Contractor (with recommendation from the Contractor's CIH) inform the City via a submittal on the additional measures to mitigate the styrene emission levels at Contractor's cost.
3. The City will be conducting ambient air monitoring at the project Tier I and Tier II locations. The City's monitoring data will take precedence over the Contractor's data with regards to implementing additional mitigation measures, with work suspension or work stoppage with this Contract. The Contractor may conduct its own air monitoring at its own costs.
4. The Styrene Monitoring Plan does not replace nor negates Contractor's sole

responsibility to identify and comply with all applicable health and safety requirements for the health and safety of Contractor's employees and Subcontractors as set forth in applicable statues, laws and regulations. Contractor shall submit site-specific Contractor Health and Safety Plan (HASP) prior to commencement of CIPL work activities, refer to Section 00 73 19.

5. If styrene emission levels exceed the regulatory limits established by the Cal/OSHA and NIOSH as shown in table above, Contractor shall suspend work immediately. For work suspensions due to exceedance with Cal/OSHA requirements, there shall be no compensation to the Contractor. It is the Contractor's responsibility to maintain levels below the requirements of Cal/OSHA and NIOSH.

3.13 CORRECTION OF DEFECTS IN SEWER CONSTRUCTED IN THIS CONTRACT

A. The City will inspect the sewer interior by television prior to expiration of the one year post-construction period, following the date of acceptance of the work.

B. All defects shall be corrected by the Contractor at no expense to the City.

3.14 RECORD DRAWINGS

A. Prior to acceptance of the work for warranty, the Contractor shall furnish the City Representative with one (1) neatly and legibly marked, in red pencil, set of full size record drawings showing all changes in the Contract Plans. Changes shall include, but not be limited to the field changes or adjustments in the final location or dimensions of the contract work; changes due to requests for information, changes due to change orders and changes to reflect the actual existing conditions. Marking of the drawings shall be accurate and current, and be done at the time work is performed. These drawings shall be presented monthly to the Resident Engineer for review.

B. Each completed Record Drawing shall be signed by the Contractor and Construction Manager to indicate that he/she has reviewed the drawings for completeness. Each completed Record Drawing shall be transmitted to the Project Engineer through the Resident Engineer as soon as the work on that drawing is completed.

C. If record drawings are not furnished, final payment will be withheld.

END OF SECTION