**SECTION 2.4**

**TECHNICAL SPECIFICATIONS FOR**

**REHABILITATION OF EXISTING WATER MAIN**

**BY CURED-IN-PLACE PIPE**

**NOVEMBER 2000**

**Part 1: General**

* 1. **Scope of Work**

Furnish all materials, labor, equipment, tools including barricading, temporary water, excavation, pre-televising, testing and chlorination fittings, tie-ins, service reinstatements and all other required incidentals for the reconstruction of existing water mains by the installation of a resin-impregnated flexible tube that is inflated within the existing pipe to form a hard, impermeable, corrosion resistant pipe within a pipe. When cured, the cured in place pipe (CIPP) will be formed to the original water main.

Contractor shall reconstruct existing water mains by the insertion of a flexible lining tube consisting of two concentric, tubular, woven and seamless polyester jackets with a watertight polymeric membrane bonded to the interior that has been saturated with a thermosetting resin.

* Inversion Method (ASTM F1216)

Liner shall be inserted into existing water main by direct inversion using a head of water.

* Pulling Method (ASTM F1743)

Line shall be inserted into the existing water main by pulling the tube into place by winching and then inflating.

The shaping of the liner may be achieved by pushing a pig through the hose using water pressure. The thermosetting resin shall then be cured only by circulating hot water through the tube to cure the resin into a hard impermeable pipe.

* Other curing methods may be used as approved by the product manufacturer.

**Part 2: Quality Assurance**

* 1. **Reference Standards**

Unless otherwise stated, the latest editions of the following documents are applicable for this specification:

ASTM D638 Standard Test Method for Tensile Properties of Plastics.

D790 Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

F1216 Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.

F1743 Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP).

NSF/ANSI 61 Drinking Water System Components--Health Effects

\*Manufacturer’s standards are also hereby made a part of this specification.

* 1. **Qualification Requirements:**
     1. Manufacturer/Installer:

No work by other than the CIPP manufacturer that involves this rehabilitation process will be accepted, unless such installers or companies are certified and licensed by the CIPP manufacturer for such work and are approved by the Owner. Unless otherwise approved, the Manufacturer/Installers must meet the following criteria to be deemed commercially acceptable:

* + - * Must satisfy all insurance, financial, and bonding requirements of the Owner, and must have had at least 5 (five) years active experience in the commercial installation.
      * Must have successfully installed at least 25,000 feet of the cured-in-place product intended for use on this project in water distribution systems in the U.S. with at least 10,000 feet installed in the State of Texas.
      * Manufacturer/ Installer’s project manager must have a minimum of 3 years of CIPP installation experience, while under the employment of the Manufacturer/ Installer’s company.

2.2.2 Product:

* The product installed shall be certified by NSF to ANSI/NSF Standard 61 and shall be listed on the NSF website accordingly. The product installed shall meet the requirements of (Sec 4.01) and shall have been commercially proven with a 5 year history of installations in North America and a minimum footage installed of 250,000 linear feet.
  1. **Warranty**
* A one year warranty for the pipe shall be included from the Contractor, and shall cover the cost of replacement pipe and freight to project site, should the pipe have any defects in material or workmanship.
* In addition to the standard pipe warranty, the CIPP contractor shall provide in writing a warranty for a period of one year for all the CIPP work including material, installation, and pressure testing at no additional cost to the owner.
* Unless otherwise specified, the warranty periods shall begin after the Certificate of Acceptance is issued for the Contract.

**2.4 Submittals**

The Contractor shall furnish all necessary catalogs cut sheets, technical literature, shop drawings and engineering data to address the following documentations:

2.4.1 Material Data:

Type of resin tube material and its physical properties

2.4.2 Process Demonstration

* Submit detailed installation procedures including curing methods, curing temperatures, inversion methods, inversion or pull-in pressures, etc.
* Method of sealing liner at services, fittings, valves or other appurtenances.
  + 1. Engineering Calculations:

Provide diameter, length, wall thickness and all structural design calculations for each water main segment to be rehabilitated. All design calculations must be sealed by a State of Texas Registered Professional Engineer.

2.4.4 Testing/TV Inspection Report

* Copies of certified independent laboratory tests on the proposed resin impregnated tube showing values for short term Flexural Modulus of Elasticity, Flexural Strength, Tensile Strength and other related properties. The testing laboratory must be a certified independent facility and not affiliated with the proposed CIPP manufacturer/installer. In addition, submit field test results from one previous CIPP project over the last three years using the same values shown on the questionnaire.
* Television inspection reports along with video made after new pipe installation.
* Copies of test reports for QA/QC of installation and curing process.

2.4.5 References

* Provide three references of projects completed within last five years by the manufacturer in which a water main was successfully rehabilitated using the proposed materials. Include contact names, addresses and phone numbers of agencies involved.

**Part 3: Product**

3.1 **Liner Size and Length:**

* The liner shall be fabricated to a size that when installed will neatly fit the internal circumference of the water main to be lined. The liner thickness shall be designed to adequately resist the full internal pressure including allowances for surge pressure and all external pressures and conditions (e.g. deflection, ring bending, buckling and minimum stiffness). The length of the liner shall be of sufficient length to effectively span the distance and carry out the insertion and seal of the liner at the end points. The Contractor shall verify the lengths in the field before cutting the liner to length. Prior to the start of work the manufacturer of the cured-in-place-pipe liner will be required to submit design calculations for wall thickness to the Engineer. Allowance for circumferential and longitudinal stretching of the liner during insertion shall be made as per the manufacturer’s standards.

3.2 **Color:**

* CIPP wall coloring after installation must be a white color that can give a clear detail examination or encapsulated television inspection equipment.

**Part 4: Structural Requirements**

* 1. **Liner Material**

The cured in place pipe liner shall be composed of two concentric, tubular, woven and seamless polyester jackets with a seamless polymeric membrane bonded to the interior. The polymeric inner membrane shall be designed to ensure water tightness. The full cured in place pipe lines shall conform to the minimum structural standards as follows:

Tensile Strength @ Yield 3,000 psi (ASTM D638)

Flexural Strength 4,500 psi (ASTM D790)

Flexural Modulus 250,000 psi (ASTM D790)

The Contractor shall furnish, prior to use of the lining materials, satisfactory written guarantee of his compliance with these specifications and the line manufacturer’s standards for all materials and techniques being used in the method.

**4.2 Design Parameters**

The following design parameters shall be used in the design of pipe liners in addition to the manufacturer’s standards and ASTM 1216:

* Ovality of Existing Pipe 2% Minimum
* Existing Pipe Condition Fully Deteriorated
* Modulus of Soil Reaction 700 psi Minimum
* Factor of Safety Against Buckling 2 Minimum
* Live Load AASHTO HS2O-44 Loading

Under Roadways AASHTO E-80 Loading under Railroads

* Soil Unit Weight 120pcf Minimum (If no

Boring Data is available in vicinity)

* Creep Reduction Factor 50% Maximum
* Internal Pressure System Working Pressure
* Depth of Cover As per plan

Liner material shall be tested in accordance with ASTM F1216, Section 8 – Inspection Practices. Certificates of tests shall be provided to the Engineer.

**Part 5: Execution**

**5.1 Preparatory Procedure**

5.1.1 Excavation of Insertion/Extraction Pits, Removal of Pipe, and Route Survey

The length and width of insertion/extraction pits shall as recommended by the pipe liner manufacturer and as approved by the Engineer.

The Contractor shall excavate the insertion/extraction pits at the locations and to the dimensions specified and approved.

The Contractor shall excavate and remove the minimum length of pipe necessary for the liner insertion and receiving operations as per manufacturer’s recommendations and as ordered by the Engineer.

The existing main shall be cut square using an approved cutting machine, leaving no split or fractured ends. All cut faces of the existing main shall be chamfered on the inside surface to a suitable profile to prevent damage to the liner pipe during or after insertion.

Edge guards or other means of protecting the liner from host pipe edges at insertion points must be submitted to the Engineer for review and approval.

A thorough examination of the route of the existing water main shall be made after cutting of the main. This should include a pipeline location survey with equipment for locating any changes in direction, valves, bends, intrusions, and other fittings that may impede the insertion and/or proper inflation of the cured-in-place-pipe liner.

5.1.2Safety

The Contractor shall carry out his operations in strict accordance with all OSHA and manufacturer's safety requirements. Emphasis shall be placed upon safety requirements for entering confined spaces and working with hot water.

The Contractor shall erect such signs and other devices as are necessary for the safety of the work site and shall secure the site and perform all work to the safety requirements of all pertinent regulatory agencies.

5.1.3 Cleaning

The cleaning of the existing water main is a critical step in the reconstruction of the existing water main with a cured-in-place-pipe liner method. It is anticipated that the existing water main will have a fair amount of rust and scale deposits on the inside walls of the pipe.

The Contractor shall clean the existing water mains using a cleaning method that is approved by the Engineer. The cleaning method shall remove all rust, scales, tuberculation, deposits, loose or deteriorated remains of any original coatings and

other foreign materials from the inside of the pipe so as to produce a smooth metal surface finish that will allow the new composite liner to adhere to the existing host pipe.

After cleaning, and again immediately before pipe liner insertion the main shall be plunged with a tight fitting rubber plunger and foam swab to clear the pipe bore of debris and water.

5.1.4 Air Quality

The Contractor is advised that all liner installation work shall be carried out in full compliance with all City, State, and Federal laws, rules, and regulations regarding Air Quality and Safety.

5.1.5 Pre-Construction Television Inspection

The Contractor shall perform a television inspection and video recording of the existing water main after the cleaning of the water main is completed. This inspection will be performed, utilizing a radial eye camera, to determine that the rust and scale deposits have been adequately removed, that the latest condition of the water main makes lining feasible, to check for leaking service connections, and to accurately identify the location of service connections. Each service connection location shall be logged for use when re-opening of service connections is required.

5.1.6 Temporary Water Service

Prior to the start of construction the Contractor shall submit to the Engineer for approval his method of providing temporary water service to customers and to emergency fire crews. This shall include the Contractor’s method to provide maintenance and protection during the entire length of the contract to ensure continued water service.

The temporary water line shall be disinfected and acceptable samples obtained and approved by the Engineer prior to connection to the customers.

**5.2 Locating Service Connections**

* Prior to installation of the cured-in-place-pipe liner the Contractor shall locate all existing water service laterals, and plug the service laterals as recommended by the manufacturer and approved by the Engineer. The insertion of plugs into the service connections may be done simultaneous with the above mentioned television inspection. The plugs are inserted so as to prevent any accumulation of epoxy inside the service line thus blocking them, and to prevent any water infiltration from a customer’s leaking shut-off valve. Furthermore, special plugs shall be inserted so as to make visible any non-penetrating service connections in the lined pipe, and allow the operators to locate the non-penetrating service connections after they have been covered with the composite liner.
* The Contractor shall plug the customer’s service lateral and provide temporary water service to the customers.
* Upon completion of installation of liner and pressure testing the Contractor shall re-open the existing service laterals to the customers from within the pipeline.

**5.3 Delivery, Storage and Handling**

* The Contractor shall transport, handle, and store liner and thermosetting resin as recommended by manufacturer.
* The Contractor shall deliver, store and handle other materials as recommended by the manufacturers to prevent damage.
* Liner materials that are defective or damaged prior to installation shall be rejected and replaced at the Contractor's expense. Liner materials damaged during installation shall be repaired or replaced as recommended by the manufacturers and approved by the Engineer.

**5.4 Installation**

5.4.1 Preparing and Inserting the Liner

The Contractor shall designate a location where the uncured resin in the original containers and the unimpregnated liner will be impregnated prior to installation. The Contractor shall allow the Engineer and/or his representative to inspect the materials and chemical impregnation “wet out” procedure. A resin and catalyst system recommended by the liner manufacturer and approved by the Engineer shall be used. The quantities of the liquid thermosetting materials inserted into the lining tube shall be as per manufacturer's standards so as to fully saturate the liner material and provide the lining thickness specified.

Immediately after cutting and prior to installation of liner, the ends of the adjacent existing water main that are not to be lined at the insertion/extraction points shall be covered/plugged so that no debris shall enter into them during reconstruction work.

The chemical impregnated liner material shall be inserted into the water main being reconstructed through the insertion point by either the direct inversion method or by the pull-in-place method, as recommended by the manufacturer. The head used to extend the liner tube shall be sufficient enough to fully extend the tube both circumferentially and longitudinally. The shaping of the liner may be achieved by pushing a pig through the hose using water pressure. The head used will fall within the manufacturer's guidelines to insure that a proper finished thickness is achieved and that the liner fit snug to the existing pipe wall producing dimples and/or at service connections and flared ends at the entrance and exit points.

Puller unit/winch cable shall be equipped with a tension gauge to measure tension during pull through.

Inflation of liners used shall be accomplished in accordance with manufacturer’s standards and specifications.

5.4.2 Curing of Liner

After inflation or inversion is completed, the Contractor shall supply a hot water heat source. The equipment shall be capable of delivering hot water to the far end of the liner to uniformly raise the temperature in the entire liner above the temperature required to initiate and effect curing of the resin system. The temperature shall be determined by the resin/catalyst system employed. The heat source shall be fitted with suitable monitors to gauge the temperature and pressure of the incoming and outgoing heat exchanger circulating heating medium. Thermocouples or temperature gauges or infra-red gun shall be used at insertion and extraction points so as to determine and record the temperature of the liner and time of exotherm.

Initial cure shall be deemed to be completed when inspection of the exposed portions of the liner show it to be hard and sound; and when temperature reading(s) at the interface of the liner with the host pipe indicate sufficient heating has occurred. The cure period shall be of a duration recommended by the resin manufacturer; modified for the site specific conditions at the time curing is effected. During this cure time, the temperature inside the liner will be continuously maintained in the range required.

Once the cure is complete, the Contractor shall cool the hardened liner to a temperature below one hundred degrees Fahrenheit (100ºF) before relieving the internal pressure. Cool down shall be accomplished as recommended by the manufacturers. Care shall be taken in the release of the internal pressure so that a vacuum will not develop that could damage the newly installed liner.

The finished lining shall be continuous over the entire length and be free from visual defects such as foreign inclusions, dry spots, pinholes and delaminations. The lining shall be impervious and free of any leakage from the pipe to the surrounding ground or from the ground to the inside of the lined pipe.

If at the insertion/extraction ends the lining fails to make a tight seal, the Contractor shall apply a seal of a resin mixture compatible with the liner.

**5.5 Preliminary Television Inspection of Installed Liner**

After the liner is sufficiently cool (below one hundred degrees Fahrenheit (100°F)) and before opening the service laterals, a preliminary television inspection and video recording of the newly installed liner shall be performed to determine if the liner is properly installed. If no services are involved then this will become the final TV inspection.

**5.6 Testing**

After installation and curing of the new liner, the lined existing water main shall be pressure tested as per ASTM F1743 Section 8.3. Testing shall comply with all applicable jurisdictional building codes, statutes, standards, regulations, and laws. All necessary fittings to complete hydrostatic testing and chlorination shall be supplied and installed by the contractor.

* + 1. Hydrostatic Testing and Leakage Testing for Pressure Piping

All hydrostatic and leakage testing shall be in accordance to Sec 506.5 COD (Hydrostatic Test) as specified in City of Dallas Addendum to the North Central Texas Council of Governments (NCTCOG) Public Works Construction Standards, Latest Edition.

* 1. **Service Connections**

After the pressure testing is completed, the Contractor shall re-open all existing service connections as ordered by the Engineer. These service connections shall be re-opened and paid for as applicable unless otherwise specified.

Whenever possible the re-opening of connections shall be done without excavation and from the interior of the newly installed liner by the use of a remote controlled cutting device. A closed circuit television system shall be used for monitoring the operation. All connections that are to be re-opened shall be satisfactorily opened to the size of the original opening, and to the depth required to completely open the water service connection to the customer. Opening shall be smooth and flush.

**5.8 Final Television Inspection**

A final television inspection and video recording of the newly lined water main including the restored service connections shall be performed immediately after work is completed. Televising equipment shall be dedicated potable water equipment. Equipment previously use in a wastewater system shall not be allowed. Should the results of this final inspection reveal any defects that are determined by the Engineer to be repairable the Contractor will be required to repair these defects as ordered by the Engineer at the sole expense of the Contractor. Should the results of this final inspection reveal any defects that are determined by the Engineer not to be repairable the Contractor will be required to remove and replace the existing water main as

ordered by the Engineer at the sole expense of the Contractor.

Payment for this final television inspection will be made under the contract bid item labeled “Television Inspection and Video Tape Recording”, unless otherwise specified.

**5.9 Pipeline Re-assembly**

After final television inspection is completed the removed sections of the existing pipeline (e.g. at insertion/reception pits, valves, connections, etc.) shall be reconstructed in accordance with the contract plans and specifications and/or as ordered by the Engineer. No end seals shall be used to seal the extremities of the liner. The necessary end pieces shall be installed so as to make proper connection to the cut and lined existing water main pipe.

**5.10 Disinfection/ Chlorination**

Once all pipe work is completed to the satisfaction of the Construction Manager, Dallas Water Utilities shall perform, as required, chlorine disinfection, sampling and analysis of the newly installed liner in accordance with the specifications and/or as ordered by the Engineer.

**5.11 Recommissioning**

Recommissioning of water main shall be done in accordance with AWWA Standards or as ordered by the Owner. Customer service shall be restored after acceptable samples have been obtained and approved by the Owner.

**5.12 Limitation and Constraints**

If wet-out is done at the site, confine the operations to one lane of traffic if possible and provide adequate devices and facilities for containing any chemical spills. In addition the Contractor will be required to follow all policies and requirements for traffic at the controlling jurisdiction. The Contractor may be required to submit a traffic control plan for approval (No Separate Payment).

**Part 6: Acceptance**

**6.1 Finish**

* The finished pipe must be continuous and free from significant defects.
* Any defects which will affect the integrity or strength of the pipe in the opinion of the Owner in the foreseeable future or warranty period, must be repaired at the Contractor's expense, in a manner agreed upon by the Owner.

**6.2** **Inspection**

After the work is completed, the contractor will provide the Owner with a video showing the before and after condition, including the reinstated water line and building lateral connections.

**6.3** **Failure to Meet Requirements**

* The Owner will view the inspection video tape and determine if all required work is complete. Any deficiencies noted by the Owner must be corrected to his satisfaction.
* Any section failing the hydrostatic pressure test must be corrected or modified by the Contractor until it passes.

**6.4 Cleanup**

Clean up the entire project area after the work is completed and all testing accepted. Remove and dispose of all excess material and debris not incorporated into the permanent installation.

**Part 7: Method of Measurement and Payment**

Method of Measurement and Payment for the work included in this section will be in accordance with the payment schedule in the Bid Proposal.

**\*\*END OF SECTION\*\***