ITEM 603.01 39 M - REHABILITATION OF EXISTING STORM DRAIN PIPELINES BY CURED IN PLACE INVERSION LINING

DESCRIPTION

The general extent and scope of work required to be performed in this section consists of all work necessary for the removal of existing material which has accumulated within the drainage pipes along the alignment of the Battery Park Underpass roadway, and the repair and relining of the pipes interior surface with a cured in place inversion lining system. The drainage pipes to be cleaned and relined are show on the construction drawings. Material, which has accumulated in the drainage system and which is to be removed, consists of, but is not limited to, concrete, bituminous asphaltic concrete, and tuberculation material from the degragation of the existing cast iron pipe, as well as other debris. Removal operation must be accomplished without damage to the pipe, manhole inlets, or surrounding infrastructure.

Videotape of the storm drainage pipe system showing general conditions are available at NYCDOT for review by the contractor prior to submitting his/her bid. These tapes are provided as general information and are not intended to provide any guarantee of all conditions within the pipe system to be repaired and rehabilitated. As part of this work the contract is to videotape the storm sewer lines before work commences and again at the conclusion of the work to demonstrate that repairs and relining complies with the contract requirements.

Contractor shall protect the drainage pipes from further degregation during overall construction activities for the project.

Scope/Intent: This specification provides for the reconstruction of storm drain pipe pipelines by installation of a cured-in-place-pipe (CIPP) via the ASTM F-1216-98 inversion method. The finished pipe shall extend over the installation length in a continuous, tight-fitting, water tight pipe-within-a-pipe. The Contractor shall provide all labor, equipment, materials, tools, and appurtenances required to clean and pretelevise, line, and post videotape the sewer pipelines.

Reference Specifications: This specification references American Society for Testing and Materials (ASTM) and National Association of Sewer Service Companies (NASSCO) standards which are made part hereof by such reference, and shall be the latest edition and revision thereof. If there is a conflict between these standards and this specification, this specification will govern.

Liability: In addition to liability requirements defined elsewhere in the Contract Documents, the Contractor will be held fully liable for any damage to manholes, laterals, or piping that is caused by the Contractor's activities during the installation of the liner.

Patents, Trade Secrets, Copyrights:

The Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product or device which is the subject of patent rights, trade secrets protection rights, or copyrights held by others. The Contractor shall indemnify and hold harmless the Owner and Engineer and anyone directly or indirectly employed by either of them from and against all claims, damages, losses and expenses (including attorney's fees and court and arbitration costs) arising out of any infringement of patent rights, trade secret protection rights, or copyrights incident to the use in the performance of the work or resulting from the incorporation in the work of any

invention, design, process, product or device not specified in the Contract Documents, and shall defend all such claims in connection with any alleged infringement of such rights.

Products and Suppliers

Since sewer products are intended to have a 50-year design life, and in order to minimize the Owner's risk, only proven products with substantial successful long-term track records will be approved. The name(s) of trenchless rehabilitation products and installers to be use on the project must provided with the bid proposals

Submittals:

At the time of bid the contractor shall provide the following submittals:

A. Design: The Bidder shall submit designs to the owner representative for each manhole to manhole section of pipe. These designs shall be made in strict accordance with ASTM F-1216-98 and project specifications. Designs shall include any assumptions made in addition to those specified herein, all calculations and inputs, and the design output.

B. Materials Certification: Joint certification of materials from the Manufacturer and Contractor shall state that the materials supplied for this project will meet or exceed requirements of this specification once installed under field conditions. The certification must include a statement indicating that physical properties of 95% or more of field samples of the composite will meet or exceed properties used as input for the designs submitted for this project.

C. Experience/Project References: Submit references of at least three (3) projects performed within the past five (5) years. These projects must be similar in scope and complexity to the project being bid. These references shall include the following: (1) Project title, location, and contract value; (2) Project description, including pipe diameters, linear feet, and number of service connections reinstated; (3) Client contact, including customer name, address, and phone number; and (4) Problems which required removal of the installed reconstruction system, or digging to reinstate service connections.

D. Service Life: Describe and document the expected service life of the proposed product. Include empirical data and third-party tests used to determine and support the - estimated service life. Include third-party test results which support the enhancement factor (K) and the percent retention of properties (creep properties) included in the submitted design.

E. Resin Impregnation: Submit a narrative and any accompanying drawings describing the procedure for resin impregnation of the tube. Special emphasis shall be placed on methods for ensuring air is evacuated from voids which are to be filled with resin. Methods for inspecting the tube to assure adequate impregnation of resin shall be included.

MATERIALS

General: An approved resin-impregnated flexible tube shall be used to form the composite, cured-in-place pipe. The resin impregnated flexible tube shall be installed via the F-1216-98 inversion method into an existing conduit by utilizing a hydrostatic head. This system is to be used for storm drains. Resin properties must be equal to or exceed the minimum criteria established herein.

Material Composition and Testing: The tube shall consist of one or more layers of flexible needled felt or an equivalent woven and/or non-woven material capable of carrying resin, withstanding installation pressures and curing temperatures, and compatible with the resin system used. The resin used shall be compatible with the rehabilitation process and be able to cure in the presence or absence of water. initiation temperature for cure shall be as recommended by the resin manufacturer and approved by the Project Engineer.

Tube Acceptance: At the time of resin impregnation, each lot shall be inspected for defects. The resin shall not contain fillers or additives, except those required for viscosity control, fire retardant, modulus enhancement, chemical resistance, or extension of pot life. Thixotropic agents which will not interfere with visual inspection may be added for viscosity control. Also, the opaqueness of the plastic coating shall not interfere with visual inspection. Resins may contain pigments, dyes, or colors which do not interfere with visual inspection of the cured-in-place liner pipe or its required properties. For testing purposes, a lot shall consist of all the tube for a given rehabilitation run.

Resin impregnation: The tube shall be vacuum-impregnated with resin (wet-out) under controlled conditions. The volume of resin used shall be sufficient to fill all voids in the tube material at nominal thickness and diameter. The resin volume quantity shall be adjusted by adding excess resin for the change in resin volume due to polymerization and to allow for any migration of resin into the cracks and joints in the original pipe. A roller system shall be used to uniformly distribute the resin throughout the tube.

The Contractor shall designate a location where the CIPP tube will be vacuum impregnated prior to installation. The Contractor shall allow the owner's representative to inspect the materials and procedures used to vacuum impregnate the tube.

Marking: Liner shall be clearly marked at an interval not to exceed 5 feet with a number which identifies the length (in footage, yardage, or meters) of the CEPP. These markings shall be clearly visible in the post-lining inspection video.

Chemical Resistance: The sewer pipe is for storm drainage, however, the CIPP shall meet the minimum chemical resistance requirements listed in Table A. CIPP samples for testing (at the Owner's discretion and expense) 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 must meet these chemical testing requirements.

Chemical resistance tests shall be completed in accordance with Test Method D 543 with the chemical solutions shown in Table A. Exposure shall be for a minimum of 12 months at 73.4°F (23ºC). During this period, the CIPP test specimens shall lose no more than 20% of their initial strength and flexural modulus.

Table A
Minimum Chemical Resistance Requirements for
Domestic Sanitary Sewer Applications

Chemical Solution	Concentration (%)
Nitric Acid (HNO_3)	5
Tap Water (PH 6-9)	100
Phosphoric Acid (H_3PO_4)	10
Sulfuric Acid (H_2SO_4)	10
Gasoline	100
Vegetable Oil	100

Detergent (LAS)	0.1
Soap	0.1

Liner Sizing: The tube shall be sized to accommodate the forces of installation, host pipe configuration, and any other pertinent factors to assure a tight fitting final product with a smooth finish.

CONSTRUCTION DETAILS

General: The required structural CEPP wall thickness shall be designed in accordance with the guidelines in Appendix XI of ASTM F-1216-98. In cases where ovality exceeds 10%, or where pipes are egg or oval shaped, alternative methods of design may be considered by the Engineer. The categories of design parameters noted in Tables B, C, and D shall be used, unless otherwise directed by the Engineer.

Common Design Parameters: Design inputs generally considered to be the same from site to site for a particular project are provided in Table B.

Table B Common Design Parameters	
Safety Factor (1)	2.0
Soil Modulus(2)	1000 psi
Soil Density (3)	120 pcf

Notes - Table B

1. The safety factor may be reduced to 1.5 at the discretion of the Engineer, normally in the case where there is accurate and detailed information known about the existing pipe and soil conditions.

2. In the absence of site-specific information, the Engineer assumes a soil modulus of 1000 psi.

3. In the absence of site-specific information, the Engineer assumes a soil density of 120 lb/ft^3.

Site Specific Parameters: The information listed in Table C is specific to each manhole to manhole run of pipe. The Bidder shall use for design the information provided by the Owner/Engineer and information the Bidder collects during site visits for each manhole to manhole run.

Table C Site-Specific Design Parameters	
Ovality	Notes 1, 2
Ground Water Depth Above Invert	Notes, 1, 3
Soil Depth Above Crown	Note 1
Live Load	Notes 1, 4

Design Condition (Partially or Fully Deteriorated)	Notes 1, 5
CIPP Thickness	Notes 1, 6, 7, 8

Notes - Table C:

1. Design thicknesses and complete site-specific designs, in accordance with ASTM F-1216-98 (Appendix XI), shall be submitted with the bid and attached at Appendix A.

2. The Bidder shall estimate the ovality by viewing the videotapes and other information provided by the Owner. If tapes are not available, the Bidder shall assume an ovality of 3%. In cases where the ovality exceeds 10%, the Bidder may consider employing alternative design methods (such as beam design methods) to determine the pipe thickness.

3. In the absence of accurate water table information or high water elevation observed during the site visit (stream, ponds, etc.), the Bidder shall assume the height of water above the invert of the pipe as '/2 the depth from ground surface to the invert of the pipe.

4. Any pipelines running under highways or other roadways shall be assumed to carry highway live loads of H20 (16,000 lbs.), if the pipe is fully deteriorated.

5. The Bidder shall determine if the pipe segments are partially or fully deteriorated based on viewing of tapes and other information provided by the Owner. If tapes are not available at the time of bid, the Bidder shall assume the pipes are partially deteriorated, unless otherwise directed by the Engineer.

6. Thicknesses specified (designed by the Bidder and approved by the Engineer) are the final, in-ground thicknesses required. Measured sample thicknesses will not include polyurethane or polyethylene coatings, any layer of the samples with and without plastic coating must meet these chemical testing requirements. Chemical resistance tests shall be completed in accordance with Test Method D 543 with the chemical solutions shown in Table A. Exposure shall be for a minimum of 12 months at 73.4'F (23'C). During this period, the CIPP test specimens shall lose no more than 20% of their initial flexural strength and flexural modulus. tube not fully and verifiably impregnated with resin, or any portion of the tube not deemed by the Engineer to be a structural component of the composite.

7. The Contractor must consider any factors necessary to ensure the final, cured-in-place pipe thickness is not less than specified (designed by the Bidder and approved by the Engineer) above. These factors include any stress applied to the material during transportation, handling, installation and cure; the host pipe's material type, condition, and configuration; weather (including ambient temperature conditions); and any other factors which are reasonably expected to be found in existing drainage sewer systems.

8. Design thicknesses provided by the Contractor at the time of bid shall be evaluated by the Engineer prior to award.

Product-Specific Design Parameters: Certain design inputs vary by manufacturer, processes design, or installation technique. These variables are listed in Table D with explanatory notes below.

Table D Minimum Product-Specific Design Parameters	
Enhancement Factor, K [1]	K = 7
Initial Flexural Strength (ASTM D 790) [2]	II_s = 4000 psi
Initial Flexural Modulus of Elasticity (ASTM D 790) [2]	E_B = 300,000 psi
Retention of Properties to Account for Long-Term Effects	50%
Long-Term Flexural Modulus of Elasticity [3]	E_L = 150,000 psi

Notes - Table D:

1. Enhancement factor (K) is the additional buckling or load resistance of the rehabilitation product due to the restraining action of the host pipe. The tighter the fit of the product within the host pipe, the greater the value of K. Third party testing of external hydrostatic loading capacity of restrained pipe samples shall be conducted to verify the enhancement factor, K. The minimum values provided are based on the "Long-Term Structural Behavior of Pipeline Rehabilitation Systems," Trenchless Technology Center, 1994.

2. Initial values are defined in ASTM D 790. The Project Engineer may, at any time prior to installation, direct the Contractor to make cured samples (according to ASTM F-1216-98) and test them in accordance with the listed ASTM standards to verify initial values of physical properties. In such tests the Contractor's samples must achieve a 95% pass-rate.

3. The initial flexural modulus is multiplied by the creep factor (or percentage retention) to obtain the long-term values used for design. Long-term values shall be verified by long-term external pressure testing of circular lengths of the pipe material by third-party labs prior to bid (e.g. Trenchless Technology Center - TTQ. It is understood that the material's modulus of elasticity will not change over time; however, by convention the modulus is reduced for design purposes for all plastic pipe sections to account for the reduced ability of plastic pipe to carry loads due to the changes in pipe geometry resulting from the effects of creep over time.

   Design Thicknesses: The Engineer reserves the right to change specified thicknesses based on new information. The bid prices will be adjusted as appropriate to increase or decrease as liners are thickened or thinned at the Engineer's direction.

Capacity: Maintenance of flow capacity of existing pipes is essential. Rehabilitated pipe shall have no significant change in capacity. An increase in flow capacity following rehabilitation is preferred, and in no case shall the flow capacity of rehabilitated pipes be significantly reduced.

CONSTRUCTION REQUIREMENTS

Contractor shall schedule sewer pipe activities in coordination with other work for the project such that the pipe repair activities occur during scheduled lane closures.

Cleaning Sewer to be Lined: Prior to entering access areas such as manholes, and performing inspection or cleaning operations, an evaluation of the atmosphere to determine the presence of toxic or flammable vapors or lack of oxygen must be undertaken in accordance with local, state, or federal safety regulations.

All internal debris shall be removed from the existing pipeline. Gravity pipes shall be cleaned with hydraulically powered equipment, high-velocity jet cleaners, or mechanically powered equipment (see NASSCO Recommended Specifications for Sewer Collection System Rehabilitation). Due to the type of material which has accumulated in the drainage system consists but is not limited to, concrete, bituminous asphaltic concrete, and tuberculation material from the degragation of the existing cast iron pipe, the contractor shall employ whatever measures are necessary to remove the hardened material without damage to the pipe. Methods and means shall comply with all federal, state and local environmental and safety regulations.

Contractor's attention is called to the fact that video tapes are available for review at the Offices of NYCDOT. These tapes are provided as general information and are not intended to provide any guarantee of all conditions within the pipe system to be repaired and rehabilitated.

Existing material which has accumulated within the pipe and which the contractor is to remove consists of bituminous asphalt concrete, concrete, and localized tuberculatin material from the degragation of the cast iron sewer pipe. The contractor is to remove this material, without further degrading the pipe material, prior to relining the pipe.

Inspection of pipelines shall be performed by experienced personnel trained in locating breaks, and obstacles by closed-circuit television or man entry. The interior of the pipeline shall be carefully inspected to determine the location of any conditions that may prevent proper installation of the impregnated tube, such as collapsed or crushed pipe, and reductions in the cross-sectional area of more than 40%. These conditions shall be noted so that they can be corrected. The original pipeline shall be cleared of these obstructions at no additional cost to the Owner. If the contract encounters a section of pipe that has totally collapsed or can not be adequately repaired with the relining process described herein, he/she shall immediately notify the owner and engineer.

Television Inspection: After the sewer section to be lined is cleaned, inspection shall be made with a color pan and tilt, rotating head camera specifically designed and constructed for sewer inspection. The subject pipes are storm sewer drain pioes, however, if necessary, sewer to be televised shall be isolated by plugs to eliminate flow from the line section. Lighting for the camera shall provide a clear picture of the entire periphery of the existing sewer.

Inversion: The wet-out tube shall be inserted through an existing manhole or by means of the ASTM F-1216-98 inversion process. The application of the hydrostatic head shall be sufficient to extend the tube to the next

designated manhole or termination point. The placement procedure shall be required to produce dimples at the service connections. Tube installation forces shall be limited so as not to stretch the tube longitudinally by more than 5% of the original length. These forces shall also be limited so as not to damage the existing pipe or manholes. The Contractor shall protect the manholes to withstand forces generated by equipment, water, or air pressures used while inverting the tube.

Curing: After placement of the liner is completed, a suitable heat source shall be required to distribute and recirculate hot water throughout the pipe. Temperature shall be maintained during the curing period as recommended by the resin manufacturer and approved by the Project Engineer. After the tube is cured, a cool-down period shall be used prior to opening the downstream end of the liner, reconnection of services, and returning normal flow into the system. The water in the pipe shall be cooled to 100'F before discharge.

End Seal: The ends of the CIPP shall be sealed to provide a smooth transition from the existing sewer pipe to the CIPP. Sealing material shall be compatible with the CIPP material and shall provide a watertight seal.

QUALITY ASSURANCE

Material Handling: The Contractor shall protect, store, and handle the pipe liner material during transportation, while on-site, and during installation in accordance with manufacturer's recommendations to ensure that the liner material is not damaged. If any part of the liner material becomes damaged before or during installation, it shall be repaired or replaced at the Contractor's expense.

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

Defects: Defects which, in the opinion of the Project Engineer, will affect the liner's structural integrity, hydraulic performance, future maintenance access, and overall liner performance shall be repaired or the line replaced at the Contractor's expense. Any lined section (from manhole to manhole or inlet) exhibiting defects will be rejected for payment until such time repairs have been made to the defective liner to the satisfaction of the Project Engineer.

Liner Thickness: The final, installed liner thickness shall not be less than the design requirements. The final product thickness measurement will be evaluated from the tap coupons, plate samples, or restrained pipe samples or as determined necessary at the discretion of the Project Engineer. It is the responsibility of the Contractor to consider site conditions and their installation process in order to determine the thickness to install to achieve the designed thicknesses. Pipe conditions may change from the time of bid; therefore, the Contractor shall notify the Project Engineer if the existing pipe has deteriorated from the condition documented on the bid tapes so that the design thickness can be changed.

Testing: The Contractor shall make restrained pipe samples from every CIPP installation and submit them to the Engineer for quality assurance testing. Plate samples will be accepted for testing where the diameter of the host pipe precludes making of restrained samples in the manhole. All samples will be made according to ASTM F-1216-98 and as directed by the Engineer. The Engineer may select 10% of samples for testing. These samples will be sent to a third-party lab approved by the Engineer. The Contractor shall pay the cost of shipping and testing. In general, testing will be consistent with the requirements of ASTM F-1216-98.

For each section of the cured-in-place pipe liner to be tested, cut and prepare two samples. Cut one from a section selected by the Project Engineer of cured liner at an intermediate manhole or at a termination point that has been initiated through a like diameter pipe which was held in place by a suitable heat sink. The other sample shall be fabricated from material taken from the tube and the resin/catalyst system used and cured in a clamped 0 Rev - 4/1/04 ~mold placed in the downtube (i.e., plate sample). The samples shall be large enough to provide a minimum of three specimens and a recommended five specimens for flexural testing. The full CIPP sample wall thickness shall be tested, whenever possible. If the sample is irregular, distorted, or of such thickness that proper testing is inhibited, then the wall thickness shall be machined away from the inside pipe face of the sample only. Thus, the test specimen shall be cut from the outside pipe face of the CIPP sample. For specimens greater than V2 inch (12.70 mm) in depth, the width-to-depth ratio of the specimen shall be increased to a minimum of 1:1 and shall not exceed 4:1. Test results must verify that the CIPP physical properties used in the design have been achieved in a minimum of 95% of the samples. The following test procedures will be completed after the sample is cured and removed:

> Test Procedure: Test specimens shall be oriented on the testing machine with the interior surface of the CIPP in tension. The following test procedure shall be followed after the sample is cured and removed.
> Short-Term Flexural (Bending) Properties: The initial tangent flexural modulus of elasticity and flexural strength shall be measured for gravity in accordance with Test Method D 790, Test Method I - Procedure A.

Training-/Qualifications: Personnel directly involved with installing the CIPP shall be trained by the manufacturer in the handling, inserting, trimming and finishing the pipe liner.

Final Television Inspection: After CIPP is in place and sewer service connections are reinstated, the liner shall be televised with color pan-tilt camera. Each line section shall be suitably isolated by sewer plugs to eliminate flow during the inspection. The pan-tilt rotating camera shall pause at each connection to evaluate the liner opening and the water tightness of the opening. The Contractor shall provide the Project Engineer a copy of the video tape inspection of each liner section.

METHOD OF MEASUREMENT

The intent of pipe to be cleaned and lined is shown on the contract drawing.

BASIS OF PAYMENT

All work associated with the item shall be part of the lump sum bid price.