HAMPTON ROADS
PLANNING DISTRICT COMMISSION

REGIONAL CONSTRUCTION STANDARDS

FIFTH EDITION

Publication Update #6

Full Committee Approved Proposed Revision #10
as Publication Update #6.

Replace - Pipe Rehabilitation by Cured-In-Place Pipe Method Section 200 (5.21.B); and, page 813-9 of Pipe Rehabilitation by Cured-In-Place Method (Section 813.2.2.A.2)

April 11, 2013

CDM Smith

Face of DVD

Manhole No. From	Manhole No. To	Pipe Diameter	Pipe Length	Street

B. Pipe Rehabilitation by Cured-In-Place Pipe Method

1. The product proposed for the cured-in-place rehabilitation of sewers must have been in use in the United States for at least three years with a minimum of 50,000 linear feet of the product installed to date in this country.

2. The liner shall generally consist of corrosion resistant polyester, vinyl ester, or epoxy thermosetting resin, or approved equal, impregnated flexible polyester felt or fiberglass fiber. The liner may also consist of glass reinforced pipe (GRP).

3. The wall color of the interior pipe surface of the cured-in-place pipe after installation shall be a light reflective color so that a clear detail examination with closed circuit television inspection equipment may be made.

4. Design inputs generally considered to be the same from site to site for a particular project, are provided in Table 200-5.21.1.

TABLE 200-5.21.1
Common Design Parameters

Safety Factor	2.0
Soil Modulus (1)	1000 psi
Soil Density (2)	120 pcf

Notes:
(1) In the absence of site-specific information, assume a soil modulus of 1000 psi.
(2) In the absence of site-specific information, assume a soil density of 120 lb/ft3 (pcf).

The information listed in Table 200-5.21.2 is specific to each manhole to manhole run of pipe. The Contractor shall use for design the information provided by the Owner and information the Contractor collects during site visits for each manhole to manhole run.

TABLE 200-5.21.2
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 (Fully Deteriorated)	Notes 1, 5
CIPP Thickness	Notes 1, 6, 7

Notes:

(1) Design thickness and complete site-specific designs, in accordance with ASTM F 1216 (Appendix XI) or ASTM F 2019

(2) The Contractor shall estimate the ovality by viewing the videotapes and other information provided by the Owner. If tapes are not available, the Contractor shall assume an ovality of 2%. In cases where the ovality exceeds 10%, the Contractor 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 Contractor shall assume a seasonal groundwater elevation variation of 3 feet below the ground surface.

(4) CIPP is subjected to traffic live loads as calculated by AASHTO Standard Specifications for Highway Bridges, HS-20-44 Highway Loading.

(5) The Contractor shall assume the pipe segments are fully deteriorated.

(6) Thicknesses specified (designed by the Contractor and approved by the Owner) are the final, in-ground thickness required. Measured sample thicknesses will not include polyurethane or polyethylene coatings, any layer of the tube not fully and verifiably impregnated with resin, or any portion of the tube not deemed by the Owner 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 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 combined or sanitary sewer systems.

5. The corrosion resistance of the resin system shall be tested by the resin manufacturer in accordance with ASTM D 543. The result of exposure to the chemical solutions listed in Table 200-5.21.3 shall produce loss of not more than 20% of the initial physical properties when tested in accordance with ASTM D 543 for a period of not less than 1 year at a temperature of 73.4°F plus or minus 3.6°F. For applications other than municipal wastewater, conduct chemical resistance tests with actual samples of the fluid to be transported in the pipe and in accordance with procedures approved by the Owner.

TABLE 200-5.21.3
Concentrations of Chemical Solutions for Chemical Resistance Test

Chemical Solution	Concentration, %
Tap Water (pH 6-9)	100
Nitric Acid	5
Phosphoric Acid	10
Sulfuric Acid	10
Petroleum Hydrocarbon Based Fuels (e.g. Gasoline, diesel, etc.)	100
Vegetable Oil[1]	100
Detergent[2]	0.1
Soap[2]	0.1
Domestic Sewage	100

1 Cotton seed, corn, or mineral oil
2 As per ASTM D 543

6. Manufacturer's Information

a. It shall be necessary for the Contractor to obtain the Owner's prior approval for all materials or processes and the Owner shall have the power at any time to order the Contractor to modify or discontinue any practice. All such orders shall be given in writing.

b. All fabricating and Contractor testing shall be carried out under cover and no materials shall be exposed to the weather until they are ready to be inserted. All materials should be protected from the weather and exposure to ultra-violet light as practicable during the manufacture and installation process.

c. Each liner shall be accompanied by suitable documentation indicating time and date of manufacture, felt thickness, number of layers, length of liner, resin types, resin content, catalyst, relevant batch numbers, etc.

7. Non-Reinforced Thermoset Cured In Place Pipe Liners (Water or Steam Cured)

a. The liner shall meet the requirements of ASTM F 1216 and shall be constructed to withstand inversion pressures, have sufficient strength to bridge missing pipe, stretch to fit irregular pipe sections, and shall invert smoothly around bends. The liner shall fit tightly to the internal circumference of the existing pipe, and a membrane integrally bonded to the internal circumference of the felt, thus forming a smooth, chemically inert internal flow surface. The membrane shall be a minimum of 0.25 mm +5% and shall not be considered to impart any structural strength of the liner. The liner shall be fabricated to a size that when installed will neatly fit the internal circumference of the pipe to be lined. Allowance for longitudinal and circumferential stretching of the liner

during installation shall be made by the Contractor.

b. The CIPP liner shall be composed of tubing material consisting of one or more layers of a flexible non-woven polyester felt with or without additives such as woven fiberglass or other fibers and meet the requirements of ASTM F 1216, ASTM F 1743, and ASTM D 5813. The felt content of the CIPP liner shall not exceed 25 percent of the total impregnated liner volume. The fabric tube shall be capable of absorbing and carrying resins, constructed to withstand installation pressures and curing temperatures and have sufficient strength to bridge missing pipe segments, and stretch to fit irregular pipe sections.

c. The CIPP liner tube may be made of single or multiple layer construction, with any layer not less than 1.5 mm thick. The wet-out fabric tube shall have a uniform thickness and excess resin distribution that when compressed at installation pressures will meet or exceed the design thickness after cure.

d. The exterior of the manufactured tube shall have distance markings along its length at regular intervals not to exceed 5 feet. Contractor shall use these marks as a gauge to measure elongation during insertion. Should the overall elongation of a reach exceed 5 percent, the liner tube shall be rejected and replaced. The Contractor shall identify the wet-out facility where all CIPP liner under this Contract will be manufactured. All CIPP liner shall be manufactured from this designated wet-out facility throughout the entire Contract unless specifically approved otherwise by the Owner in writing. Multiple wet-out facilities shall not be allowed. The application of the resin to the felt tubing (wet-out) shall be conducted under factory conditions and the materials shall be fully protected against UV light, excessive heat and contamination at all times.

e. The resin volume shall be adjusted by adding 5 to 10% 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. The resin used shall not contain fillers, except those required for viscosity control, fire retardance, or as required to obtain the necessary pot life. Thixotropic agents which will not interfere with visual inspection may be added for viscosity control. Resins may contain pigments, dyes or colors that will not interfere with visual inspection of the cured liner. However, the types and quantities of fillers and pigments added shall have prior approval of the Owner. The resin content of the liner shall be 10-15% by volume greater than the volume of felt in the liner bag. The felt resin tubing shall be vacuum impregnated with a thermosetting polyester resin and catalyst, vinyl ester resin and catalyst, or epoxy resin and hardener.

f. The Contractor shall deliver the uncured resin impregnated liner bag to the site. The bag may not be impregnated at the site unless approved by the Owner. The liner bag shall be impregnated with resin not more than 80 hours before the proposed time of installation and stored out of direct sunlight at a temperature of less than 30 °F.

Certain design inputs vary by manufacturer, process design, or installation technique. These variables are listed in Table 200-5.21.4 with explanatory notes below.

TABLE 200-5.21.4
Product-Specific Design Parameters

Minimum Enhancement Factor, K[(1)]	K = 7
Minimum Initial Flexural Strength (ASTM D 790)[(2)]	σ_s = 4500 psi
Minimum Initial Flexural Modulus of Elasticity (ASTM D 790)[(2)]	E_s = 350,000 psi
Minimum Retention of Properties to Account for Long-Term Effects [(3)]	50%
Maximum Long-Term Flexural Modulus of Elasticity [(3)]	E_L = 175,000 psi

Notes:

(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 Owner may, at any time prior to installation, direct the Contractor to make cured samples (according to ASTM F 1216 93) 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 - TTC). 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.

8. Glass Reinforced Pipe (GRP) Liners

The materials used for GRP liners shall have the following additional properties:

a. The fiberglass within the liner shall be non-corrosion material and shall be free from tears, holes, cuts, foreign materials and other surface defects. Its glass fibers must extend in a longitudinal direction to insure no longitudinal stretching during the installation process. The tube shall consist of a seamless, flexible, glass fiber with no longitudinal seams.

b. Interior and exterior plastics shall be styrene resistant to protect and contain the resin used in the liner.

c. The exterior plastic shall be UV light resistant, when applicable, and translucent to allow visual inspection of the impregnation of the resin within the glass fibers.

d. The resin shall be a chemically resistant, isophthalic polyester resin or vinyl ester resin. When cured the resin/liner system shall meet the structural and chemical resistance requirements of ASTM F 2019.

Certain design inputs vary by manufacturer, process design, or installation technique.

These variables are listed in Table 200-5.21.5 with explanatory notes below.

TABLE 200-5.21.5
Product-Specific Design Parameters

Minimum Enhancement Factor, K[(1)]	K = 7
Minimum Initial Flexural Strength (ASTM D 790)[(2)]	σ_s = 4500 psi
Minimum Initial Flexural Modulus of Elasticity (ASTM D 790)[(2)]	E_s = 725,000 psi
Minimum Retention of Properties to Account for Long-Term Effects [(3)]	50%
Maximum Long-Term Flexural Modulus of Elasticity [(4)]	E_L = 362,500 psi

Notes:
(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 Owner may, at any time prior to installation, direct the Contractor to make cured samples (according to ASTM F 1216 93) 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 - TTC). 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.
(4) E_L based on ASTM F 2019.

9. Liner Wall Thickness

a. Liner thicknesses shall be submitted for all pipe sections for Owner approval.

b. The required structural CIPP wall thickness shall be designed in accordance with the guidelines in Appendix X1 of ASTM F 1216 - or ASTM F2019. In cases where ovality exceeds 10%, or where pipes are egg or oval shaped, alternative methods of design may be considered by the Owner. The categories of design parameters noted in Tables 200-5.21.1, 200-5.21.2, 200-5.21.3, 200-5.21.4 and/or 200-5.21.5 shall be used, as appropriate, unless otherwise directed by the Owner.

c. Liner thicknesses may be modified with the Owner's approval of supporting calculations by the Contractor's Professional Engineer. The Owner reserves the right to change specified thickness based on new information. The bid prices will be adjusted to increase or decrease unit price as liners are thickened or thinned at the Owner's direction.

d. Maintenance of flow capacity of existing pipes is essential. Rehabilitated pipe shall have minimum or no change in capacity. An increase in flow capacity

following rehabilitation is preferred, and in no case shall the flow capacity of rehabilitated pipes be reduced.

e. Verify that installed thickness of the CIPP is within minus 5 % and plus 10 % of the specified thickness. The Contractor shall collect samples per Section 813.2.6 Testing. The results of the liner thickness measurements and structural analysis shall be submitted to the Owner within 14 Days and prior to payment.

f. Minimum liner thicknesses for water or steam cured polyester thermoset CIPP and GRP liners shall be:

Pipe Diameter (In.)	Polyester Thermoset CIPP (mm)	GRP (mm)
6	4.5	3.0
8	6.0	4.5
10	6.0	4.5
12	6.0	4.5
15	7.5	6.0
18	9.0	7.5

10. The length of the liner shall be that which is deemed necessary by the Contractor to effectively carry out the insertion and seal the liner at the inlet and outlet of the manhole. Individual inversion runs may be made over one or more manhole to manhole sections as determined.

11. The Contractor shall provide a liner exhibiting the previously described properties. Prior approval of Shop Drawings related to any or all materials or methods of installation shall not relieve the Contractor of this responsibility.

C. Pipe Rehabilitation using Fold and Form Pipe Method

1. The product proposed for the fold and form rehabilitation of sewers must have been in use in the United States for at least three years with a minimum of 50,000 linear feet of the product installed to date in this country.

2. PVC fold and form liner pipe shall be manufactured from polyvinyl chloride (PVC) compound which meets all the requirements for cell classification 12111-C as defined in Specification ASTM D1784.

3. Installation and material tests of fold and form pipe shall meet the minimum requirements demonstrated in ASTM F 1871, Standard Specification for Folded/Formed Poly (Vinyl Chloride) Pipe Type A for Existing Sewer and Conduit Rehabilitation.

4. The Owner reserves the right to change specified thickness based on new information. The unit prices will be adjusted to increase or decrease as liners are thickened or thinned at the Owner's direction. Minimum liner wall thickness shall be compliant with Standard Dimension Ratio (SDR) 35 requirements unless otherwise noted.

such gauge between the CIPP liner and the pipe invert at the removal end to determine the temperature during the curing process. The temperature in the CIPP-lined host conduit during the curing process shall be as recommended by the resin manufacturer. The length of time for allowing the curing process to be completed shall be of the duration recommended by the manufacturer, during which time the Contractor shall maintain the required temperature throughout the CIPP-lined host conduit. Provide a written temperature data chart to the Owner for review to ensure that curing temperatures for the resin meet the manufacturer's recommendations.

13. When indicated on the Bid form, for steam or water cured applications, temperature monitoring systems are required for all 18-inch or larger sewer, or any sized sewer in locations with significant known groundwater infiltration, or if the pipe is within 50 feet of stream, river or lake. This system shall be installed at the invert of the pipe and be installed per the manufacturers recommended procedures. The temperature sensors shall be placed at intervals as recommended by the sensor manufacturer. Additional sensors shall be placed where significant heat sinks are likely or anticipated. The sensors, if installed, shall be monitored by a computer using a tamper proof data base that is capable of recording temperatures at the interface of the liner and the host pipe. Temperature monitoring systems shall be Zia Systems, Vericure by Pipeline Renewal Technologies, or approved equal.

14. The discharge location of the water within the CIPP liner after curing must be approved by the Owner or his designated representative.

2.2. LINER INSTALLATION

A. General Procedures:

1. Conduct operations in accordance with applicable OSHA standards, including those safety requirements involving Work on an elevated platform and entry into a confined space. Take suitable precautions to eliminate hazards to personnel near construction activities when pressurized air is being used.

2. The curing period shall be carried out under **a pressure** ~~an inversion head~~ to maintain a minimum hoop tension in the liner felt of 1 lb/in^2.

3. Vent and/or exhaust noxious fumes or odors generated during and remaining after the curing process is completed. This process shall remain in place at all manholes, laterals, etc., until noxious odors have dissipated to an acceptable level in accordance with OSHA requirements for the materials used and there is no more air pollution or potential health hazard left to the general public or the construction workers.

4. Maintain a curing log of CIPP temperatures at the upstream and downstream manholes during the curing process to document that proper temperatures and cure times have been achieved.

5. Invert through manholes shall be continuous and smooth through all manholes. If a liner is installed through a manhole, the bottom portion of the liner shall remain and the bench of the manhole shall be grouted and shaped as necessary to support the liner. If the liner terminates on either side of a manhole, the invert shall be built up to