

**SU302001D Pipe Rehabilitation****GUIDELINES – PROJECTS REQUIRING PIPE REHABILITATION:****VIRGINIA DEPARTMENT OF TRANSPORTATION  
SPECIAL PROVISION FOR  
PIPE REHABILITATION**

July 30, 2015

**I. DESCRIPTION**

This work shall consist of the rehabilitation of existing storm water, surface water pipe culverts and/or sanitary sewer lines by the method or methods specified at the designated locations described in the Contract using various standard and non-standard methodologies/technologies in accordance with the requirements of this provision and as directed by the Engineer.

**II. MATERIALS**

**Cement grout** shall conform to Section 218.03(b) or (d) of the Specifications.

**Corrugated steel pipe liner** used for Method C rehabilitation shall conform to Section 232.02 of the Specifications and shall be 10 gage with 3-inch by 1-inch angular corrugations. Corrugated steel pipe used as liners shall be manufactured by QC/QA producers on the VDOT Materials Division Approved Products List.

**Flexible pipe liner systems** used for Method D rehabilitation shall be from the VDOT Materials Division Approved Products List 38 and may be subject to limitations for use as specified herein, by site-specific limitations for those locations listed in the Contract, or as shown on the VDOT Materials Division Approved Products List 38 for the specific liner system. Where such is the case, the Contractor shall use only that type or those types that conform to the requirements for all pipe rehabilitation systems listed in List 38 and what the Department has specified for the specific location listed in the bid proposal documents. The Contractor shall furnish information, services, or other requirements as detailed on List 38 for all materials used for pipe rehabilitation system(s) specified in the Contract.

Flexible pipe liners shall be one or more of the following categories as designated in the Contract:

- Category A - Cured-In-Place Pipe (CIPP)
- Category B - Fold and Form flexible liners
- Category C – High Density Polyethylene (HDPE), Polyvinylchloride (PVC), or Polypropylene (PP) slip liners
- Category D - Spray-On liners

When **Category A - Cured-In-Place Pipe liners** are specified, the liner system supplied by the Contractor shall conform to the following requirements as supported by submitted design calculations:

- Must meet Drainage Manual, Chapter 8, Section 8.3.6.7 - Table A, Flexible Liner (Method D) Type Selection Guidelines for Category A systems.

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- Must exactly follow ASTM F1216 Appendix X1.2.2 Fully Deteriorated Gravity Pipe Conditions.
- Provide groundwater table elevation at crown of pipe.
- Traffic loading is HL-93, ignore after 8 ft of cover except for multiple barrel rehabs, continue indefinitely.
- Total wet unit weight of soil is 120 pcf, 135 pcf saturated.
- Modulus of soil reaction (based on VDOT pipe installation standards):
  - 0-5 ft of cover = 1.8 ksi
  - >5-10 ft of cover = 2 ksi
  - >10-30 ft of cover = 2.2 ksi
  - >30-60 ft of cover = 2.6 ksi
  - >60 ft of cover = 2.8 ksi
- Factor of safety N = 2.0.
- Construction:
  - Any voids around exterior of host pipe must be filled for design assumptions to be valid.
- Shall specify the following:
  - Method for installation and curing.
  - Individual components.
  - Tube type (whether reinforced or non-reinforced).
  - Manufacturer name and type of resin including catalyst.
  - Volume of resin required to achieve proper impregnation and curing.
- Shall include lot numbers and expiration dates of all supplied components.
- Shall have an impermeable inner and outer plastic film or plastic pre-liner to promote complete polymerization, prevent resin migration and loss, and prevent contamination of the interior of the finished product.
- Shall conform to the following table:

Property	Test Procedures	Physical Requirements
Tensile strength at yield	ASTM D-638	3,000 PSI
Modulus of elasticity	ASTM D-790	200,000 PSI
Flexural strength	ASTM D-790	4,000 PSI

When **Category B Fold and Form flexible liners** are specified, the liner system supplied by the Contractor shall conform to the following requirements as supported by submitted design calculations:

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- Must meet Drainage Manual, Chapter 8, Section 8.3.6.7 - Table A, Flexible Liner (Method D) Type Selection Guidelines for Category B systems.
- Must exactly follow ASTM F1947 Appendix X1.2.2 Fully Deteriorated Design Condition or ASTM F1867 Appendix X1.2.3 Fully Deteriorated Design Condition.
- Provide groundwater table elevation at crown of pipe.
- Traffic loading is HL-93, ignore after 8 ft of cover except for multiple barrel rehabs, continue indefinitely.
- Total wet unit weight of soil is 120 pcf, 135 pcf saturated.
- Modulus of soil reaction (based on VDOT pipe installation standards):
  - 0-5 ft of cover = 1.8 ksi
  - >5-10 ft of cover = 2 ksi
  - >10-30 ft of cover = 2.2 ksi
  - >30-60 ft of cover = 2.6 ksi
  - >60 ft of cover = 2.8 ksi
- Factor of safety N = 2.0.
- Construction:
  - Any voids around exterior of host pipe must be filled for design assumptions to be valid.

When **Category C HDPE, PVC, PP slip liners or spirally wound liners** are specified, the liner system supplied by the Contractor shall conform to the following requirements as supported by submitted design calculations:

- Must meet Drainage Manual, Chapter 8, Section 8.3.6.7 - Table A, Flexible Liner (Method D) Type Selection Guidelines for Category C systems.
- Must follow AASHTO LRFD Bridge Design Specifications, Section 12, version in use by VDOT Structure & Bridge Division at time of submittal, except that PVC spirally wound liners will follow ASTM F1697 and F1741.
- Must provide SDR and outside diameter of pipe, for solid wall pipe.
- Must provide outside diameter, inside diameter, diameter to centroid of wall, moment of inertia, gross and effective areas of wall, for corrugated or profile wall pipe.
- Provide groundwater elevation at crown of pipe.
- Traffic loading is HL-93, ignored after 8 ft of cover except for multiple barrel rehabs continue indefinitely.
- Total wet unit weight of soil is 120 pcf, 135 pcf saturated.
- Constrained soil modulus (based on VDOT pipe installation standards):

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- 0-5 ft of cover = 1.8 ksi
- >5-10 ft of cover = 2 ksi
- >10-30 ft of cover = 2.2 ksi
- >30-60 ft of cover = 2.6 ksi
- >60 ft of cover = 2.8 ksi
- Shape factor shall be 3.0.
- Long term modulus shall be used for stiffness computation.
- Live Load Distribution Factor = 1.
- Deflection Lag Factor = 1.5.
- Bedding Factor = 0.1.
- Installation Factor = 1.5.
- Maximum deflection, deflection needed in any computations, and service long-term tension strain limit shall be 5 percent for PE, and either 5 percent or 3.5 percent for PVC depending on cell class as per AASHTO LRFD Bridge Design Specs Table 12.12.3.3.1, and 3.5 percent for PP.
- Poisson's ratio of soil shall be 0.3.
- Earth load modifier shall be 1.05 and live load modifier shall be 1.0.
- Manning's N number for open channel flow  $n = 0.011$  for smooth interior PVC and  $0.012$  for smooth interior HDPE and PP. (For hydraulic design.)
- Construction:
  - Any voids around exterior of host pipe must be filled for design assumptions to be valid.
  - The annular space between host pipe and liner pipe must be fully grouted for design assumptions to be valid.

When **Category D Spray-on liners** are specified for structural rehabilitation, the liner system supplied by the Contractor shall conform to the following requirements as supported by submitted design calculations:

- Must meet Drainage Manual, Chapter 8, Section 8.3.6.7 - Table A, Flexible Liner (Method D) Type Selection Guidelines for Category D systems.
- Because of the variety of spray-on liners available, several design options may be used. For cementitious liners, design shall be guided similarly to nonreinforced concrete pipe, or alternately, similar to fiberglass pipe (high modulus material). For other liners, polyurea for example, design shall be guided similarly to fiberglass pipe (high modulus material) or simply as plastic pipe if flexural modulus or ring bending strain results are not satisfactory.
  - Cementitious liner treated similarly as fiberglass pipe (this method is based on the proposed AASHTO LRFD Bridge Design Specifications for fiberglass pipe):

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- Articles referenced below are from AASHTO LRFD Bridge Design Specifications, Section 12, version in use by VDOT Structure & Bridge Division at time of submittal.
- The flexibility factor for fiberglass pipe shall be determined in accordance with Article 12.12.3.6, but with the modulus replaced by flexural modulus, and the flexibility factor shall be limited as specified in Article 12.5.6.3.
- Follow Section 12.12.2.2 for deflection, except replace modulus with flexural modulus (ksi) and drop the “ $e_{sc}D$ ” term.
- Factored long term strain due to flexure shall be less than or equal to  $0.9 \cdot S_b$  ( $S_b$  is ring bending strain).
- Factored buckling strain demand shall be less than or equal to  $0.7 \cdot$  nominal strain capacity for buckling demand, computed per Eqn. 12.12.3.10.1e-2, except replace modulus with flexural modulus and soil resistance factor shall be 1.0. Factored buckling strain shall be:
  - $\frac{[13.65 \cdot \text{Height of soil over crown (in feet)} + 1.75 \cdot P_L] \cdot \text{radius of liner to centroid of wall in in.}}{\text{flexural modulus in ksi} \cdot X\text{-S area of liner in in}^2/\text{in}}$ , where  $P_L$  is determined from Eqn. 12.12.3.9-1.
  - Flexural modulus shall be determined from pipe stiffness tests and per Appendix 2 of ASTM D2412, and shall be at least 1,200 ksi.
  - Long term ring bending strain,  $S_b$ , shall be determined in accordance with ASTM D5365 and results extrapolated to both 50 years and 75 years, and shall be at least 0.006.
- It is recognized that for a spray-on product, obtaining specimens for flexural modulus and ring bending strain tests would require special formwork at a fabrication facility. Similarly as is done for watertight joint testing, these tests may be done and witnessed by a PE and a report submitted, which may then be used as proof of results without having to perform the tests for each future project, as long as materials and processes have not changed. Application thicknesses not tested may be interpolated by a satisfactory method. Extrapolation beyond thicknesses tested will not be permitted on the thin side, and will only be permitted for thicker applications by satisfactory statistical data.
- GW table at crown of pipe.
- Traffic loading is HL-93, ignored after 8 ft of cover except for multiple barrel rehabs continue indefinitely.
- Unit weight of soil is 120 pcf, 135 pcf saturated.
- Modulus of soil reaction (based on VDOT pipe installation standards):
  - 0-5 ft of cover = 1.8 ksi
  - >5-10 ft of cover = 2 ksi
  - >10-30 ft of cover = 2.2 ksi

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- >30-60 ft of cover = 2.6 ksi
- >60 ft of cover = 2.8 ksi
- Shape factor shall be 3.0.
- Live Load Distribution Factor = 1.
- Deflection Lag Factor = 1.5.
- Bedding Factor = 0.1.
- Installation Factor = 1.5.
- Maximum deflection and deflections needed in any computations shall be 5 percent.
- Poisson's ratio of soil shall be 0.3.
- Earth load modifier shall be 1.05 and live load modifier shall be 1.0.
- Other liner types treated similarly as fiberglass pipe:
  - Same as for cementitious liner treated similarly as fiberglass pipe above.
- Other liner types treated same as plastic pipe:
  - Follow AASHTO LRFD Bridge Design Specifications, Section 12, for thermoplastic pipe, version in use by VDOT Structure & Bridge Division at time of submittal.
  - GW table at crown of pipe.
  - Traffic loading is HL-93, ignored after 8 ft of cover except for multiple barrel rehabs continue indefinitely.
  - Unit weight of soil is 120 pcf, 135 pcf saturated.
  - Modulus of soil reaction (based on VDOT pipe installation standards):
    - 0-5 ft of cover = 1.8 ksi
    - >5-10 ft of cover = 2 ksi
    - >10-30 ft of cover = 2.2 ksi
    - >30-60 ft of cover = 2.6 ksi
    - >60 ft of cover = 2.8 ksi
    - Shape factor shall be 3.0.
    - Live Load Distribution Factor = 1.
    - Deflection Lag Factor = 1.5.
    - Bedding Factor = 0.1.

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- Installation Factor = 1.5.
- Maximum deflection and deflections needed in any computations shall be 5 percent.
- Poisson's ratio of soil shall be 0.3.
- Earth load modifier shall be 1.05 and live load modifier shall be 1.0.
- Construction:
  - Any voids around exterior of host pipe must be filled for design assumptions to be valid.

**Smooth-wall steel pipe liner** used for Method E rehabilitation shall conform to Section 232.02(c)5 of the Specifications.

### III. GENERAL PROCEDURES

The Contractor shall submit site specific working drawings (and supportive calculations) to the Engineer according to the requirements herein and Section 105.10 of the Specifications for the rehabilitation method selected by the Contractor from the allowable methods per each location listed in the Contract prior to the start of pipe rehabilitation operations.

The Contractor shall furnish to the Engineer a certification of the acceptability of the proposed rehabilitation system to provide the necessary hydraulic capacity and structural strength to support the anticipated total load and hydrology at the site of rehabilitation, as determined from a review that has been signed and sealed by a Professional Engineer holding a valid license to practice engineering in the Commonwealth of Virginia. Such certification shall cover all design data, supporting calculations and planned rehabilitation materials.

All work and equipment shall be contained within the existing right-of-way. In the event a temporary construction easement is deemed necessary due to the selected method or product chosen by the Contractor, the Contractor shall obtain such additional easement for his convenience at no additional cost to the Department.

The Contractor shall maintain all lanes of traffic at all times in accordance with the Special Provision for **Section 512—Maintaining Traffic – Non-Schedules (Lump Sum)** unless otherwise directed by the Engineer. This maintenance of traffic shall include temporary detours if required by the Contractor's method of operations to facilitate construction and where permitted by the locality and the Department. When temporary detours are required, the Contractor shall design and construct temporary detours in accordance with Sections 105.14 and 512 of the Specifications and Standard GS-10 of the Road and Bridge Standards respectively. The cost for maintenance of traffic including temporary detours shall be bid as a lump sum amount for the specific location of each pipe rehabilitation as shown in the Contract in accordance with the Special Provision for **Section 512—Maintaining Traffic – Non-Schedules (Lump Sum)** unless otherwise specified in the Contract.

The Contractor shall contact Miss Utility prior to commencing any work that may conflict with existing utilities, and shall coordinate with the utility company(ies) and the Engineer for any adjustments deemed necessary to complete the work. The Contractor shall notify the VDOT Area Construction Engineer at least 48 hours prior to initiation of rehabilitation operations at the site.

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In the event the selected method of rehabilitation requires disturbing existing surfaces, these surfaces shall be restored in kind to original pre-construction conditions after rehabilitation operations have been completed and the cost thereof shall be included in the price bid for Pipe Rehabilitation for the specified location.

The Contractor shall obtain all required OSHA confined space entry permits where these are required by the Contractor's operations and the scope of work in the Contract.

The Department has performed an inspection of the existing pipes in each location listed in the Contract to determine the extent and nature of each pipe's deterioration or damage so as to designate the allowable methods of rehabilitation of the pipe at that specific site. Using the information collected from this inspection, the Department has determined through its engineering analysis the best practical method(s) of rehabilitation for each respective site (location) taking into account site specific conditions such as installation working space for the various types of liners, hydraulic capacity before and after rehabilitation, height of cover, soil density, and loading conditions, among other criteria. The Contractor shall select from the allowable method(s)/category(ies) for each specified location or site indicated in the Contract, how the Contractor chooses to perform the work. Regardless of the final method selected, the Contractor shall provide the Engineer documentation of the proposed procedures, materials, equipment, incidentals and resources the Contractor shall use to ensure successful rehabilitation of the existing pipe(s) to assist the Engineer in monitoring the Contractor's operations. The Contractor will not be permitted to substitute a different method(s) and category(ies), if designated, than that or those specified for the location described in the Contract.

The Contractor shall clear the existing pipe(s) designated for rehabilitation of any debris, protrusions greater than ½ inch in height and any other potential obstructions prior to the start of rehabilitation efforts. The Contractor shall then thoroughly clean and prepare the host pipe prior to the liner installation. Cleaning shall conform to the recommendations of the liner manufacturer/producer or supplier of the methodology to be used. In the absence of such recommendations, the Contractor shall submit his/her proposed method for cleaning and preparing the host pipe for the Engineer's review and acceptance. A copy of the cleaning methodology and materials shall be provided to the Engineer at least 2 working days prior to beginning the work at that location. **Please note:** All specified time limits in these specifications refer to working days, not calendar days.

**Pre-Installation Inspection** – In addition to the inspection performed by the Department, and not later than 2 to 3 weeks after cleaning the host pipe at the specified location, the Contractor shall perform a pre-installation visual/video inspection at the designated location of the pipe shown in the Contract or where directed by the Engineer. This visual/video inspection shall be conducted in accordance with the requirements of this specification and VTM 123 to verify pre-construction conditions. The inspection shall be performed in the presence of the Engineer. Video inspections shall be clearly labeled on the media with the time, date, and location of the pipe inspected. A copy of the video inspection shall be furnished to the Engineer prior to the start of rehabilitative construction. The cost of pre-Installation Inspection will be considered incidental to the cost of the installation. In the event the Contractor's inspection shows the method of rehabilitation the Contractor has selected is no longer viable at that location as verified by the Engineer, the Contractor shall select another allowable method, if specified, from those designated in the Contract. If no other method is designated, or if other methods of rehabilitation also now are deemed impracticable at that location, further work will be determined in accordance with Section 104.03.

The following methods of pipe rehabilitation are approved by the Department; however, not all methods may be appropriate for each individual location. The Contractor shall consult the Contract to determine the method (and category if designated) or methods (and categories if designated) that are permitted per the location cited. Individual methods shall conform to the criteria specified.

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## **PIPE REHABILITATION BY LINER**

**Method C - Corrugated steel pipe liner** shall be rehabilitation by insertion of a rigid corrugated steel pipe liner through an existing host pipe (36" diameter or larger corrugated or concrete pipe). Where required, pipe shall be joined by the use of coupling bands of an internal expansion type that shall provide a leak-proof joint after grouting.

Expansion devices shall be installed above the mid-point of the pipe. After the Engineer approves installation and alignment of the liner within the host pipe, the Contractor shall pressure grout the annular space between the existing pipe and the liner. Prior to grouting, the annular space shall be adequately sealed at each end. Plug holes required for injection of grout shall be satisfactorily plugged and sealed following the grouting operation.

**Method D - Flexible pipe liner** shall be rehabilitation by the use of a flexible pipe liner. Rehabilitation, as indicated in the Contract, shall be accomplished by the use of the following:

- Category A - Cured-In-Place Pipe (CIPP)
- Category B - Fold and Form flexible liners
- Category C - HDPE, PVC, or PP slip liners
- Category D - Spray-On liners

Installation and curing requirements of pipe sections for the various flexible pipe liners shall be according the manufacturer recommendations for the specific product as applicable. Joints shall meet the requirements of Section 30 of the AASHTO Bridge Construction Specifications and leak resistance as defined in AASHTO PP 63-09.

The Contractor shall furnish curing requirements for the various flexible liners to include as applicable individual components of the system, tube type (whether reinforced or non-reinforced), manufacturer name and type of resin including catalyst, volume of resin required to achieve proper impregnation and curing. All components of the systems shall be as recommended by the manufacturer for the specific system used, and all components shall include lot numbers and expiration dates. The Contractor shall submit documentation from the manufacturer to verify compliance with the requirements of this paragraph as well as installation recommendations to the Engineer at least 72 hours prior to the start of installation.

**Method D, Category A – Cured-In-Place Pipe liner method.** The Cured-In-Place Pipe liner system shall be designed, fabricated and installed in such a manner as to result in a maintained full contact tight fit to the internal circumference of the host pipe for its entire length. The installation shall adhere to the cure times and temperatures stipulated in the manufacturer's recommended installation and cure specifications and the finished product shall be free of de-lamination, bubbling, rippling or other signs of installation failure.

Pulled-in-place liner installation must be accomplished without significant liner twisting or stretching during installation. At no time shall the pulling force for liner installation exceed that established by the liner manufacturer.

All Cured-In-Place Pipe installations shall be performed in the dry. The Contractor shall consider the cost to accommodate this requirement as incidental to the cost of the installation.

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Curing for styrene-based, epoxy-based, and vinyl ester-based CIPP may be accomplished by water, steam or ultraviolet light and shall be in accordance with the liner manufacturer's recommendations.

The Contractor shall submit preconstruction installation and cure specifications (to include site specific cure time and temperature calculations) and design calculations (stamped by a licensed professional engineer) to the VDOT Engineer a minimum of 72 hours prior to initiation of installation.

The Contractor shall place an impermeable sheet immediately upstream and downstream of the host pipe prior to liner insertion to capture any possible raw resin spillage during installation and shall remove and properly dispose of any waste materials. Where the pulled-in-place method of installation is used, the Contractor shall install a semi-rigid plastic slip sheet over any interior portions of the host pipe that could tear the outer film or over any significant voids in the host pipe. The Contractor shall ensure there is no loss of impermeability of the inner and outer plastic films or pre-liner during installation. The Contractor shall promptly repair any pinholes or tears in the plastic films or pre-liner before proceeding with the installation. Where such damaged areas cannot be repaired, the Contractor shall promptly replace the impermeable plastic films or pre-liner before proceeding with the installation.

The Contractor shall not perform work without oversight of the VDOT Engineer or Inspector for the duration of the installation.

The Contractor shall monitor temperature via a minimum of three thermocouples on the outer surface of the liner (one each at the upstream and downstream ends and one approximately mid-length of the host pipe) and automatically log cure time-temperature data with a print-out from the data logger and provide such information to the VDOT Engineer.

The Contractor shall obtain and comply with all discharge-related permits, including air, water, and wastewater treatment (i.e. Publicly Owned Treatment Works or "POTW"). For any discharge to a Publicly Owned Treatment Works (POTW), the Contractor shall obtain advanced written approval from the receiving facility for acceptance of effluent waste before repair work can start and shall provide such documentation of the POTW discharge approval to the Engineer prior to the start of the installation.

The Contractor shall capture and properly dispose of all cure water and/or steam condensate and be responsible for the proper transportation and off-site disposal of process residuals. The Contractor shall provide disposal documentation from the receiving facility to the VDOT Engineer. For any discharge to a Publicly Owned Treatment Works (POTW), the Contractor shall comply with all the requirements of the POTW receiving the discharge.

The Contractor shall thoroughly rinse the cured lined pipe with clean water and capture and properly dispose of rinse water prior to re-introducing flow.

For styrene-based CIPP and vinyl ester-based CIPP, the Contractor shall employ the services of a qualified independent environmental services laboratory or environmental consultant to collect the following samples:

- pre-rehabilitation soil and water samples within 3 feet of the pipe ends (or otherwise as close as possible) upstream and downstream of the pipe location; and

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- soil and water samples within 3 feet of the pipe ends (or otherwise as close as possible) upstream and downstream of the pipe location within one week after the pipe liner has cured.

These samples shall be collected in accordance with applicable ASTM standard procedures. For styrene-based liners, samples shall be analyzed for styrene using USEPA SW 846 Method 8260. Styrene concentrations in water samples shall not exceed 2.5 mg/L. For vinyl ester-based liners, samples shall be analyzed for diallyl phthalate. Diallyl phthalate concentrations in water samples shall not exceed 0.4 mg/L. The Contractor shall report the results of all sampling to the Engineer within 4 weeks after completion of the rehabilitation. The following information shall also be supplied in the water or soil sampling reports:

**Location of pipe:**

- County, VDOT Residency
- Route number and distance to nearest intersection
- Name of stream if applicable or known

**Description of pipe:**

- Length, diameter, type i.e. concrete, corrugated steel
- Conveyance conditions i.e. wet weather only, perennial, current conditions
- General flow description i.e. high, medium, low
- Site description i.e. stream bed, earthen ditch, concrete ditch, subsurface stormwater drainage

It shall be the Contractor's responsibility to report and take appropriate corrective actions to contain and remediate any release of contaminants from cured-in-place process materials, effluent or condensate into the environment in accordance with applicable local, state or federal regulations and the Specifications. The cost for such remediation shall be at the Contractor's expense.

**Method D, Category B - Fold and form flexible liners** shall be installed in accordance with the requirements of ASTM F1216, ASTM F2019, ASTM F1743, or ASTM D5813 (as applicable) or as recommended by the liner manufacturer.

**Method D, Category C - HDPE, PVC, or PP slip liner** shall be installed in accordance with the requirements of AASHTO M326 or in accordance with ASTM F1698 as applicable or as recommended by the liner manufacturer.

**Method D, Category D - Spray-On cementitious and polyurea liners** shall be installed in accordance with the liner material manufacturer's recommendations. For spray-on cementitious or polyurea liner systems, the following requirements shall apply:

- The Contractor shall perform all installations in the dry.
- The Contractor shall thoroughly rinse the lined pipe with clean water.
- The Contractor shall install a temporary curtain at the outlet and inlet to prevent overspray during installation;

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- The Contractor shall reinstate water flow no sooner than 24 hours following installation.
- **For cementitious spray-on liners**, the Contractor shall prevent the escape of any rinse water from the lined pipe or otherwise capture it until he/she can either (1) pump it to a container for proper transportation and off-site disposal; or (2) continuously monitor the pH of the rinse water until the pH is less than 9 whereupon he/she may release it.
- **For polyurea spray-on liners**, the Contractor shall capture and properly dispose of the rinse water prior to reinstating flow; and employ the services of a qualified independent environmental services laboratory or environmental consultant to collect the following samples:
  - pre-rehabilitation water and soil samples within 3 feet of the pipe ends (or otherwise as close as possible) upstream and downstream of the pipe location; and
  - soil and water samples within 3 feet of the pipe ends (or otherwise as close as possible) upstream and downstream of the pipe location within one week after the liner has cured.

Samples shall be collected in accordance with applicable ASTM standard procedures and analyzed for total methylene diphenyl diisocyanate (MDI), methylenedianiline (MDA), and total cyanide. Concentrations of methylene diphenyl diisocyanate (MDI) in water samples must not exceed 1,000 mg/L and concentrations of methylenedianiline (MDA) in water samples must not exceed 39 mg/L. Water characterization for chemical oxygen demand (COD) and total nitrogen (TN) concentrations shall also be conducted. The Contractor shall report the results of all sampling to the Engineer within 4 weeks after completion of the rehabilitation. The following information shall also be supplied in the sampling reports:

**Location of pipe:**

- County, VDOT Residency
- Route number and distance to nearest intersection
- Name of stream if applicable or known

**Description of pipe:**

- Length, diameter, type i.e. concrete, corrugated steel
- Conveyance conditions i.e. wet weather only, perennial, current conditions
- General flow description i.e. high, medium, low
- Site description i.e. stream bed, earthen ditch, concrete ditch, subsurface stormwater drainage

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- It shall be the Contractor's responsibility to report and take appropriate corrective actions to remediate any water quality alteration resulting from the lining materials in accordance with applicable local, state or federal regulations. The cost for such remediation shall be at the Contractor's expense.

**Method E – Smooth wall steel pipe liner** shall be rehabilitation by the insertion of a smooth wall steel pipe into a host pipe. Where required, pipe shall be joined by butt welds in accordance with AWWA C-206.

The Contractor shall pressure inject a non-shrink grout into the annular space between the existing host pipe and the steel liner. The annular space between the existing pipe and the smooth wall steel liner shall not exceed 3 inches at any given point, unless otherwise approved by the Engineer. Prior to grouting, the annular space shall be sealed at each end. Holes required to facilitate injecting grout shall be plugged and sealed following grouting operations. In order to ensure stability during placement, the wall thickness of the liner shall not be less than 1/2".

**Post Installation Inspection** – The Contractor shall perform a post-installation inspection on all flexible liners installations in accordance with Section 302.03(d) of the Specifications and Virginia Test Method (VTM) 123. The finished liner shall be continuous over its entire length and be free from visual defects such as foreign inclusions, dry spots, pinholes, and delamination.

In the event a post inspection of the installation reveals a tight fit of the liner was not achieved in localized areas of the host pipe (comprising less than 20 percent of the pipe length) the annular space between the liner and the host pipe shall be filled with a resin mixture or a cementitious grout (at no cost to the Department) that is compatible with the liner system as specified by the manufacturer. Where a tight fit was not achieved on 25 percent or more of the pipe length the annular space shall be filled as designated herein, however, the Contractor will not be allowed to continue with his methodology of installation and/or the liner system used until he/she can demonstrated to the Engineer that he/she has remedied his/her operations so that it results in a snug tight fit between the installed liner and the host pipe. All such remedial efforts shall be at the Contractor's expense. Further failure(s) to perform a proper installation may result in the disallowance of the use that liner system and an adjustment in the cost or non-payment of the failed installations depending on the severity of the failure.

In the event the post installation inspection is not conducted until all or most of the locations in the Contract permitting this methodology have been performed, and the inspection reveals a tight fit between host pipe and liner has not been achieved on 25 percent or more of the host pipe's length or the finished liner is not free from visual defects such as foreign inclusions, dry spots, pinholes, and delamination, then an adjustment in the cost or non-payment of the failed installations maybe made by the Engineer depending on the severity of the failure.

The cost of post Installation Inspection will be considered incidental to the cost of the installation.

#### **IV. MEASUREMENT AND PAYMENT**

**Pipe rehabilitation (Method)** will be measured and paid for in units of linear feet of pipe for the Size, Method(s) and Category (if specified) as detailed in the Contract. Note: At locations shown in the Contract where multiple methods are permitted, the Contractor may select any of the methods specified, however, if only one method is specified, this will be the only method permitted at that location. This price shall include inspection, cleaning and preparation of the host pipe, furnishing and installing the liner, coupling and expansion devices, cement grout, design and shop drawing preparation, furnishing and installing liner and all components of the liner system, capturing any

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discharges or releases during installation or curing operations, obtaining any local, POWT, state or federal permits required to perform the work, furnishing any documentation or fees required for effluent or condensate disposal, all testing and sampling including furnishing reports and post installation video inspections for flexible liners, and waste disposal costs.

Prices for pipe rehabilitation shall also include excavating when not designated as a separate pay item attributable to this specific work; sheeting; shoring; dewatering; disposing of surplus and unsuitable material; backfilling and backfill material; compaction, restoring existing surfaces; and clearing debris and obstructions.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
(Size) Pipe Rehabilitation (Method, Category-if specified)	Linear Foot

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