

**Specification number: OPSS XXX**

**Draft Date: XXXXXXXXX**

## **DRAFT**

### **CONSTRUCTION SPECIFICATION FOR WATER MAIN REHABILITATION BY CURED-IN-PLACE PIPE (CIPP) LINING**

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<b>D XXX.01</b>	<b>SCOPE</b>
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This specification covers the requirements for the rehabilitation of water mains up to and including 400mm diameter by the installation of a tight fitting cured-in-place pipe liner.

#### **D XXX.01.01 Specification Significance and Use**

This specification has been developed for use in provincial and municipal-oriented Contracts. The administration, testing, and payment policies, procedures, and practices reflected in this specification correspond to those used by many municipalities and the Ontario Ministry of Transportation.

Use of this specification or any other specification shall be in accordance with the Contract Documents.

## **D XXX.01.02 Appendices Significance and Use**

Appendices are not for use in provincial contracts as they are developed for municipal use, and then, only when invoked by the Owner.

Appendices are developed for the Owner's use only.

Inclusion of an appendix as part of the Contract Documents is solely at the discretion of the Owner. Appendices are not a mandatory part of this specification and only become part of the Contract Documents as the Owner invokes them.

Invoking a particular appendix does not obligate an Owner to use all available appendices. Only invoked appendices form part of the Contract Documents.

The decision to use any appendix is determined by an Owner after considering their contract requirements and their administrative, payment, and testing procedures, policies, and practices. Depending on these considerations, an Owner may not wish to invoke some or any of the available appendices.

## **D XXX.02 REFERENCES**

When the Contract Documents indicate that provincial-oriented specifications are to be used and there is a provincial-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.PROV, unless use of a municipal-oriented specification is specified in the Contract Documents. When there is not a corresponding provincial-oriented specification, the references below shall be considered to be to the OPSS listed, unless use of a municipal-oriented specification is specified in the Contract Documents.

When the Contract Documents indicate that municipal-oriented specifications are to be used and there is a municipal-oriented specification of the same number as those listed below, references within this specification to an OPSS shall be deemed to mean OPSS.MUNI, unless use of a provincial-oriented specification is specified in the Contract Documents. When there is not a corresponding municipal-oriented specification, the references below shall be considered to be the OPSS listed, unless use of a provincial-oriented specification is specified in the Contract Documents.

This specification refers to the following standards, specifications, or publications:

### **Ontario Provincial Standard Specifications, Construction**

OPSS 180	General Specification for the Management of Excess Materials
OPSS 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 409	Closed-Circuit Television Inspection of Pipelines
OPSS 441	Construction Specification for Watermain Installation in Open Cut
OPSS 491	Preservation, Protection, and Reconstruction of Existing Facilities
OPSS 492	Site Restoration Following Installation of Pipelines, Utilities, and Associated Structures
OPSS 493	Temporary Potable Water Supply Services
OPSS 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems

### **ASTM International**

D638	Standard Test Method for Tensile Properties of Plastics
D790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials

D2290	Standard Test Method for Apparent Hoop Tensile Strength of Plastic or Reinforced Plastic Pipe
D2990	Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
D4541	Standard Test Method for Pull-Off Strength of Coating Using Portable Adhesion Testers
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)
F2019	Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pulled-In-Place Installation of Glass-Reinforced Plastic (GRP) Cured-In-Place Thermosetting resin Pipe (CIPP)

#### **NSF International**

NSF 61	Drinking Water System Components – Health Effects
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#### **ISO**

ISO 11296	Plastics Piping Systems for Renovation of Underground Non-Pressure Drainage and Sewerage Networks – Part 4: Lining with Cured-in-Place Pipe
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#### **CSA Standards**

S6	Canadian Highway Bridge Design Code
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#### **American Water Works Association (AWWA)**

C510	Double Check Valve Backflow Prevention Assembly
C651	Disinfecting Water Mains
M28	Liner Classifications

#### **Ministry of Environment, Conservation and Parks**

Watermain Disinfection Procedure

#### **D XXX.03 DEFINITIONS**

For the purpose of this specification, the following definitions apply:

**Contamination** means the presence of an unwanted constituent or impurity in the water system.

**Contract Administrator** means the Owner's Project Manager or its authorized representatives.

**Cured-In-Place Pipe (CIPP) Lining** means the rehabilitation of existing pipe in place by installation of a tube with one or more layers of flexible non-reinforced or reinforced resin-impregnated material.

**Engineer** means a professional engineer licensed by Professional Engineers Ontario to practice engineering in the Province of Ontario.

## D XXX.04 DESIGN AND SUBMISSION REQUIREMENTS

### D XXX.04.01 Design Requirements

The engineering design shall be in accordance with current ASTM and AWWA design standards for pressure water main rehabilitation with the following criteria:

a) Design conditions:

Unless otherwise specified in the Contract Documents, CIPP liner design shall assume fully deteriorated condition (as defined in ASTM F1216 X1) of the existing pipe.

b) Parameters for design:

Unless otherwise specified in the Contract Documents:

- i. Design life of 50 years (See Note B1 Below)
- ii. Safety factor of 2 applied to ASTM F1216 Equations X1.1 and X1.3
- iii. Safety factor of 2 applied to ASTM F1216 Equation X1.7
- iv. Groundwater table at ground surface
- v. Soil modulus of 6.9 MPa
- vi. Soil density of 2124 kg/m<sup>3</sup>
- vii. Ovality of existing pipe of 2% (See Note B2 Below)
- viii. Cover depth of 2 metres
- ix. Design Operating Pressure of 862 kPa (See Note B3 Below)
- x. Live Load as per Canadian Highway Bridge Design Code (CHBDC) CL-625-ONT Truck, or AASHTO HL-93 Truck.
- xi. Vacuum pressure of minus 101 kPa (See Note B4 Below)

Note B1: In the context of this OPSS, design life relates to the appropriate selection of values for the design properties for the CIPP liner where the appropriate values of these properties are dependent on applied stress over time. The time/stress dependency relationship for CIPP water main liner design properties shall be determined by appropriate long-term testing of the complete liner composite material, not just the resin. However, the choice of the values for the properties used in design shall also be dependent on the applied stress situation over time in the actual water main liner installation. For normally pressurized water mains, where the internal pressure is at least 3 times the external load pressure, consideration should be given to treating the external load component of the design as a short-term effect meaning that no reduction in flexural modulus (from short-term test value) is required. The components of external load include ground water pressure, soil pressure, live load pressure and vacuum pressure. In a normally pressurized water main, the internal pressure is a long-term effect and therefore the values of the design properties used for internal pressure resistance shall be the appropriate reduction from short-term test values to account for the long-term time/stress dependency of the specific properties.

Note B2: Where actual ovality of the water main to be lined exceeds 2%, the F1216 X1 design method shall not be used because equation F1216 X1.7 does not account for ovality of the existing pipe. Where existing pipe actual ovality exceeds 2%, an installation specific design method shall be used that accounts for the ovality in the liner's internal pressure resistance design and such design method shall be approved by the Contract Administrator.

Note B3: The design operating pressure represents the maximum operating pressure and is commonly above the normal operating pressure. In the design of water main liners, other pressures may be relevant to design, such as transient surge pressure and test pressure. Other relevant pressures shall be addressed in the Contract Documents.

Note B4: In accordance with ASTM F1216 Design Method, vacuum is treated as an external pressure. For design purpose, use of short-term liner flexural modulus is acceptable for vacuum resistance.

#### **D XXX.04.02                      Submission Requirements**

The design for the CIPP shall be submitted to the Contract Administrator for approval at least 14 Days prior to installation. The design calculations shall show technical assumptions, CIPP material properties, Creep Retention Factor, identify the design formulas used, and show the minimum CIPP thickness for all equation thicknesses, and the final design thickness.

The engineering design shall illustrate the installation conditions (i.e., depth of pipeline, water table, pipe invert and crown, ovality condition of host pipe, and full details of the parameters used).

Comparative flow capacity (pre vs. post-lining) calculations for the CIPP shall be provided upon request of the owner.

The design work shall bear the seal and signature of an Engineer.

The following information shall be submitted to the Contract Administrator at least 7 Days prior to commencing Work:

- a) A work plan outlining the schedule, procedures, and work site including:
  - Wet-out plan;
  - CIPP cure plan;
  - sampling plan;
  - QA/QC plan;
  - 3<sup>rd</sup> party ASTM D2990 testing; and,
  - NSF/ANSI 61 certification
- b) A disinfection and water sampling plan showing compliance with provincial regulations.
- c) A list of personnel, including backup personnel, with their qualifications and experience.
- d) A traffic control plan.
- e) Safety plan, including the company safety manual, confined space entry and emergency procedures.
- f) Temporary Water Supply Plan, when specified in the contract documents.
- g) CIPP Manufacturer's technical data containing complete information on:
  - i. Material composition and physical properties.
  - ii. Recommendations for transportation, handling, and storage.
  - iii. Repair of product damaged during installation.
  - iv. Installation procedures.
  - v. Capability, including limitations, of the product to line through deflected joints in the existing water main.
  - vi. Capability, including limitations, of the product, once cured-in-place, to survive ongoing future joint deflections in the lined water main.
- h) Basic Contingency plans for the following potential conditions:
  - i. Damage to the existing service connections, including plugged services.

- ii. Improper placement of the CIPP.
  - iii. Damage to the host pipe.
  - iv. CIPP's failure to meet design physical properties.
  - v. Contamination incidents.
- i) A notice to residents impacted by the work.
  - j) Shop drawings providing dimensional information on the pipes to be lined and the corresponding CIPP liners to be used.

## **D XXX.05 MATERIALS**

Diameter range with pressure rating shall be determined based on manufacturers' specifications and independently qualified test data and published capabilities of the product(s).

All materials used in the CIPP process that will come in contact with potable water shall be NSF/ANSI Standard 61 certified.

### **D XXX.05.01 CIPP**

The CIPP shall have the following minimum characteristics:

- i. Flexural modulus of 1,724 MPa tested in accordance with ASTM D790 or ISO 11296.
- ii. Flexural strength of 31 MPa tested in accordance with ASTM D790 or ISO 11296 (See Note C1 Below)
- iii. Tensile strength of 21 MPa tested in accordance with ASTM D638 or ASTM D2290.

Note C1: When using ISO 11296, measure flexural strength in accordance with ISO 178 until rupture occurs or until a maximum strain of 5% is reached, whichever occurs first.

Regardless of the minimum values listed above, the actual values determined by testing samples from actual liner installations shall meet or exceed the short-term test values of these properties that were used in the design of the liner for the installation. For example, if a liner installation was designed using a short-term test tensile strength of 80 MPa, installation sample test result must be at least 80 MPa, not just the 21 MPa listed above. Otherwise the liner is deficient (subject to a design reconciliation based on as tested properties).

The finished CIPP shall meet the chemical resistance, abrasion resistance, and bacteriological resistance requirements in accordance with the Contract Documents and shall be resistant to water treatment chemicals found in the water supply.

### **D XXX.05.02 Tube**

The CIPP tube shall consist of one or more layers of materials capable of carrying resin able to withstand installation loads (e.g. inversion pressure, abrasion, tensile pull load), curing temperatures, and shall be compatible with the resin system used. The material shall be capable of stretching to fit irregular pipe sections and negotiate bends without excessive folds or wrinkles as defined in the Contract Documents. Cutting or grinding of wrinkles and folds shall not be permitted. The tube shall be fabricated to a size that fits tightly to the internal circumference and the length of the original pipe when installed.

**D XXX.05.03                      Resin**

The CIPP resin shall meet the requirements of ASTM F1216 or ASTM F1743 or ASTM F2019, and shall adhere to the host pipe and service connections to prevent leakage and delamination/movement, except when the CIPP installation requires that there be no bond to the host pipe (e.g. bridge crossings).

**D XXX.05.04                      Calibration Hose**

Calibration hoses used for inflation of CIPP shall comply with the requirements of ASTM F1743.

**D XXX.05.05                      Preliners**

Preliners shall be approved by the Engineer and shall have no detrimental effects on CIPP performance. A preliner shall not be used when leak tightness of the liner is premised upon bond or adherence to the existing water main (e.g. at service connections).

**D XXX.07                              CONSTRUCTION**

**D XXX.07.01                      General**

The Contract Administrator shall be notified at least 14 days in advance of starting work.

The Contractor shall confirm the size and length of all existing pipes to be rehabilitated prior to undertaking the installation of any CIPP.

All required equipment shall be on-site in satisfactory working order and shall be sanitized in accordance with all applicable sanitation regulations prior to commencing the installation of a CIPP section.

Work shall progress and continue as required to minimize downtime on pipelines and out-of-service periods on all water service connections.

At least 7 Days prior to commencement of work, the Owner shall advise, in writing, all residents who may be affected by the rehabilitation process about the nature, duration, and expected date of any interruption in service. The Contractor shall notify all affected residents or businesses of the specific time of any disruption to their service at least 48 hours in advance and shall endeavour to minimize their inconvenience. During the course of the rehabilitation and any associated service interruption, the residents shall be kept regularly informed by the Contractor regarding any matters that affect them. When the rehabilitated water main is put back into service, residents shall be advised immediately by the Owner either verbally or in writing.

**D XXX.07.02                      Preservation and Protection of Existing Facilities**

Preservation and protection of existing facilities shall be according to OPSS 491.

**D XXX.07.03                      Transporting, Unloading, Storing, and Handling Materials**

Manufacturer's recommendations for transporting, unloading, storing, and handling of materials shall be followed.

**D XXX.07.04                      Trenching, Backfilling, and Compacting**

Trenching, backfilling, and compacting for any access pits shall be according to OPSS 401.

**D XXX.07.05                    Support Systems**

Support systems shall be according to OPSS 404.

**D XXX.07.06                    Dewatering**

Dewatering shall be according to OPSS 517.

**D XXX.07.07                    Temporary Protection Systems**

The construction of temporary protection systems shall be according to OPSS 539.

Where the stability, safety, or function of an existing roadway, railway, watercourse, other works, or proposed works may be impaired due to the method of operation, protection shall be provided. Protection may include, but not limited to, sheeting, shoring, and piling where necessary to prevent damage to such works or proposed works.

**D XXX.07.08                    Temporary Water Supply**

When specified in the Contract Documents, during the execution of the work, temporary water supply shall be provided in accordance with OPSS 493.

**D XXX.07.09                    Pipeline Cleaning and Preparation**

The cleaning method shall be approved by the Contract Administrator and shall not damage the existing pipe walls, service connections or appurtenances, where such damage will negatively affect the performance of the lined watermain. The pipe shall be cleaned as many times as necessary, and in each direction as necessary, to obtain results that are satisfactory to the Contract Administrator.

When viewed without magnification, the cleaned, prepared pipe surfaces shall be free of all sharp edges and protrusions that may cause point loads on the finished CIPP. It shall also be free of all visible contamination (e.g. sediment and biofilm), loose corrosion products (e.g. rust and graphite), dust, oxides, loose coatings/liners, and any other foreign matter. Previously-applied coatings and linings shall be completely removed unless the residual coating/lining is tightly bonded and the manufacturer and Contract Administrator agree that the residual coating or lining can be lined with CIPP without compromising the performance and integrity of the CIPP lined watermain over its design life.

Particular attention must be paid to service connections where all corrosion products (e.g. rust and graphite) shall be fully removed around the outside of each service to ensure a leak-tight seal/bond over the design life. Similar attention shall be paid to CIPP termination points where leak-tight adhesion is important for resistance to system pressures over the design life. The pipeline shall also be dried and left free of visible moisture (free standing water) in both the pipe and pipe joints prior to lining.

The cleaned and prepared surface of the existing watermain shall be suitable for CIPP installation and the CIPP liner shall adhere to the existing pipe, unless required otherwise.

The waste from cleaning and preparation operations must be handled and disposed in accordance with the contract requirements.

In the event that any service taps protrude too far into the interior of the existing pipe resulting in interference with required cleaning and preparation operations, or protrude to the extent that they have a negative effect on the CIPP over its design life, the service taps shall be trimmed back to an acceptable protrusion length. The method of trimming shall not damage the service taps and must be approved by the Contract Administrator.



When the filling or repair of voids and gaps in the existing pipe is necessary to ensure CIPP structural integrity, a detailed procedure outlining the process and materials to be used shall be submitted to the Contract Administrator for approval.

It is the Contractor's responsibility to clean and prepare the pipeline section to be lined in accordance with contract requirements.

#### **D XXX.07.10                      Closed-Circuit Television (CCTV) Inspection**

CCTV inspection shall be according to OPSS 409.

At least two CCTV inspections of each pipeline section shall be completed as follows:

a) Pre-Lining Video Inspection

After completion of the cleaning and preparation of a pipeline section and before lining, a CCTV inspection of the full length of the pipeline section to be lined shall be made and submitted to the Contract Administrator.

The pre-lining video inspection shall demonstrate that the cleaning and preparation of the pipeline section meets with the requirements of the contract. Submission of the pre-lining video inspection to the Contract Administrator does not relieve the Contractor of its responsibility to execute the cleaning and preparation in accordance with contract requirements.

When the Contract Administrator may review the pre-lining video inspection before lining and in the Contract Administrator's opinion the cleaning and preparation does not meet requirements, the Contractor shall rectify the cleaning and preparation to meet contract requirements prior to proceeding with lining installation.

At the discretion of the Contract Administrator, the requirement to submit the pre-lining video inspection prior to lining may be waived. In this case the pre-lining video inspection shall still be done before lining while its submission may be at a later time in accordance with instruction from the Contract Administrator. Regardless of the timing of the submission of the pre-lining video inspection, the execution and submission of the pre-lining video inspection does not relieve the contractor of its responsibility to clean and prepare the pipeline to be lined in accordance with contract requirements.

In the event that a post lining deficiency is present, the Contract Administrator may use the pre-lining video inspection to determine if inadequate cleaning and preparation was the cause of the deficiency.

b) Post-Lining Final Video Inspection of Complete Rehabilitation

After completion of all lining work and before returning to service, a CCTV inspection of the full length of the pipeline section shall be made and submitted to the Contract Administrator for approval.

The final CCTV inspection recording shall be submitted to the Contract Administrator for approval immediately upon completion of the work, but no more than 48 hours after the CIPP installation in each section.

The inside wall of the access point at each end of the pipeline section shall be clearly visible on the inspection video.

This CCTV video will be used to confirm the following:

- Fit and finish (no annular space and liner sized correctly),
- No evidence of stress concentrations (bumps, bubbles, delaminations)
- Tight fit of the liner to the host pipe and around service connections

- No excessive folds or wrinkles as defined in the Contract Documents
- Liner fully cured with no dry or soft spots
- Full reinstatement of service connections (visual integrity of service openings and bonds)
- No evidence of liner damage
- No eruptions or other localized defects
- No staining or bleeding of the liner surface

**D XXX.07.11 Cured-In-Place Pipe Installation**

Wet-out shall be completed in accordance with manufacturer’s recommendations to achieve full and consistent resin distribution. The manufacturer shall specify the process to be used, the volume of resin required, and any other applicable parameters.

The installation of the CIPP shall be according to the manufacturer’s procedure.

Before installation begins, the Contractor shall obtain manufacturer’s recommendations of the minimum pressure required to hold the tube tight against the existing pipes and the maximum allowable pressure, so as not to damage the CIPP liner. Once the installation has started, pressure shall be maintained between the minimum and maximum pressures and documented until the installation has been completed.

Prior to inserting the lining, the pipe must be cleaned and prepared and be in the state specified in Section D XXX.07.09, and the services must be prepared for lining.

**D XXX.07.12 Curing**

CIPP curing shall be completed according to manufacturer’s recommendations. Qualified personnel shall execute and monitor the curing process and maintain written records, including temperature and internal pressure, throughout the duration of the curing process.

These records shall be made available to the Contract Administrator upon request.

The CIPP shall be inserted and cured in accordance with the manufacturer’s parameters and procedures required for the process.

Readings shall be made and recorded at 15 minute intervals or as specified by the manufacturer for full heating and cooling cycle duration.

Throughout the curing process, temperatures shall be measured and recorded, at a minimum, both ends of the CIPP installation, as well as any accessible intermediate access points at the crown and invert of the pipe.

**D XXX.07.13 Cool-Down**

The CIPP shall be cooled in accordance with the manufacturer’s recommended minimum temperature at the prescribed cooling rate before relieving the curing pressure. Care shall be taken in the release of the pressure so that a vacuum does not develop and damage the newly-installed CIPP. The release of any cooling water shall be in accordance with the Contract Documents.

**D XXX.07.14 Inflation Bladder Removal**

For pulled-in-place installation techniques where inflation bladders are required, all portions of the bladder material shall be removed from the CIPP.

**D XXX.07.15 CIPP Termination**

The CIPP termination at and through sections shall be fully bonded and fully conforming to the host pipe, and be neat and free of obstructions to form a leak tight seal between the CIPP and the host pipe. If the CIPP termination fails to make a watertight pressure seal with the existing pipe, a seal shall be applied at this point. The sealing process shall use a material compatible with the CIPP.

**D XXX.07.16 Hydrostatic Pressure and Leakage Testing**

The lined watermain shall be pressure tested before the reinstatement of the service connections. The test pressure shall be 120 per cent of the operating pressure for the watermain location being tested. The Contract Administrator will provide the operating pressure to the Contractor for the test section(s).

The test duration and allowed make up water shall be in accordance with ASTM F1216 Section 8.3.

All pressure test results shall be reported immediately to the Contract Administrator.

**D XXX.07.17 Service Connection Reinstatements**

Service connection reinstatement shall be made from within the lined watermain with appropriate remotely-operated equipment. Restored service connections shall be cut neatly to full size without over-cutting. Cuts shall be smooth and without residual material left around the opening. Ragged edges or attached material shall be removed. The reinstatement shall not result in damage to the service connections that may impact their performance over the design life. Plugged service connections shall be rectified in accordance with contract requirements or reinstated externally.

**D XXX.07.18 Disinfection**

Post-lining water main disinfection shall be completed in accordance with applicable MECP water main disinfection procedures or as specified in the Contract Documents.

**D XXX.07.19 Site Restoration**

Site restoration shall be according to OPSS 492 or as specified in the Contract Documents.

**D XXX.07.20 Management of Excess Material**

Management of excess material shall be as specified in the Contract Documents.

**D XXX.08 QUALITY ASSURANCE**

Quality assurance for the CIPP watermain lining shall, at a minimum, include:

1. Review of the Post-Lining Final CCTV inspection.
2. Testing of samples from (and representative of) the installed CIPP liner and determining the wall thickness of the installed CIPP liner
3. Testing samples of uncured resin

## 1. Review of Post-Lining Final CCTV Inspection

The CIPP liner shall be continuous from start to finish without breaks, separations, thinning or any other indication that a discontinuity exists.

The CIPP liner shall fit tightly to the host pipeline and any geometric shape changes in the liner shall only be accepted if they reflect the geometric shape of the cleaned and prepared host pipeline. Any misshapes in the liner that are not a reflection of the shape of the host pipe are deficiencies in the liner.

The CIPP liner shall not have any lifts, sags, bubbles, protrusions, holes, pinholes or any indications that the liner wall has any separations by delamination.

The CIPP liner shall have no leaks or infiltration through the wall of the liner.

The CIPP liner shall have no indications of soft zones, uncured liner or marked discolouration.

The CIPP liner shall have no peeling or blistering of its surface.

Service connection reinstatements shall be as per OPSS D XXX.07.17.

## 2. Testing of CIPP Liner Samples and Liner Wall Thickness

Samples for testing shall be taken from the finished liner in accordance with the requirements of ASTM F1216, F1743 or F2019 as applicable to the type of liner being used. CIPP field cured restrained ~~and field-cured~~ samples shall be taken from the finished CIPP at an access point and be sufficient in size to meet the requirements of the testing specifications in the Contract Documents. For CIPP greater than 400mm where a restrained sample is not possible, a flat-plate sample shall be provided. Test samples shall be taken by the independent owner designate who is responsible for the sample chain of custody. Testing is to be done by an independent testing laboratory approved by the Contract Administrator. The samples shall be tested at a third party testing agency experienced in the testing of CIPP liners.

The samples shall be tested for flexural strength and flexural modulus as per ASTM D790 or ISO 11296 testing methods and tensile strength by ASTM D638 or D2290 methods. When using ISO 11296, measure flexural strength in accordance with ISO 178 until rupture occurs or until a maximum strain of 5% is reached, whichever occurs first.

The test results shall meet or exceed the values used in the design of the liner for the installed section from which the test sample is applicable otherwise the CIPP liner is deficient, subject to design reconciliation. It is noted that the values used in design are typically greater than the minimum qualifying properties in various standards, such as ASTM F1216 etc. and therefore such standard minimum values are not normally the relevant basis to which test values are compared.

When the sample is the appropriate type (restrained cylindrical sample) the sample shall also be measured for liner thickness in accordance with ASTM D5813. When samples are not the appropriate type for determining liner thickness, liner thickness shall be determined in a manner approved by the Contract Administrator. The thickness to be determined is the liner structural thickness and shall not include the thickness of any non-structural zones or layers.

The liner thickness shall meet or exceed the required thickness otherwise the liner is deficient, subject to design reconciliation. The required thickness is the thickness determined by the applicable liner design or a contract specified minimum thickness, whichever is greater.

### Frequency of Sampling and Testing

The number of samples to be tested shall be at least 20% of the total number of installations and shall include at least one sample for each pipe size.

#### Plate Sample De-rating

Unless otherwise specified in the Contract Documents, test results from plate samples shall be de-rated by 15% to arrive at values to be compared to the required values.

#### Design Reconciliation

In situations where one or more of the tested properties or measured thickness do not meet requirements, a design reconciliation of the original design using as tested properties as the only changed input may be performed on the approval of the Contract Administrator. Where the design reconciliation shows that required liner performance is obtained using test properties and test thickness, the liner shall not be deficient. Design reconciliation is not permitted if flexural strength, flexural modulus or tensile strength is less than the qualifying minimum values given in the applicable standard (such as ASTM F1216) or as specified otherwise in the contract documents.

#### Process Records

The Contractor's CIPP liner wetout logs and cure records shall be made available to the Contract Administrator upon request.

### **3. Testing Samples of Uncured Resin**

The Contractor shall facilitate the laboratory in obtaining a sample of the approved resin for the project from the resin manufacturer. The laboratory shall produce an infrared spectrograph of the approved resin.

The Contractor shall supply a sample of the resin used in the wetout when requested by the Contract Administrator. The Contract Administrator shall send a sample of the submitted resin from the project to a 3<sup>rd</sup> party testing laboratory for verification and confirmation vs the manufacturer's supplied resin sample.

#### **D XXX.09                      MEASUREMENT FOR PAYMENT**

##### **D XXX.09.01                  Actual Measurement**

##### **D XXX.09.01.01              Cleaning and Preparation of Host Pipe**

Measurement for host pipe cleaning and preparation shall be by length along the horizontal centreline of the host pipe between connecting points or, if there is no connecting point, to the end of the host pipe.

When the connecting point is a structure, measurement for host pipe cleaning and preparation shall be to the centre of the structure.

##### **D XXX.09.01.02              Product Installation**

Measurement for a product installation shall be by length along the horizontal centreline of the product between connecting points or, if there is no connecting point, to the end of the product.

When the connecting point is a structure, measurement for a product installation shall be to the centre of the structure.

**D XXX.09.01.03            Service Connection Reinstatement**

The number of service connections reinstated to the newly lined pipe shall be counted.

**D XXX.10                    BASIS OF PAYMENT**

**D XXX.10.01                Product Installation, “*type, diameter, or use of product*” - Item  
Service Connection Reinstatement - Item**

Payment at the Contract price for the above tender items shall be full compensation for all labour, equipment and material to do the work.

Compensation for costs associated with temporary water supply shall be as specified in the Contract Documents.

Any extraction of reaming tools or other equipment, including extraction by excavation, shall be the responsibility of the Contractor and shall be done at no extra cost to the Owner.

**D XXX.10.02                Closed-Circuit Television Inspection**

When the Contract does not contain a separate tender item for CCTV inspection, the Contract price for product installation shall include full compensation for all labour, equipment, and material to do the work of CCTV Inspection.

**Appendix XXX-A  
FOR USE WHILE DESIGNING MUNICIPAL CONTRACTS**

**Note:** This is a non-mandatory Commentary Appendix intended to provide information to a designer, during the design stage of a contract, on the use of the OPS specification in a municipal contract. This appendix does not form part of the standard specification. Actions and considerations discussed in this appendix are for information purposes only and do not supersede an Owner's design decisions and methodology.

**Designer Action/Considerations**

No information provided here.

**Related Ontario Provincial Standard Drawings**

No information provided here.