

**CONSTRUCTION SPECIFICATION FOR REHABILITATION OF NON-PRESSURE
PIPE BY CURED-IN-PLACE PIPE (CIPP) LINER**

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460.01 SCOPE

This specification covers the requirements for the rehabilitation of non-pressure pipe, including sanitary and storm sewers, by the installation of a tight fitting cured-in-place pipe liner. This scope includes full-length lining and spot repairs.

460.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

460.01.02 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.

460.02 REFERENCES

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. Unless otherwise noted, most recent published editions shall apply:

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 411	Construction Specification for the Cleaning and Flushing of Pipe Sewers, Catchbasins, Maintenance Holes, Ditch Inlets, and Oil Grit Separators
OPSS 421	Construction Specification for Pipe Culvert Installation in Open Cut
OPSS 410	Construction Specification for Pipe Sewer 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 517	Dewatering of Pipeline, Utility, and Associated Structure Excavation
OPSS 539	Temporary Protection Systems

ISO Standards

ISO 11296-4	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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ASTM International

D790	Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
D2990	Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
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)
E1252	Practice for General Techniques for Obtaining Infrared Spectra for Qualitative Analysis
D5813	Standard Specification for Cured-in-Place Thermosetting Resin Sewer Piping System

460.03 DEFINITIONS

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

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 the Professional Engineers Ontario to practice in the Province of Ontario.

Resin means a thermoset (Polyester, Vinyl Ester, Epoxy, Silica) material and catalyst system that is compatible with the lining process.

460.04 DESIGN AND SUBMISSION REQUIREMENTS

460.04.01 Design Requirements

For circular host pipe, the engineering design shall be in accordance with ASTM F1216 with the following criteria:

- a) Design conditions:
 - i. CIPP design shall assume fully deteriorated condition of the host pipe, unless otherwise specified.
 - ii. CIPP design shall assume no bonding to the host pipe wall.
- b) Parameters for design:
 - i. Long-Term Flexural Modulus determined in accordance with ASTM D2990 using a design life of 50 years, unless otherwise specified.
 - ii. Safety factor of 2.
 - iii. Groundwater depth is full soil depth, unless otherwise known.
 - iv. Soil modulus of 6.9 MPa, unless otherwise known.
 - v. Soil density of 2124 kg/m³, unless otherwise known.
 - vi. Live Load as per Canadian Highway Bridge Design Code (CHBDC) CL-625-ONT Truck, or AASHTO HL-93 Truck, unless otherwise known.
 - vii. Host Pipe ovality of 2%, unless otherwise known to be greater.
 - viii. Minimum depth of 3 metres to top of pipe, unless otherwise known.

For non-circular host pipe (such as egg, oval, or other non-round shapes) a design method other than ASTM F1216 X1 shall be used because the F1216 X1 design method is not applicable to host pipes that were not originally circular. The non-circular host pipe design method shall be as specified in the contract or proposed by the contractor for the approval by the Contract Administrator.

460.04.02 Submission Requirements

The design for the lining shall be submitted to the Contract Administrator for approval at least 14 Days prior to installation. The design calculations shall show technical assumptions, identify the design method, identify the design formulas used, identify the values of short-term tests and long-term design properties used in the design, and determine the liner wall thickness.

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

Comparative flow capacity calculations for the lined pipe 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:
 - Wetout plan;
 - CIPP cure plan;
 - Sampling plan;
 - QA/QC plan;
- b) A list of personnel, including backup personnel, with their qualifications and experience.
- c) A traffic control plan including pedestrian movements when required in the Contract Documents.
- d) A project-specific safety plan, confined space entry and emergency procedures. The Contractor's safety manual shall also be submitted.
- e) Sewer flow control plan, when required in the Contract Documents.
- f) Manufacturer's technical data containing complete information on:
 - i. Applicable ASTM standard practice (F1216, F1743, or F2019)
 - ii. Material composition and physical properties of the lining product.
 - iii. Recommendations for transportation, handling, and storage.
 - iii. Installation procedures.
 - iv. Product curing procedures listing the curing temperature and duration, including cool down time for the product.
- g) Contingency plans for the following potential conditions:
 - i. Damage to the existing service connections.
 - ii. Improper placement of the CIPP.
 - iii. Damage to the host pipe.
 - iv. CIPP's failure to achieve structural integrity.
 - v. Product damaged during installation.

h) A sample letter to residents impacted by the work shall be submitted to the Contract Administrator for approval 14 Days prior to commencing the work. As a minimum, the letter shall include:

- i. Contract number.
- ii. Emergency contact name and number.
- iii. Nature of work and expected service interruptions.
- iv. Anticipated start date and duration.
- v. Working hours.
- vi. Procedure for residents to follow during liner installation and cure.

i) For water or steam cured systems, a detailed discharge plan for release of curing medium to a receiver. When required in the Contract, plan shall include sampling, testing, and treatment.

460.05 MATERIALS

460.05.01 Liner

The CIPP liner material shall have the following minimum characteristics:

- a) Initial Structural Properties of the Lining shall meet the requirements of ASTM F1216, ASTM F1743, or ASTM F2019 as applicable to the type of liner being used.
- b) The finished CIPP liner shall meet the chemical resistance requirements in accordance with ASTM F1216, ASTM F1743, or ASTM F2019 as applicable to the type of liner being used.

460.05.02 Tube

The CIPP tube or carrier material shall meet the requirements of ASTM F1216, ASTM F1743 or ASTM F2019 as applicable to the type of liner being used.

The tube shall be marked at regular intervals not to exceed 1.5 m along its entire length with the manufacturer's name or identification symbol.

460.05.03 Resin

The CIPP resin shall meet the requirements of ASTM F1216, ASTM F1743, or ASTM F2019 as applicable to the type of liner being used.

460.07 CONSTRUCTION

460.07.01 General

At least 7 Days prior to any interruption in service, 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 and the contact information for the Contractor.

The Contractor shall be responsible for the following:

Notify the Contract Administrator at least 14 days in advance of starting work.

Determine actual size and length of all existing pipes to be rehabilitated prior to undertaking the manufacturing of any tubes.

Have all required equipment on-site and in satisfactory working order prior to commencing the installation of a lining section.

Progress and continue work as required to minimize downtime on pipelines and out-of-service periods on laterals.

Notify all affected residents and businesses of the specific time and duration of the disruption to their service at least 24 hours in advance and endeavour to minimize inconvenience to residents and businesses.

During the course of the rehabilitation and any associated service interruption, the residents shall be kept informed regarding any matters that affect them.

460.07.02 Preservation and Protection of Existing Facilities

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

460.07.03 Transporting, Unloading, Storing, and Handling Materials

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

460.07.04 Trenching, Backfilling, and Compacting

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

460.07.05 Support Systems

Where required for excavation or similar situations, support systems shall be according to OPSS 404.

460.07.06 Dewatering

Where required for dewatering procedures to stabilise the ground and keep excavations free of water, or similar situations, dewatering shall be according to OPSS 517.

460.07.07 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, sheathing, shoring, and piling where necessary to prevent damage to such works or proposed works.

460.07.08 Sewer Flow Control Plan

When specified in the Contract Documents or when required to perform the work, the sewer flow shall be controlled in the pipeline being CIPP lined. Method of flow control shall be acceptable to the Contract Administrator.

Any pumps and temporary flow lines shall be of adequate capacity and size to handle sewer flows.

When interruption of sewer line flows is necessary to properly conduct the inspection and rehabilitation operations, methods of flow control shall be used. The Contractor is to make all necessary arrangements with the owners, property managers, and residents of each building.

Unless otherwise specified in the Contract Documents, during the inspection and rehabilitation, sewer flows shall be controlled as required in order to enable proper inspection of the pipe invert. After the work is completed, flows shall be restored to normal.

When a pumped flow control is in operation, the Contractor shall maintain a primary and stand-by pump and pump power supply on-site. Sufficient power supply and hoses shall be on-site in order to allow the pump to discharge into the next downstream sewer section. The stand-by pump and power supply shall be of an equal or better capability than the primary pump and power supply. Unless otherwise specified in the Contract Documents, no pumps or related equipment shall be disconnected or removed from the sewer or work site until after all service connections have been reinstated and the Contractor has recorded the post-installation video.

All flow control pumping shall be in place and operational prior to the final pre-installation inspection. When specified in the Contract Documents, all flow control pumps and related equipment shall be silenced or contained within an acceptable sound reduction structure.

460.07.09 Preparation of Existing Pipeline

Cleaning and flushing of host pipe shall be according to OPSS 411.

All debris, grease, and other deposits shall be removed from the pipeline. Any obstructions remaining after flushing and cleaning shall be removed without damaging the host pipe. All roots that interfere with the lining installation shall be removed. Any calcite build-up in the existing pipeline that interferes with the CIPP shall be removed.

Existing protruding service laterals that interfere with the installation or performance of the liner shall be trimmed back as necessary without damage to the lateral or host pipe. Flail type equipment is not permitted for the removal of protruding laterals.

The Contractor shall install a screen in the downstream maintenance hole to catch any material, including cut outs from service connection openings that may migrate downstream. Such material shall be removed from the maintenance hole.

If the pre-installation inspection reveals an obstruction such as a protruding service connection, a dropped joint, or a collapse that prevents the lining process and the obstruction cannot be removed by conventional sewer cleaning equipment, then the Contractor shall attempt a trenchless technique to remove or repair the obstruction. Any necessary excavation shall be approved in writing by the Contract Administrator prior to the commencement of the work.

When the filling of voids is necessary to ensure structural integrity of the pipeline and to prevent bridging of the liner, the Contractor shall submit a detailed procedure outlining the process and materials to be used to fill the voids to the Contract Administrator for approval.

460.07.10 Closed-Circuit Television (CCTV) Inspection

CCTV inspection shall be according to OPSS 409.

Unless otherwise specified in the contract documents, two CCTV inspections of each pipeline section shall be completed as follows:

a) Post Preparation CCTV Inspection

After completion of the preparation of a pipeline section, a CCTV inspection of the full length of the pipeline section shall be made and submitted to the Contract Administrator. Prior to the delivery of the

24-hour service interruption notice and any lining installation taking place, approval of the prepared section shall be obtained from the Contract Administrator.

b) **Post-Lining Final CCTV Inspection of Complete Rehabilitation**

After completion of all work required for the lining of the pipeline section, a CCTV inspection of the full length of the pipeline section shall be made.

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

460.07.11 Cured-In-Place Pipe Lining Installation

The installation of the CIPP lining shall be according to manufacturers' procedures.

Before installation begins, the Contractor shall obtain carrier tube manufacturer's recommendations for the minimum pressure required to hold the tube tight against the existing pipe, and the maximum allowable pressure so as not to damage the liner tube.

460.07.12 Curing and Cool-Down

The CIPP installation shall be according to ASTM F1216 or ASTM F1743 or ASTM F2019 as applicable to the type of liner being used. Qualified personnel shall execute and monitor the curing process and maintain records, including lining temperatures and internal pressure and/or UV light intensity and duration throughout the curing and cool-down 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, or as specified in Contract Documents.

Readings shall be made and recorded at intervals as specified by the liner system manufacturer:

- a) **Heat Cured Systems:** Measure and record the interface temperature at the downstream and upstream ends of the liner as well as any accessible intermediate access points with a thermocouple at the crown and invert of the host pipe. The time required for the cure shall be determined by the liner system manufacturer and shall be adjusted to suit the lengths, diameter, thickness, field conditions, and ambient temperature applicable to each pipe lining section.
- b) **UV Cured Systems:** Measure and record the number of lamps on, the rate of travel of the light train, and total duration of the curing process. The time required for the cure shall be as specified by the liner system manufacturer.

For heat-cured systems, the CIPP shall be cooled as per resin manufacturer recommendations before relieving the hydrostatic head. Care shall be taken in the release of the static head so that a vacuum does not develop that could damage the newly installed CIPP. Prior to releasing the water used for curing the liner, the water shall be cooled to the ambient temperature of the receiver (i.e. watercourse or sewer) into which it is to drain.

460.07.13 Discharge Requirements

For any discharge, it shall be confirmed that the quality of the discharge meets the requirements of the receiver.

460.07.14 CIPP Inflation Bladder Removal

For pulled-in-place and spot repair installations where the inflation bladder is designed to not bond to the CIPP, all portions of the bladder material shall be removed from the CIPP.

460.07.15 Liner Termination

The liner termination at and through sections shall be neat and free of obstructions. If the liner termination fails to make a watertight seal with the host pipe, a seal shall be applied at this point. The sealing process shall use a material compatible with the liner and host pipe.

460.07.16 Sewer Lateral Reinstatement

Sewer lateral reinstatement shall be made internally with appropriate remotely operated equipment. Alternately when sewer size permits, reinstatements may be made manually by person entry. Excavation for lateral reinstatement shall not be allowed. Restored connection or lateral openings 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 not be permitted.

When sewer lateral flow has been interrupted, reinstatement of the lateral shall proceed urgently and with all possible speed to restore lateral flow. Laterals may be reinstated using an initial opening sufficient to restore flow, followed by completion to full reinstatement of 100% open within 24 hours.

460.07.17 Site Restoration

Site restoration shall be according to OPSS 492.

460.07.18 Management of Excess Material

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

460.08 QUALITY ASSURANCE

Quality assurance for the CIPP 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.

Any lateral reinstatements shall be as per OPSS 460.07.16.

2. Testing of CIPP Liner Samples & 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 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. 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. 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

Unless otherwise specified in the Contract Documents, samples shall be taken and tested for 30% of individual liner installations and include at least one tested sample for each size of liner installed.

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 either flexural strength or flexural modulus 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 provide the Owner with an infrared fingerprint of the approved resin for the project from the resin manufacturer.

The Contractor shall supply a sample of the resin used in the wetout when requested by the Contract Administrator. The Owner shall send a sample of the submitted resin from the project to a 3rd party testing laboratory for verification and confirmation.

CIPP Spot Repairs and CIPP Lateral Liners

Because it is normally not possible to obtain samples from a spot repair or a lateral liner due to access limitations, samples made from the same materials as installed within the pipeline shall be made above ground, on site and on the same day using cylindrical forms of the same size as the host pipeline. Procedures shall be taken, including during the CIPP cure, so that the above ground sample is representative of the CIPP installed in the pipeline. Unless otherwise specified in the Contract Documents, the requirements in the above sub sections 1, 2 & 3 are applicable.

460.09 MEASUREMENT FOR PAYMENT

460.09.01 Actual Measurement

460.09.01.01 Cleaning and Preparation of Host Pipe

Measurement for host pipe cleaning and preparation shall be by length in metres 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 in metres to the centre of the structure.

460.09.01.02 Product Installation

Measurement for a product installation shall be by length in metres 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 in metres to the centre of the structure.

460.09.01.03 Service Connection/Lateral Reinstatement

For measurement purposes, a count shall be made of the number of service connections made to the new product.

460.09.02 Plan Quantity Measurement

When payment is by Plan Quantity, such measurement shall be based on the units shown in the clauses under Actual Measurement.

460.10 BASIS OF PAYMENT

**460.10.01 Product Installation, “*type, diameter, or use of product*” - Item
Service Connection/Lateral 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.

Unless otherwise specified in the Contract Documents, compensation for all costs associated with the control of flow for sewers shall be included in the unit prices of the contract.

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.

Costs associated with the filling of identified voids shall be as specified in the Contract Documents. Any additional work done for the filling of additional voids identified in the CCTV inspection shall be paid as Extra Work. Filling of voids occurring as a result of Contractor's operations shall be done at no extra cost to the Owner.

460.10.02 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 460, November 2018
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.