

Specification number: OPSS XXX

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CONSTRUCTION SPECIFICATION FOR WATER MAIN REHABILITATION BY CURED-IN-PLACE PIPE

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D XXX.01	SCOPE
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This specification covers the requirements for the rehabilitation of water mains by the installation of a tight fitting cured-in-place pipe.

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 401	Trenching, Backfilling, and Compacting
OPSS 404	Support Systems
OPSS 409	Closed-Circuit Television Inspection of Pipelines
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
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)

NSF International

NSF 61 Drinking Water System Components – Health Effects

MOEECC

Most Recent Edition Water Main Disinfection Procedure

American Water Works Association (AWWA)

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

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) means a hollow tube containing a nonwoven or a woven material, or a combination of nonwoven and woven material surrounded by a cured thermosetting resin. Plastic coatings may be included. This pipe is formed within an existing pipe. Therefore, it takes the shape of and fits tightly to the existing pipe.

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

Lining means the process of installing a CIPP.

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 design shall assume fully deteriorated condition of the existing pipe and long-term CIPP properties with a 50-year creep reduction in accordance with ASTM D2990.

b) Parameters for design:

Unless otherwise specified in the Contract Documents:

- i. Design life of 50 years
- ii. Safety factor of 2 applied to ASTM F1216 Equations X1.1, X1.2 and X1.3
- iii. Safety factor of 3 applied to ASTM F1216 Equations X1.6 and X1.7
- iv. Groundwater table at ground surface
- v. Soil modulus of 6.9 MPa
- vi. Soil density of 1925 kg/m³
- vii. Minimum ovality of 2%
- viii. Minimum depth of 2 m to invert
- ix. Minimum working pressure of 485 kPa
- x. Live load is ASSHTO HS-20

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).

Flow capacity 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;
- 3rd 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, physical properties, and dimensions.
- ii. Recommendations for transportation, handling, and storage.
- iii. Repair of product damaged during installation.
- iv. Installation details.

- 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 sample letter to residents impacted by the work.

D XXX.05 MATERIALS

Diameter range and pressure class 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 compliant.

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.
- ii. Flexural strength of 31 MPa tested in accordance with ASTM D790.
- iii. Tensile strength of 21 MPa tested in accordance with ASTM D638.

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, operational and test pressures, 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 design 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.

D XXX.07 CONSTRUCTION

D XXX.07.01 General

The Contract Administrator shall be notified at least 48 hours 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 Engineer and shall not damage the existing pipe walls, service connections or appurtenances. The pipe shall be cleaned as many times as necessary, and in each direction as necessary, to obtain results that are satisfactory to the Engineer.

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 liners shall be completely removed unless the residual coating/liner is tightly bonded and the manufacturer and Engineer agree that the residual liner can be safely lined with CIPP without compromising performance and integrity.

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 long-term, leak-tight seal/bond. Similar attention shall be paid to CIPP termination points where long-term, leak-tight adhesion is important for resistance to system surge pressures. 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 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, including long-term performance, 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 Engineer.

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 Engineer for approval.

D XXX.07.12 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 preparation of a pipeline section and before lining, a video 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 CIPP installation taking place, approval of the prepared section shall be obtained from the Contract Administrator within 8 hours after inspection to prevent further deterioration of the prepared pipe.

b) Post-Lining Final Video Inspection of Complete Rehabilitation

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

The final video 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
- 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

D XXX.07.13 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 existing pipe. 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 starting the lining, the pipe must be prepared and in the state specified in Section XXXX.07.09.

D XXX.07.14 Curing

CIPP curing shall be completed according to ASTM F1216, ASTM F1743 or ASTM F2019. Qualified personnel shall monitor the curing process and maintain written records, including temperature, internal pressure and duration throughout 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 both ends of the CIPP installation, as well as any accessible intermediate access points at the crown and invert of the pipe.

D XXX.07.15 Cool-Down

The CIPP shall be cooled in accordance with the work plan minimum temperature at the prescribed cooling rate before relieving the hydrostatic head. Care should be taken in the release of the static head so that a vacuum does not develop and damage the newly-installed CIPP. The release of cooling water shall be in accordance with the Contract Documents and approved work plan.

D XXX.07.16 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.07.17 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.07.18 Finished CIPP

Samples

CIPP restrained and field-cured samples shall be taken from the finished CIPP at an access point, sufficient in size to meet the requirements of ASTM D790, ASTM D638, and ASTM D5813 in accordance with ASTM F1216 and the contract specifications. 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 number of samples to be tested shall be at least 20% of the total number of installations.

Testing

Testing will be completed to confirm the CIPP installation meets the following minimum design requirements:

- Resin uniformly saturated and fully cured
- Fit and finish, no annular space, liner sized correctly,
- Liner thickness in accordance with ASTM D5813
- Flexural and tensile properties in accordance with ASTM D790 and D638
- Hoop tensile strength in accordance with ASTM D2290 if fold or wrinkles or other defects are observed.
- Adhesion of the liner to the host pipe in accordance with ASTM D4541
- Water tight seal between the liner and host pipe at the termination point.

Furthermore, each CIPP section shall be hydrostatically tested for leakage in accordance with f ASTM F1216 section 8.3.

b) Resin

The Owner shall obtain an infrared fingerprint of the approved resin for the project from the resin manufacturer. The Contractor shall supply a sample of the resin 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.

D XXX.07.20 Service Connection Reinstatements

Service connection reinstatement shall be made internally with appropriate remotely-operated equipment. Restored connections 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 be removed. Plugged service connections shall be rectified in accordance with contract requirements or reinstated externally.

D XXX.07.21 Disinfection

Post-lining water main disinfection shall be completed in accordance with applicable MOEECC water main disinfection procedures or as specified in the contract documents.

D XXX.07.22 Site Restoration

Site restoration shall be according to OPSS 492.

D XXX.07.23 Management of Excess Material

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

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.
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 video 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.

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

The designer should specify the following in the Contract Documents:

- Temporary Water Supply (XXX.07.08)
- Cost of filling voids that have been specifically identified (XXX.10.01)

The designer should determine if noise restrictions are required, if so, they should be specified in the Contract Documents.

The designer should ensure that the General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

No information provided here.