



**CONSTRUCTION SPECIFICATION FOR
CLOSED-CIRCUIT TELEVISION (CCTV) INSPECTION OF PIPELINES**

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409.01	SCOPE

This specification covers the requirements for inspection of new and existing pipelines, subdrain and outlet pipes, pipe sewers, watermains, pipe culverts and other accessible conduits by closed-circuit television (CCTV).

409.02 REFERENCES

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

Ontario Provincial Standard Specifications, Construction

OPSS 407	Installation of New Maintenance Holes, Catch Basins, Ditch Inlets and Valve Chambers
OPSS 411	Cleaning and Flushing of Culverts, Pipe Sewers, Catch Basins, Maintenance Holes, Ditch Inlets, and Oil-Grit Separators

CSA Standards

PACP	Pipeline Assessment and Certification Program (PACP®), Canadian Edition including CSA PLUS 4012-10
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Water Research Centre (WRc) Publication

MSCC Manual of Sewer Condition Classification, 5th Edition, 2013.

409.03 DEFINITIONS

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

Digital Storage Device means a compact disc (CD), digital videodisc (DVD), flash memory card, hard drive, or other industry-standard digital storage mediums.

Drainage Structure means as defined in OPSS 407.

NASSCO means the National Association of Sewer Service Companies which certifies inspectors to perform inspection of pipelines, and code viewed pipe conditions.

Pipeline means storm, sanitary, watermains, pipe culverts or other accessible pipe conduit.

409.04 DESIGN AND SUBMISSION REQUIREMENTS

409.04.01 Submission Requirements

409.04.01.01 CCTV Inspection of Pipelines

The following information shall be submitted to the Contract Administrator 10 Business Days prior to the start of the CCTV inspection operations:

- a) A copy of the CCTV operator's NASSCO Certification. A copy of the certificate is required for each CCTV operator working on the Contract.
- b) A sample inspection report, resolution tests of digital video recording format, and digital data file. One submission is required for each camera proposed for use on the work. The camera make, model, and serial number shall be clearly identified on each video recording.
- c) The details of the coding accuracy verification system that is to be used to verify inspection accuracy shall be submitted for approval.

409.05 MATERIALS

409.05.01 Digital Storage Device

Digital storage device with minimum universal serial bus (USB) 3.0 or higher compatibility shall be placed inside an envelope with a label displaying the following information:

- a) Owner's name
- b) Contract number
- c) Sewer identification number
- d) City or town

- e) Street name
- f) Inspection date

The digital storage device shall include a file in either Word or text format including the information provided above. The digital storage device shall be labelled. The label shall include the information in points a) and b) above to identify the content.

409.05.02 Photographs

Digital photograph files shall meet or exceed a resolution of at least 640 x 480 pixels. Printed photographs shall be in colour with a minimum image size of 90 x 70 mm and shall be reproduced on premium glossy photo quality paper.

409.06 EQUIPMENT

409.06.01 General

Inspection and camera equipment used to inspect watermains shall have been used exclusively for work in watermains only.

409.06.02 Inspection Equipment

409.06.02.01 General

The inspection equipment shall be capable of surveying a length of pipeline up to:

- a) 300 m when entry to the pipeline may be obtained at each end of the pipeline.
- b) 30 m when rodding is used.
- c) 150 m when a self-propelled unit is used when entry is at only one end of the pipeline.
- d) 200 m when being towed.

Each survey unit shall contain a means of transporting the CCTV camera in a stable condition through the pipeline.

When the CCTV camera is towed by winch and cable through the pipeline, all winches shall be stable during the entire CCTV inspection. All cables shall be of steel or of an equally non-elastic material to ensure the smooth and steady progress of the CCTV camera.

Each unit shall carry a sufficient number of guides and rollers so that, when inspecting, all cables are supported away from pipeline and maintenance hole edges. All CCTV cables and lines used to measure the camera's location within the pipeline shall be maintained in a taut manner and set at right angles, when possible, to run through or over the measuring equipment.

409.06.02.02 Subdrains and Outlet Pipes

The inspection equipment shall also be capable of providing CCTV inspection of subdrain and outlet pipes of minimum 100 mm inside diameter within a wet environment and shall be capable of negotiating a minimum 45° bend.

409.06.03 Inspection Vehicle

The inspection vehicle shall contain a separate area for viewing, recording, and controlling the CCTV operation.

The viewing and control area shall be insulated against noise and extreme temperatures. Cooling and heating units shall be independent from the main vehicle engine and in good working order. External and internal sources of light shall be controlled in a manner as to ensure the light does not impede the view of the monitor screen. Seating accommodation with clear view of the monitor screen shall be provided for the operator and one additional person.

All equipment used within the pipeline shall be stored outside the viewing, recording, and control area.

The inspection vehicle shall include a cell phone or suitable alternative as agreed by the Contract Administrator for the duration of the work.

409.06.04 Video Equipment Quality

409.06.04.01 General

The electronic systems, television camera, and monitor shall meet the minimum requirements specified in the following clauses.

409.06.04.02 Camera

409.06.04.02.01 General

The pan and tilt camera shall have the capability of panning the pipe at 360° with tilt capability of 275° to ensure complete inspections and view of all laterals and deficiencies.

409.06.04.02.02 Colour Constancy

The lighting shall be set prior to commencing the inspection to ensure the camera provides optimum results when used with its own illumination source. To ensure colour constancy, no variation in illumination shall take place during the inspection.

409.06.04.02.03 Focus, Iris, and Illumination

The adjustment of focus and iris shall allow optimum picture quality to be achieved and shall be remotely operated. The illumination shall be such as to allow an even distribution of the light around the pipeline perimeter without the loss of contrast or flare out of picture shadowing.

409.06.04.02.04 Resolution

The live picture shall be visible with no interference and capable of registering a minimum number of lines of resolution at the periphery as indicated below:

- a) Fixed view camera - 350 lines of resolution.
- b) Pan and tilt camera - 400 lines of resolution.

409.06.04.03 Camera Position Meter-Reading Device

A suitable meter-reading device shall be used that enables the cable length to be accurately measured to indicate the location of the camera. The meter-reading device shall be accurate to $\pm 1\%$ of the length of the pipeline being inspected. The tolerance shall be demonstrated using one or both of the following methods:

- a) Cable calibration device; or
- b) Tape measurement of the surface distance between maintenance holes.

The measuring device shall be replaced if the accuracy test fails. The Contract Administrator may require that the lengths of pipeline first inspected with the original measuring device be reinspected using the new measuring device.

409.06.04.04 Digital Video Recorder

Digital video recorders shall be able to capture in colour from the live video source with the following requirements:

- a) Movie photographic experts group (MPEG) -2 or higher or as required by Owner.
- b) NTSC 720 x 480 @ 29.97 frames per second.
- c) Data/Bit Rate: MPEG-1 @ 2.4 M-bits/sec.

Video capture equipment shall be capable of capturing digital video from first generation recordings with no frame loss.

409.06.04.05 Monitor

Monitors shall be a minimum size of 21 inches and shall support resolution equal to or greater than the corresponding video camera resolution.

409.07 CONSTRUCTION

409.07.01 Certified CCTV Operator

CCTV inspection shall be performed by a person holding a NASSCO certification. The CCTV operator shall be used to operate the inspection equipment and code the inspection. This person shall have a valid original card issued by the certifying agency in their possession at all times.

Operators failing to meet the coding accuracy requirements on two occasions shall not be permitted to code on the remainder of the Contract, unless they successfully re-attain NASSCO qualification based on the standard being used (i.e., Canadian Edition of PACP or MSCC).

409.07.02 Pipeline Cleaning

All new and existing pipelines shall be cleaned and flushed according to OPSS 411 immediately prior to the CCTV inspection.

409.07.03 Resolution and Digital MPEG Video Recordings

Prior to the start of the CCTV inspection, the resolution of digital MPEG video playback for each camera shall be confirmed by recording a resolution chart approved by the Contract Administrator, using the following procedures:

- a) Set up the camera in the same position the actual inspection will be taking place.
- b) Show the camera being introduced and reaching its final position for the test.
- c) Fill the monitoring screen with the resolution chart.

- d) Illuminate the resolution chart evenly and uniformly without reflections ensuring that the illumination source accurately simulates the lighting used in the pipeline.
- e) Record a test video for 30 seconds.
- f) Identify the camera make, model, and serial number on the recording.
- g) Record the test at the start of a digital recording.

The resolution test shall be submitted to the Contract Administrator for approval.

409.07.04 Coding Accuracy

Prior to commencement of the CCTV inspection, a formal coding accuracy verification system shall be developed and submitted for approval to the Contract Administrator prior to implementation. The coding accuracy shall be based on accuracy as a function of the number of defects or construction features not recorded, and the correctness of the coding and classification shall be recorded.

Verification of coding accuracy shall be completed on a random basis on a minimum of 10% of the inspection reports. A minimum of two accuracy verifications shall be completed for each operator, for each week working.

Inspections not satisfying the accuracy requirements shall be re-coded and verified that it meets the following:

- a) Accuracy requirements; and
- b) Accuracy of the inspections immediately preceding and following the non-compliant inspection.

Coding accuracy verifications shall be submitted to the Contract Administrator along with the corresponding video recording.

409.07.05 CCTV Inspection

409.07.05.01 General

Work shall not commence in a work shift until the Contract Administrator is satisfied that all items of the inspection equipment have been provided and are in full working order. The work shall include a CCTV inspection of the pipeline and the preparation of all video, digital, and written reports.

409.07.05.02 Camera

409.07.05.02.01 General

CCTV camera inspections shall be carried out according to the pipe condition coding practices as outlined in the MSCC or the Pipeline Assessment and Certification Program (PACP®)

A fixed camera may be used for pipelines less than 300 mm in diameter. For pipelines equal to or greater than 300 mm, a pan and tilt camera shall be used. Each camera shall have a sample submission report acceptable to the Contract Administrator prior to being used for the inspection of the work. The camera lens shall be kept clean at all times during the inspection.

409.07.05.02.02 Camera Position

The camera lens shall be positioned centrally in a circular pipeline and at two-thirds of the vertical dimension in a non-circular pipeline with a positioning tolerance of $\pm 10\%$ of the vertical pipeline dimension.

In all instances, the camera lens shall be positioned looking along the longitudinal axis of the pipeline.

409.07.05.02.03 Camera Travel Speed

The travelling speed of the camera in the pipeline shall be limited to:

- a) 0.10 m/s for pipeline of diameter less than or equal to 200 mm.
- b) 0.15 m/s for diameters exceeding 200 mm but not exceeding 310 mm.
- c) 0.20 m/s for diameters exceeding 310 mm.

409.07.05.03 Inspection

Flow control measures shall be implemented to ensure a minimum of 80% of the height of the pipeline is visible for the entire inspection and shall be approved by the Contract Administrator.

All fog shall be evacuated from the pipeline and the pipeline kept clear of fog during the inspection.

At the start of each pipeline inspection, the length of pipeline from zero chainage up to the cable calibration point shall be recorded and reported in order to obtain a full record of one of the following:

- a) Pipe sewer length from the inside face of the maintenance hole to the inside face of the next maintenance hole or outlet end of the pipe sewer;
- b) Pipe culvert length from one end of the pipe culvert to the other;
- c) Watermain length from the valve pit entry point to the valve pit exit point or termination of the cement mortar lining;
- d) Subdrain length from one outlet pipe to the other; or
- e) The entire length of the outlet pipe.

The position of the meter-reading entered on to the data display at the cable calibration point shall allow for the distance from the start of the inspection to the cable calibration point so that the meter-reading at the start of the inspection is zero.

In the case of inspection through a maintenance hole when a new header sheet is required, the meter-reading shall be set at zero with the camera focused on the outgoing pipe entrance.

At the start of each pipe segment to be inspected, a data generator shall electronically generate and clearly display on the viewing monitor and video recording a record of data in alphanumeric form containing the following information as a minimum:

- a) Automatic update of the camera's meter-reading position in the pipeline from adjusted zero.
- b) Pipeline dimensions.
- c) Maintenance hole and pipe length reference numbers.
- d) Date of inspection.
- e) Road name and location.
- f) Direction of inspection.

g) Start time of inspection.

h) Pipeline use.

Once the inspection is underway, an automatic update of the camera's meter-reading position in the pipeline from zero in metres and tenths of a metre shall be continually displayed.

The camera shall be stopped when defects are being noted on the coding sheet. Defects in each pipeline length shall be coded according to the standard being used (NASSCO Canadian Edition of the Pipeline and Assessment Certification Program (PACP) or MSCC). Any variation from the manual shall be noted in the inspection report.

The inspection shall be restarted at the opposite end of the pipeline if a blockage or obstruction is encountered.

409.07.05.04 Digital Video Recorder

All inspections shall be recorded in colour.

Digital video recordings shall be saved to a computer hard drive and transferred to a portable hard disk drive, compact disc, or digital video for submission.

A digital format video recording of an inspection shall be produced in colour from a first generation recording by one of the following methods:

- a) A computer system and a video capture card shall be used to capture the recording continuously, regardless of the progression of the inspection. Prior to submission, the raw digital data shall be edited to remove pauses when the inspection progress was not continuous;
- b) A computer system and a video capture card shall be used to intermittently capture the recording. Prior to submission, the raw digital file shall be edited to form one continuous file; or
- c) Specialized video recording equipment capable of pausing and resuming live recording shall be used to capture original recording. A single file is to be produced for submission.

Non-linear video editing software shall be used to edit digital videos. Edited digital files shall not be recompressed.

409.07.06 Final Documentation

409.07.06.01 Inspection Reporting

Inspection reports shall be submitted to the Contract Administrator in the following formats within 10 Business Days of the completion of the fieldwork:

- a) Two portable digital drives, each containing identical inspection report information unless otherwise specified in the Contract Documents.
- b) Two copies of the digital video recording, unless otherwise specified in the Contract Documents.

The entire inspection shall be contained within one digital file on a digital storage device, as applicable. When possible, reverse set-up inspections shall be recorded immediately after the original inspection.

Each digital file shall contain the file name, as specified by the Owner and shall include the following:

- a) Contract number

- b) E<Entity number>
- c) F<From entity number>
- d) T<To entity number>
- e) Street, Park, or Highway Name

For example: "910-200_ESP729_FM5328_TM5350_BERRY_ST.MPEG" indicates that this is from Contract 910-200, the pipe segment is referred to as SP729, inspection is from MH 5328 to MH 5350 on Berry Street, of this video recording.

All required header information fields in the report shall be completed and verified for correctness. The report shall be printed and presented as specified in the Contract Documents.

All dimensions in the inspection report shall be metric.

The inspection report shall clearly identify all defects and include photographs.

Non-compliant submissions shall be corrected and resubmitted at no expense to the Owner.

409.07.06.02 Drawings

One clean set of the digital drawings showing maintenance hole numbers that coincide with the coding sheets shall be returned to the Contract Administrator on completion of the inspection. The drawings shall be clearly annotated to show any discrepancies between the drawings and the inspection report. Such discrepancies shall be brought to the attention of the Contract Administrator during the inspection.

409.07.07 Management of Excess Material

Management of excess material shall be according to the Contract Documents.

409.08 QUALITY ASSURANCE

409.08.01 Acceptance

The Contract Administrator will check that the following submissions are in compliance with the Contract Documents:

- a) Printed and digital inspection reports;
- b) Digital MPEG video recordings;
- c) Magnetic data files; and
- d) Coding accuracy checks.

Submittals shall be reviewed by the Contract Administrator and their acceptance confirmed within 10 Business Days of submission. Only inspections with minimum accuracy for header information of 95% and minimum detail accuracy for defects and features of 85% will be accepted. Non-compliant submissions will be returned for correction. Corrected submissions shall be returned to the Contract Administrator for review within 5 Business Days.

409.09 MEASUREMENT FOR PAYMENT

409.09.01 Actual Measurement

Measurement for a CCTV inspection of pipeline shall be measured in metres on the ground surface along the centreline of the pipe sewer from the centre of one drainage structure to the centre of another drainage structure or outlet end of the pipe sewer.

Measurement for a CCTV inspection of pipe culverts shall be measured in metres on the ground surface along the centreline of the pipe culvert from one end of the pipe culvert to the other end of the pipe culvert.

Measurement for a CCTV inspection of subdrain and outlet pipe shall be by length in metres on the ground surface along the centreline of the subdrain from the centre of one drainage structure to the centre of another drainage structure or the outlet end of the subdrain.

Measurement for a CCTV inspection of watermain shall be measured in metres on the ground surface along the centreline of the watermain from the valve pit entry point to the valve pit exit point or termination of the cement mortar lining.

When surface measurement cannot be obtained due to obstruction or traffic restrictions, measurements captured by CCTV meter-reading device shall be used.

In the event that a CCTV inspection is terminated due to a blockage or collapsed pipe or the pipe is inaccessible, measurement shall be in metres for the actual length of pipeline inspected as determined from the chainage indication on the record media.

409.09.02 Plan Quantity Measurement

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

409.10 BASIS OF PAYMENT

409.10.01 CCTV Inspection - Item

Payment at the Contract price for the above tender item shall be full compensation for all labour, Equipment, and Material to do the work.