

## SASTT TECHNICAL STANDARD

### Trenchless construction works

### Part TT5: CCTV Inspections of pipelines

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# SASTT-TS-TT5: 2021

Edition 1

## Table of changes

Change No.	Date	Scope

## Acknowledgement

SMEC South Africa (Pty) Ltd was appointed by the Southern African Society for Trenchless Technology (SASTT) to prepare this standard for the CCTV Inspections of pipelines. The standard was prepared by Mike King of SMEC South Africa and independently reviewed by Alaster Goyns of PIPES.

This standard is partially based on a specification written by SMEC South Africa for the City of Cape Town in 2007. SMEC South Africa and the City of Cape Town are acknowledged in this regard.

The standard is being posted on the SASTT website. Any comments will be put on record and these incorporated in future editions of this document.

## Foreword

This SASTT technical standard was approved by the Board of SASTT on 5 October 2021.

This document was published on 15 October 2021 and posted on the SASTT website.

SASTT-TS standards consist of a number of parts in various stages of preparation, under the general title *Trenchless construction works*.

Annex A forms an integral part of this document. Annexes B, C and D are for information only.

## Introduction

Each SASTT-TS standard addresses a specific category of trenchless construction works. The prime purpose of the production of these standards is to create a set of standards that are generally applicable to trenchless construction works and which can be readily modified so that they are applicable to developments in existing techniques or development of new techniques for trenchless works.

The SANS 2001 and SASTT-TS family of standards provides technical descriptions of the materials and workmanship standards required in the execution or performance of the works when completed (or both). These standards do not make reference to the actions of those responsible for executing the works or the parties to a contract, i.e., to the constraints relating to the manner in which the construction is to be performed. Neither do they deal with the commercial arrangements of such contracts. These standards are suitable for use in any "in-house" construction work or in any engineering and construction works contracts, for example; design by owner; design and build; develop and construct construction management or management contracts.

Standard requirements pertaining to the manner in which works are constructed can be found in the SANS 1921 *Construction and management requirements for works contracts* family of standards.

Attention is drawn to the possibility that certain content in this document might be the subject of patent rights. SASTT shall not be held responsible for identifying any or all such patent rights.

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## **Trenchless construction works**

### **Part TT5:**

### **CCTV Inspections of pipelines**

## **1 Scope**

### **1.1 General**

This standard specification for the CCTV inspections of pipelines covers the internal and external inspection of gravity pipes. The scope is limited to non-pressure pipelines that flow by gravity (sewer and stormwater pipelines). These pipelines typically have a circular cross-section, but in this context can be rectangular, elliptical, oval or egg shaped. The pipes may be of any material.

The internal inspection of pipelines is categorised as a trenchless method of collecting data used in their condition assessment. It is a technique that is fundamental to the asset management of underground pipelines. In addition, CCTV inspections, in particular, are an integral procedure used in the implementation of trenchless technologies.

The external inspection of pipelines is an essential part of the assessment of a pipeline's condition needed to determine the best rehabilitation method to be applied. **Annex C** further describes the external inspection of pipelines further. Although not a trenchless technique the external inspection of pipelines is included in this standard.

Although this standard is primarily for the CCTV inspections of underground municipal pipelines between manholes using CCTV cameras on self-propelled tractors, it can generally be applied to other similar but specialised survey techniques that include sidescan camera systems, laser light ring profiling systems (sometimes on floats with sonar profiling) and 3D lidar profiling.

Condition surveys of pipelines can have the following purposes:

- Condition surveys of an area on a sampling basis.
- Condition surveys of specific (trunk) pipeline or reticulation area.
- Condition surveys to identify pipelines for rehabilitation.
- Re-inspection surveys to follow up on progress of deterioration.
- Inspections for approval of newly constructed infrastructure.
- Inspections just before, during and after pipe rehabilitation.
- Emergency pipe inspections following a collapse or blockage.

## **2 Normative references**

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. Information on currently valid national and international standards can be obtained from Standards South Africa.

### South African National Standards

SANS 1200, *Standardized Specification for Civil Engineering Construction.*

SANS 2001, *Construction works.*

SANS 1921, *Construction and management requirements for works contracts.*

SANS 10403, *Formatting and compilation of construction procurement documents.*

## **3 Definitions and abbreviations**

### **3.1 Definitions**

For the purposes of this document, the definitions given in SANS 10403 and the following additional definitions apply:

#### **CCTV inspections**

Closed circuit television cameras are used to carry out internal inspections of pipelines with appropriate transport and lighting mechanisms to view the internal surfaces.

#### **informative**

a supplement that provides additional information intended to assist the understanding or use of the document.

#### **manhole length**

refers to the pipeline between two consecutive manholes.

#### **normative**

that with which it is necessary to conform in order to be able to claim compliance with the standard.

#### **overpumping**

the transportation of the flow in a pipeline around a specific section of pipeline that is being inspected. Comprises pumps and bypass pipelines.

#### **Owner**

the organisation that owns the pipeline that is being inspected.

#### **Pre-inspections**

are inspections to open manholes and make a preliminary assessment to determine what pipeline cleaning is required to allow a proper and complete survey to be performed.

#### **specification data**

is data, provisions and variations that make this standard applicable to a particular contract or works.

#### **suitable**

is capable of fulfilling or having fulfilled the intended function or fit for its intended purpose.

**Survey Contractor**

the Survey Contractor is the specialist entity (contractor, subcontractor, or in-house team) engaged by the Owner to implement the pipeline survey.

**Survey Operator** means a trained person who controls the inspection equipment and performs the defect coding.

### 3.2 Abbreviations

The following abbreviations are used in this document:

<b>CCTV</b>	Closed Circuit Television
<b>DVD</b>	Digital Video Disk
<b>GIS</b>	Geographic Information System
<b>GPS</b>	Global Positioning System
<b>JPEG</b>	Joint Photographic Experts Group (a still image format)
<b>MPEG</b>	Moving Picture Experts Group (a video format)
<b>MSCC</b>	Manual of Sewer Condition Classification (WRc) (UK)
<b>NTRIP</b>	Networked Transport of RTCM via Internet Protocol
<b>SANS</b>	South African National Standards
<b>SARTSM</b>	South African Road Traffic Signs Manual
<b>SRM</b>	Sewerage Rehabilitation Manual (WRc) (UK)
<b>WRc</b>	WRc Plc (Public Limited Company) previously Water Research Centre (UK)
<b>XML</b>	Extensible Markup Language

## **4 Requirements**

### **4.1 Equipment**

The CCTV inspection system shall comprise the following:

#### **4.1.1 Camera and transporter combinations**

The type of camera and transporter to be used shall be as specified in the **specification data**. The **specification data** will also state the sizes, types, and shapes of pipelines to be inspected by each type of camera and transporter. The type(s) shall be one or more of the following:

- Fixed camera
- Pan and rotate camera (with or without zoom)
- Self-propelled tractor (fixed direction or steerable)
- Skid transporter
- Pontoon/float
- Push rod camera system
- Laser light ring equipment
- Sonar equipment
- Sidescan camera system
- Zoom camera on pole
- 3D lidar scanning equipment

The camera and transporter system must be capable of transporting the camera in a stable manner through the pipeline being inspected in accordance with the specifications for inspections below. They must be able to tolerate the environment within the pipeline including 100% humidity.

##### **4.1.1.1 Cameras general**

Cameras shall be capable of providing a colour picture quality in accordance with these specifications.

The adjustment of focus and light sensitivity (iris) shall allow optimum picture quality to be achieved and shall be remotely operated. The adjustment of focus and iris shall provide a focal range from 150 mm in front of the camera lens to infinity. The distance along the pipeline in focus from the initial point of observation shall be a minimum of twice the vertical dimension of the pipeline.

Cameras shall be “High Resolution” analogue type cameras with at least 460 TV Lines (total screen width) or shall be “HD Ready” resolution digital cameras producing a frame size of at least 1280 x 720 pixels, unless otherwise specified in the **specification data**.

##### **4.1.1.2 Fixed cameras**

The camera must be fixed so that it looks forward along the axis of the pipe. The camera shall be equipped to automatically produce an upright picture.

##### **4.1.1.3 Pan and rotate cameras**

Pan and rotate (tilt) cameras shall be capable of tilting to 90° from the horizontal and rotate for a full 360° view. When in motion the camera must be fixed forward looking along the axis of the pipe.

The camera shall have a zoom facility if specified in the **specification data**. This is usually required in larger pipelines for close ups of defects and features.

#### 4.1.1.4 Illumination equipment

The illumination shall be matched to the light sensitivity of the camera, such as to allow an even distribution of the light around the pipeline perimeter without the loss of contrast, flare out of picture or shadowing, and to allow pipeline cracks, defects and any other features to be clearly visible. The illumination in conjunction with the iris setting shall provide an adequate depth of field for the size of pipelines to be inspected. The lights shall be controlled remotely.

#### 4.1.1.5 Camera transporters

Camera transporters shall be able to position the camera centrally in the pipeline's cross section. This is defined as the centre of a circular pipe. For an egg shaped pipeline this is defined as being on the vertical centreline and two thirds of the vertical height above the invert. A positioning tolerance of 10% of the vertical and horizontal dimensions of the pipeline is allowed.

#### 4.1.1.6 Self-propelled tractor transporters

The tractor must be self-propelled and capable of travelling at least 200 m through a pipeline from an access point. The tractor must be able to reverse under its own power. It is advisable that the camera cable and connectors are strong enough to be used to manually recover the camera and tractor, if so required.

The tractor must be fitted with an inclinometer for measuring, displaying and recording the gradient of the pipeline. The equipment must be capable of recording at least three gradient readings per metre. The software must be capable of providing an indicative gradient profile of the inspected pipeline.

The tractor shall be steerable if specified in the **specification data**. Steerable tractors are usually required for the inspection of larger pipelines or pipelines with a flatter profiled bottom where the tractors may not easily keep their alignment and wander. Steering also allows obstructions to be negotiated.

#### 4.1.1.7 Skid transporters

Skid transporters of cameras must be capable of being pulled both ways through 100 m of pipeline with access at both ends, unless specified otherwise in the **specification data**.

#### 4.1.1.8 Pontoon/float

Floating transporters of cameras and/or laser and sonar profiling equipment must be capable of being pulled both ways through 200 m of pipeline with access at both ends, unless specified otherwise in the **specification data**. The pontoon or float must be stabilised to reduce the risk of capsizing, be unsinkable and be in the shape of a hull.

#### 4.1.1.9 Push rod camera systems

This camera would only be used for inspections where self-propelled tractors or skid transporters would not be able to negotiate through the pipe.

Push rod camera systems must be capable of travelling 60 m into a pipeline from an access point. Shorter cable lengths can be used for smaller diameter residential inspections.

#### 4.1.1.10 Laser light ring profiling equipment

The cross sectional profile of a pipe can be determined by recording the image of a laser light ring

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projected onto the inside wall of the pipe. The image of the ring will reveal discontinuities in the pipe profile and any siltation or debris along the pipe invert. The profile will reveal pipe ovalities, offsets, cracks, holes, erosion, and corrosion. The laser profiler is typically mounted on a CCTV camera transporter. The CCTV inspection and the laser survey are performed either simultaneously or consecutively.

Laser profiling can reveal geometric discontinuities that the eye may not discern from a CCTV inspection. Furthermore, with a calibrated light ring inspection, reasonably accurate measurements may be determined. In post-processing, automated measurements such as cross-sectional dimensions and ovalities can be quantified and 3-D models can be created for examination. The profiles must be aligned with templates of the existing pipes (showing the original pipe internal profile and wall thickness (if known)) to reveal the depth and extent of pipe corrosion, deformation of the internal diameter due to overloading, and any other defects.

If required, detailed specifications may be provided in the **specification data**.

### **4.1.1.11 Sonar profiling equipment**

Sonar equipment mounted under a floating platform is used to create a cross-sectional profile of a pipe under water. Sonar profiling is typically used to supplement laser profiling when a pipeline cannot be emptied. Specialised software combines the laser and sonar profiles to create a single profile of the pipe.

The profiles are then processed and analysed as per laser profiling described above.

If required, detailed specifications may be provided in the **specification data**.

### **4.1.1.12 Sidescan camera systems**

Sidescan cameras and systems are available in South Africa that use a wide angle fish-eye lens that captures a full 360° view of the pipe. The digital image can be unfolded by software to provide a two dimensional longitudinal view. This enables inspections to take place at speed.

Some sidescan cameras systems are capable of projecting seven laser dots onto the pipe wall allowing the software to continuously measure the ovality of the pipe from the camera images. This is performed on a separate run through the pipe, usually on the return.

If required, detailed specifications may be provided in the **specification data**.

### **4.1.1.13 Zoom camera on pole**

Zoom cameras are available on telescopic poles with integral lighting and controls for inspecting into pipelines with the operator being on the surface. The pole is lowered into the manhole and camera aimed into the pipeline. The camera is zoomed and a good view can be seen down the pipeline allowing an assessment of its condition and what cleaning requirements might be required. Zoom cameras are useful tools for Pre-Inspections.

If required, detailed specifications may be provided in the **specification data**.

### **4.1.1.14 3D Lidar profiling**

3D Lidar (**L**ight **D**etection and **R**anging) scanning equipment and techniques can be applied to perform internal surveys of pipelines to provide a dense and accurate 3D cloud of coordinated points that models the surfaces, allowing visualisation and dimensional analysis.

If required, detailed specifications may be provided in the **specification data**.

#### **4.1.2 Cable and line systems**

Sufficient guides and rollers shall be used to ensure all cables and lines are supported away from the pipe and manhole structures to avoid snagging, damage or abrasion of the cables and lines.

#### **4.1.3 Pipe plugs**

Sufficient numbers of pipe plugs for flow control shall be provided for the range of pipeline shapes and sizes to be inspected.

#### **4.1.4 Metreage measuring device**

The CCTV inspection equipment shall include a metreage measuring device. The device, which is normally applied to the cable for measuring the camera metreage, shall be accurate to  $\pm 1\%$  or 0,3 m whichever is the greater. The equipment or its control must be able to be reset to any input metreage.

The measuring device accuracy shall be checked and calibrated at least weekly.

#### **4.1.5 Survey vehicle**

The contractor shall provide a CCTV survey vehicle to be in attendance at each CCTV Inspection undertaken. The vehicle must house the CCTV Inspection Operator and equipment.

The vehicle shall be equipped with amber flashing lights, road cones, signage and flags which shall be used in accordance with the National Road Traffic Regulations.

#### **4.1.6 GPS receiver**

Where required in the **specification data** the Contractor shall provide a GPS receiver capable of recording the position of the centre of each manhole cover to be opened during the inspection survey. The coordinates are required to confirm the pipe sections that are being surveyed. In addition, the Owner may use the information in their Geographic Information System (GIS). The **specification data** will specify the accuracy required.

#### **4.1.7 Ancillary equipment**

The contractor shall provide all monitors, recorders, recording media, manuals, software, power supply, lighting, and any other equipment necessary to operate and control the CCTV inspection to provide the specified Survey Report deliverables.

The CCTV inspection shall be recorded directly to hard disk.

The data displayed on the monitor should be able to be moved around the screen so that observations are not obscured. It must also be possible to switch the data off for unrestricted view of the pipeline.

### **4.2 Personnel**

#### **4.2.1 Survey operators**

The Contractor shall provide sufficient numbers of suitable skilled and trained Survey Operators, survey team members and all the necessary equipment for the survey.

The Survey Operator shall have been trained in and be fully conversant with picture interpretation, defect coding and classification according to the WRc Manual of Sewer Condition Classification 5<sup>th</sup> Edition (MSCC5), (or other system specified in the **specification data**) and using the Survey

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Contractor's software (or specific software if specified in the **specification data**). All Survey Operators shall submit certification of such training, issued by the software agents, to the Owner prior to the commencement of Survey. Since software agents may also be CCTV contractors, SASTT expects such agents to provide training in a professional manner.

The Survey Contractor shall maintain a competent team leader in charge of the survey on site at all times and who is approved in writing by the Owner prior to the commencement of the survey.

The Owner may require the Survey Contractor to remove from the site any person employed by the Contractor who, in the opinion of the Owner, misconducts himself or is incompetent or negligent in the performance of his duties or fails to conform to the safety requirements.

### **4.3 Picture quality**

The information obtained from a CCTV inspection is only as good as the quality of the video images. In particular it is important that the picture resolution allows defects to be correctly identified. The picture shall not be distorted, so that any deformation and defects in the pipeline can be assessed. The video and still images shall be colour (not black and white).

#### **4.3.1 Test chart**

To ensure that the quality of the image is acceptable, tests shall be carried out with a Marconi Resolution Chart No 1 with a colour bar, clearly differentiating between colours with no tinting to show white, yellow, cyan, green, magenta, red, blue, and black.

#### **4.3.2 Picture testing**

At the start of the work each camera shall be tested for acceptance. The Owner may require a camera to be retested to ensure continued compliance with the specification.

The camera shall be positioned centrally and at right angles to the test chart at a distance where the full test chart just fills the monitor screen. The chart shall be illuminated evenly and uniformly without any reflection. A recording of thirty seconds duration shall be made to confirm the testing and demonstrate that the picture quality is in compliance.

#### **4.3.3 Picture specification**

The camera, electronic systems and monitor shall be of such quality as to achieve the following.

##### **4.3.3.1 Shades of grey**

The grey scale shall show equal changes in brightness ranging from black to white with a minimum of five clearly recognisable stages.

##### **4.3.3.2 Colour**

With the monitor control adjusted for correct saturation, the six colours including black and white shall be clearly resolved with the primary and complementary colours in order of decreasing luminance. The grey scale shall appear in contrasting shades of grey with no tint.

##### **4.3.3.3 Linearity**

The background grid shall show squares of equal size, without convergence/divergence over the whole of the picture. The centre circle shall appear round and have the correct height/width relationship ( $\pm 5\%$ ).

#### **4.3.3.4 Resolution**

With the monitor colour turned down, the live picture shall be clearly visible on the monitor with no interference. The monitor shall be capable of registering a minimum of 250 lines.

#### **4.3.3.5 Colour contrasting**

To ensure the camera provides similar results when used with its own illumination, the lighting shall be fixed in intensity prior to starting the inspection. To ensure colour constancy the illumination should not be varied during the inspection.

#### **4.3.4 Pipeline environment**

There must be a clear view for the pipelines to be properly evaluated. Unacceptable conditions might include:

- Camera out of focus
- Insufficient lighting
- Fog or steam in pipeline
- Condensation or grease on lens
- High flow level
- Debris or spider webs over lens
- Camera not stationary for still pictures
- Camera moving too fast through pipeline

### **4.4 Site operations for inspections**

#### **4.4.1 Planning**

The Owner shall provide the Survey Contractor with three sets of layout plans showing the extent of the survey and the pipelines to be inspected. If available, long sections should also be included. The plans shall show the pipeline reference numbers, the pipe and manhole materials, diameters and the approximate lengths and depths. One set of plans shall be kept in safekeeping by the Survey Contractor and annotated with record information and delivered to the Owner as a deliverable. The drawings may be provided as hardcopies and/or electronically, as specified in the **specification data**.

The layout plans shall indicate if pipelines are subject to pump station discharges, excess baseflow, industrial effluent and if debris can be expected in the pipelines. Pipelines that are known to be or are suspected to be in a poor condition shall also be indicated on the plans.

The extent of the survey and the time for completion requires the Survey Contractor to provide a sufficient number of fully equipped survey teams. The Owner may specify in the **specification data** a minimum number of survey teams required.

The Survey Contractor shall prepare a schedule of each week's planned inspections, giving locations, dates and times. The schedule shall be submitted to the Owner at least a week in advance, to enable him to liaise with the operators of the system.

The Survey Contractor shall provide the Owner with a follow up report giving details of inspections completed with times and dates.

The Owner will advise the Survey Contractor of any works or operations on the system that may affect his survey inspections, so that the Contractor can plan accordingly. The Contractor shall notify the Owner without delay should the execution of the Survey be frustrated or delayed as a result of such works or operations.

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If, due to high flows or traffic conditions, the Survey Contractor anticipates requiring overpumping, night or weekend working, he shall request approval by the Owner. Overpumping plans must be approved by the Owner.

### **4.4.2 Health and safety**

The Survey Contractor shall observe the provisions of the Occupational Health and Safety Act 85 of 1993. Working on underground pipelines presents hazardous conditions and the Contractor's attention is drawn to the Occupational Health and Safety Act - General Safety Regulations and in particular Regulation No. 5 – Work in Confined Spaces.

The Contractor's attention is drawn to the fact that the existing pipelines are live. In sewers where there is a gravity flow of raw sewage and which are possibly fed by pumped flow, significant flow surges can be expected. Stormwater pipelines convey rainwater, but these systems may have a strong baseflow from watercourses, subsurface drainage, and infiltration. Vigilance is necessary as rainfall elsewhere in the catchment can result in sudden increases in the flow.

The safety of all workers and the provision of all necessary safety equipment for the protection of workmen shall be the Contractor's sole responsibility. Approved gas testing equipment and breathing apparatus must be available on site at all times and regular tests are to be made to check for the presence of gases.

The following subsections describe some of the construction hazards that may be found. These subsections are provided for information only and in no way relieves the Contractor of any responsibilities.

#### **4.4.2.1 Dangerous gases**

In any pipeline there is a potential for gases to accumulate, which can cause asphyxiation or poisoning. Typically, work may only proceed in a manhole that has been ventilated by removing the covers of both the upstream and downstream manholes for at least half an hour. The pipeline atmosphere must be tested for gasses. Where there is evidence of gasses workmen shall use full-face breathing apparatus.

In addition, men working within the manhole and pipeline shall wear safety harnesses and lifelines. Men working in the manholes shall be observed at all times and there shall always be two men suitably equipped on the surface ready for rescue work.

#### **4.4.2.2 Explosive gases**

Gases found in pipelines can be explosive. No naked flames or smoking shall be allowed within five metres of an open manhole

#### **4.4.2.3 Drowning**

The flow in the pipeline could be strong and should a person fall in they may find it difficult to extricate themselves. There is a danger of being swept away and drowned.

Workmen shall wear harnesses and lifelines each securely held by two workmen suitably equipped on the surface and securely belayed.

#### **4.4.2.4 Infection and cleanliness**

Due to the high concentrations of bacteria in sewage (and possibly stormwater), many of them pathogenic, every precaution must be taken by workmen against infection. Typically, precautions to

be taken against diseases are the avoidance of contamination of food and drink or of the infection of cuts and abrasions. Workmen should be taught not to touch their faces during work or until they have washed. Adequate washing facilities should be provided. All cuts and abrasions should be given immediate treatment including disinfecting, however slight they may be. The site should be provided with the necessary first-aid equipment. Persons entering manholes shall wear safety gumboots with steel toe caps.

#### **4.4.2.5 Acidic conditions**

In pipelines corrosion may have been caused by sulphuric acid forming on the exposed internal surfaces of the manholes and pipes from hydrogen sulphide gas. Typically, the internal surfaces of the manholes and pipes may be acidic and caution must be taken.

#### **4.4.3 Accommodation of traffic**

The Survey Contractor shall perform the survey in such a manner as to cause as little interference as possible to the flow of traffic and pedestrians.

The Contractor shall at all times liaise and obey the instructions of the traffic department and shall not close any roads, traffic lanes or sidewalks or undertake inspections at night without the approval of the traffic department.

The survey vehicle shall be parked with due consideration to traffic and the safety of personnel. The vehicle shall operate its amber flashing lights at all times.

The Owner must be informed of parked vehicles hindering the survey. The Owner will investigate and instruct the Contractor accordingly. In the meantime, the Contractor shall proceed with inspecting the next accessible sections of pipeline to be inspected.

The Contractor shall comply with Chapter 13 of Volume 2 of the South African Road Traffic Signs Manual (SARTSM) and provide all necessary signs, cones etc.

All personnel shall wear high visibility safety jackets etc.

#### **4.4.4 Pre-inspections and cleaning**

Where specified in the **specification data** the Survey Contractor shall perform pre-inspections to determine what pipeline cleaning is required. The pre-inspections shall take place early in the contract to allow cleaning to be implemented timeously prior to the CCTV inspections. The objective of the pre-inspections of the manholes and adjoining pipelines is to determine if they are clean enough to allow a proper and complete CCTV inspection and assessment. The contractor will have to use strong lights (one million candle power) and mirrors to view into the pipeline from both ends. Zoom cameras on poles are preferred for pre-inspections and images and video recordings can be provided for each pre-inspection. Where specified in the **specification data**, only zoom cameras on poles shall be used. The contractor shall make a report for each manhole, recording depth and any silt, debris, evidence of flow surcharging, roots, cobwebs, deposits, fat that may obstruct the camera or obscure the view of the pipeline. The reports shall be submitted to the Owner.

The cleaning of pipelines is covered in the **specification data**. If necessary, the pipeline must be cleaned, and all silt, debris and roots removed and disposed of at a waste disposal site licenced to receive such waste that may be categorised as hazardous. Cleaned material must be collected at the downstream manhole using dams/screens and not allowed to pass further downstream. Care shall be exercised with jetting equipment to avoid damage to the pipe. The bore of the pipe must be sufficiently clean to allow the passage of the camera transporter.

### 4.4.5 Manholes - access

The Survey Contractor shall make all reasonable efforts to locate manholes. If the manhole appears to be buried beneath an asphalted road surface the Contractor shall inform the Owner who will make arrangements to have the manhole found, built up and reinstated. If the manhole appears to be buried in hand excavatable material, the Contractor shall notify the Owner and attempt to expose the manhole. The Contractor shall make all reasonable efforts to find the manhole for a period of 15 minutes, failing which he shall proceed to the next manhole for inspection and notify the Owner.

The Contractor shall make all reasonable efforts to open the manhole cover and gain access into the manhole for a period of 15 minutes, failing which he shall proceed to the next manhole for inspection and notify the Owner who will make arrangements to have the seized manhole cover opened.

If the cover is found to be damaged or is damaged in the course of the inspection, the Owner shall be immediately informed so that arrangements can be made to replace it.

If specified in the **specification data**, the position of the centre of the manhole cover shall be measured with the GPS receiver and recorded.

The Contractor shall clean the covers and frames and their mating surfaces before closing the manholes and check that the site is left in a safe and satisfactory condition.

### 4.4.6 Manholes - inspections

Where it is a requirement of the **specification data**, the manhole through which the camera enters the pipeline shall be inspected and a manhole inspection report produced. The inspection shall be in accordance with WRc Manual of Sewer Condition Classification 5<sup>th</sup> Edition (MSCC5) Part B Manholes and Inspection Chambers (or other system specified in the **specification data**). This specifies the condition codes for defects and features to be recorded. The CCTV camera shall be used to provide footage of each manhole showing any defects and features. Inspections of manholes, if required, will be measured and paid for separately. The manhole depth from cover to the deepest invert shall be recorded.

### 4.4.7 Dealing with flows

#### 4.4.7.1 Allowable depth and velocity of flow

The depth of flow allowed in the pipeline through which the inspection is to take place shall not exceed 20% of the pipe diameter for all pipe sizes, unless specified otherwise in the **specification data**.

The velocity of the flow should not be such that it causes surface waves and spray that obscures the camera view or affects the camera image. This can occur if the flow velocity is more than 0,8 times the critical velocity. The **specification data** may indicate which manhole lengths may be affected by high flow velocities.

With pipes of 600 mm diameter and larger where the camera and frequently other equipment is floated through the pipeline on a pontoon it is essential that this flow velocity requirement is met to ensure the stability of the pontoon.

If the maximum depth of water flow exceeds the specified depths or if the flow velocities affect the camera image, then the Survey Contractor shall discuss with the Owner what measures to take. Either the flow shall be lowered by plugging the line and/or overpumping the flow or by rescheduling the CCTV inspection to a time when there is less flow. Depending on the circumstances, the Owner may decide to increase the maximum depth of flow allowable.

#### **4.4.7.2 Plugging**

The Survey Contractor shall be responsible for dealing with flows in the pipelines as far as is reasonably possible by using pipe plugs for limited periods without affecting the general operation of the pipeline. Such measures shall be implemented without causing any flooding or pollution. Arrangements shall be subject to the Owners approval.

#### **4.4.7.3 Blockages and high flows**

Any blockages or temporary increases in flow shall be immediately reported to the Owner by the Survey Contractor, who shall proceed to the next section of sewer that can be inspected. The Owner will arrange for the blockage to be cleared.

If, in the opinion of the Owner, the flow is too great for the Contractor to deal with by temporary plugging, the Owner will arrange for overpumping, authorise night or weekend working, or make alternative arrangements.

#### **4.4.7.4 Overpumping**

The Survey Contractor shall plan and implement any overpumping specified or approved by the Owner.

The Contractor shall determine from the flows the necessary pumping rates and shall submit an overpumping plan with a sketch of the layout, the location of pumps and power plants, flow extraction and discharge points, number and sizes of pumps and the number, size and lengths of pumping mains to the Owner for approval. The proposal must include accommodation of traffic, noise suppression and the contact person on site directly responsible for the overpumping operation. There shall be a contingency plan for failure of the overpumping system and shall include having standby pumps and power supplies.

The Contractor shall be responsible for any spillage, flooding or pollution resulting from the overpumping operation.

The detailed specifications and pay items for overpumping shall be included in the **specification data**.

#### **4.4.7.5 Forced ventilation**

The Survey Contractor may submit proposals to the Owner for approval to use forced ventilation to remove gasses and introduce fresh air into the system. This may also be required if hot effluent causes misty conditions in the pipeline.

#### **4.4.8 Recovering equipment**

The Contractor shall be responsible for the recovery of his camera system and any other inspection equipment from any section of pipeline forming part of the Survey. If excavation is necessary, then this shall be carried out with the approval of the Owner.

#### **4.4.9 Abandonment of inspection**

Abandonment of the inspection of a length of pipeline may be considered in the following circumstances.

- Manhole not located
- Manhole inaccessible

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- Pipeline condition affecting picture quality
- Contractor's equipment at risk
- Progress impeded
- Unsafe conditions
- High flow, blockage or silt in pipeline
- Unacceptable health and safety risk
- Risk to structural integrity of manhole or pipeline

The Survey Contractor shall inform the Owner, photograph the situation if possible, then inspect the line from the opposite direction if appropriate or proceed with the next section that can be inspected.

### 4.4.10 Start of pipeline inspection

#### 4.4.10.1 Distance measurement

The distance measurement in the survey shall be calibrated to be zero when the pipe entrance fills the camera view frame. This ensures that when a defect or feature fills the camera view frame, the distance recorded will accurately be the distance from the pipe entrance to the defect. In addition, when the pipe end at the final manhole fills the camera view frame, the distance measurement will be the actual length of pipes between manholes.

If specified in the **specification data**, the distance measurement shall be calibrated to be zero at the centre of the start manhole and end at the centre line of the final manhole. When a defect or feature fills the camera view frame, the distance recorded will be the distance of the camera from the centre of the start manhole.

With the distance being measured with a cable counter, it may be necessary to re-calibrate the distance measurement once the camera has entered the pipe and the cable is taut.

#### 4.4.10.2 Data displayed and recorded at start of pipeline inspection

At the start of each manhole length being inspected, a data generator shall electronically generate and clearly display on the viewing monitor and video recording, a continuous record of data in an alpha numeric form containing the following minimum information:

- Service type (eg stormwater, sewer)
- Continuous display of date and time
- Road name and location
- Manhole length reference number
- Size and shape (eg 600 x 800 egg shaped)
- Inspection direction (eg downstream/upstream)
- Current metreage
- Any other information specified in the **specification data**

The pipeline/manhole length reference number will be determined in accordance with the **specification data**.

The data must be displayed for between 5 and 10 seconds at the start of each inspection.

At the start of the survey the pipe end in the manhole wall must be visible.

### 4.4.11 During inspection

#### 4.4.11.1 General

Pipelines shall normally be inspected in a downstream direction as the equipment goes with the flow

minimising splashing and damming up. Upstream inspections may be undertaken in the following circumstances:

- Pipeline too long for inspection from one end only.
- Upstream manhole missing or not found.
- Obstructions prevent complete inspection from upstream manhole.

The camera shall proceed continuously through the pipeline at a steady speed except at features and defects where it must stop. Pan & Rotate cameras shall not proceed again unless the camera has been reset to its default forward facing position.

#### 4.4.11.2 Camera speed limits

The minimum and maximum camera speeds shall be as follows, unless specified otherwise in the **specification data**:

Pipeline Size	Camera Speed
smaller than 200 mm diameter	0,05 m/s to 0,10 m/s
200 mm to 300 mm diameter	0,05 m/s to 0,15 m/s
larger than 300 mm diameter or new or rehabilitated pipelines	0,10 m/s to 0,20 m/s

If the minimum speeds are consistently unachievable due to lack of traction or for any other reason, the Contractor shall fit a tow line to the camera and pull it through the pipeline or take other appropriate action (eg use different wheels, increase the weight of the carriage or clean the pipe).

#### 4.4.11.3 Stopping at defects and features

When a defect or feature is detected the camera shall be stopped in a position where the defect or feature can be clearly seen, and the defect or feature recorded in accordance with its classification code. Still images shall be captured of every defect, feature, and connection unless otherwise specified in the **specification data**.

Still images shall be taken whilst the camera is stationary. With repeated defects of the same code a still image of only the first instance is necessary. If there are no defects or features a general photograph (Code GP) still image is required at least once in a manhole length. If a defect is continuous a general image (Code GP) is required at least every 5 metres.

If a pan and rotate camera is used the camera must first stop as above to record the defect or feature with the camera facing forward. For major defects (or as specified in **the specification data**), the camera shall then pull up next to the defect, stop, pan, rotate and view the defect in focus with the camera at rest.

Where specified in the **specification data** a pan and rotate camera shall stop at each joint and execute a 90° tilt upwards to the vertical and a full 360° rotation.

#### 4.4.11.4 Other stops

If the camera is stopped for reasons other than defects or features, the recording should be paused.

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### **4.4.11.5 End of inspection**

The camera must enter the final manhole to record the view into it.

### **4.4.11.6 Data displayed and recorded during inspection**

Once the survey is underway, the data generator shall electronically generate, clearly display and record the following data:

- Current metreage
- Manhole length reference number
- Gradient/inclination
- Time and date
- Any other information specified in the **specification data**

The data displayed should be located on the screen such that observations are not obscured.

### **4.4.12 Man-entry inspections**

Larger sizes of pipes and culverts can be inspected by personnel and photographic records made using hand-held cameras. Although this method is attractive and a relatively easy way to inspect larger pipelines, around the world it is not favoured nowadays because of the inherent safety concerns. In addition, steerable tractors can negotiate large pipelines and the standard inspection reports prepared in the normal way.

Any anticipated man-entry surveys shall be indicated in the **specification data**.

There may be cases where man-entry is the only option to inspect a pipeline. These inspections shall only take place with the approval of the Owner. The Survey Contractor shall prepare a work plan for approval of the Owner which adequately addresses all safety concerns including the Occupational Health and Safety Act - General Safety Regulations and in particular Regulation No. 5 – Work in Confined Spaces. A minimum of two men are required in the pipeline. The Contractor shall have a person nominated as supervisor on the surface to monitor the whole operation.

Manual inspections should be conducted in such a manner as to transmit the video signal to the survey vehicle. In addition, direct voice communication between the in-pipe personnel and the above ground supervisor and the CCTV Inspection Operator shall be maintained at all times whilst men are underground. Camcorders should not be used.

Safety of the in-pipe inspection crew is of prime concern. Adequate ventilation should be provided, and this is normally in the range of two 200 m<sup>3</sup> per minute or larger air movers. In addition, both exhaust and blower type air movers should be available to provide push-pull ventilation.

## **4.5 Reporting**

### **4.5.1 Survey report deliverables**

The survey report shall include the following items:

- Project database and appropriate viewer software
- Pre-inspection reports
- Video recordings
- Still images
- Pipeline inspection reports

- Structural and maintenance ratings per pipeline
- Manhole inspection reports
- Coded data in electronic format
- Updated layout plans (hardcopy and/or electronic)
- (Thematic maps, if specified in the **specification data**)
- Any other deliverable specified in the **specification data**

Where specified in the **specification data**, thematic maps may be required to indicate the following:

- All observations overlaid on the pipe sections
- Colour coded structural gradings of each pipe section
- Colour coded maintenance gradings of each pipe section

The **specification data** shall specify the number of hard copies and electronic copies of the survey report, the media for the electronic data, and the time period within which they are to be provided by the Survey Contractor. All copies shall be fully labelled. If the Owner requires separate survey reports for different sections of pipeline, it shall be stated in the **specification data**.

The Survey Contractor shall maintain an archive of the electronic data for a period of 12 months.

If the **specification data** requires manholes to be inspected, the survey report shall include the above deliverables that pertain to manhole inspections.

The Owner may request that some of the items of the survey report be supplied as the survey proceeds. The Survey Contractor shall comply with reasonable requests for the supply of certain items whilst the survey is in progress.

The report shall be prepared and presented in accordance with the WRc Manual of Sewer Condition Classification 5<sup>th</sup> Edition (MSCC5) (or other system specified in the **specification data**). A copy of this document shall be kept in the survey vehicle.

#### **4.5.1.1 Recording of data**

All observations shall be captured into an electronic database using the Survey Contractor's software (or specific software if specified in the **specification data**). Inspection capturing and defect recording shall be in accordance with the specified software requirements and be compliant with the WRc Manual of Sewer Condition Classification 5<sup>th</sup> Edition (MSCC5) or other system specified in the **specification data**. Hand written, manually created or voice over reports will not be acceptable.

Where it is not possible to survey a Manhole Length, a dummy inspection should still be created stating the reason why the inspection cannot be conducted.

If specified in the **Specification Data**, the GPS co-ordinates of the manholes shall be recorded.

Coding shall be in accordance with the following sections of the WRc MSCC5 (or other system specified in the **specification data**):

- Part A - Drains and Sewers
  - Section 2 - Coding Principles
  - Section 3 - Header Details
  - Section 4 - Condition Codes
- Part B – Manholes and inspection chambers
  - Section 5 - Coding Principles
  - Section 6 - Header Details
  - Section 7 - Condition Codes

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### 4.5.1.2 Video recordings

Video recordings shall be encoded to MPEG or AV1 format. Analogue recordings shall be to standard PAL broadcast standard video producing a 720 x 576 pixel resolution with a capture rate of at least 25 frames per second and a 4:3 aspect ratio. "HD Ready" digital recordings shall produce a frame size of 1280 x 720, typically at 60 frames per second.

The video recordings shall be readable using Windows Media Player or VLC software. There shall be separate video files for each manhole length.

### 4.5.1.3 Still images

The still colour images shall be captured from the video recording in JPEG format.

The digital image shall be referenced in the inspection report.

Colour prints of still images required by the Owner shall be printed A6 size (4 per A4 page) each image with its reference.

### 4.5.1.4 Pre-inspection reports

If pre-inspections are required by the **specification data**, a pre-inspection report shall be generated for each manhole. The pre-inspection reports shall record:

- Manhole reference.
- Manhole depth.
- A list of any silt, debris, roots, cobwebs, deposits, evidence of flow surcharge, fat that may obstruct the camera or obscure the view of the adjoining pipelines.
- Images and videos from zoom cameras.

### 4.5.1.5 Pipeline inspection reports

An inspection report shall be generated for each manhole length. The inspection reports shall have three components:

- Header information at the top of the first page for each manhole length.
- A graphic of the pipeline running down the left side of the page showing manholes, manhole depths, direction of flow, connections and all coded defects and features.
- On the right of each defect or feature its:
  - Metreage
  - Defect code
  - Description/observations
  - Elapsed time
  - Still image reference
  - Condition grade

The condition grade of the of the defect or feature shall be in accordance with the WRc Sewerage Rehabilitation Manual (2002) Volume 1 Appendix G Computerised Condition Grading or later version of this manual (or other system specified in the **specification data**)
- Gradient profile
- Pipe material observed

#### **4.5.1.6 Manhole inspection reports**

If manhole inspections are required by the **specification data**, an inspection report shall be generated for each manhole. The inspection reports shall record:

- Header information at the top of the page for each manhole.
- Manhole depth.
- Manhole shape or type.
- Material.
- Cover type and material.
- A list of coded defects and features.
- A list and graphic of the layout of the incoming and outgoing pipelines.
- Still images.

#### **4.5.1.7 Annotated layout plans**

The Survey Contractor shall supply one set of the layout plans annotated with inspection references and any corrections found necessary during the survey. The layout plans, which may be digital but must include a hardcopy, are a record of the extent of the survey, which pipelines were scheduled to be inspected and the pipelines that were actually surveyed, plus any corrections (e.g. additional or incorrectly positioned manholes). All references including additional information and corrections to be shown.

#### **4.5.1.8 Thematic maps**

Where specified as a deliverable in the **specification data**, thematic maps shall be provided by the CCTV Contractor.

## **5 Compliance with the requirements**

### **5.1 Quality control**

#### **5.1.1 Survey contractor's quality control system**

The Survey Contractor shall have a quality control system. The system shall be submitted to the Owner for approval prior to the commencement of the survey. The system shall effectively gauge the accuracy and consistency of the survey report deliverables and also be in accordance with the requirements of this specification. The system shall be operated by the contractor and the results submitted to the Owner for acceptance. Although the contractor is expected to perform his own internal audits in accordance with his quality control system, the Owner will perform audits on at least 5% of the inspections.

#### **5.1.2 Initial sample**

The Survey Contractor shall submit for the Owners's approval, a sample video recording and still images for all cameras prior to their use. The sample video shall be of a complete inspection, including using the test chart. The samples will be used to verify compliance with the assessed picture quality. The contractor shall also supply a sample inspection report.

#### **5.1.3 Initial audit**

The Owner shall perform an audit on the deliverables from the first manhole length inspected by each CCTV Inspection Operator after its completion.

The Owner shall check this work as soon as possible and advise the Survey Contractor of any deficiencies. Items that should be checked may include:

- Header information
- Pipe cleanliness
- Picture quality
- Camera speed
- Accuracy of defect and header recording

The electronic data must be transferable to the client's system.

Such initial audits shall be performed whenever a new CCTV Inspection Operator commences inspections on the contract.

#### **5.1.4 Subsequent audits**

The Owner shall perform ongoing audits on at least 5% of the inspections. The Owner shall select inspections at random for auditing. The results of each audit will be forwarded to the contractor.

#### **5.1.5 Accuracy of reporting**

The system shall be such that the accuracy of reporting is divided into headers and details as described in the WRc Manual of Sewer Condition Classification Part A, and shall be measured in two ways for each, namely:

- Number of faults not recorded (omissions).
- The correctness of the coding and classification of each fault recorded.

The minimum levels of accuracy shall be 95% for headers and 85% for details.

### **5.1.6 Calculation of reporting accuracy**

The percentage accuracy of each inspection is determined from:

Accuracy = ((Number of entries - Number of errors or omissions) / Number of entries) x 100

### **5.1.7 Unacceptable inspections**

The Owner shall then forward the results of any unacceptable CCTV Inspections to the Survey Contractor for rectification. The Contractor shall advise the Owner on the steps he will take to remedy the faults and improve quality in that regard. These measures are to be implemented straight away. This may require the pipeline to be re-inspected.

If the Owner suspects other inspections may be unsatisfactory, the Owner may require the Contractor to submit adjacent or other inspections for auditing.

If auditing results are consistently unacceptable, the Owner may require the Survey Contractor to review his internal work methods, check the procedures used or replace the CCTV Inspection Operator.

## **5.2 Acceptance**

### **5.2.1 Acceptance of deliverables**

The survey report deliverables specified in Section 4.5.1 shall be delivered to the Owner for acceptance in terms of this standard specification.

**Annex A**

(normative)

**Preparation of specification data associated with this part of SASTT-TS-TT5 for inclusion in the scope of work**

This specification data forms an essential element of this part of SASTT-TS-TT5; without such data, the requirements are incomplete.

The format for the specification data has been developed to be compatible with the requirements of table D.1 of SANS 10403:2003. The specification data should be incorporated in the scope of work as illustrated in table A.1.

**Table A.1 — Incorporating this part of SASTT-TS-TT5 in the scope of work**

1	2	3						
Topic	Aspect	Text						
<b>CONSTRUCTION</b>								
<b>Works specifications</b>	<b>Applicable part(s) of SASTT-TS</b>	The following parts of SASTT-TS and associated specification data are applicable: 1) SASTT-TS ..... 2) SASTT-TS ..... The associated specification data are as follows: <table border="1" style="margin-left: 40px;"> <tr> <td style="width: 50%;">Specification data pertaining to SASTT-TS - .....</td> <td>Essential Data: The requirements for ..... are ..... The requirements for ..... are .....</td> </tr> <tr> <td></td> <td>Variations: 1)..... 2).....</td> </tr> <tr> <td></td> <td>Additional clauses: 1).....</td> </tr> </table>	Specification data pertaining to SASTT-TS - .....	Essential Data: The requirements for ..... are ..... The requirements for ..... are .....		Variations: 1)..... 2).....		Additional clauses: 1).....
	Specification data pertaining to SASTT-TS - .....	Essential Data: The requirements for ..... are ..... The requirements for ..... are .....						
		Variations: 1)..... 2).....						
	Additional clauses: 1).....							
<b>Applicable national and international standards</b>								
<b>Particular/generic specifications</b>								

Develop the specification data based on the contents of table A.2.

Table A.2 — Specification data associated with this part of SASTT-TS-TT5

1	2	
Specification data associated with this part of SASTT-TS-TT5	Guidance notes.	
	Clause number	Consideration
<b>Essential Data</b>		
The type(s) of camera and transporter shall be .....	4.1.1	Required.
Sizes, types, and shapes of pipelines to be inspected are ....	4.1.1	Required.
The camera(s) shall be ..... type with a resolution of .....	4.1.1.1	If different resolution required.
The camera shall have a zoom facility ...	4.1.1.3	If required.
The camera transporter shall be steerable ...	4.1.1.6	If required.
The following detailed specifications shall apply to laser light ring profiling ...	4.1.1.10	If required.
The following detailed specifications shall apply to sonar profiling ...	4.1.1.11	If required.
The following detailed specifications shall apply to sidescan camera systems ...	4.1.1.12	If required.
The following detailed specifications shall apply to zoom cameras on poles ...	4.1.1.13	If required.
The following detailed specifications shall apply to 3D Lidar profiling ...	4.1.1.14	If required.
A GPS receiver is required to record manhole positions .... to an accuracy of ....	4.1.6 4.4.5 4.5.1.1	If required.
The defect coding and classification shall be in accordance with ...	4.2.1 4.4.6 4.5.1 4.5.1.1	Specify system if not WRc Manual of Sewer Condition Classification 5 <sup>th</sup> Edition (MSCC5)
The survey shall be recorded using ..... software.	4.2.1 4.5.1.1	If specific software is required.
The Owner shall provide (... copies) of the layout plans in hardcopy and/or electronically (in .... format).	4.4.1	Required.
The Survey Contractor shall provide at least ..... fully equipped survey teams.	4.4.1	If necessary.

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1	2	
Specification data associated with this part of SASTT-TS-TT5	Guidance notes.	
	Clause number	Consideration
The Survey Contractor shall perform pre-inspections of the manholes and pipelines ...	4.4.4 4.5.1.4	If required.
Zoom cameras on poles shall be used for pre-inspections complying with the following specification ....	4.4.4	If required.
The pipelines <ul style="list-style-type: none"> <li>○ are assumed to be clean,</li> <li>○ shall be cleaned by others</li> <li>○ shall be cleaned by the Survey Contractor in accordance with specification ...</li> </ul>	4.4.4	The Survey Contractor needs to know if the pipelines need cleaning and by who.
Manholes shall be inspected, and Manhole inspection reports produced.	4.4.6 4.5.1 4.5.1.6	If required.
The allowable depth of flow is ...	4.4.7.1	If not 20% of pipe diameter. This must be reasonable as full containment of flows is difficult to achieve using pipe plugs, which is exacerbated by infiltration and inflows from connections. However, if the inspections are to investigate suspected invert erosion or cracking, then no flow should be specified. Inspections of new pipelines for acceptance should ideally have no flow or not more than 5% of the pipe diameter.
The following manhole lengths might have high velocity flows that affect the camera view ....	4.4.7.1	List any manhole lengths that may have velocities in excess of 0,8 times the critical velocity and what measures must be implemented to remedy this.
Overpumping will be required as follows ...	4.4.7.4	Specifications and pay items if required.
The distance measurement shall be from the centre of the start manhole.	4.4.10.1	Specify this if it is not measured from the pipe entrance.
Additional information to be displayed and recorded at the start of the inspection are .....	4.4.10.2	If required.
The manhole length reference number shall be in accordance with ...	4.4.10.2	To be specified.
Camera speed limits	4.4.11.2	If different speed limits required.

1	2	
Specification data associated with this part of SASTT-TS-TT5	Guidance notes.	
	Clause number	Consideration
Still images are ...	4.4.11.3	Any additional or amended requirements for still images.
The following defects, features, joints that must be viewed using pan and rotate are ....	4.4.11.3	If not just major defects.
Additional information to be displayed and recorded during the inspection are .....	4.4.11.5	If required.
Man-entry inspections <ul style="list-style-type: none"> <li>○ shall be performed on the following pipelines ....</li> <li>○ May be performed on the following pipelines ...</li> <li>○ Are not permitted.</li> </ul>	4.4.12	If required.
The survey report deliverables shall include thematic maps prepared by the contractor according to the following specification ...	4.5.1 4.5.1.8	If required.
The survey report shall include the following additional deliverables ...	4.5.1	If required.
The Survey Contractor shall provide ... hardcopies and ... electronic copies of the survey report, on ... electronic media, and within ... days of the completion of each manhole length/group of pipelines.	4.5.1	Required.
The condition grading of the defects or features shall be in accordance with ...	4.5.1.5	Specify system if not WRc Sewerage Rehabilitation Manual (2002) Volume 1 Appendix G Computerised Condition Grading
<b>Additional clauses:</b> 1 .....  2 .....		<i>State additional requirements, if any.</i>
<b>Variations:</b> 1 Replace ... with the following:  2 The provisions of ... do not apply.		<i>State variations, as applicable.</i>

**Annex B**  
(informative)

**Pipe inspection guide**

**B.1 Recommendation**

It is recommended that the 4<sup>th</sup> Edition of the *New Zealand Gravity Pipe Inspection Manual* by Water New Zealand be used as a further reference on pipeline inspection matters. It is current (2019), comprehensive (338 pages) and the original edition (1989) was largely based on the UK WRc Manual of Sewer Classification (1980).

It is downloadable (47 Mb) for free from <https://www.waternz.org.nz/Resources/knowledgebase-landing> under technical documents.

(Also available is a 2017 report on the 3<sup>rd</sup> Edition entitled *Recommendations for the Revision of New Zealand Pipe Inspection Manual* available for free from <https://resources.quakecentre.co.nz/review-of-new-zealand-pipe-inspection-manual/>. This 113 page report formed the basis for the revision for the 4<sup>th</sup> edition. It is an interesting review of the state of the art and best practices, including reviews of inspection methods, condition grading and defect codes, amongst other aspects.)

**B.2 Contents**

The manual comprises the following parts, which includes sections noted to be of interest in preparing **specification data** clauses.

Preface

The preface includes an interesting section entitled - Inspection and Condition Assessment as Part of Good Asset Management.

Part A: Planning for the Inspection of Drains and Sewers

This part includes interesting descriptions for choosing the right assets to inspect, planning, procurement, quality control, inspection methods and equipment, pipe wall samples (coupons), infiltration, cavities, video quality, quality control, qualifications and auditing. Figure A1.1 is a table regarding the frequency of inspections.

Of specific interest are sections that relate to the following specification data clauses.

- 4.1.1                    A2.3 Types of equipment
- A2.4.1 Measuring pipe profile

Part B: Preparing of Drains and Sewers for Inspection

This part includes interesting descriptions for pre-inspection cleaning, jetting and pressures, camera operation, screen displays, allowable water depth, camera speed, measuring pipe inclination, abandoning inspections, pipe materials, pipe sizes, (NZ defect coding),

Of specific interest are sections that relate to the following specification data clauses.

- 4.4.10.1 B1.2.2.6 Setting the distance counter for manhole centre
- 4.4.7.1 B1.2.3.1 Allowable depth of flow
- 4.4.11.3 B1.2.3.3 Observing Defects and features  
B.1.2.3.5 Photos

Part C: Private Drains and Sewers

Not applicable to SA.

Part D: Preparation of Manholes for Inspection

Not applicable to SA.

Part E: Interpretation of Inspection Results

Part E1 Preliminary Condition Grading  
Not applicable to SA.

Part E2 Understanding Asset Condition  
Of interest.

Part E3 Assessment of New and Lined Pipe  
Of general interest and particularly pipe cracking, autogenous healing, pre-installation defects, plastic pipe deflection, new liners.

Part F: Ground Water Infiltration Source Detection

Of general interest.

Appendix A Format for Electronic Transfer of Coded Data

Appendix B Pipe and Liner Materials

Appendix C Notes on the Assessment of Crack Widths in Reinforced Concrete Pipe  
Interesting on the mechanism of pipe cracking.

Appendix D Notes on Identifying Latent Defects and Features in Lined Pipe  
Interesting description of CIPP liners.

Appendix E Examples of Manhole Cover Types, Shapes and Lifting Arrangements.

Appendix F Notes on Factors Relating to Video Quality  
Interesting, with specifications of common makes of camera.

Appendix G Model Particular Specification  
Interesting

Glossary  
Interesting.

**Annex C**  
(informative)

**The external inspection of pipelines**

The external inspection of pipelines is an essential part of the assessment of pipelines that require rehabilitation to fully understand their condition and determine the best rehabilitation method to be applied.

This is where the controlled exposure of the pipe for inspection is important. Just one inspection pit can reveal many aspects of the pipe that are important to its assessment and the design of the rehabilitation. It can reveal how good the bedding and side support is.

Before doing any inspections of opened manholes or externally exposed or opened sections of the pipeline a check on the presence of hydrogen sulphide in the pipeline atmosphere should be done and the necessary precautions taken.

After excavating down to within 0.5 m or 1.0 m of the pipe, probes or a DCP can be used to assess the existing side support and the existence of any cavities. It might be found that the pipe is encased or haunched in concrete, which cannot be determined from looking inside the pipe. After exposing the pipe, it can be inspected for external corrosion. It is essential to have the pit long enough to encompass a joint, so that it can then be also inspected and its configuration determined.

If practical, a sample should be cut from the pipe wall. The sample should be cut at an angle so that it can be glued/fitted back in place. The size of the sample should be big enough for the inside of the pipeline to be inspected. The pipe wall sample will reveal the thickness of the pipe wall and the material from which it was made. If it is a concrete pipe one can determine whether it was made with dolomitic aggregate, has a sacrificial layer, has a CAC dolomitic layer, what steel reinforcement was used, the extent of any corrosion and take a sample of any corrosion products. If the sample is corroded, it might be advantageous to take another sample (e.g. below the flowline) to determine the original wall thickness.

The existence of hydrogen sulphide in the pipe atmosphere should be noted and precautions taken.

If possible, the external outside diameter should be measured accurately with callipers. The internal dimensions of the pipe should be measured, and any corrosion lips/shoulders noted. An important measurement is from the invert to the outside top of the pipe, this is a dimension not usually affected by corrosion and can be used when identifying the pipe in pipe catalogues. Probing with a steel rod can give a good indication of unseen erosion or corrosion features. Cracks and fractures must also be explored. Photographs of the external and internal parts of the pipe must be taken.

This external inspection of the pipeline is important in determining if a pipeline is fully or partially deteriorated. It is also the only opportunity to assess the modulus of soil reaction adjacent to the pipeline.

The findings must be evaluated together with the CCTV inspections of the same length of pipeline. This combination of internal and external inspections will enable an estimate of the remaining pipe wall thicknesses or the pipe deformations and provide the basis for determining the residual strength of the pipes at these locations. The information gleaned from such an inspection may inform and justify the need to perform more inspections elsewhere on the pipeline to check for consistency of the conditions found.

## Annex D

(informative)

### Items that may be needed to cover measurement and payment

The following may have to be addressed in the Pricing Data section of the project document when compiling that section for a particular project (refer to annex D of SANS 10403: 2003).

At present the SANS 2001 series of standards are being prepared to replace the existing SANS 1200 series of specifications.

It is planned that for measurement and payment SANS 2001 will adopt the Third Edition of the Civil Engineering Standard Method of Measurement (CESMM3) published by the UK Institution of Civil Engineers (ICE) or a South African version thereof.

Until SANS 2001 is fully completed and introduced, it will be necessary to refer back to the SANS 1200 measurement and payment clauses and/or the following particular measurement and payment clauses. This also applies to the SASTT-TS series of standards.

The following are measurement and payment clauses that would be suitable for such reference:

#### D1 MEASUREMENT AND PAYMENT

##### D1.1 General

Pipe cleaning, point repairs, manhole opening and repairs, and any other work shall be measured and paid separately.

##### D1.2 Scheduled Items

#### CCTV INSPECTION SURVEY

#### GENERAL

##### Contract establishment

These general pay items should be covered by the standard pay items in the General Section of the Standard Specifications (SANS 1200) but are included here for smaller or emergency contracts.

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV1	General	
CCTV1.1	Contract establishment	Sum

Lump sum for establishment on site for the entire contract, including disestablishment at end of the contract. The pay item shall include all items which are general to the project as a whole. Such items shall include but are not limited to the following.

- Establishment and disestablishment of plant and equipment.
- Provision of insurances and sureties.
- Provision of all plant, equipment, and personnel to carry out the works.

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- Supervision of the works.
- Contractors company and head office overheads.
- Provision of computer hardware and software required for the contract.
- Notification and liaison with private property owners, tenants and the public.
- Keeping the sites clean and tidy throughout the contract.
- Liaison with other authorities.
- Attending site and progress meetings.
- Providing written progress reports.
- Liaison with the Owner.

### Accommodation of traffic

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV1.2	Accommodation of traffic	Sum

Lump sum for complying with the requirements for the accommodation of traffic specifications.

### Health and safety

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV1.3	Health and safety	Sum

Lump sum for complying with the requirements for health and safety.

## SETTING UP EQUIPMENT AND PREPARATORY WORK

### Pre-inspections of manholes and pipelines

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV2	Pre-inspection	No

Pay item for the pre-inspection of manholes and pipelines using strong lights and mirrors to determine the need for cleaning. The pay item shall be measured and paid per manhole and shall include the inspection of all pipelines that need to be inspected from within that manhole. The rate includes for all costs incurred in inspecting the manhole and pipelines including the recording and the reporting of the findings to the Owner.

### Unsuccessful search for manhole

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV3	Unsuccessful search for manhole	No

Pay item for searching for a manhole which is not found after 15 minutes and the search is abandoned. The rate includes for all costs incurred in the search for the manhole. The costs incurred in searching for manholes that are found is deemed to be included in the rates for pre-inspections and CCTV inspection set up at manholes.

**Unsuccessful attempt to open manhole**

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV4	Seized manhole cover	No

Pay item for attempting to gain access to a manhole which is unsuccessful after 15 minutes. The rate includes for all costs incurred in attempting to open the manhole. The costs incurred in successfully opening manhole covers is deemed to be included in the rates for pre-inspections and CCTV inspection set up at manholes.

**Measure and record GPS coordinates of manholes**

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV5	Measure and record GPS coordinates of manholes	No

Pay item for measuring and recording the GPS coordinates of each manhole.

The rate includes for all costs incurred in measuring and recording the GPS coordinates in the format and accuracy specified.

**CCTV inspection set up at manholes in road reserves**

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV6	CCTV inspection set up at manholes in road reserves	
CCTV6.1	Manholes up to 2 m deep	No
CCTV6.2	Manholes over 2 m deep	No

Pay item for setting up and work in preparation for a CCTV Inspection at manholes located within road reserves. Measurement is per depth category.

Payment shall include for locating the manhole, opening and re-fitting the cover, effecting safety precautions, moving personnel and equipment between sites and setting up of equipment ready for inspections and removal at the completion of the inspection.

**CCTV inspection set up at manholes outside road reserves**

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV7	Extra over CCTV6 for manholes outside road reserves	No

Extra over pay item for additional costs for setting up and preparatory work at manholes located outside road reserves including additional costs of access and/or liaising with landowners or tenants.

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### CCTV inspection set up at manholes not accessible by conventional two wheel drive vehicles

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV8	Extra over CCTV6 for manholes not accessible by conventional two wheel drive vehicles	No

Above pay items are on the basis that the manholes are accessible by means of conventional 2 wheel drive vehicles. Where this is not possible this extra over pay item has been provided to allow the Contractor additional payment in respect of the additional costs of access.

### CCTV INSPECTION

#### Inspect pipelines

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV9	Inspect pipelines	
CCTV9.1	Circular pipes	
CCTV9.1.1	Up to and including 125 mm dia.	m
CCTV9.1.2	Over 125 mm dia. but not exceeding 200 mm dia.	m
CCTV9.1.3	Over 200 mm dia. but not exceeding 450 mm dia.	m
CCTV9.1.4	Over 450 mm dia. but not exceeding 900 mm dia.	m
CCTV9.1.5	Over 900 mm dia. but not exceeding 1200 mm dia.	m
CCTV9.1.6	Over 1200 mm dia. but not exceeding 1800 mm dia.	m
CCTV9.1.7	Exceeding 1800 mm dia.	m
CCTV9.2	Egg shaped pipelines	
CCTV9.2.1	Up to and including 600 mm wide	m
CCTV9.2.2	Over 600 mm but not exceeding 900 mm wide	m
CCTV9.2.3	Over 900 mm but not exceeding 1200 mm wide	m
CCTV9.2.4	Exceeding 1200 mm wide	m
CCTV9.3	Rectangular culverts	
CCTV9.3.1	Up to and including 900 mm wide	m
CCTV9.3.2	Over 900 mm but not exceeding 1200 mm wide	m
CCTV9.3.3	Over 1200 mm but not exceeding 1800 mm wide	m
CCTV9.3.4	Exceeding 1800 mm wide	m

Measurement shall be for the linear metre of pipeline inspected according to category and size.

Payment shall include for all costs to perform the inspection, including safety requirements, planning, dealing with flows (but excluding overpumping, forced ventilation and the plugging of flows), including calibration of equipment, testing of equipment, internal quality control and rectification of unacceptable inspections.

**Pan and rotate camera**

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV10	Extra Over CCTV9 for pan and rotate camera	m

Extra over for using a pan and rotate camera instead of a fixed forward looking camera where specified.

**Laser light ring profiling**

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV11	Extra over CCTV9 for laser light ring profiling	m

Extra over for using a laser light ring in addition to CCTV inspection where specified.

Payment to include for all additional requirements to perform a laser light ring survey in addition to a CCTV inspection, including provision of laser light ring results and recordings.

**Sidescan camera inspection**

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV12	Extra over CCTV9 for sidescan camera inspection	m

Extra over for using a sidescan camera in addition to CCTV inspection where specified.

Payment to include for all additional requirements to perform a sidescan inspection including provision of system to produce results and recordings.

**3D Lidar profiling**

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV13	Extra over CCTV9 for 3D Lidar profiling	m

Extra over for using a 3D Lidar profiling in addition to CCTV inspection where specified.

Payment to include for all additional requirements to perform a Lidar survey in addition to a CCTV inspection, including provision of data and models.

**Non-circular pipelines**

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV14	Extra over CCTV9 for non-circular pipelines (specify shape & dimensions)	m

Extra over for the CCTV inspection of non-circular pipelines.

Payment includes for additional costs for equipment including transporters to negotiate the

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non-circular cross-section in accordance with the specifications.

### Brick pipelines

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV15	Extra over CCTV9 for brick pipelines	m

Extra over for the inspection of brick pipelines.

Payment to include for the additional costs for coding of brick pipelines in accordance with the specifications.

### Man-entry inspection

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV16	Extra over CCTV9 for man-entry inspection	m

Extra over for the inspection of pipelines using personnel to enter and negotiate the pipeline.

Payment to include for the additional costs to perform the inspection, including additional supervision and safety requirements.

### Work outside normal working hours

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV17	Work outside normal working hours	
CCTV17.1	Extra over CCTV6 and CCTV9 for night work Monday to Friday	m
CCTV17.2	Extra over CCTV6 and CCTV9 for weekend work	m

Extra over for night work (Monday to Friday) or weekend work authorised by the Owner.

Payment to include for the additional costs to perform the inspections at night or at weekends.

### Survey reports

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV18	Survey reports	m

Pay item to cover the cost of producing the survey report deliverables.

### Inspect manholes

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV19	Inspect manholes.	No

Measurement shall be for the number of manholes inspected.

Payment shall include for all costs to perform the inspection, including safety requirements,

planning, dealing with flows (but excluding overpumping, forced ventilation and the plugging of flows), including calibration of equipment, testing of equipment, provision of deliverables, internal quality control and rectification of unacceptable inspections.

**Overpumping**

CCTV20 The pay items for overpumping shall be specified in the **specification data**.

Overpumping will normally be paid per hour

**Forced ventilation**

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV21	Forced ventilation	Hour

Pay item to cover the cost of providing forced ventilation, where approved by the Owner.

**Plugging of flows**

<u>Pay Item</u>	<u>Description</u>	<u>Unit</u>
CCTV22	Plugging of flows	Hour

Pay item to cover the cost of plugging flows, where approved by the Owner.

Plugging of flows shall be measured and paid per hour and categorised by the pipe diameter.

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## D1.3 Typical Bill of Quantities

Pay Item	Description	Unit	Quantity	Rate	Amount
	<u>CCTV INSPECTION SURVEY</u>				
	GENERAL				
CCTV1	General				
CCTV1.1	Contract establishment	Sum			
CCTV1.2	Accommodation of traffic	Sum			
CCTV1.3	Health and safety	Sum			
	SETTING UP EQUIPMENT AND PREPARATORY WORK				
CCTV2	Pre-inspection	No			
CCTV3	Unsuccessful search for manhole	No			
CCTV4	Seized manhole cover	No			
CCTV5	Measure and record GPS coordinates of manholes	No			
CCTV6	CCTV inspection set up at manholes in road reserves				
CCTV6.1	a) Manholes up to 3 m deep	No			
CCTV6.2	b) Manholes over 3 m deep	No			
CCTV7	Extra over CCTV6 for manholes outside road reserves	No			
CCTV8	Extra over CCTV6 for manholes not accessible by conventional two wheel drive vehicles	No			
	CCTV INSPECTION				
CCTV9	Inspect pipelines				
CCTV9.1	Circular pipes				
CCTV9.1.1	a) Up to and including 125 mm dia.	m			
CCTV9.1.2	b) Over 125 mm dia. up to 225 mm dia.	m			
CCTV9.1.3	c) Over 225 mm dia. up to 450 mm dia.	m			
CCTV9.1.4	d) Over 450 mm dia. up to 900 mm dia.	m			
CCTV9.1.5	e) Over 900 mm dia. up to 1200 mm dia.	m			
CCTV9.1.6	f) Over 1200 mm dia. up to 1800 mm dia.	m			
CCTV9.1.7	g) Over 1800 mm dia.	m			
CCTV9.2	Egg shaped pipelines				
CCTV9.2.1	a) Up to and including 600 mm wide	m			
CCTV9.2.2	b) Over 600 mm but not exceeding 900 mm	m			
CCTV9.2.3	c) Over 900 mm but not exceeding 1200 mm	m			
CCTV9.2.4	d) Exceeding 1200 mm wide	m			
CCTV9.3	Rectangular culverts				
CCTV9.3.1	a) Up to and including 900 mm wide	m			
CCTV9.3.2	b) Over 900 mm but not exceeding 1200 mm wide	m			
CCTV9.3.3	c) Over 1200 mm but not exceeding 1800mm wide	m			
CCTV9.3.4	d) Exceeding 1800 mm wide	m			
CCTV10	Extra over CCTV9 for pan and rotate camera	m			
CCTV11	Extra over CCTV9 for laser light ring survey	m			
CCTV12	Extra over CCTV9 for sidescan camera inspection	m			
CCTV13	Extra over CCTV9 for 3D Lidar profiling	m			
CCTV14	Extra over CCTV9 for non-circular pipelines (specify shape and dimensions)	m			
CCTV15	Extra over CCTV9 for brick pipelines	m			
CCTV16	Extra over CCTV9 for man-entry inspection	m			
CCTV17	Work outside normal working hours				
CCTV17.1	a) Extra over CCTV6 and CCTV9 for night work Monday to Friday	m			
CCTV17.2	b) Extra over CCTV6 and CCTV9 for weekend work	m			
CCTV18	Survey reports	m			
CCTV19	Inspect manholes	No			
CCTV20	Overpumping	h			
CCTV21	Forced ventilation	h			
CCTV22	Plugging of flows	h			