



Specification for Conduit Condition Evaluation (CCTV Survey)

References:

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2. Course Note, Conduit Condition Evaluation Course for Operators, Engineers/Surveyors and Managers, UTI, 2005
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4. HKHA161/95, Detection of Leakage from buried water carrying services in the vicinity of slopes 'and retaining walls within the lands 'maintained by Housing Authority.
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6. Hong Kong Institute of Utility Surveyors(2006), Constitution.
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8. Works Branch (1996), Hong Kong Government, Code of Practice on Inspection & Maintenance of Water Carrying Services Affecting Safety of Slope.
9. 黃敬博士工程師，郭啓業先生-如何利用非破損方法(管內閉路電視(CCTV)檢測)以改善城市管道狀況，

**HKIUS Guidelines for
Requirements for Conduit Condition Evaluation (CCTV Survey)****Foreword**

It's been more than ten years now since the disastrous landslip that occurred in Kwun Lung Lau on Hong Kong Island on 23 July, 1994. Since 1995, the Government of HKSAR has awarded tens of millions of dollars in contracts related to detection of leakage from buried water carrying services throughout the territory. As expected, this sequence of events generated an increasingly large pool of "underground utility surveyors", with most working almost independently, devoid of any standardized surveying methods, quality requirements (on survey results) and the "registration" of operation personnel in the market.

In view of the availability of the multitude of method statements, specifications, training manuals, and the contracts documents produced for the vast number of underground utility survey contracts (by government and private projects), the following sections try to provide a comprehensive set of guidelines, by addressing the following topics in general:

- Utility Services Information to be investigated
- Level of Accuracies
- Types of Deliverables and Schedules
- Requirements for Deliverables

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26.5 CONDUIT CONDITION EVALUATION BY CCTV SURVEY

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| <i>Description</i> | 26.5.1 | <p>(1) The Utility Surveyor/Contractor shall conduct the preliminary visual inspection and CCTV surveys at or between the two prescribed points to discover evidence of their structural, service and integrity condition in accordance with the Conduit Condition Evaluation Codes for Hong Kong, published by HKIUS so as to detect any sign of leakage within the drains.</p> <p>(2) The Utility Surveyor/Contractor shall also perform CCTV surveys at all associated branches from the drains (if any) within the corresponding Zone of Influence/survey boundary as confirmed by the client.</p> <p>(3) The Utility Surveyor/Contractor shall report to the client and the Employer for any signs of leakage and/or damages of the of drains.</p> |
| <i>CCTV Survey Equipment</i> | 26.5.3 | <p>(1) The surveying equipment shall be capable of surveying a length of drain up to 350m where entry to the drain may be obtained at each end and up to 30m by rodding, or up to 150m where a self-propelled unit is used where entry is at one end only. The Utility Surveyor/Contractor shall maintain this plant in full working order and shall satisfy the client at the commencement of each working shift that all items of plant have been provided and are in full working order and fully calibrated in accordance with the manufacturer's recommendation.</p> <p>(2) Each survey unit shall contain a means of transporting the CCTV camera in a stable condition through the drain under inspection. Such equipment shall ensure the maintained location of the CCTV camera on or near to the central axis of the drain (see Clause 26.5.4.1(1) in this PS).</p> <p>(3) Where the CCTV camera is towed by winch and bond through the drain, all winches shall be stable with either lockable or ratcheted drums. All bonds shall be steel or of an equally non-elastic material to ensure the smooth and steady progress of the CCTV camera. All winches shall be inherently stable under loaded conditions.</p> <p>(4) Each unit shall carry sufficient numbers of guides and rollers such that, when surveying, all bonds are supported away from the drain and manhole structures and all CCTV cables and/or lines used to measure the camera's location within the drain are maintained in a taut manner and set at right angles, where possible, to run through or over the measuring equipment.</p> <p>(5) Each unit shall carry a range of flow control equipment, as opposed to overpumping equipment, for use in controlling the flow during the survey. A minimum of one item of each size of equipment ranging from 100mm to 900mm diameter inclusive shall be carried.</p> |

- (6) In many locations it is anticipated that access to the slopes may be difficult for the normal type of vehicle mounted CCTV survey equipment. A complete range of CCTV inspection equipment must be available to enable difficult locations such as step pipes and steep slopes to be surveyed under a safe working condition.
- (7) The Utility Surveyor/Contractor shall use colour cameras with a pan and rotate head with forward view and side viewing capability to enable the internal conditions of junctions and connections to the drains to be inspected closely.
- 26.5.4 CCTV Survey
- Camera Position* 26.5.4.1 (1) Wherever prevailing conditions allow, the camera shall be positioned to reduce the risk of picture distortion. In the case of circular or regular shaped Prescribed Sections, the camera lens shall be positioned centrally within the Prescribed Sections. In all instances the camera lens shall be positioned looking along the axis of the pipeline. A positioning tolerance of $\pm 10\%$ of the vertical pipeline dimension shall be allowed. In addition, the camera shall be positioned so that the long side of the photograph is horizontal.
- (2) When a photograph or a video print is taken to illustrate a specific defect during CCTV survey it may be necessary to relax the requirement in sub-clause (1) above of this PS Clause. Where a photograph print is taken to illustrate a specific defect it shall occupy the central part of the photograph print and be clearly in focus and accurately reflect the defect. If necessary a second photograph print shall be taken at the location to put the defect depicted in the specific photograph prints into perspective in the overall context of the drain.
- (3) During CCTV survey the Utility Surveyor/Contractor shall take a photograph to illustrate degree of mortar loss, size of a crack/fracture, size of a void or any other quantifiable defect a suitable metric scale shall be included in the photograph, clearly visible and in focus within the photograph.
- CCTV camera speed* 26.5.4.2 (1) The speed of the CCTV camera in the drain shall be limited to:
0.1m/s for drains of diameter less than or equal to 200mm;
0.15m/s for diameters exceeding 200mm but less than or equal to 300mm and;
0.2m/s for drain greater than 300mm, or such other speed as agreed by the client to enable all details to be extracted from the video tape recording.
- (2) The camera shall be "stopped" for a few seconds to ensure that an accurate and clear record is taken whenever defects are being noted on the coding sheet.
- Linear measurement* 26.5.4.3 (1) The CCTV monitor display shall incorporate an automatically updated record in metres and tenths of a metre of the meterage of the camera position from the cable calibration point which is also called "adjusted zero".

- (2) The Utility Surveyor/Contractor shall use a suitable metering device which enables the cable length to be accurately measured; this shall be accurate to $\pm 1\%$ or 0.3m whichever is the greater. Testing of the cable shall be done before any works in a shift.
- (3) The Utility Surveyor/Contractor shall demonstrate that the tolerance in sub-clause (2) is being complied with using one or both of the following methods in conjunction with a linear measurement audit form which shall be completed and submitted to the client each day during the CCTV survey:
- use of a cable calibration device; and
 - tape measurement of the surface between manholes.

If the Utility Surveyor/Contractor fails to meet the required standard of accuracy of HKIUS, the client shall instruct the Utility Surveyor/Contractor to provide a new device to measure the chainage. The client may at his discretion instruct, in writing, the Utility Surveyor/Contractor to re-survey those lengths of drains first inspected with the original measuring device recording inaccurate measurements using the new measuring device.

- (4) When requested by the client in writing at any time during the course of the survey, the Utility Surveyor/Contractor shall demonstrate that the above tolerance is being complied with. The device used by the Utility Surveyor/Contractor to measure the chainage along the drain will be compared with a standard tape measure and the results will be noted. If the Utility Surveyor/Contractor fails to meet the required standard of accuracy the Engineer shall instruct the Utility Surveyor/Contractor to provide a new device to measure the chainage. The client may at his discretion instruct, in writing, the Utility Surveyor/Contractor to resurvey those lengths of drain inspected with the original measuring device.

*Data display,
video
recording and
start of survey*

- 26.5.4.4 (1) At the start of each drain length being surveyed, the length of drain from zero chainage up to the cable calibration point shall be recorded and reported in order to obtain a full record of the drain length.

The meter reading entered onto the data display at the cable calibration point must allow for the distance from the start of the survey to the cable calibration point such that the meterage at the start of the survey is zero.

In the case of surveying through a manhole where a new header sheet is required, the meterage shall be set at zero with the CCTV camera focused on the outgoing drain entrance.

The Crew Leader (the qualified person with training) shall ensure that the meterage counter starts to register immediately when the camera moves.

- (2) At the start of each manhole length a data generator shall electronically generate and clearly display on the viewing monitor and video recording a record of data in alpha-numeric form containing the

following minimum information:

- Automatic update of the CCTV camera's meterage position in the Pipeline line from "adjusted zero" (see Clause 26.5.4.3(1) of this PS).
- Pipeline dimensions.
- Manhole/Prescribed Section length reference numbers.
- Date of survey.
- Road name/location.
- Direction of survey.
- Time of start of survey.
- Pipeline classification (Storm Drain or Foul Sewer).
- Name of qualified operator or HKIUS membership #

The size and position of the data display shall be such as not to interfere with the main subject of the picture.

- (3) Once the survey of the manhole length is under way, the following minimum information shall be continually displayed:
 - Automatic update of the CCTV camera's meterage position in the drain line from "adjusted zero" (see Clause 26.5.4.3(1) of this PS).
 - Pipeline dimensions.
 - Manhole/Prescribed Section length reference numbers.
 - Direction of survey.
 - Name of qualified operator or HKIUS membership #
- (4) The Utility Surveyor/Contractor shall demonstrate the correct adjustment of the recording apparatus and monitor by use of the test tape or other device approved by the Engineer. The Utility Surveyor/Contractor shall then demonstrate satisfactory performance of the camera by the recording of the appropriate test device at the commencement of each day for a minimum period of 15 seconds. (See Clause 26.5.4.5 of this PS).
- (5) All video cassette tapes shall be supplied by the Utility Surveyor/Contractor and shall be best quality high grade (HG) new and unused prior to recording and shall be of a Video Home Systems (VHS) format.
- (6) Provision of facilities to photograph the drain.
- (7) When recording the conditions of the drain, video tapes as specified above shall have a running time of 3 hours.
- (8) CCTV survey video records shall also be converted to CD-ROM in digital formats as stated in Clause 26.5.4.6(1) of this PS.

*Picture
quality -
camera, video
tape recorder*

26.5.4.5 The Utility Surveyor/Contractor shall provide the test device(s) on site at all times to enable practical demonstration of compliance with the requirements of this section. Test devices for the camera shall utilise the Marconi Resolution Chart No.1 or its derivatives, or such device as may be approved by HKIUS(see

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| <i>and monitor</i> | Clause 26.5.4.10 of this PS). The Utility Surveyor/Contractor shall submit the test devices for the video tape recorder and monitor for approval by the client. |
| <i>Survey reporting</i> | <p>26.5.4.6 (1) The Utility Surveyor/Contractor shall use a computer programme to produce the report of the CCTV survey. The Utility Surveyor/Contractor shall prepare the CCTV survey's video record in one of the following digital formats: MPEG VIDEO(mpg), AVI VIDEO(avi), QUICK TIME FILE(mov) or other formats agreed by the client for recording in the computer system. The Utility Surveyor/Contractor shall take reference to the coding (where appropriate) as laid down in the WAA/WRC "Manual of Sewer Condition Classification" Forth Edition, published 2004. or the UTI's HKCCEC2005, "Conduit Condition Evaluation Codes, Hong Kong" Second Edition, 2005.</p> <p>(2) The Utility Surveyor/Contractor shall supply the necessary number of copies and types of report for each item as confirmed with the client.</p> <p>(3) The client may require different sections of the survey to be carried out using different survey methods in which case different survey reports will be required. If the client requires separate survey reports for any section of the survey or requires some or all of the section to be grouped together in a single survey report, this shall be noted in writing prior to the commencement of that part of the work and pay separately.</p> <p>(4) The client may request that some of the items of the survey report listed in reporting section of the Specification shall be supplied to the client as the survey proceeds. But notwithstanding this the Utility Surveyor/Contractor shall comply with reasonable requests from the client to supply the information on some of the items listed in the preamble whilst the survey is in progress.</p> <p>(5) The report of the CCTV survey shall contain summary ranking and scores for both structural and service conditions Grade 3, 4 and 5 as defined in the structural assessment photographs for drains as contained in the WAA/WRC Sewerage Rehabilitation Manual or the UTI's HKCCEC2005, "Conduit Condition Evaluation Codes, Hong Kong" Second Edition, 2005 with associated service conditions.</p> <p>(6) For each survey extent, the Utility Surveyor/Contractor shall submit, upon the completion of all required surveys of the drains, a summary of manhole references, drain lengths surveyed, diameter/section details, summary ranking scores for cross referencing the manhole survey results to demonstrate that no drains are missing from survey.</p> <p>(7) All CCTV Survey results shall be checked by manager members of HKIUS before submission.</p> <p>(8) Each Utility Surveyor shall maintain a record of his survey results and accuracy rating to be inspected by the client in accordance with the quality requirements of as contained in the WAA/WRC Sewerage Rehabilitation Manual or the UTI's HKCCEC2005 "Conduit Condition Evaluation Codes, Hong Kong" Second Edition, 2005.</p> |

Leakage Detection of Buried Water Carrying Services -
Conduit Condition Evaluation (CCTV Survey for Drains)

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| <i>Metric measurement</i> | 26.5.4.7 | (1) | All dimensions of drain sizes shall be METRIC. For the purpose of metrication, imperial sized drains shall be converted on the basis of 1 inch = 25.4mm. Measurement of drain sizes shall be on nominal diameter dimensions quoted to the nearest mm. |
| <i>Video print annotation</i> | 26.5.4.8 | | Video prints shall be clearly identified in relation to the location (minimum requirement manhole start and finish numbers or Prescribed Section length reference numbers), survey direction, chainage, print number, and date when the print was taken. The annotation shall be clearly visible and in contrast to its background, shall have a figure size no greater than 5mm, and be type printed. The annotation shall be so positioned as not to interfere with the subject of the print. |
| <i>Control sample photographs and / or video prints and / or video tapes</i> | 26.5.4.9 | (1) | The client may at his discretion issue a written instruction to the Utility Surveyor/Contractor to provide a sample of the photographs and/or video prints and/or CCTV tapes taken during the Contract period. The client shall give a written instruction and the Utility Surveyor/Contractor shall provide the information within 5 working days of receiving the written instruction. |
| | | (2) | The sample photographs video prints and CCTV tape recordings supplied by Utility Surveyor/Contractor shall be held by the client for the duration of the Contract and shall be used as a control against which the Utility Surveyor/Contractor's performance shall be measured. If, in the opinion of the client and agreed by the utility surveyor, any photographs, video prints and CCTV tape recordings provided under the Contract fall significantly below the standard of the samples of the Technical Submission, the work in question shall be re-executed. The Technical Submission submitted by the Utility Surveyor/Contractor shall form the base of standard for acceptance. |
| <i>CCTV picture quality</i> | 26.5.4.10 | (1) | The CCTV camera shall have suitable illumination and shall be capable of providing an accurate and clear record of the drain's internal condition. |
| | | (2) | The Utility Surveyor/Contractor shall submit to the client for approval a test device for the CCTV equipment and make available on site throughout the Contract, enabling the tests specified in this Clause to be checked by the client. |

The test card shall be the Marconi Resolution chart No. 1 or its derivatives with a colour bar, clearly differentiating between colour with no tinting to show the following:

- White
- Yellow
- Cyan
- Green
- Magenta
- Red
- Blue
- Black.

At the start of each and every working shift, the camera shall be

positioned centrally and at right angles to the test card at a distance where the full test card just fills the monitor screen, ensuring that the edges of the test card castellations coincide with the edges of the horizontal and vertical scan (raster). The card shall be illuminated evenly and uniformly without any reflection. The illumination shall be to the same colour temperature as the colour temperature of the lighting that will be used on the CCTV camera in the drain. The test shall be recorded and submitted to the client daily for subsequent use, the recording time to be at least 15 seconds. The type of camera used is to be reported on the test recording. The recording must show the camera being introduced into the test device and reaching its stop position.

Other test devices may be proposed by the Utility Surveyor/Contractor for use subject to approval by the client with reference to HKIUS.

- (3) The electronic systems, television camera and monitor shall be of such quality as to enable the following to be achieved:

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.

Colour

With the monitor control adjusted for correct saturation, the six colours plus 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.

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 ($\pm 5\%$)

Resolution

The live picture must be clearly visible with no interference and capable of registering a minimum number of TV lines/picture height lines. The resolution shall be checked by the Utility Surveyor/Contractor with the monitor colour turned down. In the case of tube cameras this shall be 350 lines and in the case of CCD type cameras 250 lines.

Colour constancy

To ensure the camera shall provide similar results when used with its own illumination source, the lighting shall be fixed in intensity prior to commencing the survey. In order to ensure colour constancy, generally no variation in illumination shall take place during the survey.

- (4) The Utility Surveyor/Contractor shall note that the client may periodically check both the live and video picture colour consistency

against the colour bar. Any differences will necessitate re-survey of these drain length affected at the Utility Surveyor/Contractor's expense.

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| <i>Video playback</i> | 26.5.4.11 | Video playback of the recorded CCTV surveys shall be capable of a resolution of a minimum of 250 lines recorded at standard VHS speed. |
| <i>Focus/ iris/ illumination</i> | 26.5.4.12 | The adjustment of focus and iris shall allow optimum picture quality to be achieved and shall be remotely operated. The adjustment of focus and iris shall provide a minimum focal range from 150mm in front of the camera's lens to infinity. The distance along the drain in focus from the initial point of observation shall be a minimum of twice the vertical height of the drain. The illumination must be such as to allow an even distribution of the light around the drain perimeter without the loss of contrast, flare out of picture or shadowing. |
| <i>Photographs and CCTV video prints</i> | 26.5.4.13 | <p>(1) High quality colour video prints, are required for the CCTV survey. The video prints shall be a minimum of 110 x 84mm.</p> <p>(2) In addition to the frequency and requirements specified in Clauses 26.5.4.1(2) and (3), and noted in sub-clause (5) below, where photographs or prints are not otherwise required a general condition photograph or print shall be taken not more than 10m after the previous photograph or print in the drain.</p> <p>(3) All photographs and prints shall be supplied in card index files. All photographs or prints relating to one manhole length shall be kept together and in order by chainage, lowest chainage at the front, highest chainage at the back. Each manhole length shall be clearly identified by inserting a cardboard (or equivalent metal, plastic, etc) divider. The divider shall be annotated on the top face to show start manhole number and finish manhole number to the annotation specification laid out in Clause 26.5.4.8 of this PS. The annotation of finish/start manhole shall be clearly visible when all the photographs or prints are installed in the drawer. Each drawer shall contain approximately 600 photographs or prints (this may be amended to take into account the need to keep a complete manhole length together).</p> <p>(4) Video prints must clearly and accurately show what is displayed on the monitor which shall be in proper adjustment.</p> <p>(5) The following photographs and video prints are required:</p> <p style="margin-left: 20px;">(a) pipelines</p> <p style="margin-left: 40px;">All junctions and connections defective or otherwise (as defined in the WRC/WAA "Manual of Sewer Condition classification", 4th Edition) or the UTI's HKCCEC2005, "Conduit Condition Evaluation Codes, Hong Kong" Second Edition, 2005.</p> <p style="margin-left: 40px;">Continuous defects: at the beginning of the defect thereafter at 5m intervals.</p> <p style="margin-left: 40px;">General condition at each pipeline length.</p> |

Leakage Detection of Buried Water Carrying Services -
Conduit Condition Evaluation (CCTV Survey for Drains)

- Cracks
- Fractures
- Holes
- Broken pipes
- Deformation
- Collapse
- Severe joint displacement or open

(b) All Manholes/Chambers/Pits

All junctions and connections and other appropriate features.

(6) Photograph and negative (or digital) filing cabinets are to be provided by the Utility Surveyor/Contractor

26.5.5 Drain Cleaning

Objective and extent of works

26.5.5.1 (1) The supply of water for heavy drain cleaning plant is limited by the size of water meter that can be attached to a WSD hydrant upon WSD's prior approval. There will be no special dispensation on this Contract for use of larger hydrants and therefore the Utility Surveyor/Contractor must plan his cleaning operations to take this into account and the time required by the Utility Surveyor/Contractor to apply for the approval of WSD for the use of such hydrants. A system of supplying sufficient water to enable the equipment to work efficiently and effectively together with a method of disposal of the arisings will have to be devised and used for the Contract by the Utility Surveyor/Contractor.

(2) The objective of drain cleaning carried out under the Contract is to expose the fabric of the drains by removing silt, grease and debris deposits so that an accurate assessment of its condition can be made by CCTV survey. Drains may not need cleaning before CCTV survey works. However, if instructed or as the Utility Surveyor sees appropriate, drains shall be cleaned by high pressure water jetting or by other methods agreed by the client

(3) The Utility Surveyor/Contractor shall clean the drains where required and the rates shall be agreed before commencement of works.

(4) During drain cleaning, the flows in the drain shall be maintained.

(5) On completion of the works the Utility Surveyor/Contractor shall ensure that all equipment is removed from the system and that the drains are free flowing.

Working area for cleaning

26.5.5.2 (1) The working area in which plant and machinery operates is to be kept to a minimum. Plant not in use is to be removed from the works as to minimise disruption to traffic and the general public.

(2) The working area is to be free from debris when the Utility Surveyor/Contractor leaves the site at the end of each visit.

(3) Open manholes, machinery and standing equipment are to be protected to ensure the safety and convenience of the public or others at all times.

Leakage Detection of Buried Water Carrying Services -
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| <i>Cleaning units</i> | 26.5.5.3 | (1) | The Utility Surveyor/Contractor shall only use equipment previously approved by the client. |
| | | (2) | The Utility Surveyor/Contractor shall provide sufficient suitable cleaning units, of adequate capacity, in good condition, including standby units in the event of breakdown, in order to complete the works within the Contract period. |
| | | (3) | The cleaning unit(s) provided for cleaning purposes shall be capable of operating up to 200m from the point of access to the drain to be cleaned. |
| | | (4) | Each cleaning unit shall comply with safety requirements defined in the safe working procedures detailed in the Safety Plan approved by the client for the execution of the Works. |
| <i>Operational requirements</i> | 26.5.5.4 | (1) | Each cleaning unit shall carry sufficient numbers of guides and rollers such that when cleaning all bends are supported away from drains and manhole structures. |
| | | (2) | Each cleaning unit shall carry a range of flow control equipment, as opposed to overpumping equipment, for use in controlling the flow during the execution of the works. A minimum of one item of each size of equipment ranging from 100mm to 900mm diameter inclusive shall be carried. |
| | | (3) | Equipment used to clean drains shall be operated in a way to prevent the operation of overflows. Where flows in the drains are such that the overflow will operate during cleaning operations, then the Utility Surveyor/Contractor shall make arrangements to prevent the premature overflow or stop operations until such flows are reduced to allow cleaning to continue. |
| | | (4) | The system of silt and debris removal shall be capable of operating in such a way as to minimise the obstruction to drain flows and the cleaning operations. |
| <i>Arisings</i> | 26.5.5.5 | (1) | The Utility Surveyor/Contractor is to remove all silt, grease, debris, detritus, etc. that is lodge in the lengths of drain required to be surveyed under the Contract or as directed by the client or his representative. Such material to be caught and collected in a trap located at the manhole or chamber from where the drain is being cleansed. |
| | | (2) | The arisings shall be deposited into suitable closed containers. The type and capacity of containers to be employed for the holding and transport of the arisings shall be supplied by the Utility Surveyor/Contractor. |
| | | (3) | The method of working shall be such that drain cleaning work is not held up through a lack of an empty container in which the arisings are deposited. |
| | | (4) | The Utility Surveyor/Contractor shall bear in mind that it may not |

- always be possible for the container to be sited immediately adjacent to the manhole from which arisings are being raised and should allow for the fact that “double handling” of the arising may be necessary. The Utility Surveyor/Contractor shall provide for such “double handling” to be carried out safely and efficiently.
- (5) The Utility Surveyor/Contractor must make his own arrangements for the tipping of material removed from the drains.
- Winching equipment* 26.5.5.6 (1) The Utility Surveyor/Contractor shall provide conventional power winching equipment (approved by the client) together with ancillary equipment, winching buckets, breakers, scrapers, etc. tools and safety apparatus for cleaning the drain for purpose of inspection and accurate assessment of the conditions of the internal fabrics of the drain. The Utility Surveyor/Contractor shall demonstrate the successful cleaning of a cleaned drain by CCTV survey.
- (2) Dredging of drains shall be undertaken by the Utility Surveyor/Contractor by passing various sized buckets through the drains to physically remove accumulated silt, sludge and other debris. Where conditions dictate, power boring equipment and/or winching equipment including cables, lines, props, tools must be available at all time as required by the Engineer.
- (3) The equipment shall be capable of operating efficiently in the sizes of drains stated and in drains up to distances of 200m between adjacent manholes.
- (4) Certain sections of drain will be flowing entirely full or in a surcharged condition and the Utility Surveyor/Contractor should be prepared at all times to use manually pushed rods, mechanical boring equipment or other methods to pass a leading line through the pipeline prior to commencing dredging operations with the winching equipment.
- (5) The Utility Surveyor/Contractor shall work in such a manner that excessive quantities of debris and silt are not allowed to pass downstream from any section of drain in which work is being carried out.
- (6) Any item of plant or equipment associated with the work which may cause obstruction to the flow in the drain must be removed from the drain at the close of work and meal breaks each day. The Utility Surveyor/Contractor shall be permitted to leave a line or winching cable through the drain during temporary breaks in the work.
- (7) Dredging operations in a particular section of drain will generally proceed in a downstream direction.
- (8) The maximum size of winch bucket used shall have a diameter of 90% of the pipeline up to a maximum of 600mm.
- (9) The Utility Surveyor/Contractor’s attention is drawn to sizes of manhole covers and access restrictions. It should be noted that the maximum size of bucket listed in sub Clause (8) may not be practical

due to restricted access. The Utility Surveyor/Contractor shall ensure that his working procedure will not be unduly affected by such restrictions.

- (10) The winches used to draw buckets and scrapers shall be power driven. They shall incorporate a torque limiting device so as to prevent the breaking of winching lines in the event of the line becoming jammed by obstructions.
- (11) Where the operational equipment is towed by winch and bond through the drain, all winches shall be stable with either lockable or ratcheted drums. All bonds shall be steel or of an equally non-elastic material to ensure the smooth and steady progress of the equipment. All winches shall be inherently stable under loaded conditions.

*Pressure
jetting
equipment*

- 26.5.5.7 (1) The equipment used shall be sufficient for the purposes of attaining the degree of cleanliness specified due to availability of wide range of equipment. In general high flow rates are associated with lower pressures and low flow rates with higher pressures. The Utility Surveyor/Contractor shall also take due regard of the structural condition of the drain to be cleaned so as to minimise any damage imparted to the fabric of the drain during cleaning operations in accordance with the following criteria:

- (a) Preferred working from downstream manhole
- (b) Maximum holding/stationary time of nozzle at 60 seconds
- (c) Applicable minimum flow rate corresponding to the drain diameters are shown as below:

| Minimum Flow Rate (l/s) | Maximum Recommended Drain Diameter (mm) |
|-------------------------|---|
| 0.4 | 225 |
| 1.5 | 450 |
| 3.0 | 900 |
| 4.5 | 1600 |

- (d) For the same power output increase in flow rate can be more effective than increasing the pressure when removing debris from a drain.
- (e) The Utility Surveyor/Contractor shall observe the maximum pump pressure that can be applied to existing drains with the following properties:

| Structural Condition Grade* | Drain Material | Maximum Pump Pressure (bar/psi) |
|-----------------------------|---------------------------------|---------------------------------|
| 1, 2 | Pitch Fibre, brick, masonry | 100/1500 |
| 1, 2 | Plastic (PE, PP & PVC) | 180/2600 |
| 1, 2 | Asbestos cement, clay, concrete | 340/5000 |
| 3 | Pitch Fibre, brick, masonry | 100/1500 |

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|------|--|----------|
| 3 | Plastic CPE, PP & PVC, asbestos cement, clay, concrete | 130/1900 |
| 4, 5 | All | 80/1200 |

*Structural grading is in accordance with the Sewerage Rehabilitation Manual WRc, 2001 or the HKIUS' HKCCEC2005, "Conduit Condition Evaluation Codes, Hong Kong" Second Edition, published August, 2005.

- (2) The jetting unit must be capable of jetting a minimum distance of 100m either upstream or downstream from a manhole. Minimum nominal hose size being 25mm diameter.
- (3) Successive passes using the pressure jetting technique shall be used with the silt removed at manholes until such time that the drain is clean. No silt shall be allowed to pass beyond the section of drain being cleaned.
- (4) Pass rates (rewind speed) for the jetting head shall be at a consistent speed avoiding jerking and excessive variations. Typical pass rates being 100mm to 200mm/second. The hose reel shall be power driven in the rewind direction.
- (5) The client shall approve the jetting equipment proposed to be used by the Utility Surveyor/Contractor which shall be categorised from the table below:

| Category | Machine Type | Capacity Litres/Minute Min – Max | Pressure* (Bar) Min – Max |
|----------|--|--|---------------------------------|
| 1 | High pressure/low volume – trailers | 41 – 155 | 210 – 700 |
| 2 | High pressure/low volume – mini | 41 – 155 | 210 – 700 |
| 3 | High pressure/low volume – non-HGV/HGV jetter/combo | 38 – 160 | 210 – 350 |
| 4 | Low pressure/high volume - HGV | 113 – 213 | 103 – 138 |
| 5 | Low pressure/high volume – combination | 110 – 318 | 120 – 210 |
| 6 | Low pressure/high volume – super combination | 340 – 770 | 138 – 180 |
| 7 | Low pressure/high volume – separate jumbo jetter/suction units | 340 - 700 | 137 – 170 |

*Note: maximum operating pressure for nozzles other than pencil type jets shall not exceed 340 bar

- (6) The Utility Surveyor/Contractor shall note the requirements as described in Clause 26.5.5.6(1) of this PS and shall apply the appropriate category jetting equipment including selection of suitable nozzle during the cleaning operation.
- (7) The Utility Surveyor/Contractor shall note that the performance of

cleaning of low pressure machines is severely reduced when the nozzle is submerged and the Utility Surveyor/Contractor shall reduce the flow in the drain so as to ensure maximum performance when such machines are in operation.

- (8) Where a jetting unit is fitted with airflow suction unit for removal of detritus from the drain, it shall be capable of removing materials such as sludge, silt and bricks from depths up to 10m with a minimum suction of 70m³/minute. A tank with minimum capacity of 5m³ shall be provided by the Utility Surveyor/Contractor and be capable of decanting off collecting liquors back to the drain. The suction hose of such a system shall have a minimum internal diameter of 150mm.
- (9) Jetting equipment shall be calibrated prior to commencing work on site by an approved body such as the supplier/distributor and calibration certificates made available for inspection by the Engineer upon request.
- (10) Such equipment, in particular the nozzles and pressure relief valves, shall also be maintained on a regular basis in accordance with the manufacturer's specification. The Utility Surveyor/Contractor shall make available to the Engineer on a monthly basis, copies of his maintenance certificates and/or schedules.
- (11) An automatic pressure relief valve shall be incorporated on the pump discharge chamber to prevent the pressure exceeding the safe maximum for the whole system. This may take the form of:
- a pressure relief valve or bursting disc in holder; or
 - an automatic pressure regulating valve (unloading valve).
- (12) The maximum working pressure is defined as the lowest value of the maximum working pressure ratings of all individual components of the system.
- (13) All systems shall also comply with the provisions laid down in UK document:
- "The Code of Practice for the use of High Pressure Water Jetting Equipment" published by the Association of High Pressure Water Jetting Utility Surveyor/Contractors, 1986 and subsequent revisions and amendments thereto.
 - The "Code of Practice for Sewer Jetting" published by the Water Research Council, 1997 and subsequent revisions and amendments thereto.
- (14) All High Pressure Water Jetting equipment shall be operated by qualified and trained personnel such as members of HKIUS.
- Standard Report 26.6 Form* (1) The Utility Surveyor/Contractor shall submit different survey report forms bound together as a Leakage Detection Report generated computer System as referred in PS Section 26 - **Appendix 26A**.

Quality Control for operator*Quality Control* 26.7*Procedures*(extracted from
UTI Manual of
Conduit
Condition
Evaluation
Code, Hong
Kong, 2004)**(1) General**

The accuracy of the coding system is highly reliant on the skill of the Surveyor/Operator who carries out the inspection and produces the report. A quality control system to continuously monitor the standard of coding is therefore required.

The Quality Control Procedure should be agreed with the Client, who should specify the level of accuracy required, prior to the commencement of any contract.

The system should measure the accuracy of reporting and in particular:

- The number of defects/features not recorded (omissions).
- The correctness of the coding and classification of each defect/feature recorded.

Reports may fail due to inaccuracies in either the Header or Observation Sections.

(2) Methodology

The following is a suggested format for self-assessment of the survey results and a measure for the ongoing professional development of the Surveyor. It should also be recognized that there is an element of subjectivity, which needs to be allowed for when reviewing the results. (Industry mean would be around 5%.)

- At the end of each week (or day if more appropriate), each surveyed length will be numbered sequentially in the order in which it was conducted and the total noted for each Surveyor.
- The sample surveys for quality control for each Surveyor are then to be selected by the use of computer generated random numbers or other such equivalent method.
- The number of lengths selected shall be 5% or min. of the total lengths surveyed.
- A copy of the relevant section of the video recording relating to the selected lengths should be retained by the contractor for future reference.
- Information on the length selected and its contents are entered on a survey selection log.
- All header information should be checked to ensure that entries are correctly entered.
- All codes or numbers should be checked to ensure that entries are

correctly used.

- All the compulsory fields completed.

The percentage of accurate entries should be determined and any that fall below the agreed threshold value should be rejected.

In checking the data section, each error/omission should be treated on an equal basis whether or not it is a minor or major error or omission. During the checking, each error/omission should be highlighted on the report from which the following totals are calculated for each report:

- The number of actual entries that should have been made.
- The number of actual errors/omissions made.

These totals should be entered on the right of the survey report being checked and the individual column totals should be entered on the survey log.

The accuracy of each survey is determined from:

$$\text{Accuracy} = \frac{\text{The actual number of entries} - \text{The number of actual error/omissions}}{\text{The actual number of entries}} \times 100\%$$

The result should be entered on the survey detail rating form.

It should be noted that all percentage points created by the control procedure should be rounded down to the nearest whole number.

(3) Interpretation of Results

Should a report of any survey length fail to achieve the specified standard, it should be recoded and the report of that length resubmitted.

In addition the coding of the five lengths completed immediately before and after the failed length should also be subjected to rechecking as part of an additional quality control check.

If there are any failed reports in this additional check, these should be recoded and resubmitted. Should any failure occur in the increased sample the selection should be increased by a further five lengths before and after, as above, until the required accuracy is achieved.

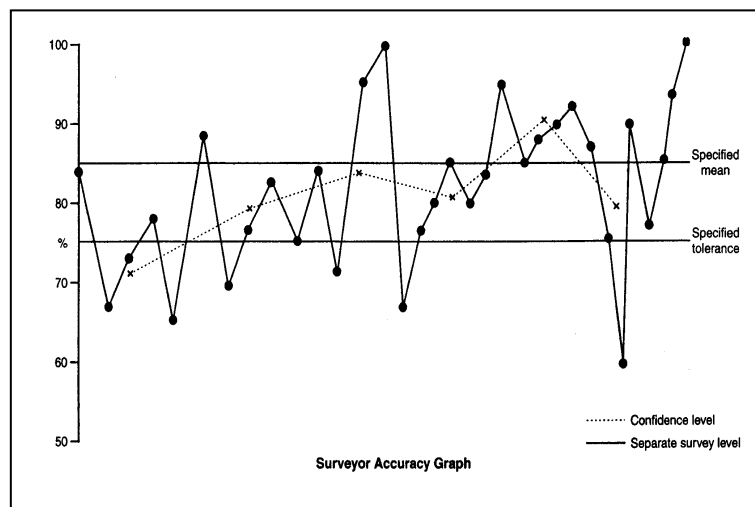
The ongoing accuracy of the Surveyor (the confidence level) should be calculated by taking the mean of each 5 percentage results (each 5 representing one control unit).

Both the individual survey percentages and the mean results should be entered on to the Surveyor's Accuracy Graph. This graph should have two boundaries:

- Specified mean – The level of accuracy expected.
- Specified tolerance – The level to which the accuracy can fall before specified action is taken

Any Surveyor whose quality control results fall below the specified accuracy on more than two occasions should be deemed to have failed his control criteria and should be subject to retraining before resuming duties.

SAMPLE OF SURVEYOR'S ACCURACY GRAPH



(C-SRM)

26.8. Deliverables

The Utility Survey Specialist shall supply the following for each site:

26.8.1 Preliminary Stage

- One set of preliminary digital data.
- One set of paper copy of drawings
- Control results, including simple description of permanent ground markers.
- One Copy of brief technical report.
- One set of photographs.

26.8.2 Interim Stage

- one set of interim digital data.
- one set of paper drawings in 1:100 scale
- one copy of interim technical report.

26.8.3 Final Stage

- 2 copies of Final Report which is a compilation of all deliverables required under interim stage to incorporate all comments provided by the Engineer.

26.9. Delivery Schedule

- 26.9.1** The Utility Surveyor shall supply for the Site preliminary digital data and paper check plots including a draft technical report with control results within one (1) week after the programmed completion of the works for the Site. The Engineer may direct the Contractor to submit preliminary reports of the Site during the execution of investigation, the Contractor shall submit the reports within 1 week after the Engineer has given such written instruction at no additional costs.
- 26.9.2** The Engineer shall return a copy of preliminary data with comments and correction progressively within one week of receipt of preliminary data. The Contractor shall incorporate the Engineer's comments on the preliminary data within the preparation of his Final Survey report.
- 26.9.3** The Utility Surveyor shall submit a Final Report for the investigation within 4 weeks after the completion date of the Works.

26.10. Electronic Data Files for Utility Services

- 26.10.1** The results of the investigation (layout plan only) shall be supplied in AutoCad R14 or above or DGN/GIS/IDMS format. All surface and underground features shall be located as described in Clauses 1 and 2. Non graphic information shall be included in the AutoCad or DGN/GIS/IDMS file database as block attributes or similar. All data shall be separated by type into a logical system of AutoCad or DGN/GIS/IDMS layers as approved by the Engineer.
- 26.10.2** The Utility Surveyor shall submit a schedule of AutoCad or DGN/GIS/IDMS standards to the Engineer for approval, which shall contain proposed division of investigation data into separate AutoCad or DGN/GIS/IDMS files and layers; naming conventions; symbol definitions and annotation.
- 26.10.3** Data files shall be labelled with the filename, number, extent, size, date of investigation, or revision, to be agreed with the Engineer.

26.11 Presentation of Drawings

1. The investigation results (layout plan only) shall be plotted in 1:100 scale or other scale to be confirmed in A1/A3 drawings on the specified grid and datum approved by the Engineer. The layout, border and title block shall be approved by the Engineer.
2. The drawings shall show building lines, roads with road names and traffic lane road markings, pavement and kerbs, and other significant physical features within the investigated area.

26.12. Preliminary and Final Report

The Utility Survey Specialist shall examine, analyse, process and interpret the investigation results and incorporate findings in a report. The report shall include the following essential information:

- (a) Introduction
 - Project name and Location
 - Site appreciation
- (b) Details of Investigation
 - Date of Investigation
 - Detailed description of the investigation procedure adopted
 - All equipment used for the investigation
 - Identification of supervisor and equipment operators carrying out the investigation
- (c) Investigation results
 - Summary of results(certified by O/MHKIUS)
 - Report on examination, analysis and interpretation of the investigation results;
 - Identification of utilities, chambers (including all manholes) and sub-surface anomalies (if possible by GPR survey);
 - Records of on-site verification of data handled by the qualified person (MHKIUS) responsible for the Report;
 - Report on difficulties encountered
- (d) Appendix
 - floppy diskettes or CDR for the digital data files of qualitative and numeric data about the underground assets found;
 - Engineering Drawings (updated) showing the types and location of various underground assets;
 - Survey Photographs -3R coloured photographs (prints and negatives/digital copy in JPEG format)

The drawings and textual report will be certified and stamped by the approved qualified person responsible for the preparation of the Report.

The Utility Surveyor shall supply the Survey Report as described fully as in the above. This report shall include all results with a detailed discussion and accompanying plans. It shall be prepared and signed by an qualified person who shall hold one of the following qualifications: -

- i) MHKIUS (CCE(CCTV&ME)) &
- ii) MICE, or MHKIE or MHKIS with 5 years relevant training and experiences,
- iii) A Degree in Civil Engineering from a British Commonwealth or equivalent University, plus a minimum of ten years' relevant training and experience in utility surveys.

26.13. Non-compliance: utility investigation result

- (1) The utility investigation survey result for a site shall be considered as not complying with the specified requirements if the position or level of any underground services reported in the preliminary stage deliverables does not comply with the requirements of Conduit Condition Evaluation Code, Hong Kong, UTI, 2005.
- (2) If the utility investigation result for a particular site does not comply with the specified requirements, the Contractor shall re-execute utility investigation in the area within a week from receiving notification by the Engineer. The Utility Surveyor shall submit the investigation result as deliverables defined in Clause 26.9-26.12. within 2 weeks from receiving notification.
- (3) If the utility investigation result again fails to comply with the specified requirements, the Utility Survey Specialist shall repeat the work specified until the result complies with the specified requirements. The costs for re-execution of utility investigation shall be borne by the Contractor.

Appendix 26A-Forms for CCTV Survey

- 1. CCTV Survey Form A- Summary of Works/Drainage Schedule**
- 2. CCTV Survey Form B-Summary of Defects**
- 3. CCTV Survey Form C- Long Hand Report (Computer Generated with Defect Codes, Scores and Grades)**
- 4. CCTV Survey Form C – Site Coding Sheet to be completed by O/M/FHKIUS**
- 5. CCTV Survey Form D – Defect or General Photos**

(Updated samples may be found in www.hkius.org.hk)