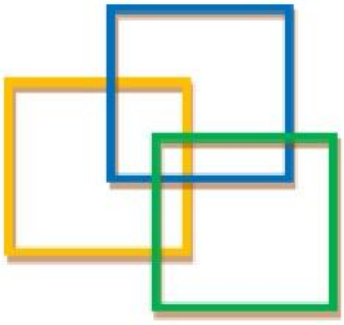
Hong Kong Institute of Utility Specialists
Non – profit Making Organization

Particular Specification For Water Leakage Detection Survey (WLD Survey)



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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 (BWCS) both on slopes and on the roads throughout the territory. As expected, this sequence of events generated an increasingly large pool of "Utility Specialists (US)", 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 before the establishment of HKIUS in 2002.

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 method statement, by addressing the following topics in general and where the abbreviation can be found in the Appendix:

(1) Utility Services Information to be Investigated
(2) Level of Accuracies
(3) Types of Deliverables and Schedules
(4) Requirements for Deliverables

You are welcome to take reference to this particular specification for your contract and in case you need further information, please send an e-mail to info@hkius.org.hk or call Ir Dr. King Wong.

Mr, Zico Kai Yip KWOK
(郭啟業先生)
President, HKIUS (2010-11)
April, 2011

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D1. Description

Utility Specialists shall conduct the preliminary visual inspection and LNC surveys at or between the two prescribed contact points to detect and find any leaks within the Survey Boundary. If LNC survey is found not suitable or could not produce a good result, the Utility Specialists shall carry out further leakage detection surveys by shortening (dividing the main into shorter segments) or shifting the contact points for the LNC surveys and by listening on top of the pipe and exposed features using other mechanical and electronic leak detectors (acoustic detectors) or carry the leakage detection work during midnight or low flow period until reasonable results.

The Utility Specialists shall perform further leak detection surveys at all associated branches of water mains within the corresponding Zone of Influence/survey boundary, and spikes found from the LNC surveys.

If the result from the LNC survey indicates a spike, the Utility Specialists shall carry out further leak detection surveys to verify the suspected leak. In case of the spike being found in the connection with other branch pipes, further leak detection surveys shall be performed to confirm the suspicions. Pinpointing by ELD/MLD for the suspected leaks is required unless otherwise instructed by the client not to carry out.

All LNC set up (contact) points and found leaks shall be marked on-site by red-paint with sufficient information confirmed with the client and photographed for inspection and record.

If contact points cannot be located or alternate contact points are desired, the Utility Specialists is responsible to propose in advance with a layout plan to the client to show the location of the new contact points. The Utility Specialists can break or extend the survey into a shorter or longer segment, but the necessity or request for modifications shall not affect the performance of the survey results.

Contact points include hydrants, accessible valves, exposed pipes, and others as find appropriate. The Utility Specialists shall be responsible to inform the client to expose water mains for creating contact points for LNC survey, if necessary for completion of the leakage detection, and to reinstate the site back to its original condition complying with Highway Department, Geotechnical Engineering Office or related Government departments' requirements and to the satisfaction of the Engineer.

D2. Survey Equipment

D2.1 Types of Equipment

The major equipment to be used for slope leakage detection Contract includes the following items:

(1) Leak Noise Correlators

(2) Mechanical Leak Detectors

(3) Electronic Leak Detectors

(4) Noise Loggers

(5) Pipe locators

(6) Color Closed Circuit Television (for further instruction from client)

Other equipment to be used for the Works includes the following items:

(1) Measuring tapes and wheels

(2) Flashing lights

(3) Spray paints

(4) Valve Keys

(5) Manhole cap opening tools

(6) Traffic diversion cones/signs

(7) Safety equipment (including multi-sequence warning indicator mounted on working vehicle of each leakage detection team)

(8) Chlorine/fluoride test kits and conductivity meter

(9) Sign boards

(10) Camera

Utility Specialists shall submit detailed equipment list to the client for approval before the commencement of the Works. Unless otherwise instructed by the client, the equipment used for the Works shall be approved by the client before any survey is carried out.

D2.2 Introduction of Equipment

Leak Noise Correlator

Leak Noise Correlator is a leak location instrument. It shall consist of two microphones (sensors), two hydrophones, and a corrlator. The microphone are attached to contact point while hydrophone are attached to the hydrants along the water main to be surveyed and

using the correlator to cross correlates the leak noise reaching two microphones to calculate the suspected position.

Mechanical Leak Detector

Mechanical Leak Detector is a passive device similar to doctor's stethoscope which transfers the leak noise to the Operator's ear directly through ground microphones.

Electronic Leak Detector

Electronic Leak Detector consists of a microphone, amplifier and frequency filter. The sound of leak is amplified and transmitted to either one of the headphones, loudspeaker or indicating meter electronically. Unwanted noise can be removed by electronic frequency filters.

Noise Logger

Noise Logger is a leak location instrument, which is installed at valves along the water main to be surveyed and using the receiver unit to receive the radio signal. The information can be downloaded into a computer to display the leak location.

D3. Survey procedure

D3.1 Leak Noise Correlator survey

Calibration, Planning and Preparation

(1) Check Record Plans, Traffic Permit and other information.

(2) Boundary Definition and Visual Inspections for valves, chambers and pits of different utilities.

(3) Safety precautions – PTW, TTA, PPE.

Operation

The Utility Specialists shall follow the equipment supplier's operation procedures and instructions to carry out the Leak Noise Correlator survey. The survey procedure shall be described, but not limited to, as the following:

(1) Connect two microphones (sensors) to the transmitter and processor at either side of the pipe under analysis. Contact points include exposed pipes, valves, hydrants and stopcocks.

(2) The signal from the transmitter shall be amplified and transmitted by radio telemetry to the processor automatically. The Utility Specialists shall apply different frequencies and filters to obtain the best accuracy results.

(3) Type of pipe material, pipe diameter, pipe length under investigation shall be entered into the correlator correctly to reflect the field measurement or as provided in the record Drawings.

(4) Sound propagator from the leak to each sensor. The processor compares this signal and determines the difference between the time taken from the leak to reach one sensor compared to the other, and the distance of the leak from the sensors at each end of the pipe shall be computed and the leak position shall be automatically indicated.

Report

The survey result shall be prepared in a professional manner by MHKIUS (WLD) and to include all necessary information including:

(1) Name of Operator(s), (A/O/M/FHKIUS)

(2) Location of Survey,.

(3) Date and Time of Survey,

(4) Total length of survey,

(5) Number of survey setups,

(6) Results (LNC print outs),

(7) Analysis of Results,

(8) Suspected or confirmed leak location with plan,

(9) Any difficulties encountered,

(10) Recommendations.

D3.2 Mechanic Leak Detector

Calibration, Planning and Preparation

(1) Check Record Plans, Traffic Permit and other information.

(2) Boundary Definition and Visual Inspections for valves, chambers and pits of different utilities.

(3) Safety precautions – PTW, TTA, PPE.

Operation

The general survey procedure of Mechanic Leak Detector are:

(1) The Utility Specialists is responsible to find the location and alignment of water main by using pipe locator for locating pipes if necessary.

(2) Use contact microphone to listen for leak sounds at meters, hydrants, valves and other points of direct contact.

(3) Place the sensing heads on the ground firmly against the surface.

(4) Move the sensing heads along the top of water main until the sound is the same intensity in both sensing heads and reaches both ears at the same time. This is the spot directly above the leak.

Report

Please refer to Clause D3.1 in this Particular Specification

D3.3 Electronic Leak Detector

Calibration, Planning and Preparation

(1) Check Record Plans, Traffic Permit and other information.

(2) Boundary Definition and Visual Inspections for valves, chambers and pits of different utilities.

(3) Safety precautions – PTW, TTA, PPE.

Operation

(1) Utility Specialists is responsible to find the location and alignment of water main. The Utility Specialists shall use pipe locator for locating pipes if necessary.

(2) Use contact microphone to listen for leak sounds at meters, hydrants, valves and other points of direct contact.

(3) Place the sensing heads on the ground firmly against the surface.

(4) Take readings along the top of water main at two meters interval. Listen to the sound, and adjust the filter for the highest response to the leak frequency to locate the leaks.

Report
Please refer to Clause D3.1 in this Particular Specification

D3.4 Noise Logger

Calibration, Planning and Preparation
(1) Check Record Plans, Traffic Permit and other information.

(2) Boundary Definition and Visual Inspections for valves, chambers and pits of different utilities.

(3) Safety precautions – PTW, TTA, PPE.

Operation
The survey procedure of Noise Logger shall be described, but not limited to, as the following:

(1) The Utility Specialists shall carry out the preparation works, visual inspection and seepage water sampling and reporting, etc.

(2) Install loggers to listen for leak sounds at appropriate locations of the pipe under analysis. The spacing between noise loggers shall not exceed 100m unless otherwise requested by the client.

(3) The data from the logger shall be transmitted by radio signal to the receiver. The logger shall be interrogated from a moving vehicle or human.

(4) The information shall be downloaded into a computer to display the leak position.

Report
Please refer to Clause D3.1 in this Particular Specification

D4. Quality Control and Quality assurance

D4.1 Result Confirmation

The quality control procedures and the level of accuracy shall be agreed with the client prior to the commencement of any contract. Quality control is essential to maintain the quality of the survey as well as the professionalism of the industry.

Surveys for investigating the buried water carrying services may involve the use of special equipment and techniques, specific knowledge is required for making judgment based on the information available. Employ qualified and experienced personnel to carry out the survey gives a certain level of guarantee on the quality of the survey. The personnel requirements of carrying out the surveys are stated in clause D10

The easiest and most direct way to verify the survey result of water leak detection is exposing the section of water main at the suspected leak location. As the sound cannot be retrieved in the office, the quality check shall be carried out on-site. The accuracy of the survey can be ensured by resurveying using alternative methods. Certain number of site check shall be carried out by other teams in random basis.

Confirmation of LNC result can be performed by exchanging the position of the blue and red transmitter and repeat the survey to see if the result/ the position of the suspected leak point agree with the previous one. Also, qualified leak detection specialists can be employed to reconfirm the leak position using mechanic leak detectors. Other methods like noise loggers can also be considered if appropriate.

D5. Deliverable

D5.1 Preliminary Stage

(1) One set of preliminary digital data.

(2) One set of paper copy of drawings.

(3) Control results, including simple description of permanent ground markers.

(4) One copy of brief technical report drafted by MHKIUS (WLD) and checked by RPUS

(5) One set of photographs.

D5.2 Interim Stage (where necessary)

(1) One set of interim digital data.

(2) One set of paper drawings in 1:100 scale.

(3) One copy of interim technical report drafted by MHKIUS (WLD) and checked by RPUS.

D5.3 Final Stage

2 copies of Final Report drafted by MHKIUS (WLD) and checked by RPUS which is a compilation of all deliverables required under interim stage to incorporate all comments provided by the Engineer.

C6. Deliverable

C6.1 Preliminary Stage

(1) One set of preliminary digital data.

(2) One set of paper copy of drawings.

(3) Control results, including simple description of permanent ground markers.

(4) One copy of brief technical report drafted by MHKIUS (WLD) and checked by RPUS.

(5) One set of photographs.

C6.2 Interim Stage (where necessary)

(1) One set of interim digital data.

(2) One set of paper drawings in 1:100 scale

(3) One copy of interim technical report drafted by MHKIUS (WLD) and checked by RPUS.

C6.3 Final Stage

2 copies of Final Report drafted by MHKIUS (WLD) and checked by RPUS which is a compilation of all deliverables required under interim stage to incorporate all comments provided by the Engineer.

D7. Electronic Data File for Utility Services

D7.1 Requirement of Data format

The results of the investigation shall be supplied in DWG/DGN/GIS/IDMS format. All surface and underground features shall be located as described in Clauses C4 in the Particular Specification for Utility Mapping for Non-Destructive Method. Non graphic information shall included in the DWG/DGN/GIS/IDMS file database as block attributes or similar. All data shall be separated by type into a logical system of DWG/DGN/GIS/IDMS layers as approved by the Engineer.

The Contractor shall submit a schedule of DWG/DGN/GIS/IDMS standards to the Engineer for approval, which contain proposed division of investigation data into separate DWG/DGN/GIS/IDMS files and layers; naming conventions; symbol definitions and annotation.

Utility services shall be recorded as continuous features between junctions, surface access points (e.g. stop valve or manhole) or changes in characteristic (e.g. pipe diameter/voltage). Completed lines and line strings the approval from the Engineer.

Data files shall be labeled with the filename, number, extent, size, date of investigation, or revision, to be agreed with the Engineer.

D7.2 Surface features

All surface features defined Clause C1 in this Particular Specification shall be shown in the correct 3D position in the file. Annotations shall be placed at the same z-value as the feature using the correct abbreviation. All surface features should be shown proportionally.

D7.3 Underground services

Underground services shall be recorded in three dimensions below each surface feature, at change of director and bifurcations, and with intervals not exceeding 10 metres. Other than at surface features, the location of the services run shall be marked as a cross at the 3D position at maximum 10 meter intervals. Depth below ground shall be annotated at each surface feature and at changes of depth. Annotation shall be placed at the same z-value as the recorded point. For example:

0.68d
…..X……

Where space permits at 1:100 scale, each service run shall be annotated with the type of utility, diameter of pipe or voltage or number of lines etc, at appropriate intervals.

D8. Presentation and Drawing

The investigation results (layout plan only) shall be plotted in 1:100 scale or other scale to be confirmed in A1 drawings on the specified grid and datum approved by the Engineer. The layout, border and title block shall be approved by the Engineer.

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.

D9. Preliminary and Final Report

Report shall consist of the followings:

(1) Introduction
   a. Project name and Location
   b. Site appreciation

(2) Details of Investigation
   a. Date of Investigation
   b. Detailed description of the investigation procedure adopted
   c. All equipment used for the investigation
   d. Identification of supervisor and equipment operators carrying out the investigation

(3) Investigation results
   a. Summary of buried utilities
   b. Report on examination, analysis and interpretation of the investigation results
   c. Identification of utilities, chambers, manholes and relevant surface installations
   d. Records of on-site verification of data handled by qualified person responsible for the report

(4) Appendix
   a. Floppy diskettes or CDR for the digital data files of qualitative and numeric data about the underground assets found;
   b. Engineering Drawings (updated) showing the types and location of various underground assets;
   c. Survey Photographs - 3R colored photographs (prints and negatives/digital copy in JPEG format)

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

The Utility Specialist 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:

(1) RPUS or MHKIUS (WLD) with two years local post qualification experience;
or the followings

(2) MICE, or MHKIE or MHKIS with 10 years experiences, each year 35 hours CPD training, and 14hours refreshment training every 3 years.

D10. Personnel Requirement

In order to maintain the Utility Profession's requirements for the consistency, reliability and accuracy of reports, inspection shall be performed by a properly trained and accredited personnel, for example, OMHKIUS or MHKIUS.

Personnel responsible for surveying and report preparation shall hold a certified qualification issued by a Registered Training Organization (RTO), such as Utility Training Institute (UTI) or The Hong Kong Polytechnic University or equivalent approved by HKIUS.

A certified qualification shall be:

Either Degree, Professional Diploma, Professional Certificate or equivalent approved by HKIUS in Utility Surveying and Management or related subject awarded by a RTO such as Utility Training Institute or The Hong Kong Polytechnic University.

Further information can be referred to the Appendix A2 in this PS.

References

(1) 16/WSD/97, Leakage Detection of Buried Watermains Affecting Slopes - Stage I, Water Supplies Department

(2) 3M Cable Locator User Manual

(3) Course Note, Advanced Water Leakage Detection/Survey for Operators, Engineer/ Specialists and managers, UTI, 2005

(4) DC96/19, Investigation of Sewers and Drains Behind and Adjacent Fill Slopes and Retaining Walls, Drainage Services Department.

(5) 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.

(6) Constitution, Hong Kong Institute of Utility Specialists(2011).

(7) King Wong (2000), The design of Water Leakage Detection Methods for Hong Kong. An unpublished Master Degree Thesis at The University of Hong Kong.

(8) Method Statement for Water Leak Detection, HKIUS, 2011.

(9) Sample report for Water Leak Detection, HKIUS, 2011

(10) W. Lai, S. Tsang & K. Wong, Applications of Ground Penetrating Radar in Civil Engineering Works, 2004

(11) Work procedures for Water Leak Detection, HKIUS, 2011

(12) Code of Practice on Monitoring & Maintenance of Water Carrying Services Affecting Slopes, ETWB (2006), Hong Kong SAR Government.

Appendix

A1 Abbreviations

Company/ Organization	
Code	Description
BD	Buildings Department, HKSARG
CEDD	Civil Engineering and Development, HKSARG
DSD	Drainage Services Department, HKSARG
EMSD	Electrical and Mechanical Services Department, HKSARG
EPD	Environmental Protection Department, HKSARG
HA	Hong Kong Housing Authority, HKSARG
HKIUS	Hong Kong Institute of Utility Specialists, HKSARG
HKURC	Hong Kong Utility Research Centre
HyD	Highways Department, HKSARG
LandsD	Lands Department, HKSARG
LD	Labour Department, HKSARG
PolyU	The Hong Kong Polytechnic University
UTI	Utility Training Institute
WRc	Water Research Centre
WSAA	Water Services Association Australia
WSD	Water Supplies Department, HKSARG
WTI	Water Training Institute
Others	
Code	Description
%	Percentage
BMP	Bitmap (Picture Format)
BWCS	Buried Water Carrying Service
CCE	Conduit Condition Evaluation

Company/ Organization	
CCE(CCTV & ME)	Conduit Condition Evaluation(Closed Circuit Television & Man- Entry)
CCES	Conduit Condition Evaluation Specialists
CCTV	Closed Circuit Television
CD	Compact Disc
CL	Cover Level
COP	Code of practice
CP	Competent Person
DN	Nominal Diameter
DP	Design Pressure
DVD	Digital Versatile Disc
e.g.	Exempli Gratia
GIS	Geo-Information System
EPR	Environmental Protection Requirements
etc.	et cetera
GL	Ground Level
H	Height
HKCCEC	Hong Kong Conduit Condition Evaluation Codes
HPWJ	High Pressure Water Jetting
hr	Hour
Hz	Hertz
ICG	Internal Condition Grade
ID	Internal Diameter
IDMS	Integrated Data Management System
IL	Invert Level
ISO	International Standards Organization
JPEG	Joint Photographic Experts Group (Picture Format)

Company/ Organization	
kHz	Kilo- Hertz
kPa	Kilopascal
m	Meter(s)
ME	Man Entry
MHICS	Manhole Internal Condition Survey
mm	Millimetre(s)
Mpa	Megapascal
MPEG	Motion Picture Experts Group (Video Format)
MS	Method Statement
MSCC	Manual of Sewer Condition Classification, UK
OHSAS	Occupational Health and Safety Assessment Series
PPE	Personal Protective Equipment
ppm	Parts per million
PS	Particular Specification
PSI	Pound Per Square Inch
QA/ QC	Quality Assurance/ Quality Control
Ref.	Reference
RMSE	Root Mean Square Error
RPUS	Recognized Professional Utility Specialist
RTO	Recognized Training Organization
SCG	Service Condition Grades
SOPs	Safe Operator Procedures
SPF	Sun Protection Factor
SPG	Structural Performance Grade
SRM	Sewer Rehabilitation Manual
STP	System Test Pressure
TTA	Temporary Traffic Arrangement

Company/ Organization	
US	Utility Specialist
VHS	Video High Speed
W	Width
WLD	Water Leakage Detection
WO	Works Order
WP	Work Procedure

A2 Requirements for Personnel Carrying Out Inspection

Training and Experience Requirements for Personnel Carrying Out Inspection (HKIUS standard, 2011)

Title	Role	Minimum Training Requirement	Minimum Years of Practical Experience	Qualification
Project Leader	Responsible for contract administration and preparation, checking and certifying of reports for compliance with the technical specification.	➤ At least 35 hours of CPD every year ➤ At least 14 hours for refreshment training in every three years ➤ Relevant training in RTO (e.g. PolyU, UTI) for surveys and data collection ➤ Has attended training courses for relevant survey/detection methods, and Possesses a valid training certificate for relevant survey/detection methods used	10 years in contract administration, preferably in works related to the inspection, survey and in data management.	Either: M/FHKIUS, RPUS plus CP, CW or MHKIE/ R.P.E. plus CP, CW and relevant training in RTO (e.g. PolyU, UTI) for surveys and data management
Deputy Project Leader	Responsible for assisting project leader and acting the post of project leader when project leader temporary not with the team	➤ At least 35 hours of CPD every year ➤ At least 14 hours for refreshment training in every three years ➤ Relevant training in RTO (e.g. PolyU, UTI) for surveys and data collection ➤ Has attended training courses for relevant survey/detection methods, and Possesses a valid training certificate for relevant survey/detection methods used	10 years in contract administration, preferably in works related to the inspection, survey and in data management.	Either: M/FHKIUS, RPUS plus CP, CW or MHKIE/ R.P.E. plus CP, CW and relevant training in RTO (e.g. PolyU, UTI) for surveys and data management
Team Leader	Responsible for works arrangement and data processing including checking of raw data for quality and consistency.	➤ At least 35 hours of CPD every year ➤ At least 14 hours for refreshment training in every three years ➤ Relevant training in RTO (e.g. PolyU, UTI) for surveys and data collection ➤ Has attended training courses for relevant survey/detection methods, and Possesses a valid training certificate for relevant survey/detection methods used	5 years in works related to the inspection, survey and in data management.	M/FHKIUS, RPUS, CP, CW
Crew Leader	Responsible for supervising the field works and site safety.	➤ At least 35 hours of CPD every year ➤ At least 14 hours for refreshment training in every three years ➤ Relevant training in RTO (e.g. PolyU, UTI) for surveys and data collection ➤ Has attended training courses for relevant survey/detection methods, and Possesses a valid training certificate for relevant survey/detection methods used	3 years in works related to the inspection, survey and in data collection	O/MHKIUS, CP, CW
Operators	Responsible for operating equipment and carrying out inspection and survey.	➤ At least 35 hours of CPD every year ➤ At least 14 hours for refreshment training in every three years ➤ Relevant training in RTO (e.g. PolyU, UTI) for surveys and data collection ➤ Has attended training courses for relevant survey/detection methods, and Possesses a valid training certificate for relevant survey/detection methods used	2 years in works related to the inspection, survey and in data collection.	AMHKIUS, CP, CW