



Hong Kong Institute of Utility Specialists

Incorporated as a Non – profit Making Organisation

Specification for Utility Mapping By Non-Destructive Methods

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HKIUS Guidelines for Requirements for Pre-Construction Existing Utilities 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 HK has awarded tens of millions of dollars in sum of contracts related to detection of utility services throughout the territory. As expected, this sequence of events generated an increasingly large pool of "underground Utility Specialists", 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

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.

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President, HKIUS (2007/09 & 2009/10)

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Requirements for Pre-Construction Existing Utilities Survey**Utility Services Information to be Investigated and Reported****1. Utility Services Information to be Investigated****1.1 Surface Features**

The Utility Specialist shall investigate all surface features relating to underground utilities, such as fire hydrants, valve chambers/pits, manholes, drawpits, inspection covers and gullies, including all street furniture connected to pipes and cables such as lamp posts, illuminated road signs and bollards, telephone booths etc. The footprint of such features at road or pavement level shall be recorded in three dimensions.

There is no requirement to re-investigate kerbs, back of pavement and street furniture which does not have a power supply or associated underground services.

1.2 Underground utility services to be investigated**All surveys need to be conducted by A/O/M/FHKIUS (US(PCL) &/or GPR)**

The Utility Specialist shall locate and identify all underground services within the sites to be investigated. The condition of services is not required to be investigated. Excavation is excluded, except where necessary to open existing covers.

Underground services shall be located continuously and recorded in three dimensions at intervals not exceeding 5 metres at discrete areas, or at intervals not exceeding 10m for survey along the road and at each surface feature, change of direction and bifurcation. Where bands of cables/ducts are identified, the upper and lower outer cables/ducts will be traced in order to be able to provide a cross section of the cable/duct band.

Depth below ground shall be annotated at each surface feature and at significant (more than 0.3m change) changes of depth. Annotations shall be placed at the same z-value as the recorded point. Where cable/duct bands are identified, notes will include the number of cable/ducts and configuration (e.g. 24 way – 6 across, 4 down).

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

The following services are required to be located, identified and described:

Surface water drainage

- all drains and drain connections with invert levels.
- all manholes which are within survey area and immediate upstream and downstream manholes outside the survey area.
- type and diameter of pipework.
- connections to storm/foul and combined water sewers.
- depth below ground shall be annotated at each surface feature and at significant changes of depth.
- internal dimensions of manholes and invert levels of manholes and their connection pies.

Foul sewerage

- all sewers and sewer connections with invert levels.
- all manholes within the survey area, and also immediate upstream or downstream manholes outside the survey area.
- type and diameter of pipework.
- connections to foul/storm and combined water sewers.
- depth below ground shall be annotated at each surface feature and at significant changes of depth.
- Internal dimensions of manholes and invert levels of manholes and their connection pipes.

Water mains (including cooling water mains)

- pipe routes including fire mains with levels.
- valve and meter pits.
- diameters and material specifications.
- classification (ie salt water, fresh water, cooling water, etc)
- owner/operator.
- connections to building.
- depth below ground shall be annotated at each surface feature and at significant changes of depth.
- dimensions and levels of the thrust blocks & concrete surrounds (if available)..
- Internal dimensions of valve and meter pits.

Telecommunications

- cable routes with levels, numbers and sizes of ducts.
- cable draw pits and manholes.
- owner/operator.
- connections to buildings.
- depth below ground shall be annotated at each surface feature and at significant changes of depth.
- number and configuration of cables/ducts.
- dimensions and levels of concrete surrounds (if available).
- internal dimensions of cable draw pits and manholes.

Ventilation ducts

- grilles and underground ventilation ducts including duct routes, levels and sizes.
- depth below ground shall be annotated at each surface feature and at significant change of depth.

Electricity

- cable routes and levels.
- cable draw pits and manholes including those associated with traffic control and street lighting.
- voltages classified as:
Low (0-11kv), High (over 11kv-66kv) and Transmission (132kv or over).
- connections to buildings.
- depth below ground shall be annotated at each surface feature and at significant changes of depth.
- dimensions and levels of concrete surrounds (if available)..
- internal dimensions of cable draw pits and manholes.

Cable TV

- cable routes with levels and junction boxes.
- connections to buildings.
- depth below ground shall be annotated at each surface feature and at significant changes of depth.
- dimensions and levels of concrete surrounds (if available)..
- internal dimensions of cable drawpits and junction boxes.

Combined services ducts

- internal box dimensions of ducts and access points.
- all pipes and cables identified and surveyed as for individual services.
- dimensions and levels of concrete surrounds (if available)..

Gas main

- pipe routes with levels;
- valve and meter pits;
- diameters, material specifications and working pressures;
- depth below ground shall be annotated at each surfaced feature and at significant changes of depth.
- dimensions and levels of concrete surrounds (if available)..
- internal dimensions of valve and meter pits.

Other services

- other services including abandoned services which are located during the survey shall be recorded with any available information regarding the identity or type of materials or services.

Annotations and Abbreviations

All underground utility services and associated surface feature shall be annotated as attributes in the digital/electronic computer drawings and on the hard copy drawings. Annotations shall be placed at the same z-value as the feature using the correct abbreviation. Annotations shall be provided in separate layers (one for each utility layer) to enable them to be switched on and off for presentation purposes.

2. Accuracies**2.1 Accuracy of surface features**

Accuracy of surface feature shall be in accordance with sub-clauses 2.4 to 2.6 inclusive.

2.2 Accuracy of location and survey of underground services

Underground services which can be located without excavation, such as cables and connected metal pipes which can be located by surface detection equipment, and drains, manholes, chambers and drawpits shall be located and investigated to the accuracies given below.

Underground services shall be located continuously and recorded in three dimensions at intervals not exceeding 5 metres at discrete areas or at intervals not exceeding 10m for survey along the road, and at each surface feature, change of direction and bifurcation.

The position and level of locatable services, at the recorded points and intervals defined above, shall be related to grid control points and bench marks to better than ± 100 mm root mean square error on the ground. 90% of a representative sample of points on locatable services shall be within ± 165 mm or 0.1d (depth) whichever ever is bigger.

Positions and levels shall be related to the specified grid and datum and shall normally be related to the centre of metallic pipes or cables, crown of ducts and inverts of sewers and drains.

Any known underground services or information which cannot be investigated to the accuracies stated above, other than by excavation, shall be entered in a unique layers defined as “unreliable”, as approved by the Engineer. The Utility Specialist shall itemise in his Reports the types of services which have been classified as “unreliable” and other circumstances, such as local areas of interference, where the specified accuracies cannot be achieved. The Utility Specialist shall make his best judgment to provide details of these “unreliable” services or information as requested by the Engineer. The Utility Specialist shall specify in the Report the reasons of such services or information cannot be investigated.

Wherever full details of underground services cannot be determined without excavation, these details shall be deduced from the utility undertakers’ record drawings and entered into the drawing in a unique layer defined as ‘records’.

Wherever access is available from the surface, the Contractor shall check the depth to underground services. Positions of exact measurements shall be noted as attributes in the Drawings.

2.3 Instruments

All instruments used in the investigation shall be recently calibrated and a copy of the calibration certificate shall be supplied to the Engineer.

2.4 Grid and Plan Control Accuracies

- (a) Plan control shall be calculated on a local Transverse Mercator Grid suitable for use as a plane rectangular grid with Scale factors not exceeding one part in 20,000.
- (b) Permanent Ground Markers shall be connected by a closed net.
- (c) The net shall be adjusted by ‘least square’ to obtain a best mean fit. Misclosures within the net shall not exceed one part in 20,000. For distances between adjacent Permanent Ground Markers of less than 300 metres, the maximum error shall not exceed ± 15 mm. Temporary survey stations for mapping shall be in sympathy with the nearest marker in the closed net to better than one part in 12,000.

2.5 Height Datum and Vertical Accuracies

- (a) All heights supplied by the Utility Survey Specialist shall be related to the latest published values of Hong Kong Principal Datum Bench Marks.
- (b) Permanent Ground Markers and Permanent Bench Marks shall be connected by a closed levelling net which shall be tied to a minimum of three Hong Kong Principal Datum Bench Marks.
- (c) Vertical misclosures within the leveling net and between Bench Marks shall not exceed: $\pm(12\sqrt{K})$ mm where K is the sum of the distance leveled in kilometres.
- (d) Principal Datum Bench Marks which exceed these tolerances shall be omitted from the adjustment.
- (e) The height difference between adjacent Permanent Ground Markers and Permanent Bench Marks shall not be in error by more than ± 5 mm when checked by precise leveling.

2.6 Accuracies, Tolerances, Errors and Corrections

Wherever accuracies or tolerances are specified herein, they are defined as Maximum Errors or statistically based Root mean square errors (rmse) as follows:-

Maximum errors

- (a) Maximum errors are only used for fieldwork misclosures and plotting of Map grids and control points.
- (b) All errors exceeding the maximum allowable tolerance including consequential errors, shall be corrected by the Utility Survey Specialist at his own expense.

Root mean square errors

- (a) The rmse are related to checks on representative dimensions or levels.
- (b) The following conditions have to be satisfied:
 - at least 67% of all readings must be correct to or better than rmse;
 - at least 90% of all readings must be correct to or better than 1.65 times the rmse;
 - all readings must be correct to or better than 3 times the rmse.

All readings not complying with the above three conditions, including consequential errors, shall be corrected by the Utility Survey Specialist at his own expense.

2.7 LIC Digital Maps

- (a) The Utility Specialist shall be provided the basic horizontal and vertical survey control plans and data from the Survey and Mapping Office of the Lands Department relating to the Site Area, check the given control point values and establish survey control networks based on the survey control obtained from the Survey and Mapping Office.
- (b) The Utility Specialist shall check the LIC digital maps provided by the Lands Department and verify and update (at 1/1000 or better standard relevant to the project area) the information contained therein as necessary in relation to the areas indicated on the drawings. The Utility Specialist shall maintain the information in the various different layers as provided in the LIC digital data.

3. Deliverables

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

3.1 Preliminary Stage

- (a) One set of preliminary digital data.
- (b) One set of paper copy of drawings.
- (c) Control results, including simple description of permanent ground markers.
- (d) One Copy of brief technical report drafted by MHKIUS (US(PCL) & GPR) and checked by RPUS (US(PCL) & GPR)
- (e) One set of photographs.

3.2 Interim Stage (Where necessary)

- (a) one set of interim digital data.
- (b) one set of paper drawings in 1:100 scale
- (c) one copy of interim technical report drafted by MHKIUS (US(PCL) & GPR) and checked by RPUS (US(PCL) & GPR)

3.3 Final Stage

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

4. Delivery Schedule

- 4.1 The Utility Specialist 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.
- 4.2 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.
- 4.3 The Utility Specialist shall submit a Final Report for the investigation within 4 weeks after the completion date of the Works.

5. Electronic Data Files for Utility Services

- 5.1 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 1 and 2. Non graphic information shall be 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.
- 5.2 The Contractor shall submit a schedule of DWG/DGN/GIS/IDMS standards to the Engineer for approval, which shall contain proposed division of investigation data into separate DWG/DGN/GIS/IDMS files and layers; naming conventions; symbol definitions and annotation.
- 5.3 Utility services shall be recorded as continuous features between junctions or surface access points (e.g. stop valve or manhole) or changes in characteristic (e.g. pipe diameter/voltage). Completed lines and line strings shall not be used without the approval of the Engineer.
- 5.4 Data files shall be labelled with the filename, number, extent, size, date of investigation, or revision, to be agreed with the Engineer.

5.5 Surface features

All surface feature defined Clause 1.1 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 to scale.

5.6 Underground services

Underground services shall be recorded in three dimensions below each surface feature, at change of director and bifurcations, and at intervals not exceeding 10 metres. Other than at surface features, the location of the services run shall be marked by a cross at the 3D position at maximum 10 metre 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.

5. Presentation of Drawings

1. The investigation results shall be plotted in 1:100 scale A1 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.
3. Cross-sections (minimum of 2) shall be provided as instructed by the Engineer to scale and shown at regular intervals, more frequently at points of change and congestion. Cross-sections shall show surface feature, underground utilities (size, depth and type), sub-surface anomalies (GPR Survey results analysed by MHKIUS(GPR)), pavement and kerbs, and other significant physical features.
4. A key plan of 1:1000 scale on each drawing to show the following:
 - (i) The location of the site.
 - (ii) The 1:1000 topographical map index in which the site is located.

6. Preliminary and Final Report

The Utility 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 buried utilities and radar anomalies
 - 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 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 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: -

- i) RPUS (US(PCL)) or MHKIUS (US(PCL) & GPR) with two years local post qualification exp. ; & one of the followings:
- ii) MICE, or MHKIE or MHKIS with 10 years relevant training and experiences; or
- 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.

7. 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 Clause 2.2.
- (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 Contractor shall submit the investigation result as deliverables defined in Clause 3. 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 in Clause 2 until the result complies with the specified requirements. The costs for re-execution of utility investigation in accordance with Clause 2 shall be borne by the Utility Specialist.