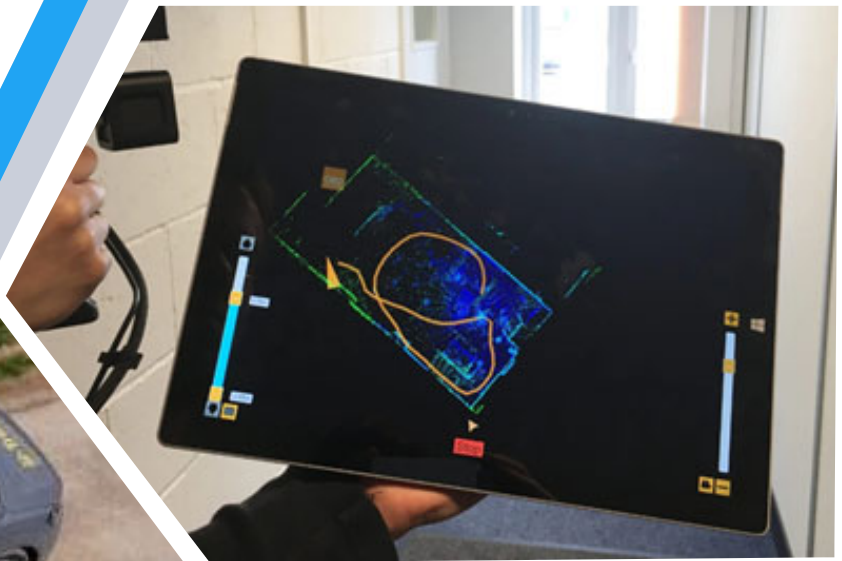




CONSTRUCTION
INDUSTRY COUNCIL
建造業議會



Reference Materials - Sample Specification for Provision of Surveying Services by a Mobile Mapping System with Laser Scanner

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PREFACE

The Construction Industry Council (CIC) is committed to seeking continuous improvement in all aspects of the construction industry in Hong Kong. To achieve this aim, the CIC forms Committees, Task Forces and other forums to review specific areas of work with the intention of producing Alerts, Reference Materials, Guidelines and Codes of Conduct to assist participants in the industry to strive for excellence.

The CIC appreciates that some improvements and practices can be implemented immediately whilst others may take more time for implementation. It is for this reason that four separate categories of publication have been adopted, the purposes of which are as follows:

Alerts	The Alerts are reminders in form of brief leaflets produced quickly to draw the immediate attention of relevant stakeholders to the need to follow some good practices or to implement some preventive measures in relation to the construction industry.
Reference Materials	The Reference Materials are standards or methodologies generally adopted and regarded by the industry as good practices. The CIC recommends the adoption of the Reference Materials by industry stakeholders where appropriate.
Guidelines	The Guidelines provide information and guidance on particular topics relevant to the construction industry. The CIC expects all industry stakeholders to adopt the recommendations set out in the Guidelines where applicable.
Codes of Conduct	The Codes of Conduct set out the principles that all relevant industry participants should follow. Under the Construction Industry Council Ordinance (Cap. 587), the CIC is tasked to formulate codes of conduct and enforce such codes. The CIC may take necessary actions to ensure compliance with the codes.

If you have read this publication, we encourage you to share your feedback with us. Please take a moment to fill out the Feedback Form attached to this publication in order that we can further enhance it for the benefit of all concerned. With our joint efforts, we believe our construction industry will develop further and will continue to prosper for years to come.

ABBREVIATIONS

BMMS	Backpack Mobile Mapping System
DMI	Distance Measuring Instrument
DSM	Digital Surface Model
DTM	Digital Terrain Model
FOV	Field of View
GNSS	Global Navigation Satellite System
HKPD	Hong Kong Principal Datum
INS	Inertial Navigation System
IMU	Inertial Measurement Unit
MMS	Mobile Mapping System
SLAM	Simultaneous Localisation and Mapping
VMMS	Vehicle-based Mobile Mapping System

1. INTRODUCTION

A mobile mapping system (MMS) equipped with a laser scanner can offer numerous benefits in surveying in comparison with the traditional surveying methods. It can improve data capture efficiency by acquiring a large amount of accurate and geo-referenced survey grade data within a short period of time. It is a more cost-effective surveying solution and can be adopted to reach inaccessible, hard-to-reach, or unsafe site areas where it might be difficult or impossible to obtain survey data by traditional surveying methods.

This publication presents sample specification clauses that can be adopted/adapted for the procurement of the surveying services by a MMS with laser scanner. It is written to provide reference materials for competent professionals in the preparation of contracts.

The sample specification clauses should be modified or added, where necessary, for the preparation of a particular specification, to suit the requirements of each individual project. Notes are given in italics against some of the clauses on the issues to be considered or factors to be taken into account in finalising the contract requirements.

Practitioners are encouraged to apply to the CIC to seek funding support under the Construction Innovation and Technology Fund (CITF²). Reference should be made to the CIC's CITF website on the pre-approved lists of technologies under the different categories (<http://www.citf.cic.hk/?route=search>). The website provides details of technological solutions that may be applicable in construction projects as well as information on relevant service providers.

As technologies advance rapidly, it is crucial to consult service providers on their latest technological solutions when preparing specifications. In particular, the italicised text in the specification clauses of this publication should be reviewed and updated, where appropriate. Appropriate functional requirements should be included in the specifications to meet the needs of the project and to derive value for productivity improvement and cost effectiveness.

² *The CITF was established by the HKSAR Government to encourage wider adoption of innovative constructive methods and new technologies in the construction industry. The CITF provides funding support to consultants, levy paying contractors, registered specialist trade contractors and registered subcontractors to adopt new technologies in their Hong Kong construction projects. For details, please refer to the CITF website at www.citf.cic.hk. Please note that application for CITF should be made before committing expenses. Technology will only be approved where it is found to meet the objectives of the CITF after assessment by the relevant Vetting Sub-Committee.*

2. SAMPLE SPECIFICATION CLAUSES FOR PROVISION OF SURVEYING SERVICES BY A MOBILE MAPPING SYSTEM WITH LASER SCANNER

2.010 General Requirements

- (1) The Contractor shall provide the services required himself or employ a competent service provider to provide the service.
- (2) The survey shall be conducted using the most appropriate system to meet the needs of the task required in terms of efficiency, safety and survey accuracy, and to comply with all relevant legal requirements. The system shall comprise, but not limited to: (i) a vehicle-based mobile mapping system (VMMS), (ii) a backpack mobile mapping system (BMMS), and/or (iii) a hand-held laser scanner. (*Note: Other than a car or a van as carrier of a VMMS, there are other transport devices equipped with laser scanners in the market such as smart dogs or unmanned aerial vehicles*).
- (3) The mobile mapping system (MMS) shall comprise laser sensors/scanners, and/or a camera system capable of carrying out 360-degree panoramic imaging where appropriate, a navigation system (e.g. Global Navigation Satellite System (GNSS), an Inertial Measurement Unit (IMU), and a Distance Measurement Instrument (DMI)), and a unit to control all these components and capable of synchronising the timing of all measurements and records of the collected data.

(Note: The Contractor shall be responsible for IT security if the mobile mapping system provided is connected to the Client's IT system. For government projects, the Contractor shall comply with the relevant Government IT security regulations, policies and guidelines.)

- (4) The MMS shall be capable of collecting raw data that can be processed to give point cloud data with the required accuracy. The point cloud data captured by the MMS shall have intensity values and Red-Green-Blue Colour (RGB) values.
- (5) The Contractor shall provide a MMS that is capable of carrying out data capture for the task required. The MMS shall not operate in raining conditions or during periods of Amber, Red or Black Rainstorms, or Typhoon Signal Number 3 or higher issued by the Hong Kong Observatory.
- (6) Within 15 working days of receiving an instruction from the Architect/Engineer to survey a facility / a group of facilities, the Contractor shall submit a site-specific method statement, which shall contain the following items for the Architect/Engineer's agreement:

(Note: The term "Architect/Engineer" may be changed to other terms to suit different project situations. For example, Supervising Officer, Contract Manager, and Appointing Party, etc., may be used as appropriate.)

- (a) Details of the MMS equipment and plant, which shall include a relevant calibration certificate of the whole system, including laser sensor(s) / scanner(s), INS, GNSS, camera system, all trajectory data, parameters of interior orientation of cameras and exterior orientation files of images, etc. If calibration of the equipment is carried out outside the Hong Kong SAR, necessary datum transformation parameters shall be provided.

- (b) The method for data acquisition at each survey location, which shall include design of the data acquisition routes, proposed speed of the mobile platform taking into account the safety requirements, the quality control process adopted, and the procedures for checking the MMS data quality to ensure achievement of the stated accuracy.
- (c) The method for carrying out the ground verification survey, which shall include details of the proposed Registered Professional Surveyor (Land Surveying), for the Architect/Engineer's agreement.
- (d) The method for data processing to obtain deliverables derived from the MMS data.

(Note: The deliverables may include a point cloud, digital terrain model (DTM), digital surface model (DSM) and 3D images, which meet the requirements to be specified by the Architect/Engineer).

(7) The minimum technical requirements of the equipment shall be as follows:

	Vehicle-based Mobile Mapping System (mainly for outdoor scanning or tunnel scanning)	Backpack Mobile Mapping System (for both indoor and outdoor scanning)	Hand-held Laser Scanner (mainly for indoor scanning and some specific outdoor scanning)
Components	GNSS+IMU+ DMI (optional)	GNSS+IMU or SLAM	IMU or SLAM
360° panoramic or spherical camera	Required	Required	As instructed by the Architect/Engineer
3D horizontal and vertical positional accuracy relative to ground control points	3D: $\pm 30\text{ mm}$	3D: $\pm 50\text{ mm}$ <i>(under open sky area)</i>	3D: $\pm 10\text{ mm}$ <i>(or as instructed by the Architect/Engineer)</i>
Field of view (FOV) of laser sensors	360°	360°	360°
Operation range	<i>At least 100m</i>	<i>50m to 100m</i>	<i>At least 10m</i>
Measurement rate	Up to 300 kHz, or as instructed by the Architect/Engineer	Up to 300 kHz, or as instructed by the Architect/Engineer	Up to 300 kHz, or as instructed by the Architect/Engineer
Laser classification	Eye safe (Laser Class 1)	Eye safe (Laser Class 1)	Eye safe (Laser Class 1)

- (8) The Architect/Engineer shall comment on the submitted method statement within 5 working days.
- (9) The Contractor shall commence field work within 15 working days upon receiving agreement from the Architect/Engineer on the method statement and an instruction to proceed.

- (10) The Contractor shall have *at least 5 years of experience* in performing surveys for inspection of facilities, which involve access through confined spaces.

(Note: This is needed only where access through confined spaces is required.)

- (11) The Contractor shall ensure that all requirements under the Personal Data (Privacy) Ordinance (Cap. 486) have been duly complied with in relation to the data/information collected.

2.020 Ground Verification Survey

- (1) The Contractor shall conduct a ground verification survey at each survey location to obtain checkpoint data for comparison with the MMS data for quality control purposes. The locations and number of checkpoints shall be agreed by the Architect/Engineer.

- (2) The required accuracy of the ground verification survey shall be subject to prior agreement with the Architect/Engineer.

(Note: The survey accuracy should be sufficient to achieve the objectives of the task required. Advice from a Registered Professional Surveyor (Land Surveying) should be sought if needed).

- (3) If required by the Architect/Engineer, the results and accuracy of the ground verification survey shall be certified by a Registered Professional Surveyor (Land Surveying) registered under the Surveyors Registration Ordinance (Cap.417).

- (4) The Contractor shall make all arrangements and obtain permissions as necessary to gain access to the checkpoints for conducting the ground verification survey, and shall carry out any remedial works at his own cost if found to be necessary. No tree felling shall be allowed.

2.030 Existing Condition Survey of Specific Facilities

- (1) Where required by the Architect/Engineer, the Contractor shall carry out an existing condition survey of the following facilities by MMS and the Contractor shall submit a works programme to the Architect/Engineer for approval before the commencement of the works:

Locations	Description of the facility / facilities to be covered at each location
<i>(List the required locations)</i>	<i>(List the facilities requiring existing condition survey by MMS and provide drawings.)</i>

- (2) A digital report to record, analyse and present the results of the completed survey shall be submitted. Videos and laser scans in MP4 format, if required, shall be submitted together with the report.

- (3) The facilities to be surveyed by MMS shall be as shown on the drawings provided by the Architect/Engineer.

2.040 Deliverables

- (1) The Principal Dataset shall contain point cloud data, raster format dataset, spherical panoramic images and a digital summary document as specified below. All spatial data shall be geo-referenced to the Hong Kong 1980 Grid System. Levels shall be marked relative to the Hong Kong Principal

Datum (HKPD). The Contractor shall obtain the prior agreement of the Architect/Engineer on the submission format of the deliverables.

- (2) The requirements for the Principal Dataset for each survey location shall be as follows unless otherwise agreed by the Architect/Engineer:
 - Post-processed survey data points in *LAS version 1.4 format* or a newer version as agreed by the Architect/Engineer.
 - Ground and non-ground point cloud data in .PTS format, .e57 format and/or .RCP format containing the co-ordinates, elevation, intensity values and RGB values.
 - Raster format dataset containing a Digital Terrain Model (DTM), a Digital Surface Model (DSM) and intensity values. Each model shall be provided in GeoTiff or JPEG format. Unless otherwise agreed by the Architect/Engineer, the raster model shall be provided with a *0.5 m* grid.
 - Spherical panoramic images with at least 7000 x 3500 pixels and an aspect ratio of 2:1 in GeoTiff or JPEG format for VMMS and/or BMMS shall be provided. If requested by the Architect/Engineer, the Contractor shall provide a software for data processing, viewing the spherical panoramic images and blurring human faces and car number plates.
 - Each data file shall be provided with a metadata file. The content and format of the metadata file shall be agreed by the Architect/Engineer.
- (3) The preliminary results of the ground verification survey and the results of the accuracy assessment of the MMS survey shall be in Excel format unless otherwise agreed by the Architect/Engineer.
- (4) Where required by the Architect/Engineer, the Contractor shall carry out integration of the MMS data with airborne LiDAR data to be provided by the Architect/Engineer.
- (5) The Contractor shall submit to the Architect/Engineer preliminary results meeting the requirements given in Clause 2.040 (1) to (4) *within 15 working days* after completion of the field work at each MMS survey location.
- (6) The Architect/Engineer shall provide comments on the preliminary results to the Contractor *within 10 working days* of receipt of the preliminary results.
- (7) The Contractor shall submit to the Architect/Engineer a digital copy of the Final Principal Dataset and a digital copy of the final report *within 15 working days* of receipt of all comments on the preliminary results for the survey location. The Final Principal Dataset shall meet the requirements for the Principal Dataset given above, corrected and updated as necessary.
- (8) The Contractor shall submit to the Architect/Engineer a digital copy of the Final Principal Dataset, and a digital copy of the final report in a hard-drive or other appropriate storage medium as agreed by the Architect/Engineer.
- (9) Unless otherwise agreed by the Architect/Engineer, the final report shall be in editable Acrobat format.

Enquiries

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