SCSI

Chartered property, land and construction surveyors

MEASURED SURVEYS OF BUILDINGS

1st edition, SCSI Guidance Note

RICS®

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Measured Surveys of *Buildings*
Guidance Note
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Contents

SCSI guidance notes

This is a guidance note. Where recommendations are made for specific professional tasks, these are intended to represent 'best practice', i.e. recommendations that in the opinion of SCSI meet a high standard of professional competence. Although members are not required to follow the recommendations contained in the note, they should consider the following:

When an allegation of professional negligence is made against a surveyor, a court or tribunal may take account of the contents of any relevant guidance notes published by SCSI in deciding whether the member had acted with reasonable competence.

In the opinion of SCSI, a member conforming to the practices recommended in this note should have at least a partial defence to an allegation of negligence if they have followed those practices. However, members have the responsibility of deciding when it is inappropriate to follow the guidance.

It is for each surveyor to decide on the appropriate procedure to follow in any professional task. However, where members do not comply with the practice recommended in this note, they have a good reason. In the event of a legal dispute, a court or tribunal may require them to explain why they decided not to adopt the recommended practice. Also, if members have not followed this guidance, and their actions are questioned in an SCSI disciplinary case, they will be asked to explain the actions they did take, and this may be taken into account by the panel.

In addition, guidance notes are relevant to professional competence in that each member should be up to date and should have knowledge of guidance notes within a reasonable time of their coming into effect.

Document status defined

SCSI and RICS produces a range of standards . These have been defined in the table below. This document is a guidance note.

Document status defined

Type of document	Definition	Status
Standard International standard	An international high level principle based standard developed in collaboration with other relevant bodies	Mandatory
Professional statement SCSI/RICS professional statement (PS)	A document that provides members with mandatory requirements or a rule that a member or firm is expected to adhere to. This term also encompasses practice statements, Red Book professional standards, global valuation practice statements, regulatory rules, SCSI/RICS Rules of Conduct and government codes of practice.	Mandatory
Guidance and information SCSI/RICS code of practice	Document approved by SCSI/RICS, and endorsed by another professional body/ stakeholder, that provides users with recommendations for accepted good practice as followed by conscientious practitioners.	Mandatory or recommended good practice (will be confirmed in the document itself). Usual principles apply in cases of negligence if best practice is not followed.
SCSI/RICS guidance note (GN)	Document that provides users with recommendations or approach for accepted good practice as followed by competent and conscientious practitioners.	Recommended best practice. Usual principles apply in cases of negligence if best practice is not followed.
SCSI/RICS information paper (IP)	Practice-based information that provides users with the latest technical information, knowledge or common findings from regulatory reviews.	Information and/or recommended best practice. Usual principles apply in cases of negligence if technical information is known in the market.
SCSI/RICS insight	Issues-based input that provides users with the latest information. This term encompasses thought leadership papers, market updates, topical items of interest, white papers, futures, reports and news alerts.	Information only.
SCSI/RICS economic/ market report	A document usually based on a survey of members, or a document highlighting economic trends.	Information only.
SCSI/RICS consumer guide	A document designed solely for use by consumers, providing some limited technical advice.	Information only.
Research	An independent peer-reviewed arm's length research document designed to inform members, market professionals, end users and other stakeholders.	Information only.

Preface

This first edition of **Measured Surveys of *Buildings*** is published by SCSI and prepared by the SCSI Geomatics Professional Group and a specialist Practice Standards and Specifications Working Group. This publication forms part of a series of specifications and guidelines intended to assist those connected with the requesting, purchasing and production of surveys and mapping material at large scales and high accuracies, by promoting good practice and avoiding the duplication of effort.

SCSI would like to thank the following main authors and reviewers of this first edition:

- Philip Mulreid MSCSI, Apex Surveys
- Ray Murphy MSCSI, Murphy Surveys
- Ben King FSCSI, Department of Communications
- Niamh O'Reilly FSCSI, Dublin Institute of Technology
- RICS Mapping and Positioning Practice Panel (MAPPP)
- RICS Geomatics Professional Group
- James Kavanagh MRICS, RICS, Director Land Group
- All participants in the extensive consultation process

The primary intention of this guidance note is to place the relationship and understanding between chartered surveyor and client at the core of any survey project. It is also hoped that it provides a reference document that supports downstream survey data users as well as enhanced collaboration processes such as BIM.

Unlike many survey specifications, this document is intended to provide guidance only and is not intended to be incorporated verbatim into the text of individual contracts. In particular, it requires choices to be selected throughout, thus making alternative choices inapplicable. Specification users are free to select the parts of the specification that are relevant to them to incorporate into their own specifications. However, the value of this specification is its structure, which will become familiar to clients and surveyors. Users should therefore ensure that they retain the order of clauses within their documents and acknowledge the SCSI/RICS as source where used.

Any comments or feedback on this document should be sent to info@scsi.ie and marked for the attention of the Geomatics Professional Group.

Measured Surveys of Buildings – Introduction

This measured survey specification is designed for use by land, engineering and measured building surveyors who are acting in an advisory capacity, and by survey-knowledgeable clients who specify their own surveys. This document should help clients to communicate what they require and expect to receive in terms of survey detail, accuracy, grid, types of survey, formats and final deliverables. It will help both parties to clarify related project information issues such as contacts, timescales, data management systems, site access, omissions and supply of existing information. It will assist in having a well-defined set of goals and expectations from a survey for all concerned.

It is recommended that the client and surveyor's initial meeting(s) or discussions in relation to completion of this specification are recognised as being of critical importance to the success of a survey project, and that if uncertainty exists on either side, it is highlighted and resolved before finalisation.

The first question should always be: What is the purpose of this survey?

A complete measured survey project specification is contained within this guidance note, and particular attention should be paid to the survey detail accuracy band table. The client can choose which features to include in the proposed survey in the relevant section.

Clients and surveyors should also pay attention to the notes and recommended good practice highlighted in boxes throughout this specification. These should be followed unless both parties have agreed it is not appropriate to do so.

Not all measured surveys may require a full specification, and where the client–surveyor relationships and expectations are mature, the shorter 'quick specification' may be sufficient. However, when specifying surveys all parties are expected to have sufficient competence in the land survey (geomatics) field.

1. Project information

The information given in the following clauses provides essential information needed for the project.

1.1 Project designation

The following are the main client references for this project:

Project name:	
Project reference no:	

1.2 Purpose of project

The project objective is to provide survey information to enable the following work to be carried out by the client:

1.3 Client/agent responsible for payment of works

On completion of the works payment shall be made by:	
Contact name:	
Position:	
Address:	
Phone no:	
Email:	

1.4 Survey location/extent of survey

The location and extent of the survey is shown:

The location and extent of the survey is shown on the following map(s) attached to this specification:	
The site contact name and contact details are:	

Should contact be made with the site contact prior to visiting site for tendering purposes? (Y/N)	

Recommended good practice

It is recommended that the client provides a digital map or plan of the survey extents in PDF, Google Earth (KMZ/ KML) and source computer-aided design (CAD) format which allows the surveyor to measure areas, distances, etc.

1.5 Survey schedule dates

The following are the proposed/key survey schedule dates as known at the time of specification issue (if not known, insert 'to be confirmed'):

Tender submission: (also include in cover letter or email)	
Award project:	
Lead time from award of contract to start date (weeks):	
Programme for delivery of the survey (weeks from start date):	
Other (please specify any interim deliverables etc.):	

1.6 Project contacts

1.6.1 Client

Client organisation name:	
Contact name:	
Position:	
Address:	
Phone no:	
Email:	

1.6.2 Client representative for matters concerning the project

Rep. organisation name:	
Contact name:	
Position:	
Address:	
Phone no:	
Email:	

1.6.3 Other (known local and statutory authorities, etc.)

Rep. organisation name:	
Contact name:	
Position:	
Address:	
Phone no:	
Email:	

1.7 Site access principles

The following site access principles apply to these works (select one of the following):

(a)	There is no specific limitation on site access and the surveyor need make no special arrangements.	
(b)	The surveyor shall inform the client in advance of the proposed access dates required, so that the client may make arrangements with the owners/occupiers.	
(c)	Other (specify)	

Recommended good practice

In all cases the client should provide a letter of introduction on request from the surveyor to facilitate site access and enquiries from landowners, including authorities. Should the surveyor encounter landowners/occupiers who deny access, he/she should retire politely and inform the client immediately. The client should ensure that confidential matters, and to whom letters of introduction cannot be shown, are clarified.

1.8 Site access requirements

Responsibility for the following site access requirements is as follows (NA if not applicable, some items are pre- selected, replace Y with N if not applicable).

Default requirements

It is the client's responsibility to ensure clear site access prior to the survey commencement. Clear site access includes relevant Local/Road Authority notifications, third-party notifications (e.g. householders), and removal of vehicles or obstacles from the survey area.

Requirement	By client	By surveyor	Comments
Keys to buildings/ gates	Y		
Industry safety cards, i.e. Safe Pass/ CSCS/SLG/PTS		Y	
Personal photo ID cards		Y	
Letters of appointment (which surveyors can produce to members of the public if required)	Y		

Non-typical requirements

Note
Will only be completed if specifically selected by the client and may add to the cost.

Requirement	By client	By surveyor	Comments
Garda clearance certificates*			
Security clearance certificates			
Site-specific permits			
Other (specify)			

**Such as criminal records certificates.*

1.9 Survey facilities

Responsibility for the following survey facilities are: (NA if not applicable, some items are pre-selected, replace Y with N if not applicable)

Default Requirements

Requirement	By client	By surveyor	Comments
Site Inductions (site procedures and health and safety)	Y		
Appropriate equipment and software to carry out the works		Y	
Traffic management		Y	

Note
It is mandatory that survey works on roads are carried out as per Chapter 8 of the Traffic Signs Manual.

Non-typical requirements

Note
Will only be completed if specifically selected by the client and may add to the cost.

Tick as required:

Requirement	By client	By surveyor	Comments
Office space/ co-location			
Security personnel			
On-site welfare (on-site toilets etc.)			
Temporary access equipment (Mobile Elevated Work Platforms etc.)			
Temporary lighting/ power			
Training courses (specify)			

1.10 Information to support project execution

Default requirements

Requirement	By client	Comments
Know site-specific hazards	Y	

Non-typical Requirements

Note
Will only be completed if specifically selected by the client and may add to the cost.

Tick as required:

Requirement	By client	By surveyor	Comments
OSI digital mapping for the survey area (digital – specify format)			
Imagery – satellite photography and/or orthophotography for the survey area			
Existing/previous survey information (specify)			
Supply of templates for deliverables			
Supply of templates for safety-critical document submissions			
Example survey deliverables			
Other (specify)			

1.11 Competency of survey staff

The surveyor is responsible for ensuring that his/her staff are qualified, competent, appropriately insured and trained to do the tasks for which they are engaged. Relevant qualifications can include professional and technical membership of SCSI and third-level qualification in surveying, geomatics or similar.

Surveyors responsible for setup of traffic management must hold valid Construction Skills Certification Scheme Signing Lighting and Guarding Card.

1.12 Calibration and checking of equipment

The surveyor is responsible for ensuring that all equipment is calibrated/verified and checked prior to use and maintained as such throughout the period of survey works, as well as ensuring it is fit for the survey purpose required.

Calibration certs of all equipment/instrumentation should be supplied to the client on request. Survey equipment should be calibrated as per the manufacturer's instructions, which is generally yearly for total stations but varies for other survey equipment.

1.13 Protection of property

The client should notify the surveyor of any restrictions in relation to the marking of survey control, vegetation clearance and security requirements. Surveyors should be aware of the potential damage that survey marking can cause to structures, underground utilities and the environment, and take appropriate steps to mitigate this.

Road marking spray	Y/N
Are there any restrictions with regard to using road marking spray etc. to mark up survey control points in outdoor locations on the site?	

1.14 Risk assessment and safety briefing

Unless expressly removed by written instruction, the surveyor is responsible for the preparation of method statements, risk assessments, and safety and associated documents prior to works commencement and for the safety of staff. The surveyor shall provide health and safety documentation to the client as indicated in the following table (tick as appropriate):

Document	Supply for info	Submit for client approval	Comments
Method statement			
Health and safety risk assessments			
Traffic management plans			
Photographic evidence of daily traffic management setup			
Other (please specify)			

The client is to provide the surveyor with any templates to be used for the above documents if required. Where client approval is specified, this shall be provided within one week. If no response is received within that time, the document will, by default, be deemed approved by the client.

Recommended good practice

Notwithstanding legal requirements, the client should notify the surveyor of any hazards known to him/her prior to the preparation of the risk assessment (e.g. asbestos, confined spaces, site works).

1.15 Traffic management

The requirements of the survey investigation may necessitate the works to be carried out on existing road networks and streets, and therefore require the preparation of a traffic management plan. The preparation of this plan must take cognisance of the Department of the Environment's *Traffic Signs Manual* (2010).

Minimum traffic management requirements as follows:

a) Traffic management plans to be submitted to the client prior to commencement of works on site.

b) Traffic management plans must be developed by a qualified person who has taken the Traffic Management Design Course (two-day course).

c) Implementation, supervision and removal of TM on site to be provided by a Signing Lighting and Guarding certified person (three-day course).

1.16 Client-identified project constraints

The following specific client constraints (e.g. working hours) will apply to the work carried out under this project (NA if not applicable):

Where constraints are identified by the client after commissioning of works these shall be communicated as soon as practicable to the surveyor and agreement sought on resolution/cost/impact.

1.17 Surveyor-identified project constraints

Any constraints identified by the surveyor must be raised in writing to the client during the tender period. Where constraints are identified after commissioning of works, these shall be communicated as soon as practicable to the client and agreement sought on resolution/impact/cost.

1.18 Obscured features

The surveyor will not be responsible for omission of details obscured during site survey dates unless action for clearance in advance has been agreed. This may include:

a) Features obscured by vegetation, debris, snow, sand, earth, when working outside and plaster, cladding, carpet, etc. when working inside buildings

b) Features obscured by vehicles, trailers, temporary covers, stacked materials

c) Features inside buildings obscured by coverings, furniture, fixtures and fittings

d) Features inside inspection covers/manholes/chambers obscured by debris, blockages (where internal chamber survey details are requested in the scope)

e) Features obscured by flooding when undertaking non hydrographic surveys

f) Features omitted due to lack of adequate lighting or physical access (i.e. at height)

g) Setting out of points where the placement of appropriate markers is restricted due to obscuration, lack of permission, impermeable or unmarkable surfaces

h) Other (specify)

1.19 Action to reduce/remove obscured features

Actions for reducing or removing obscured items are:

	Y/N
Should be identified by the surveyor and shall be communicated as soon as practical to the client and agreement sought on resolution/ impact/cost:	
Other (specify)	

1.20 Access issues

The surveyor shall advise the client of any access restrictions or related issues that could have an impact on the survey requirements or deliverables. The surveyor should notify the client as soon as practical of such issues and ensure that all reasonable steps are taken to reduce adverse impacts.

Additional cost may apply for unforeseeable factors such as:

a) Any change in site conditions from previously advised

b) Any delays on site through no fault of the surveyor

c) Access restrictions or limitations

d) Revisits to survey areas that were inaccessible at the time of survey

e) Lost time due to site induction requirements

f) Previously unknown features that require more detailed investigation

g) Locally requested changes to the survey extents or additional or amended works requested while on site

1.21 Survey records retention

The surveyor shall retain survey records for this number of years: (recommended seven)	

Recommended good practice

It is recommended that surveyors keep copies of all survey records, including those obtained from other parties, for a period of no less than seven years. Surveyors and clients should take note of any legal or quality management system requirements to retain records when deciding on this option.

1.22 Data ownership

Recommended good practice

Surveyors shall also observe any legal requirements for records preservation, client confidentiality and protection and ensure that adequate storage and security systems are in place to avoid loss or unauthorised access to records.

1.23 Cost for supply of records

Where the surveyor is requested by the client to make accessible all or part of his/her survey records, which are not included as deliverables, the surveyor shall make these available at an agreed cost.

Once it is agreed, the surveyor shall confirm the access lead time by agreement with the client no more than one. week after formal request, with information to be provided within one month of request date.

2. Survey accuracy, control, coordinate grid and datum

2.1 Survey accuracy banding

The survey detail accuracy band shall be used to define what accuracies are to be achieved for different surveyed features independent of plot scale.

Where a client requires a bespoke or customised accuracy band(s), he/she shall complete row(s) for custom accuracy in band X Y for plan and band Z for height on the table and insert a prefix for the band within which it falls.

All accuracies quoted within the accuracy band table are taken as the accuracy of individual survey points relative to the survey control points. Verification of the survey detail accuracy by site checks must include measurement to or from survey control.

Relative accuracy between survey detail points shall be subject to the accuracy of each detail point's banding combined, plus the control parts per million (PPM) multiplied by the distance in excess of 100m between the points. This can be calculated by squaring the standard deviation of each survey detail point's relevant band accuracy, adding them together and then taking the square root of the total to establish the relative accuracy, i.e. $\sqrt{(\sigma 12+\sigma 22)}$ plus the distance minus 100m multiplied by the specified control PPM.

For example, the relative plan positional accuracy between a band B point and a band D point, located 200m apart and surveyed from survey control specified with 20 PPM, will be: [√(42+102)]+[((200m-100m)*1/50000)]=[11]+[2]=13mm.

2.2 Survey detail accuracy band table

The accuracy band table does not determine the level of detail shown for each feature, although it does indicate the minimum size of a feature that will be shown true to scale (true shape/geometry) and not symbolised. Clients may customise this if appropriate to their needs. In general, features will be surveyed by the minimum number of points required to show their geometric position or extents. For example, a tree can be described by a centre point with trunk diameter, spread diameter and a ground and crown level or height. Clients should seek advice from their survey consultant to ensure the correct levels of detail on a feature are surveyed, and to ensure this is consistent with the type of survey outputs requested (i.e. computer-aided design (CAD) model, imagery, scanned point cloud, bespoke measurement, etc.).

The accuracy values stated in the table show both 1 sigma (standard deviation/error) and 2 sigma values. 1 sigma accuracy means that 68% of normally distributed observation residuals will fall within the band value shown for 1 sigma, with 95% falling within the 2-sigma value. Using sigma accuracy it can be noted that 99.7% of observations will fall within 3 times the 1 sigma value.

Clients should select an accuracy band that suits their accuracy and confidence requirements. For example, a client requiring 10mm plan accuracy at 95% confidence interval should select a band C survey (i.e. +/- 10mm at 2 sigma or 95% confidence).

Recommended good practice

Clients should seek advice from a chartered land surveyor on the implications of the chosen accuracy band in relation to cost and quality, to ensure that the accuracy bands chosen are suitable for the survey outputs and intended survey data uses.

Plan accuracy (X,Y)			Height accuracy (Z)[1]			
Band	**1 Sigma**	**2 Sigma**	**Band**	**Accuracy hard detail**	**Accuracy soft detail**	**Example survey types/uses[2]**
A	+/- 2mm	+/- 4mm	A	+/- 2mm	N/A	Monitoring, high-accuracy engineering setting out and fabrication surveys
B	+/- 4mm	+/- 8mm	B	+/- 4mm	N/A	Monitoring, high-accuracy engineering and measured building surveys and setting out
C1	+/- 5mm	+/- 10mm	C1	+/- 5mm	N/A	Engineering surveying and setting out, high-accuracy measured building surveying, heritage recording
C2	+/- 10mm	+/- 20mm	C2	+/- 5mm	+/- 25mm	Engineering surveying and setting out, high-accuracy measured building surveys, high-accuracy topographic surveys
D	+/- 10mm	+/- 20mm	D	+/- 10mm	+/- 25mm	Engineering surveying and setting out, measured building surveys, high-accuracy topographic surveys, boundaries, area registration
E	+/- 25mm	+/- 50mm	E	+/- 10mm	+/- 50mm	Measured building surveys, topographic surveys, lower-accuracy setting out, net area surveys, valuation surveys, area registration
F	+/- 50mm	+/- 100m	F	+/- 50 mm	+/- 100mm	Low-accuracy measured building surveys, topographic surveys, high-accuracy utility tracing, gross area surveys
G	+/- 100mm	+/- 200mm	G	+/- 50 mm	+/- 100mm	Topographic surveys, low-accuracy measured building surveys, utility tracing surveys, boundary mapping
H	+/- 250mm	+/- 500mm	H	+/- 125mm	+/- 250mm	Low-accuracy topographic surveys, national urban area mapping, geotechnical mapping, tree surveys
I	+/- 500mm	+/- 1000mm	I	+/- 500mm	+/- 1000mm	Low-accuracy topographic mapping, national non-urban mapping, general boundary mapping, asset mapping
J	+/- 1000mm	+/- 2000mm	J	+/- 1000mm	+/- 2000mm	Large-area GIS asset mapping
X Y	(Custom)		Z	(Custom)	(Custom	Note: To create a customised band, please select the band letter required and add as a prefix to XY or Z (i.e. +/- 125mm plan = G-XY)

[1]Multiply by 2 for 2 sigma values. [2]Example survey types/uses – The table includes examples for users of the types of survey and output that may be suitable for different accuracies. However, this is not an exhaustive list of examples nor fixed to each band.

Default accuracy band selection

The default topographic survey detail accuracy band for this project will be:	

Recommended good practice

Survey features captured at bands A, B and C are generally considered to involve additional work and may incur additional cost. The methods of survey required are dependent on the survey band selected. It should be remembered that all surveys shall be connected to a local and/or national grid system.

Note

For reference the ***Topographic Specification for Urban Projects*** states the following:

The relative accuracy of the plan position of critical detail and well-defined features shall, when checked, not exceed ± 25mm.

The relative accuracy of the plan position of soft, less well-defined features and vegetation shall, when checked, not exceed ± 50mm.

A tolerance of 95% will be used as the acceptance criterion for the relative accuracy of plan position. All coordinates shall fall within 3 times the above values.

2.3 Survey coordinate reference system

The survey shall use the following coordinate reference system in plan (select one of the following):

Irish Transverse Mercator (ITM)	
Irish Grid (IG)	
An existing local grid for which there are existing survey control points	
A site grid based on existing site features (e.g. a building grid). Give details:	
An arbitrary grid proposed by the surveyor.	
Other (specify)	

Recommended good practice

The selection of grids, height datum and transformation of coordinates is often a complex matter that may have serious technical and financial implications for a project. The client should seek advice from a chartered land surveyor if necessary.

SCSI recommends the use of the ITM coordinate system where possible as this is the most accurate and consistent national coordinate system.

Clients should be aware of the scale factor and its possible impact on the survey. If in doubt, consult a chartered geomatics surveyor.

Where a survey control network is tied into or based on pre-existing survey control points, the source of the coordinate values, expected accuracy, hierarchy and reference grid and height datum shall be confirmed by the client and verified by the surveyor. The surveyor shall notify the client of any discrepancies in supplied control or transformation values that exceed required accuracies and provide advice on potential implications or solutions to resolve them.

The survey shall use the following height (vertical) datum (select one of the following):

Surveyed heights (levels) shall be orthometric and quoted in metres above Malin Head (OGM15).	
Surveyed heights (levels) shall be orthometric and quoted in metres above a datum defined by the client.	
Surveyed heights (levels) shall be orthometric and quoted in metres above a datum defined by the surveyor (this option could apply, for example, to a building, where the datum might be a floor level).	

Recommended good practice

It is recommended that all surveys should be related to the national height datum (Malin Head).

From 26 August 2016, the geoid model on which onshore mapping in Ireland is based has changed from OSGM02 to OSGM15, therefore all heights related to Malin Head datum have changed.

Malin Head levels from surveys prior to 26 August 2016 (using OSGM02) will not coincide with levels surveyed using the new OSGM15.

You should be aware that there was a crossover period of approx. six months when both OSGM02 and OSGM15 were in use.

OSGM15 is now the geoid for Ireland and should be used for all future surveys.

2.4 Connection of chosen survey grid to other coordinate reference systems (where applicable)

This section only applies where there is a requirement to connect an existing legacy coordinate system to ITM, ING or other specific coordinate system.

The client requires that (select one of the following):

The surveyor shall use transformation formulae provided by the client when converting between the survey grid specified and other specified coordinate system.	
The surveyor shall observe and compute transformations between the survey grid specified and other specified coordinate system.	

2.5 Survey control network

The surveyor shall establish survey control points that shall be linked together by a network of observations to realise the survey grid on the ground. This network shall include all types of observations required to establish plan and height control and provide sufficient redundancy in observations to allow proof of accuracy.

Background information

A network can include conventional traversing but should also include cross-bracing and self-checking geometry to ensure that geometric weaknesses are mitigated and required accuracy is maintained throughout the network. These observations can include links to national or global survey control networks, allowing a coordinated survey control point to be geospatially linked or transformed to national or global coordinate systems.

All survey control point network observations, regardless of observation method, shall be computed and adjusted rigorously using the most appropriate technique to ensure that the survey control accuracy is achieved, and supports the detail accuracy as defined in the accuracy band table and survey detail specification.

Recommended good practice

Where national grid control is relied on for dynamic survey capture (i.e. mobile surveying systems), specific survey control points local to the survey extents shall be established to verify the accuracy of the surveyed detail and/or control the trajectory of the survey sensor.

2.6 Survey control plan accuracy

The surveyor should use appropriate equipment and techniques to achieve the accuracies required.

Survey control plan accuracy is specified as a minimum between adjacent points (+/- mm) less than 100 metres apart and a ratio or PPM for points over 100 metres apart up to a maximum distance.

Where a survey control network is established, it shall be observed and adjusted to achieve the following plan accuracy in the following hierarchy:

Hierarchy	Plan accuracy (x/y)
Primary control	
Secondary control	

Note

For reference, the ***Topographic Specification for Urban Projects*** states the following.

The relative accuracy between permanent survey control stations shall, when checked, not exceed 1 part in 30,000 for distances exceeding 150 metres. For shorter distances the relative accuracy should be not exceed ± 5 mm.

The absolute accuracy of any permanent survey control station shall, when checked, not exceed ± 25mm.

Recommended good practice

The survey control should be established to a higher accuracy than the detail. For example, detail accuracy band D requires accuracy of +/- 10mm on hard detail, therefore the survey control used to survey hard detail should have a greater accuracy than +/- 10mm.

Recommended good practice

It is recommended to establish survey control in a hierarchy from primary to secondary to tertiary (first, second or third order) etc. working from the whole to the part (i.e. establish primary control over the full extents of the survey followed by the addition of secondary/second-order points etc. to increase density of survey control points for survey detail observation purposes).

The surveyor shall ensure that the required accuracy and suitability of survey control points and traverse/network observations have been met prior to processing of survey detail observations. The client and surveyor should consider survey control accuracy requirements for the life cycle of a project including future phases that may require a higher accuracy (i.e. setting out, monitoring).

2.7 Survey control height accuracy

Survey control height accuracy is specified as a minimum between adjacent points (+/- mm) less than 100 metres apart and a ratio or PPM for points over 100 metres up to maximum distance.

Where a survey control network is established, it shall be observed and adjusted to achieve the following height accuracy in the following hierarchy:

Hierarchy	Height accuracy (z)
Primary control	
Secondary control	

Recommended good practice

The survey control should be established to a higher accuracy than the detail. For example, detail accuracy band D requires accuracies of +/- 10mm on hard detail, therefore the accuracy survey control used to survey hard detail should be greater than +/- 10mm.

Recommended good practice

When tying into national grid or global survey control, it is recommended that the tie-in should include observations to sufficient numbers of national or global survey control reference points within and surrounding the survey area.

Where use of mobile survey capture systems is envisaged (i.e. vehicle mounted systems), the trajectory path and adjustment files of sensors must be recorded and evidenced to prove the achievement of survey detail accuracy. In such cases sufficient secondary and tertiary survey control points shall be established within the survey for ease of verification.

For high-precision height datum establishment it is common for specialist markers to be used which may require specific adapters. Any use of such markers should be agreed in detail with the client.

Note

For reference, the ***Topographic Specification for Urban Projects*** states the following.

The relative accuracy of heights between any two site benchmarks shall, when checked, not exceed ± 10mm × k, where k is the square root of the distance in kilometres between the points being considered, or ± 5mm, whichever is the greater.

The absolute accuracy of the one permanent control station held fixed, when checked, shall not exceed 20mm.

2.8 Survey control outputs

The following table confirms the survey control outputs required:

Description of output	Y/N
Survey control report in PDF version to include the following: • Station location diagrams • Station location photographs • Survey control coordinate list • Survey control observation adjustments • Survey control network diagram • Survey control levelling observations and reductions (if applicable) • Survey control levelling network diagram (if applicable) • Survey control grid and datum definition/s and transformations between other systems where requested (if applicable) • Survey control tie-in report showing connections to existing survey control and misclosures or changes to legacy values (if applicable)	
Primary stations to be included on AutoCAD drawing	
Survey control reporting not required	

Recommended good practice

Survey control may be observed simultaneously with observations to detail but should always be computed before computing detail observations. The surveyor should ensure that the control is systematic and gross error-free and conforms to the accuracy specification before computing detail observations. If the surveyor fails to do this, he/she runs the risk of having to re-compute the detail survey should an error be found subsequently in the control survey.

2.9 Survey control marker locations

Permanent markers for survey control shall not be placed so that they present a health and safety hazard to people or animals or cause damage to property or equipment. Clients shall be consulted if any doubt or difficultly arises.

The surveyor shall locate permanent markers for survey control (select one of the following):

As required for the survey at the surveyor's discretion	
As required by the client and confirmed in advance to the surveyor. Method of confirmation will be: (please specify)	

In certain environments (railways, heritage, industrial/commercial buildings), installation of permanent markers may be strictly controlled. Clients and surveyors should ensure that any such constraints are reconciled with the survey control permanent marker requirements and locations and clearly understood.

Recommended good practice

It is good practice to ensure that the survey control points are located in stable locations with good inter-visibility to other points on the network (for measuring angles) and are likely to be free from disturbance (particularly construction works).

When setting up survey control points for monitoring surveys, it is essential that sufficient primary points are located outside any zone of influence of expected movement. The same may be appropriate for all survey works where subsequent site changes are likely to cause substantial loss or disturbance to the survey control network points.

2.10 Survey control marker types

The following requirements for survey control marker type selection shall be followed (select one of the following):

The surveyor shall use his/her discretion to select the most appropriate marker type for all survey control points noting the examples shown in ***appendix A***	
The following types of markers (see examples in ***appendix A)*** shall be used for primary control:	

Recommended good practice

If using specialist marker types that require specific adapters etc., these should be detailed in the specification and/or confirmed by the surveyor in the survey report to ensure future compatibility/usefulness.

If survey control is taken from existing site features, it should be of sufficient stability and definition (plan and height) to allow verification of the survey control accuracy requirement.

2.11 Survey control maintenance

The following are the survey control maintenance requirements (select one of the following):

It is not expected that survey control will be disturbed, therefore the surveyor should install in practical locations where disturbance is least expected to occur.	
The client shall take full responsibility for the protection and maintenance of survey control points post installation.	
Other (specify)	

Recommended good practice

Clients should consider in a Survey Strategy, or otherwise, the ongoing need to maintain and replace survey control points, particularly where changes are inevitable as part of planned works. Clients should allow for verification and update of survey control at various stages in a project life cycle including prior to setting out, construction works, final as-built surveys and project hand back.

Clients should also consider any need for densification or improvement of survey control if tasks require higher accuracies than those initially anticipated at commissioning (such as for monitoring works).

2.12 Survey control point records

Regardless of the survey control output requirements, the surveyor shall record the following in relation to survey control permanent markers or reference points:

a) control point hierarchy, accuracy and name
b) plan coordinates and grid

c) height value and datum
d) type of marker
e) photograph of marker and location
f) sketch or plan with dimensions (to 1cm resolution) to adjacent visible features.

Supply of survey control records can be confirmed in the survey outputs table and the format in the deliverables section ***(section 4).***

Recommended good practice

Where use or tie-in to existing survey control points has been specified, a similar list of information defining the existing survey control points should be supplied by the client where available.

3. Measured building surveys

This section of the specification refers to the internal and external survey of standing buildings or structures.

This section will be used by the client to specify which measured building survey features will be surveyed and to what accuracy band, as stated in the survey detail accuracy band table at ***section 2.***

3.1 Accuracy

3.1.1 Default accuracy band

The default topographic survey detail accuracy band for this project will be: *(skip if already stated at section 2.2)*	

Recommended good practice

Survey features captured at bands A, B and C are generally considered to involve additional work and may incur additional cost. The methods of survey required are dependent on the survey band selected. It should be remembered that all surveys shall be connected to a local and/or national grid system as outlined in ***section 2***.

3.1.2 Survey control accuracy

Survey control plan accuracy

Hierarchy	Plan accuracy (x/y)
Primary control *(skip if already stated at section 2.6)*	
Secondary control *(skip if already stated at section 2.6)*	

Survey control height accuracy

Hierarchy	Height accuracy (z)
Primary control *(skip if already stated at section 2.7)*	
Secondary control *(skip if already stated at section 2.7)*	

Recommended good practice

The survey control should be established to a higher accuracy than the detail. For example, detail accuracy band D requires accuracies of +/- 10mm on hard detail, therefore the accuracy survey control used to survey hard detail should be greater than +/- 10mm.

3.1.3 Point spacing

The spacing/resolution of surveyed detail points on digital terrain model (DTM) features shall be such that any point interpolated on the DTM is correct to within twice the specified accuracy band of the surveyed features.

The maximum distance (point spacing) in metres between surveyed points shall be: *(excludes curved features, which will require tighter point spacing)*	

Recommended good practice

1:500 surveys are often required for rural environments, with 1:250 for urban environments.

1:500 surveys generally require point spacing of 15m.

1:250 surveys generally require point spacing of 10m.

There is generally not much benefit to reducing point spacing below 10m and this adds significant cost to the survey.

3.2 Measured building survey outputs

The following table confirms the topographic survey outputs required. The delivery type column is to be used to define the generic output format: CAD, point cloud, report, hard copy, image file, video file, spreadsheet, textual data, database, GIS database etc.

Section 4 deliverables shall be used to confirm the specific client requirements for each delivery output.

Typical outputs

Output	Required (Y or N)	Delivery type/ comments
Floor plan(s) drawing		
Elevation(s) drawing		
Cross-sections *(confirm how many in comments)*		
Survey report		

Non-typical outputs

Output	Required (Y or N)	Delivery type/ comments
Roof plan		
Reflective ceiling plan		
Ceiling voids (opening up works)		
Attic plan		
3D CAD model		
Building informa-tion modelling (BIM)		
Point cloud		
International Property Measurement Standards (IPMS)/areas and dimensions		
Other (specify)		

3.3 Floor plans

Recommended good practice

The following tables provide a listing of features to be surveyed. This is not intended to be exhaustive, and the client should add features and comments if required.

Some features have been pre-selected as 'default features'. These are considered by SCSI to be features that, if present on site, should be surveyed and presented on a standard topographic survey, irrespective of the accuracy band selected by the client. However, features not required for a specific survey can be identified by the client by replacing the Y with an N in the relevant box.

'Non-typical' features are not typically surveyed/required at all accuracy bands and will not be surveyed unless specifically selected by inserting Y in the relevant box.

3.3.1 Structures

Default features

The following features to be included as standard; if any features are not required, please specify in comments.

Feature	Comments
Beams Ceilings Columns Doors Floors Steps/stairs/ramps/lifts Walls Windows	

Non-typical features

Note

Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands and may add cost to the survey.

Feature	Required (Y or N)	Comments
Attic spaces		
Under-floor details		
Additional feature detail not requested above (specify detail required)		
Other (specify)		

3.3.2 Fitting out

Default features

The following features to be included as standard; if any features are not required, please specify in comments.

Feature	Comments
Partitions Raised floor/changes in floor level	

Non-typical features

Note
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands and may add cost to the survey.

Feature	Required (Y or N)	Comments
Cupboards		
Above false ceiling		
Fixed furniture		
Floor, wall and ceiling description and finishes		
Planters		
Window details (specify requirements)		
Architraves		
Fireplaces		
Skirting		
Details of joinery		
Balustrades		
Additional feature detail not requested above (specify detail required)		
Other (specify)		

3.3.3 Heights/levels annotation

Default features

The following features to be included as standard; if any features are not required, please specify in comments.

Feature	Comments
Arch heights Beam soffits Ceiling heights Floor levels at centre of each room Floor levels at stairs (top and bottom) General floor levels Window and door heights	

Non-typical features

Note
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands and may add cost to the survey.

Feature	Required (Y or N)	Comments
Floor levels at doorways		
Floor levels in corners of each room		
Heights of other features (specify features and detail required)		

3.3.4 Services

Default features

The following features to be included as standard; if any features are not required, please specify in comments.

Feature	Comments
WCs, sinks and basins Inspection chambers (cover location and level only)	

Non-typical features

Note
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands and may add cost to the survey.

Feature	Required (Y or N)	Comments
Fire equipment		
Lights		
Pipework		
Plant		
Radiators		
Risers		
Service intakes		
Sprinklers		
Switches/sockets		
Additional feature detail not requested above (specify detail)		

3.4 Roof features (if requested at 3.2)

Default Features

The following features to be included as standard; if any features are not required, please specify in comments.

Feature	Comments
Ridge lines Parapets Chimneys (where visible from ground) Gutters Eaves	

Non-typical Features

Note
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands and may add cost to the survey.

Feature	Required (Y or N)	Comments
Drainage features		
Fire escapes, catwalks (outline only)		
Plant and services (outline only)		
Surface materials		
Vents		
Windows and skylights (outline only)		
Aerials		
Plant rooms		
Additional feature detail not requested above (specify detail)		
Other (specify)		

3.5 Attics and ceiling void features (if requested at 3.2)

Note
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands and may add cost to the survey.

Feature	Required (Y or N)	Comments
Ceiling joists size, spacing and alignment		
Hatches		
Services (specify detail required)		
Tanks (outline only)		
Trusses size, spacing and alignment		
Additional feature detail not requested above (specify detail required)		
Other (specify)		

3.6 IPMS/Area and dimension features (if requested at 3.2)

Note
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands and may add cost to the survey.

Feature	Required (Y or N)	Comments
Dimensions (specify detail)		
Main room dimensions (annotated)		
Room areas		
Room volumes		
Gross external area (GEA)		
Gross internal area (GIA)		
Net internal area (NIA)		
IPMS 1		
IPMS 2		
IPMS 3		
Additional feature detail not requested above (specify detail)		
Other (specify)		

3.7 Cross-section features (if requested at 3.2)

Default features

The following features to be included as standard; if any features are not required, please specify in comments.

Feature	Comments
External building envelope shown in outline detail Principal heights Structural members (where visible)	

Note
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands and may add cost to the survey.

Feature	Required (Y or N)	Comments
Sections to show simple outline elevation of facing wall		
Additional feature detail not requested above (specify detail)		
Other (specify)		

3.8 Elevation features (if requested in 3.2)

Default Features

Following features to be included as standard, if any features are not required, please specify in comments.

Feature	Comments
Door and windowsills and heads Door and window reveals General pattern of window glazing Parapets Outline MEP Principal heights Chimneys (where visible from ground level) Roof details (where visible from ground level) Balconies	

Non-typical features

Note
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands and may add cost to the survey.

Feature	Required (Y or N)	Comments
Stonework/brickwork details		
String courses		
Material surface types		
Indicate floor levels with broken lines		
Individual bricks and stonework		
Additional feature detail not requested above (specify detail)		
Other (specify)		

3.9 Other – Specialist requirements or environments not yet covered

Default features

Note
The features below are not classified above and are to be identified and selected by the client. The table has been intentionally left blank for completion by the client.

The following features to be included as standard; if any features are not required, please specify in comments.

Feature	Comments

4. Deliverables

The following defines the client requirements for specific deliverable formats and method of delivery. It is designed to allow a client to refer to his/her existing formats and templates where appropriate.

Due to a lack of convention in relation to digital formatting and standards, this section does not incorporate a default specification for formats, and it is the client's responsibility to ensure that sufficient information is supplied to the surveyor. Where the client does not provide sufficient detail, the surveyor shall confirm to the client the proposed format of deliverables.

Recommended good practice

Clients should note that software versions and formats supported change rapidly over time. It is recommended that along with a client system-compatible format, a standard exchange format should be specified. For certain agencies that have long archiving periods this can be a prerequisite for acceptance of survey data (heritage).

The list given here is by way of suggestion and not exhaustive, nor does it guarantee that all information in one format can be consistently exchanged into another.

The formats applicable to the deliverables shall be based on the requirements selected in ***Section 3***.

Deliverable type	Relevant output(s) (specified at section 3)	Software system	Version	Exchange format (file type)	Suggested exchange formats	Info
CAD					*.dxf, .DWG	4.1
Digital terrain model (DTM)					*.dxf, .DWG	4.2
Building information modelling (BIM)					Revit®,AutoCAD, MicroStation and Navisworks	4.3
Point cloud					*.LAS; E57	4.4
Point cloud viewer						4.5
GIS					*.dxf, *. SHP	4.6
Survey reports					*.pdf, *.docx	4.7
Imagery/ photography					*.jpeg ; *.TIF, *.ECW	4.8
Video					*.mpeg, *.avi	4.9
Spreadsheet					*.csv, *.txt	4.10
Textual data						4.11
Hard copy						4.12
Other						

Method of delivery

The surveyor shall send the survey deliverables to the client via:

Method	Required
FTP site	
Upload to client's system	
Email attachment	
Delivered portable hard drive, USB or CD/DVD	
Delivered hard copy	
Other (specify)	

It is assumed that any method of delivery (e.g. hand/post/courier) to the client's specified address is acceptable.

Presentation standards

The following presentation standards shall be used:

Client-supplied standards	
Surveyor-defined standards	
CAD layers and presentation to be as per the ***Topographic Specification for Urban Projects***	
Other (specify)	

Non-typical features related to CAD (where applicable)

Note
Features below will only be surveyed if specifically selected by the client. These are not typically surveyed/required at all accuracy bands and may add cost to the survey.

Item	Required (Y or N)	Comments
Client-specified colours (please specify)		
Pre-fix level layer naming		
Suffix-fix level layer naming		

4.1 CAD deliverables

4.1.1 Presentation of CAD deliverables

Recommended good practice for layering

Feature descriptive level/layer naming
(Trees, walls, road markings, roads, buildings, walls, windows, etc.)
Detail segregation (groups/classification, i.e. BIM, utility groups, entity types (3D surfaces, strings, points))
Legend
Key/location plan
North arrow

4.1.2 Format of CAD Deliverables

Recommended good practice

The client should ensure that CAD-deliverable formats and presentation standards are well specified and compatible with his/her own or intended users' systems. Consideration should also be given to the contents of drawing title blocks. These should include:

- survey reference number
- survey date
- filename
- project/drawing title
- survey company
- client name
- legend (all used symbols, abbreviations, line styles, etc.)
- north point/arrow
- annotated map grid
- scale bar
- plot scale and applicable paper size
- key plan
- grid and datum
- location data referred to elsewhere (cross-sections).

Clients should also note that developing conventions in relation to BIM are designed to increase collaboration and sharing of data in a consistent manner and this can lead to significant efficiencies in data management and decision making. Clients should therefore keep abreast of BIM guidance and overlapping specifications (e.g. BIM execution plan) when completing this section.

Due to the move away from hard copy plans/drawings, it is good practice that all digital drawings with title blocks be output as *.pdf as a proof copy. The *.pdf copy serves as a record of the digital deliverable.

4.2 Digital terrain model (DTM)

Recommended good practice

When specifying a grid format, clients should be aware of the increase in data file sizes with increasing density of points, particularly over large areas. It may be suitable in such circumstances to specify multiple densities or test data sets in consultation with the surveyor. It is important to specify the grid cell size and the position of the centre of cells.

4.3 Building information modelling (BIM)

4.3.1 Presentation of BIM model

Recommended good practice

Should surveys be required for BIM, it is recommended that a BIM deliverable shall be provided in accordance with the employer's information requirements (EIR) and the BIM execution plan (BEP) as specified in PAS 1192-3:2014 or other equivalent standard as applicable.

4.3.2 Format of BIM deliverables

Recommended good practice

Some BIM software packages use an internal coordinate system that is then referenced to real-world coordinates. It is important that surveyors engaging in surveys to BIM projects read ***section 2*** and correctly set project coordinate systems to enable integration with real-world coordinate systems.

4.4 Point cloud

Recommended good practice

Clients should specify cleaning of spurious data from moving objects captured during the creation of point clouds (i.e. people, moving vehicles, false reflections from car mirrors, etc.).

The client should take care to ensure point cloud deliverable formats including generic formats that will serve as future archive of data as well as formats compatible with their own or their intended users' systems.

Clients should also note that developing conventions in relation to BIM are designed to increase collaboration and sharing of data in a consistent manner and this can lead to significant efficiencies in data management and decision making. Clients should therefore keep abreast of BIM guidance and overlapping specifications (i.e. BIM execution plan).

4.5 Point cloud viewer

Recommended good practice

Where clients have requested point cloud data, they should consider specifying a point cloud viewer output.

When specifying colour image overlaid point cloud viewing formats, clients should also seek delivery of light intensity only formats to ensure changes in capture between scanning and image does not result in misinterpreted survey data (i.e. moving vehicles).

Recommended good practice

The client should take care to ensure that point cloud viewer formats specified are compatible with his/her own or intended user's systems. Where a client does not have a point cloud viewer, he/she may be able to download one online as many manufacturers provide free downloadable viewers. Clients should also note that point cloud viewers can work on lower performance PCs and generally rely on smaller files that can be shared over online hosting systems.

4.6 GIS

Recommended good practice

The client should take care to ensure that GIS deliverable formats and presentation standards are well specified and compatible with their own or their intended users' systems.

GIS data requires detailed format specification in terms of the data topology, rules for feature code snaps, nodes, creation of polygons, dark links, etc. This is not a trivial consideration in large datasets, and it will have a significant effect on the cost of the data capture and processing.

4.7 Report

Recommended good practice

It is considered good practice to produce a survey report for various types of surveys. It can provide proof of provenance, methodology and agreed specification and can act as an important historical reference document in case of dispute. It can also aid future use of survey deliverables (particularly survey control) and enhance the future value of the surveyed data.

The client should specify the following as a minimum for topographic and utility survey reports where requested: date of survey, details of the specification being followed, outline methodology, computing and presentation of the survey, equipment used, site photography, details of quality control for site and processing work, survey issues or difficulties encountered on site (omissions, access, etc.).

For survey control reports in addition to the above, the client should also specify survey control network diagram, list of supplied survey control, numerical results (loop closures, residuals, etc.), network adjustment files, details of survey control points (including location information sufficient to find control stations).

4.8 Imagery/photos

Recommended good practice

The client should note that file sizes can vary dramatically with different file formats. Clients, where appropriate, should consider multiple formats that preserve the original data capture but also provide lighter file format for ease of handling and sharing.

Clients should consider specifying geo-location attribute capture of imagery to ensure that location and direction of view can be verified.

4.9 Video deliverables

Recommended good practice

The client should note that file sizes can vary dramatically with different file formats. Where appropriate, clients should consider multiple formats that preserve the original data capture but also provide lighter file format for ease of handling and sharing.

Where clients require CCTV or fly-through video files they should consider specifying supply of a flight path and video trajectory with time, distance correlation. This is particularly important for condition surveys of sewers.

4.10 Spreadsheets

Recommended good practice

The client should consider carefully spreadsheet output requirements for monitoring or macro-driven spreadsheet outputs. This can include validation tools and coordinate conversions where reporting requires change of system from site capture to output analysis.

4.11 Textual data

Recommended good practice

The client should consider carefully specific textual data formats if they are system dependent. In particular, sample data and trial inputs should be included in the specification if submissions are likely to be used in critical operations that require high reliability in data sequencing.

4.12 Hard copy

Recommended good practice

Due to the move away from hard copy plans/drawings to digital deliverables, the client should specifically state if hard copy deliverables are required. These could be paper/film plots, photographic negatives, etc.

Clients should be aware that it is not advisable to scale from paper plots.

Appendices

Appendix A: Definitions
Appendix B: References and online resources

Appendix A: Permanent ground markers

Absolute accuracy

Absolute accuracy is the measurement of RMSE of normally distributed error vectors relative to a defined grid and/or height datum. This is typically measured from the nearest survey control marker which was used as part of the primary grid establishment. (See the Ordnance Survey table overleaf.)

Accuracy

In general, when accuracies (or tolerances) have been specified, they refer to vector errors and are defined statistically as root mean square errors (RMSE) or standard deviation. The RMSE or standard deviation is equivalent to 68% of normal distribution of random errors and is often used to express tolerance or confidence in measurements. The standardised normal distribution table determines the ratio of RMSE to different confidence or measurement error tolerances. A 90% tolerance or confidence in a set of measurements is equal to 1.65 times the RMSE or standard deviation when a representative sample of points is tested. Thus a RMSE of ± 0.1m indicates that in a representative sample of 100 points, not less than 68 shall be correct to better than ± 0.1m, and not less than 90 points shall be correct to better than ± 0.165m. Any errors exceeding three times the RMSE (outside of 99.7% of confidence or tolerance in the normal distribution of errors) in this case ± 0.3m, may be regarded as gross errors or mistakes.

Datum

The starting point or source of a grid (horizontal datum), height (vertical datum) or projected coordinate system (map datum). It is commonly referred to in relation to vertical heighting or levelling but can be applicable to a grid origin, global spheroid shape and origin, and origin of a true bearing or rotation and scale factor in a map projection.

Georeferencing

To georeference something means to define its existence in physical space. That is, establishing its location in terms of a map projection and/or coordinate system.

Grid

Generally an orthogonal and planar (flat) coordinate system used to define locations on a map. A grid can have an arbitrary or local origin, or be geospatially related to an earth based datum. Grids can have a 1:1 true-scale factor or be projected from curved surfaces to have non uniform or non-unity scale factors.

Projection

Projections contain the parameters by which measurements on the ground or in space have been scaled, rotated or shifted to present them on a map coordinate system. They are typically used for large areas, country wide or global mapping systems to overcome representing earth curvature on a plan.

Relative accuracy

Relative accuracy is the measurement of RMSE of normally distributed vector errors between proximate features shown in survey or setting out on the ground. The calculation can be made independently of the absolute accuracy of features shown on a grid (i.e. the distance between a two buildings measured from the same survey). (See the Ordnance Survey table overleaf.)

Survey control

The physical markers or point features that are used to realise coordinate grids on the ground, often referred to as permanent ground markers or PGMs where specifically installed for that purpose. Survey control is typically made up of a number of points observed along interconnected baselines. They are used for setting out or mapping all other features to the established grid. Survey control is generally classified as primary, secondary or tertiary depending on its importance in defining a grid and/or its accuracy for use in surveying or setting out.

Survey traverse or survey control network

The complete set of baselines measured between survey control points is called a survey traverse or control network where the baselines exceed more than 1 (i.e. more than 2 points). Where the set of baselines closes back on itself it is typically called a traverse loop. A closed traverse is one that starts and ends on a known baseline, even where the baseline is the original start of the traverse (i.e. as in a closed loop traverse). Where a traverse includes cross-bracing of multiple baselines (more than 2 baselines observed from one survey control point) it is typically referred to as a network. Where a baseline does not close back it can be called a flying traverse or in the case of a single baseline a traverse leg. As with survey control, survey traverses or survey control networks can also be classified as primary, secondary or tertiary depending on its importance in defining a grid and/or its accuracy for use in surveying or setting out. Traverses can include angle, distance, height and co-ordinate measurement.

The following table, based on more than 40 years of accuracy testing, represents the absolute and relative accuracy of UK Ordnance Survey large scale topographic mapping data:

Original survey scale	99% confidence level	95% confidence level	RMSE*
1:1250			
Absolute accuracy	0.9m	0.8m	0.5m
Relative accuracy	+/- 1.1m (up to 60m)	+/- 0.9m (up to 60m)	+/- 0.5m (up to 60m)
1:2500			
Absolute accuracy	2.4m	1.9m	1.1m
Relative accuracy	+/- 2.5m (up to 100m)	+/- 1.9m (up to 100m)	+/- 1.0m (up to 100m)
1:10 000			
Absolute accuracy	8.8m	7.1m	4.1m
Relative accuracy	+/- 10.1m (up to 500m)	+/- 7.7m (up to 500m)	+/- 4.0m (up to 500m)

Table 1: Ordnance Survey mapping accuracies of large scale topographic mapping data

(Confidence level is how frequently a parameter falls within the quoted limits.)
*RMSE (root mean square error) is the square root of the mean of the squares of the errors between the observations.
Source: www.ordnancesurvey.co.uk/oswebsite/support/products-services.html

Appendix B: Definitions

Bannister, A., and Raymond, S., *Surveying* (7th edition), Pearson, 1998

Beach, M., and Schofield, M. *Engineering Surveying* (6th edition), A Butterworth-Heinemann, 2007

Bomford, G. *Geodesy* (4th edition), Clarendon Press, Oxford, 1980

Hofmann-Wellenhof, B., Lichtenegger, H., Wasle, H. *GNSS – Global Navigation Satellite Systems: GPS, GLONASS,*

Galileo and More, Springer-Verlag, New York, 2007

Iliffe, J.C. and Lott, R. *Datums and Map Projections for Remote Sensing, GIS and Surveying* (2nd edition), Whittles

Publishing, Dunbeath, 2008

Kaula, W. *Theory of Satellite Geodesy: Applications of Satellites to Geodesy*, Dover Publications Inc, Mineola, NY, 2003

Leick, A. *GPS Satellite Surveying* (3rd edition), John Wiley & Sons, Chichester, 2004

Metric Survey Specifications for Cultural Heritage 2009 English Heritage (available to download at www.englishheritage.org.uk/publications/metric-survey-specification/)

Seeber, G. *Satellite Geodesy, Foundations, Methods and Applications* (2nd edition), Walter de Gruyter, Berlin, 2003

Survey4BIM task group – www.bimtaskgroup.org/survey4bim/

Uren, J. *Surveying for Engineers* (5th edition), Palgrave Macmillan, 2010

Van Sickle, J. *GPS for Land Surveyors* (3rd edition), CRC Press, Lincoln, US, 2008

The International Standards Organisation (ISO)

ISO produces several suites of standards related to many of the surveying and measurement topics contained within the guidance note. This listing is by no means exhaustive and all ISO standards can be sourced at www.iso.org/iso/home.htm

ISO 17123-1:2010 gives guidance to provide general rules for evaluating and expressing uncertainty in measurement for use in the specifications of the test procedures of ISO 17123-2, ISO 17123-3, ISO 17123-4, ISO 17123-5, ISO 17123-6, ISO 17123-7 and ISO 17123-8.

ISO 17123-2, ISO 17123-3, ISO 17123-4, ISO 17123-5, ISO 17123-6, ISO 17123-7 and ISO 17123-8 specify only field test procedures for geodetic instruments without ensuring traceability in accordance with ISO/IEC Guide 99. For the purpose of ensuring traceability, it is intended that the instrument be calibrated in the testing laboratory in advance.

ISO 17123-1:2010 is a simplified version based on ISO/IEC Guide 98-3 and deals with the problems related to the specific field of geodetic test measurements.

ISO 4463-3:1995 – Measurement methods for building – Setting-out and measurement

ISO/TS 12911:2012 – Establishes a framework for providing specifications for the commissioning of building information modelling (BIM).

ISO 9849:2000 – Optics and optical instruments – Geodetic and surveying instruments – Vocabulary

ISO 19152:2012 – Geographic information – Land Administration Domain Model (LADM)

British Standards Institute (BSI)

BSI also produces suites of standards and Publically Available Standards (PAS) which can be sourced at http://shop.bsigroup.com/

British Standards Institute (BSI) PAS 128:2014 – Specification for underground utility detection, verification and location

British Standards Institute (BSI) PAS 1192-2:2013 – Specification for information management for the capital/delivery phase of construction projects using building information modelling, PAS 1192-3:2014 (when available)

The International Federation of Surveyors (FIG)

FIG produces a series of best practice documents of measurement subjects. A full suite of FIG publications can be sourced at www.fig.net/pub/figpub/index.htm

No. 49 Cost Effective GNSS Positioning Techniques. FIG Commission 5 Publication. FIG Report, 2010

The Survey Association (TSA)

TSA also produces a suite of geomatics and surveying related client guides and guidance notes many of which are cross-endorsed by RICS. These can be sourced at www.tsa-uk.org.uk/

Network RTK GNSS Best Practice (2012)

The Essential Guide to Utility Surveys (2009)

Detailed guidance notes for specifying a utility survey (2009)

RICS professional guidance

EDM calibration, 2nd edition (2008)

Guidelines for the use of GNSS in land surveying and mapping, 2nd edition (2010)

Vertical aerial photography and digital imagery, 5th edition (2010)

Terms and Conditions of Contract for Land Surveying Services, 3rd edition (2009)

Code of Measuring Practice, 6th edition (2007)

Boundaries: procedures for boundary identification, demarcation and dispute resolution, 3rd edition (2014)

Party wall legislation and procedure, 6th edition (2011)

Rights of light, 1st edition (2010)

Daylighting and sunlighting, 1st edition (2012)

RICS Geomatics client guides

Guides for the client and other professional advisers (available to download from www.rics.org/uk/knowledge/moreservices/guides-advice/rics-geomatics-client-guide-series/)

Virtually real: terrestrial laser scanning: Understanding an evolving survey technology

Reassuringly accurate: Controlling accuracy for better results

Scale: Avoid tripping up over step changes in scale

Virtually level: Transition from traditional benchmarks to heighting using GNSS

Virtually right? – Networked GPS: A useful guide from RICS on aspects of cost effective networked GPS correction services

Map projection Scale-Factor: Avoid the potential dangers of scale-factor

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