

Category 1 Standard

1-026 Topographical Surveys and Mapping

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1 Purpose

- 1.1 The purpose of this standard is to define the requirements for and the procedures for performing and recording topographical surveys and to define the controls on the use of Ordnance Survey (OS) mapping.

2 Scope

- 2.1 The scope of this standard is to define:
- a) the requirements for topographical surveys and mapping performed by LU and its Suppliers surveying LU fixed assets;
 - b) the requirements for topographical surveys and mapping for projects promoted by LU or its Suppliers on land and assets not currently owned by LU and;
 - c) the procedures to control the use of OS mapping and other OS survey products that are licensed to LU.
- 2.2 This standard replaces 1-026 A1

3 Requirements

3.1 London Survey Grid and datum

3.1.1 London Survey Grid (LSG) definition

- 3.1.1.1 All topographical survey and mapping work shall be reported on the London Survey Grid.

Note: The London Survey Grid is a Transverse Mercator Projection with parameters chosen to minimise grid distortion caused by the Earth's curvature over the LU area. The distortion is such that for large portions of the area projection corrections can be ignored. The Grid was formerly known as the LU Grid, the LUL Grid or the Crossrail Grid

A network of primary survey stations with London Survey Grid co-ordinates has been established across London.

- 3.1.1.2 LSG height datum shall be used. The LSG height datum level is set at approximately 100m below OS Datum at Newlyn.

Note: The LSG height datum is an orthometric height datum chosen to provide positive values for areas of interest to LU. This datum is realised by the network of OS benchmarks that have been connected by spirit levelling to LU survey control points. In areas that will interface with Crossrail projects the Crossrail First Order benchmarks should be used. Trials in 2009 indicated that GPS survey heights can be transformed using the Ordnance Survey Geoid Model 2002 (OSGM02), plus the 100m shift, to produce acceptable LSG Height Datum values

The London Survey Grid is defined by the following parameters:

Parameter	Value
Spheroid	WGS 84
Semi major axis	6,378,137.000m
Semi minor axis	6,356,752.3142m
1/f (f = earth's flattening)	298.25722356300
e"	0.00669437999013
Datum	Xrail84 *
Projection	Transverse Mercator
Central meridian	W000°-09'-30"
Latitude of true origin	N051°-10'-00"
Easting of true origin/ central meridian	78,250.000m
Northing of true origin	-2,800.000m
Central meridian scale factor	0.9999999
• Xrail84 * = Datum as derived by the Crossrail project in 1984.	

3.1.2 Grid computation

3.1.2.1 Distances shall be reduced to the WGS 84 spheroid.

3.1.2.2 The London Survey Grid scale factors given in Attachment 7.1 shall be used.

3.1.3 Relationships between London Survey Grid and other grids

3.1.3.1 *Ordnance Survey grid* (also known as the British National Grid or OSGB36)

3.1.3.1.1 The formulae in Tables 1 and 2 in Attachment 7.3 shall be used for conversion of OS mapping to and from London Survey Grid within the areas shown in Attachment 7.2. These formulae are accurate to a commensurate standard as the OS mapping ie +/- 400mm.

3.1.3.1.2 To obtain more precise conversions of existing survey information held on the OS grid a local best fit formula shall be derived from the nearest primary or other common survey control stations.

3.1.3.2 *JLE grid*

The formulae in Tables 3 and 4 in Attachment 7.5 shall be used for conversion of JLE digital data to and from London Survey Grid within the areas shown in Attachment 7.4.

Note: Automation of conversion. LU holds a grid converter utility designed to convert MicroStation 2D and 3D design files from one co-ordinate system to another. It will change a file's scale, rotation, location, working units and global origin.

3.1.4 Control surveys

3.1.4.1 Primary Control stations consist of the original control points that were used as a basis for the Crossrail and Earth Structures Projects and were confirmed by the 2002 re-observation programme. These are considered to be permanent points in long term stable locations. The co-ordinate values shall not be changed without an amendment to this standard. These surveys have been computed as a single coherent system known as the London Survey Grid based on WGS84. Transformation parameters have been established to the National Grid (OSGB36). In 2002 a re-observation program was carried out by LU which proved the consistency of the original work and established transformation parameters to ETRS89. Further analysis by Prof Marek

Ziebart of University College London in April 2009 confirmed the transformation parameters. The list of Primary control points is included as Attachment 7.6

Note: Primary Control Surveys have been carried out for the Crossrail Project and the LU Earth Structures Project.

3.1.4.2 Secondary control points consist of control schemes that are based on Primary control and have been adjusted by a rigorous method. These control points shall be permanent points in long term stable locations. The co-ordinate values may be varied as a result of re-observation and re-computation. Such variations shall only be introduced after the LU Land Survey Manager has notified all parties that have received a controlled issue of this information and no objections have been raised. Secondary control points shall be the minimum requirement for surveys in project interface areas.

3.1.4.3 Third order control points consist of control schemes that are based on any combination of Primary, Secondary or Third Order control and have been adjusted by a rigorous method. The control points shall be established to be durable and stable for the duration of the project. The project surveyor may only vary the co-ordinate values as a result of re-observation and re-computation in which case the point will be re-numbered. The LU Land Survey Manager shall distribute revised values to parties that have received a controlled issue of this information.

3.1.4.4 Fourth order control points consist of control schemes that are based on any combination of Primary, Secondary or Third Order control. The control points may be in situation where the durability or stability is doubtful or where conditions have prevented a rigorous regime of observation and computation. The project surveyor may vary the co-ordinate values as a result of re-observation and re-computation. The LU Land Survey Manager shall not further distribute this information.

3.1.5 GPS and ETRS89

The following Seven Parameter Transformation shall be used when converting ETRS89 data onto the London Survey Grid based on the Geoid model OSGM02

Method	Seven Parameter
Rotation about x axis	-0°00'03.577824"
Rotation about y axis	0°00'03.484437"
Rotation about z axis	0°00'02.767646"
Translation along x axis	19.019m
Translation along y axis	115.122m
Translation along z axis	-97.287m
Scale factor (PPM)	18.60847540

Note: The convention used for the rotations is that a positive rotation acts in a clockwise sense as viewed along the rotation axis looking towards the origin. Checks should be made to ensure that this notation is used correctly.

Note: GPS has been used to establish the entire primary control network, and is now routinely used for survey work. The transformation parameters between London Survey Grid and ETRS89 allow the use of recorded base station data from the National GPS Network service.

3.2 Ordnance Survey mapping

3.2.1 Supply of data

- 3.2.1.1 LU shall supply OS data for use on projects related to LU infrastructure and operations.
- 3.2.1.2 LU departments and suppliers wishing to obtain OS digital data and copyright licensing shall contact the LU Land Survey Data Manager.
- 3.2.1.3 Requests shall be submitted in the form given in Attachment 7.7
- 3.2.1.4 Suppliers shall enter into a Contractor Licence Agreement with the LU Land Survey Data Manager and abide by the copyright conditions as described in the Appendix 1 Licensed Use of the Public Sector Mapping Agreement (PSMA) Member Licence. The current form of Contractor Licence Agreement and copyright conditions are to be found in Attachment 7.11.
- 3.2.1.5 The recipient of data issued by LU shall acknowledge receipt within 10 working days.
- 3.2.1.6 The LU Land Survey Data Manager shall maintain records of requests for OS data and issue data in a controlled manner.

Note: LU has a licence for the business use of OS digital data, which falls under the Copyright, Designs and Patents Act. Failure to comply with this procedure could lead to an infringement of Crown copyright which is a criminal offence under the Act, and would also lead to the loss of LU's licence and expose the company to civil proceedings for damages.

3.2.2 Copyright requirements

- 3.2.2.1 LU is a party to the TfL member licence to use OS data under the PSMA for the supply and use of digital data and licensing of copyright works.
- 3.2.2.2 Users of OS data shall abide by the terms of the agreement which shall be for Internal Business Use (including display and promotion) and limited internet applications only.

Note: There is a Public Sector Mapping Agreement between the DCLG and OS for the supply of OS mapping data to all public bodies. LU receives data licensed under this agreement through TfL. The Public Sector Mapping Agreement, which may be varied from time to time, at present, includes the provision of the products listed in table below. Additional products are now made available free to use known as OS Open Data. All products are available free of charge and can be supplied as national coverage.

The Public Sector Mapping Agreement, which may be varied from time to time, at present, covers the provision of the following:

PSMA data Product	Update Cycle	Notes
MasterMap; Topography	On Line, Change only update	
MasterMap; Integrated Transport Network inc. Road Routing Information	On Line, Change only update	
1:10,000 Raster	Annual, Change only update	To be withdrawn in 2013
1:50,000 Raster	Annual, Change only update	



PSMA data Product	Update Cycle	Notes
Address-Point	Quarterly	To be replaced by National Address Gazetteer in 2011
Code Point	Quarterly	
Code Point with Polygons	6 Monthly	
1:25,000- Raster	Annual	
Vector Map Local	Annual	
OpenData Product	Update Cycle	Notes
1:50,000 Scale Gazetteer	Annual, Change only update	
1:250,000 Colour Raster	Annual	
Boundary-Line	6 Monthly	
Code-Point Open	Quarterly	
Land-Form Panorama	Not Maintained	
Meridian 2	6 Monthly	
MiniScale	Annual	
OS Locator	6 Monthly	
Strategi	Annual	
Vector Map District	Not specified	
Street View	6 Monthly, Change only update	

3.3 Topographical surveys

- 3.3.1 The Supplier shall appoint a Survey Co-ordinator / Project Manager
- 3.3.2 The Supplier shall advise the LU Land Survey Manager of the nominated Survey Co-ordinator/Project Manager.
- 3.3.3 The Supplier's Survey Co-ordinator shall prepare and promote model specifications for the various types of survey carried out.

Note: The following surveys are typically used:

- Land surveys;
- Building surveys:
- Un-connected survey – Using simple methods which do not enable one part of the survey to be related to another, this would not normally be acceptable for LU work;
- Semi-connected survey – One floor (normally the ground floor) is surveyed with all parts connected by instrumental control. Other floors are matched by assuming verticality of common features;
- Fully connected survey – All floors are instrumentally related to a common survey control framework.
- Buried utilities surveys:
- Record information – Underground service information to be taken from statutory or other authorities' record drawings and plotted to agree as closely as possible with surveyed surface features;
- Direct visual surveys – Accessible inspection chamber covers should be lifted where permissible and services positively identified;



- Direct visual surveys supplemented by record drawings – Accessible inspection chamber covers should be lifted where permissible and services positively identified. Routes of services between access points to be taken from record drawings and plotted to agree as closely as possible with surveyed surface features and trench scars where obvious;
- Full investigation including electronic tracing – Services to be fully investigated by visual survey supplemented by electronic, or other tracing of inaccessible routes.
- Track Surveys
- Detailed surveys of track alignment for track design purposes
- Clearance surveys to establish the clearance between line side objects and rolling stock
- Scanned Surveys
- Track trolley mounted scan surveys
- Tripod mounted static scan surveys

3.3.4 The items listed in Attachment 7.8 are typical items for inclusion in the model specifications.

3.3.5 The Supplier shall establish procedures to record and monitor survey activities.

3.3.6 Survey control

3.3.6.1 The Supplier's Survey Co-ordinator shall obtain a list of relevant LU survey stations from the LU Land Survey Data Manager.

3.3.6.2 The Suppliers Survey Co-ordinator shall advise the LU Survey Manager in writing of any inconsistencies or inaccuracies found in the information supplied by the LU Survey Data Manager.

3.3.7 Survey requirements

The survey requirements will be defined in the site specific survey specification. The following should be used as guidance for minimum standards:

3.3.7.1 The maximum planimetric error between permanent survey control stations shall not exceed 1 part in 20,000 for distances exceeding 200 metres. For shorter distances the maximum error shall not be greater than 10mm.

3.3.7.2 The height difference between any two points used as permanent bench marks shall not be in error by more than $\pm 12 \times k$ mm, where k is the square root of the distance in kilometres between the points being considered, or ± 5 mm, whichever is the greater.

3.3.7.3 For Land Surveys:

- a) The accuracy of planimetric detail shall be such that the plan position of any well defined point of detail shall be correct to within 0.3mm r.m.s.e. at the plan scale when checked from the nearest permanent control station;
- b) Ground survey spot levels on hard surfaces shall be correct to ± 10 mm r.m.s.e. and elsewhere to ± 50 mm r.m.s.e., except on ploughed or otherwise broken surfaces;
- c) At least 90% of all contours shall be correct to within one half of the specified contour interval;
- d) Any contour which can be brought within this vertical tolerance by moving its plotted position in any direction by an amount equal to 1/10th of the horizontal



distance between contours, or 0.5mm at plan scale, whichever is the greater, shall be considered as correct.

3.3.7.4 For Building Surveys:

- a) The maximum error between permanent survey control stations shall not exceed $\pm 5\text{mm}$ or 1 part in 10,000 for distances exceeding 50 metres;
- b) The height difference between any two points used as permanent bench marks shall not be in error by more than $\pm 3\text{mm}$ on any floor or by more than $\pm 1.5\text{mm}$ per metre of height between floors;
- c) In fully-controlled surveys the absolute plan position of well defined detail shall be accurate to $\pm 15\text{mm}$ at 1:50 scale or $\pm 30\text{mm}$ at 1:100 scale, when checked from the nearest survey control station on that floor;
- d) Directly measured figured dimensions shall be quoted to the nearest 0.01 metre;
- e) The quoted level of any feature relative to the nearest bench mark on that floor shall be to $\pm 5\text{mm}$.

3.3.8 Survey report

3.3.8.1 The Supplier shall ensure a technical report is prepared for each survey.

3.3.8.2 The technical report shall confirm that the survey meets the requirements as laid down in the site specific survey specification.

Note: The technical report is intended to assist future users in making a judgement about the suitability, quality and accuracy of the survey.

3.3.8.3 The report shall contain details of control points established during the survey.

3.3.8.4 A Survey Station record sheet shall be prepared for each control point which shall contain the information highlighted in Appendix 7.9 and may also contain additional information and photographs.

3.3.8.5 Survey Control point details shall be delivered as a spreadsheet in the form given in Attachment 7.9.

3.3.9 Retention of survey information

3.3.9.1 Survey information shall be retained in a form compliant with the LU Standard 1-691 (Information).

3.3.9.2 CAD information shall comply with LU Standard 1-037 (Computer Aided Design Data).

3.3.9.3 The Supplier's Survey Co-ordinator shall be the custodian of the survey information, and shall supply a copy of the information to the LU Land Survey Manager within one month of completion of the survey.

Note: The LU Land Survey Manager may release this information, without reference to the Supplier, or their Surveyor, subject to such rules and conditions as may be determined by LU and the requirements of the Freedom of Information Act and the Environmental Information Regulations. Surveys shall be procured so that the IPR in the survey information is vested in LU and IPR issues are not an inhibitor to the free use of survey information within LU..

3.4 Digital tunnel outline maps

Note: The LU Land Survey Manager is required to maintain maps to show the outline of the London Underground tunnels to supply to internal and external bodies legitimately requiring information about the location of LU infrastructure.