

AERIAL LIDAR SURVEYING – TECHNICAL SPECIFICATION

This document is for internal and contract specific use only.

Disclaimer

NGG and NGET or their agents, servants or contractors do not accept any liability for any losses arising under or in connection with this information. This limit on liability applies to all and any claims in contract, tort (including negligence), misrepresentation (excluding fraudulent misrepresentation), breach of statutory duty or otherwise. This limit on liability does not exclude or restrict liability where prohibited by the law nor does it supersede the express terms of any related agreements."

TABLE OF CONTENTS

PURPOSE AND SCOPE	1
PART 1 – PROCEDURAL	1
1 GENERAL REQUIREMENTS	1
2 LIDAR POINT DENSITY	2
3 DIGITAL IMAGERY	2
4 QUALITY & ACCURACY	3
5 CO-ORDINATE SYSTEM	3
6 WIDE AREA SURVEYS	3
7 GROUND BASED SURVEYS	3
8 FORMS AND RECORDS	4
PART 2 - DEFINITIONS AND DOCUMENT HISTORY	4
9 DEFINITIONS	4
10 AMENDMENTS RECORD	4
11 IMPLEMENTATION	4
PART 3 - GUIDANCE NOTES AND APPENDICES	4
12 ASSOCIATED DOCUMENTS	4
13 APPENDICE	5
APPENDIX A - PLS CADD MODELS	5
APPENDIX B - CONDUCTOR TEMPERATURE CALCULATION	11
APPENDIX C - CLEARANCE SCHEDULE	13
APPENDIX D - ROUTE SCHEDULE	18
APPENDIX E - FILE NAMING CONVENTION	19

PURPOSE AND SCOPE

This specification defines National Grid's requirements for the provision of Aerial Laser Survey (ALS) services. It defines the technical requirements for the data capture of National Grid Assets and the technical details required in the various products to be supplied to National Grid.

PART 1 – PROCEDURAL

1 GENERAL REQUIREMENT

1.1 Aerial Survey Specification

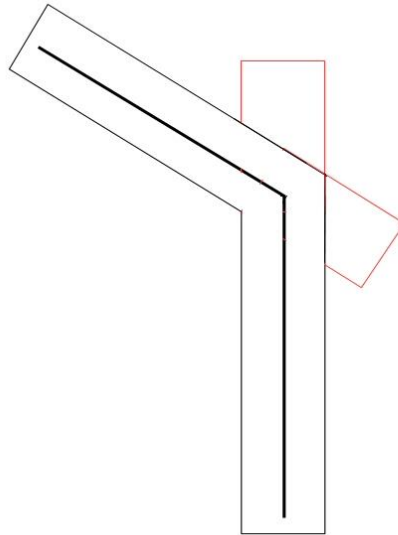
The survey shall capture LiDAR data; digital imagery; and other supporting data sets, as described in this specification.

1.1.1 Swath Width for Survey of Electrical Power Line Routes

The swath width coverage for all power line surveys will be a minimum of:

- (a) Aerial Laser Survey Swath - 150m this will be $\pm 75\text{m}$ on the centre line of the route.
- (b) Extended Coverage around tension Towers. During construction works when pulling conductors onto the towers, a pulling winch is placed at a distance from the base of the tension tower. In order to enable the engineers to model this extra LiDAR data

must be included within the model (as shown in red below) to a distance of 150m from the base of the tower. This is only required where the line deviates by $>30^\circ$.



- (c) Substation Survey. The area of each substation associated with the power line to be surveyed plus 50m beyond the substation boundary fence.

2 LIDAR POINT DENSITY

Sufficient point density must be obtained to allow accurate portrayal of all required features to the tolerances as specified.

This will be a minimum of 25 unique multiple-return pulses/points per square metre. A minimum of First return & Last return will be recorded.

The LiDAR system used must be capable of scanning the lines at an acute angle to minimise shadowing from the conductors or structures.

Sufficient points shall be identified on all building roofs, under-crossing wires or any other objects, to ensure all clearance checks can be undertaken.

3 DIGITAL IMAGERY

The survey shall collect digital imagery of the power line route & associated substations in the following formats:

3.1 Downward-Looking Digital Imagery

The survey shall collect downward looking digital imagery of the power line route and substations in the same time-frame as the LIDAR data.

The following specifications shall be met:

- 3.1.1 The swath of the imagery shall be as stated in 1.1.1 above as a minimum.
- 3.1.2 The pixel size of the raw imagery shall be a maximum of 5cm.
- 3.1.3 Shadowing effects to be minimised.

- 3.1.4 Minimal cloud cover of power line route with an exception being made for industrial generated cover i.e. Power Stations/ Factories.
- 3.1.5 All imagery shall be delivered with identical resolution.
- 3.1.6 All towers should be clearly visible in the images.

4 QUALITY & ACCURACY

The XYZ positions of all features to be captured as part of this project are to have an accuracy of better than $\pm 200\text{mm}$ at a 95% Confidence Limit (data that is accurate to, or better than, the required amount 95% of the time). This requirement can be considered as the “absolute” accuracy requirement.

For each tension section, the following “relative” accuracy requirements, for the relative XYZ positions, are to be met:

- 4.1 That the calculated vector between any insulator attachment, conductor attachment or conductor points within a tension section, and any other insulator attachment, conductor attachment or conductor points within the same tension section, is to be within $\pm 150\text{mm}$ @ 95% Confidence Limit of the true vector between any two such points.
- 4.2 That the calculated vector between any conductor point within a tension section, and any other ground point, building point or other crossing points, within the same tension section, is to be within $\pm 150\text{mm}$ @ 95% Confidence Limit of the true vector between any two such points.
- 4.3 That the calculated vector between any conductor point within a tension section, and any vegetation point within the same tension section, is to be within $\pm 250\text{mm}$ @ 95% Confidence Limit of the true vector between any two such points.
- 4.4 A daily Quality Assurance comparison will be carried out to check and compare the surveyed co-ordinates between a base station and the Laser scanning unit.

Where an infringement to a ground feature code is identified in the PLS CADD model, it will be the responsibility of the Service Provider to provide evidence in the form of a report that the ground data provided is accurate and not a misclassification error. When possible the contractor should use alternatives to field based surveys such as Google Earth or similar to give evidence of true ground. Where an infringement exists the Contractor will be asked to provide an additional survey to obtain the correct ground levels. If on completion of the survey the infringement is not confirmed there shall be no cost passed to National Grid for the additional survey.

5 CO-ORDINATE SYSTEMS

The following co-ordinate systems shall be used in the delivery of all spatial data provided as part of this contract:

- 5.1 Point coordinates shall be referenced using OSGB36-OSTN02 Newlyn height datum in metres.

6 WIDE AREA SURVEYS

The Service Provider shall provide a capability to survey additional wider areas for potential “New Build” projects i.e. new OHL and Substation alignment optioning. The cost for this is to be based on a 1km^2 rate. The data to be provided will be classified LiDAR data and Aerial Photography as per the previous specification. The data can be at a reduced point density and the photography at an increased pixel size provided suitable object definition can be obtained for OHL design projects.

7 GROUND BASED SUREYS

On an ‘Ad-Hoc’ basis ground based Lidar surveys might be required for areas needing dense data coverage i.e. condition assessment of Towers.

8 FORMS AND RECORDS

Not applicable

PART 2 - DEFINITIONS AND DOCUMENT HISTORY

9 DEFINITIONS

Not applicable.

10 AMENDMENTS RECORD

Issue	Date	Summary of Changes / Reasons	Author(s)	Approved By (Inc. Job Title)
2	May 2016	New Document, adapted from previous technical spec.	Nick Hanmer Asset Integrity, OHL & Cables.	David Miller Asset Integrity Manager.

11 IMPLEMENTATION

11.1 Audience Awareness

Audience	Purpose Compliance (C) / Awareness (A)	Notification Method Memo / letter / fax / email / team brief / other (specify)
NG, The Tenderer, The Contractor	C&A	Team Brief/e-mail

11.2 Training Requirements

Training Needs N/A / Informal / Workshop / Formal Course	Training Target Date	Implementation Manager
N/A		

11.3 Compliance

This document outlines the minimum requirements of the Contractor when carrying out Aerial LiDAR Surveys. All works completed by the contractor must always meet these minimum requirements.

11.4 Procedure Review Date

This should be reviewed prior to the end of the current contract, so that an updated version is used during the next Tender process. This is normally 3 years from publication date; however this may be extended to 5 years if the 3 year contract is extended to 5 years.

PART 3 – GUIDANCE NOTES AND APPENDICES

12 ASSOCIATED DOCUMENTS

PS(T) 113 – Inspection of Overhead Line Assets

13 APPENDICE**APPENDIX A - PLS CADD MODELS****A1 LIDAR Feature Coding**

The processed LIDAR data will be classified into the following feature codes, will be provided in LAS format and also within a PLS-CADD .bak file. The feature codes to be provided are as follows:

Feature Codes

LiDAR Survey Codes	
Feature	Feature Code
Tower Base	1
¹ Full Ground	2
¹ High Vegetation (>2.0m Above Ground)	3
¹ Medium Vegetation (>0.5m <2.0m Above Ground)	4
¹ Low Vegetation (<0.5m Above Ground)	5
Tower Structure	10
³ Ground / Model Key Points	20
Wires Left Phase(s)	30
Wires Middle Phase(s)	31
Wires Right Phase(s)	32
Wires Earth/Shield	33
Parallel Power Lines	50
River Navigable	100
Lake Navigable	102
Pond Non Navigable	103
Swimming Pool	104
Stream Non-Navigable	107
Roads	120
Bridges	128
Footpath/Sidewalk/Track	131
Motorways	135
Railways	136
Fence	140
Wall	141
Building	143
² Filtered High Vegetation	151
Power Line Crossings Wires	160
Street Furniture	169
Power Line Crossing Structures	170
Leisure Area	189
Processing Plant / Industrial	205
Substation	206
Temporary Object	207

Traditional Survey Codes	
Feature	Feature Code
Ground Spot Level	400
National Grid Tower Foot	401
National Grid Tower Top	402
National Grid Attachment Points	403
National Grid Conductor Points	404
Other Powerline Conductor Points	405
Other Powerline Post Top	406
Other Powerline Tower Top	407
Other Powerline Tower Foot	408
Other Powerline Attachment Points	409
Building	410
Channel	411
Ditch	412
Waterway Edge	413
Water Level	414
Fence Base	415
Fence Top	416
Foliage Line	417
Hedge	418
Tree Top	419
Tree Base	420
Verge Line	421
Bank Bottom	422
Bank Top	423
Kerb Top	424
Road	425
Parking	426
Path / Track	427
Manhole Cover	428
Railway	429
Railway OHL	430
Bridge	431
Street Furniture	432
Substation	433

Interpolated Ground Points	300
⁴ Miscellaneous Points	999

- ¹ *These files should not be imported into the PLS-CADD .bak file*
- ² *Filtered High Vegetation - Where required filtering will be applied as appropriate, to produce file sizes capable for input into PLS-CADD. For each occasion used, a report will be produced identifying filtering techniques & parameters used.*
- ³ *Model Key Points, a minimum of 1 point every 20m or where there is a change in elevation of greater than or equal to 10cm.*
- ⁴ *Misc Points – not classified elsewhere. Any point that does not fit into any of the above classifications shall be discussed & agreed with National Grid.*

A PLS-CADD .FEA file will be provided by National Grid. The LAS files should contain the above mentioned feature codes.

A2 PLS-CADD Model

For each surveyed route an “as built” PLS-CADD engineering model will be created in accordance with the requirements outlined below.

The engineering models shall be produced using the latest production version of PLS-CADD which will be agreed before PLS model build commences.

Models are to be based on the final captured survey data.

A detailed set of notes will be recorded with each model in the Project Notes (Lines->Edit->Project Notes) dialogue. These notes will include the following as a minimum:

- Line reference & name: i.e. 4VM Bolney - Ninfield
- Voltage: i.e. 400kV
- Configuration: Double Circuit for example
- Structure Types: Lattice Steel Towers, L6, L2 etc for example
- Number of Structures (excluding gantries): 34 for example
- Conductor: twin500mm² AAAC ‘RUBUS’ for example
- Insulator types: S400 L6/1/2/3/4, L8, L12 (4.7m) for example
- Date of ALS survey: 14-06-2007 for example
- ALS survey data collected by: Contractor name
- Any other relevant information about the line

An Error Report shall accompany any model which does not meet the survey specification. This report will contain screen shots of the areas affected.

The model will contain only data sets produced under this specification, including:

- Feature Coded LIDAR data
- Temperature-corrected conductor model
- Digital Ortho-photo mosaic. All the aerial imagery gathered during the survey will be attached to the PLS model in ECW format. The image drawing options should be set to dynamically resample in the attachment options

Cable files provided by National Grid shall be utilised in the model. The PLS model will contain the relevant conductor and will be modelled (after creep) to match the survey points using the appropriate method in PLS-CADD – graphically sagged finite element. This should include all phase wires including the downloads into the substation and the Earth wire.