NORTH LONDON WASTE AUTHORITY

NORTH LONDON HEAT AND POWER PROJECT

GRID CONNECTION STATEMENT

The Planning Act 2008 The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 Regulation 6 (1) (a) (i)

AD05 . 08

Arup | Revision 0 | October 2015

nlwa
north london waste authority

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Glossary

See Project Glossary (AD01.05)

Executive summary

i.i.i This report is the Grid Connection Statement for the proposed Energy Recovery Facility (ERF) which forms part of the North London Heat and Power Project (NLHPP). It has been prepared to support the North London Waste Authority's (the Applicant's) application (the Application) for a Development Consent Order (DCO) made pursuant to the Planning Act 2008 (as amended).

i.i.ii The purpose of this document is to demonstrate the feasibility and proposed approach to grid connection upgrade works to support the proposed increase in electrical export capacity, while maintaining necessary levels of connection resilience. The existing EfW export level is around $30MW_e$, while the proposed ERF would generate around $70MW_e$ in power only mode (gross).

i.i.iii UK Power Networks (UKPN) is the relevant Distribution Network Operator (DNO) pursuant to an electricity distribution licence issued in accordance with the provisions of the Electricity Act 1989 as amended by the Utilities Act 2000. National Grid (NG) owns and operates the electricity transmission system in England and Wales, pursuant to an electricity transmission licence issued in accordance with the provisions of the same legislation.

i.i.iv UKPN distributes power at 132kV and below, together with that generated by embedded generation stations connected to the distribution network. Transformers at the Tottenham Grid Substation (TGS) provide the connection with the 132kV system and Tottenham Supergrid.

i.i.v The proposed ERF would export electricity via 33kV underground cabling circuits to the TGS, approximately 2km from the Edmonton EcoPark. The existing grid connection circuits require upgrading by overlaying oil filled sections with polymeric replacements. A further two underground cable circuits are proposed alongside the existing circuits to ensure 70MVA can be exported in case of failure of one of the circuits. Works within the Edmonton EcoPark would connect the ERF facility to a new step-up transformer compound (also located within the Edmonton EcoPark). Export to grid would be via new UKPN switchgear associated with the new step-up transformers.

i.i.vi No works are required on the interconnections to the Tottenham Supergrid or on the transmission system to accommodate the increase in electricity that would be exported to the national grid.

i.i.vii UKPN has proposed to use existing easements to accommodate the required upgrade works. Therefore, works do not require consent as UKPN would use its statutory undertaker's rights to undertake the grid connection upgrade works.

1 Introduction

1.1.1 This Grid Connection Statement has been prepared to support North London Waste Authority's (the Applicant's) application (the Application) to the Secretary of State for Energy and Climate Change for a Development Consent Order (DCO) made pursuant to the Planning Act 2008 (as amended).

1.1.2 The Application is for the North London Heat and Power Project (the Project) comprising the construction, operation and maintenance of an Energy Recovery Facility (ERF) capable of an electrical output of around 70 megawatts (MW_e) at the Edmonton EcoPark in north London with associated development, including a Resource Recovery Facility (RRF). The proposed ERF would replace the existing Energy from Waste (EfW) facility at the Edmonton EcoPark.

1.1.3 The Project is a Nationally Significant Infrastructure Project for the purposes of Section 14(1)(a) and section 15 in Part 3 of the Planning Act 2008 (as amended) because it involves the construction of a generating station that would have a capacity of more than 50MWe.

1.2 Purpose of this Report

1.2.1 The purpose of this document is to demonstrate the feasibility and proposed approach to grid connection upgrade works to support the proposed increase in electrical export capacity, while maintaining necessary levels of connection resilience. The existing EfW export level is around $30MW_e$, while the proposed ERF would generate around $70MW_e$ in power only mode (gross).

1.2.2 This Statement forms part of a suite of documents accompanying the Application submitted in accordance with the requirements set out in section 55 of the Planning Act and Regulations 5, 6 and 7 of the Infrastructure Planning (Applications: Prescribed Forms and Procedures) Regulations 2009 (APFP Regulations 2009), and should be read alongside those documents (see Project Navigation Document AD01.02).

1.3 Document structure

1.3.1 This Statement is structured as follows:

a. Section 2 describes the existing and proposed generation;

b. Section 3 describes the existing and proposed grid connection infrastructure;

c. Section 4 sets out the installation and construction details;

d. Section 5 sets out the responsibility for the grid connection;

e. Section 6 sets out the delivery mechanism for the grid connection;

f. Section 7 sets out the conclusions.

1.4 The Applicant

1.4.1 Established in 1986, the Applicant is a statutory authority whose principal responsibility is the disposal of waste collected by the seven north London boroughs of Barnet, Camden, Enfield, Hackney, Haringey, Islington and Waltham Forest (the Constituent Boroughs).

1.4.2 The Applicant is the UK's second largest waste disposal authority, handling approximately 3 per cent of the total national Local Authority Collected Waste (LACW) stream. Since 1994 the Applicant has managed its waste arisings predominantly through its waste management contract with LondonWaste Limited (LWL) and the use of the EfW facility at the existing Edmonton EcoPark and landfill outside of London.

1.5 The Application Site

1.5.1 The Application Site, as shown on the Site Location Plans (A_0001 and A_0002 in the Book of Plans (AD02.01)), extends to approximately 22 hectares and is located wholly within the London Borough of Enfield (LB Enfield). The Application Site comprises the existing waste management site known as the Edmonton EcoPark where the permanent facilities would be located, part of Ardra Road, land around the existing water pumping station at Ardra Road, Deephams Farm Road, part of Lee Park Way and land to the west of the River Lee Navigation, and land to the north of Advent Way and east of the River Lee Navigation (part of which would form the Temporary Laydown Area and new Lee Park Way access road). The post code for the Edmonton EcoPark is N18 3AG and the grid reference is TQ 35750 92860.

1.5.2 The Application Site includes all land required to deliver the Project. This includes land that would be required temporarily to facilitate the development.

1.5.3 Both the Application Site and the Edmonton EcoPark (existing and proposed) are shown on Plan A_0003 and A_0004 contained within the Book of Plans (AD02.01). Throughout this report references to the Application Site refer to the proposed extent of the Project works, and Edmonton EcoPark refers to the operational site. Upon completion of the Project the operational site would consist of the Edmonton EcoPark and additional land required to provide new access arrangements and for a water pumping station adjacent to the Deephams Sewage Treatment Works outflow channel.

Edmonton EcoPark

1.5.4 The Edmonton EcoPark is an existing waste management complex of around 16 hectares, with an EfW facility which treats circa 540,000 tonnes per annum (tpa) of residual waste and generates around 40MW_e (gross) of electricity; an In-Vessel Composting (IVC) facility; a Bulky Waste Recycling Facility (BWRF) and Fuel Preparation Plant (FPP); an Incinerator Bottom Ash (IBA) Recycling Facility; a fleet management and maintenance facility; associated offices, car parking and plant required to

operate the facility; and a former wharf and single storey building utilised by the Edmonton Sea Cadets under a lease

1.5.5 In order to construct the proposed ERF, the existing BWRF and FPP activities would be relocated within the Application Site; the IVC facility would be decommissioned and the IBA recycling would take place off-site.

Temporary Laydown Area and eastern access

1.5.6 The proposed Temporary Laydown Area is an area of open scrubland located to the east of the River Lee Navigation and north of Advent Way. There is no public access to this area. The Temporary Laydown Area would be reinstated after construction and would not form part of the ongoing operational site.

1.5.7 In addition to the Temporary Laydown Area the Application Site includes land to the east of the existing Edmonton EcoPark which would be used for the new Lee Park Way entrance and landscaping along the eastern boundary.

Northern access

1.5.8 The Application Site also includes Deephams Farm Road and part of Ardra Road with land currently occupied by the EfW facility water pumping station between the junction of A1005 Meridian Way and Deephams Farm Road.

1.6 Surrounding area

1.6.1 The Application Site is located to the north of the A406 North Circular Road in an area that is predominantly industrial. The Lee Valley Regional Park (LVRP) is located to the east of the Edmonton EcoPark.

1.6.2 Land to the north and west of the Application Site is predominantly industrial in nature. Immediately to the north of the Edmonton EcoPark is an existing Materials Recovery Facility (MRF), which is operated by a commercial waste management company, alongside other industrial buildings. Further north is Deephams Sewage Treatment Works. Beyond the industrial area to the north-west is a residential area with Badma Close being the nearest residential street to the Application Site (approximately 60m from the nearest part of the boundary) and Zambezie Drive the nearest to the Edmonton EcoPark at approximately 125m west.

1.6.3 Eley Industrial Estate, located to the west of the Application Site, comprises a mixture of retail, industrial and warehouse units.

1.6.4 Advent Way is located to the south of the Application Site adjacent to the A406 North Circular Road. Beyond the A406 North Circular Road are retail and trading estates; this area is identified for future redevelopment to provide a housing-led mixed use development known as Meridian Water.

1.6.5 The LVRP and River Lee Navigation are immediately adjacent to the eastern boundary of the Edmonton EcoPark, and Lee Park Way, a private road which also forms part of National Cycle Network (NCN) Route 1,

runs alongside the River Lee Navigation. To the east of the River Lee Navigation is the William Girling Reservoir along with an area currently occupied by Camden Plant Ltd. which is used for the crushing, screening and stockpiling of waste concrete, soil and other recyclable materials from construction and demolition. The nearest residential areas to the east of the Application Site and LVRP are located at Lower Hall Lane, approximately 550m from the Edmonton EcoPark and 150m from the eastern edge of the Application Site.

1.7 The Project

1.7.1 The Project would replace the existing EfW facility at Edmonton EcoPark, which is expected to cease operations in around 2025, with a new and more efficient ERF which would produce energy from residual waste, and associated development, including temporary works required to facilitate construction, demolition and commissioning. The proposed ERF would surpass the requirement under the Waste Framework Directive (Directive 2008/98/EC) to achieve an efficiency rating in excess of the prescribed level, and would therefore be classified as a waste recovery operation rather than disposal.

1.7.2 The main features of the Project once the proposed ERF and permanent associated works are constructed and the existing EfW facility is demolished are set out in the Book of Plans (AD02.01) and comprise:

a. a northern area of the Edmonton EcoPark accommodating the proposed ERF;

b. a southern area of the Edmonton EcoPark accommodating the RRF and a visitor, community and education centre with offices and a base for the Edmonton Sea Cadets ('EcoPark House');

c. a central space, where the existing EfW facility is currently located, which would be available for future waste-related development;

d. a new landscape area along the edge with the River Lee Navigation; and

e. new northern and eastern Edmonton EcoPark access points.

1.7.3 During construction there is a need to accommodate a Temporary Laydown Area outside of the future operational site because of space constraints. This would be used to provide parking and accommodation for temporary staff (offices, staff welfare facilities), storage and fabrication areas, and associated access and utilities.

1.7.4 Schedule 1 of the draft DCO (AD03.01) sets out the authorised development and the works are shown in the Book of Plans (AD02.01), supplemented by Illustrative Plans (included in the Design Code Principles, AD02.02) that set out the indicative form and location of buildings, structures, plant and equipment, in line with the limits of deviation established by the draft DCO (AD03.01).

1.8 Stages of development

1.8.1 The proposed ERF is intended to be operational before the end of 2025, but with the precise timing of the replacement to be determined. In order to do this, the following key steps are required:

a. obtain a DCO for the new facility and associated developments;

b. obtain relevant environmental permit(s) and other licences, consents and permits needed;

c. identify a suitable technology supplier;

d. agree and arrange source(s) of funding;

e. enter into contract(s) for design, build and operation of new facility and associated development;

f. move to operation of new facility; and

g. decommission and demolish the existing EfW facility.

1.8.2 Site preparation and construction would be undertaken over a number of years and it is expected that the earliest construction would commence is 2019/20, although this may be later. Construction would be implemented in stages to ensure that essential waste management operations remain functioning throughout. This is especially relevant for the existing EfW facility and associated support facilities.

1.8.3 The stages of the Project are as follows:

a. Stage 1a: site preparation and enabling works;

b. Stage 1b: construction of RRF, EcoPark House and commencement of use of Temporary Laydown Area;

c. Stage 1c: operation of RRF, EcoPark House and demolition/clearance of northern area;

d. Stage 1d: construction of ERF;

e. Stage 2: commissioning of ERF alongside operation of EfW facility, i.e. transition period;

f. Stage 3: operation of ERF, RRF and EcoPark House, demolition of EfW facility; and

g. Stage 4: operation of ERF, RRF and EcoPark House, i.e. final operational situation.

2 Description of the generation

2.1 Existing generation

2.1.1 The existing EfW plant has a rated power output of 52.7MW_e, although the practicable peak generation capacity of the facility is around 40MW_e (gross), equating to a net output to the local electricity grid of up to 37MW_e. The Edmonton EcoPark incorporates its own step-up transformers in an existing transformer compound to enable connection to the local electricity Distribution Network Operator (DNO) who in this case is UK Power Networks (UKPN). Existing step-up transformers feed electricity at 33kV to the grid via UKPN switchgear and metering equipment located within the compound and the turbine hall.

2.1.2 The existing EfW facility, electrical cables, transformers and main power cable route are shown on drawing number 35180/LON/CVD/004/E included in Appendix A.

2.2 Proposed generation

2.2.1 The proposed ERF would have a gross power generation capacity of around 70MW_e in power only mode, processing around 87.5 tonnes per hour of waste with a calorific value of 10MJ/kg. The final ancillary electrical load of the Edmonton EcoPark would be approximately 10.5MW_e, leaving up to an expected 61MW_e available for net export to the grid in power only mode.

2.2.2 The ERF would be enabled for CHP operation by employing an extraction condensing steam turbine with a controlled extraction point. The Project includes provision for the supply of heat to the boundary of the Application Site for connection for distribution to heat customers. Supply of heat would result in a reduction in power output depending on the quantity of heat exported; however, at times of no heat export the ERF would require its maximum electrical grid export capacity. For further information on the proposed use of heat from the ERF please refer to the CHP Development Strategy (AD05.06) submitted with the Application.

2.2.3 The ERF would generate electricity at the 11kV voltage level from a single turbine alternator. The electricity would be conducted from the alternator, located within the ERF building, to a pair of new step-up transformers, to be located in a new transformer compound at the Edmonton EcoPark. The indicative location of the proposed transformer compound is shown on supporting plan D_0005 included in the Design Code Principles (AD02.02).

2.2.4 This would house step-up transformers (33kV/11kV) to increase voltage levels from 11kV as received from the alternator to 33kV for export to the local distribution network (‘Tottenham Grid‘).

2.2.5 The capacity of the new step-up transformers would enable export up to 70MVA under the proposed design as shown in the following indicative schematic provided by UKPN in Figure 2.1. The final arrangement and sizing of transformers is subject to detailed design. Note that all figures

provided by UKPN refer to the existing UKPN substation on the Edmonton EcoPark as Deephams, which is the official record name. Figure 2.2 indicates the area reserved for new transformer/switchgear required for upgrade of the electrical grid connection, all located within the Application Site.

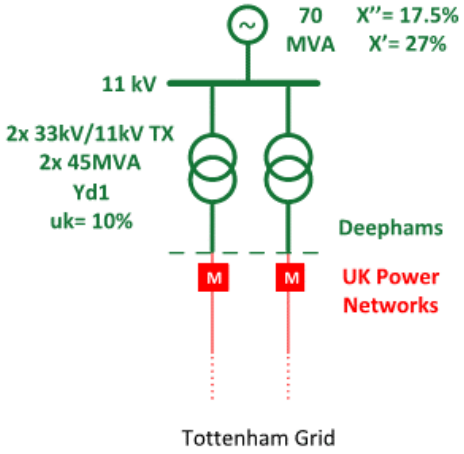


Figure 2.1: Proposed schematic design for export to grid from the ERF (Source: UKPN February 2015)

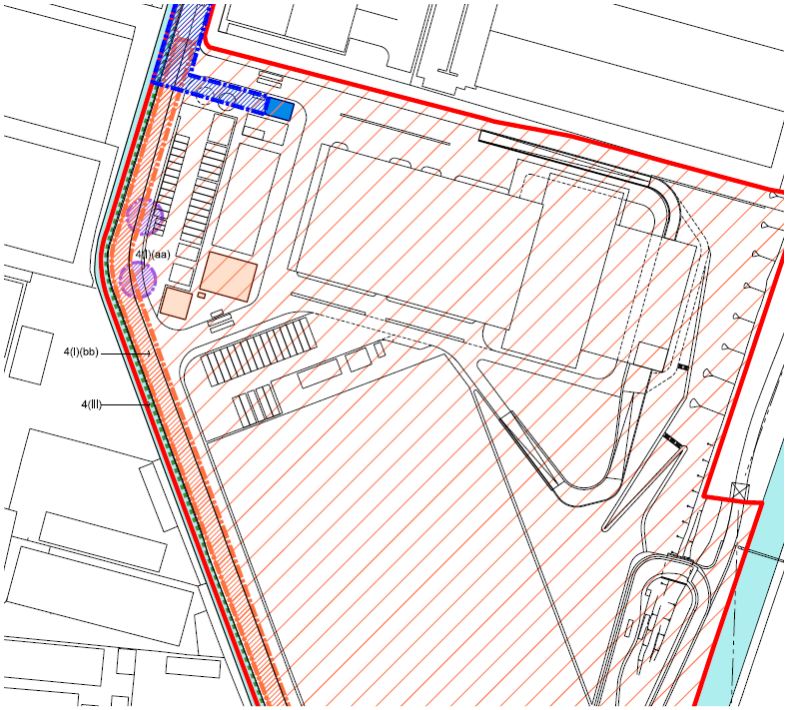


Figure 2.2: Extract from indicative application drawing D_0005 showing the area reserved for new transformer/switchgear required for upgrade of the electrical grid connection

3 The grid connection

3.1 Existing grid connection

3.1.1 The existing EfW exports electricity at 33kV to the Tottenham Grid from a UKPN open terminal switch yard (located in the existing transformer compound) containing existing isolation and earthing switches, metering equipment and other assets. UKPN owned protection and metering equipment is also located within the existing turbine hall. Two underground cable circuits export the power from the Edmonton EcoPark to the UKPN Tottenham Grid Substation (TGS), approximately 2km from the Edmonton EcoPark (detailed route plan included at Appendix B). The TGS connects to the National Supergrid system via the co-located UKPN 123kV Substation. The existing connection is shown schematically in Figure 3.1 and spatially in Figure 3.2.

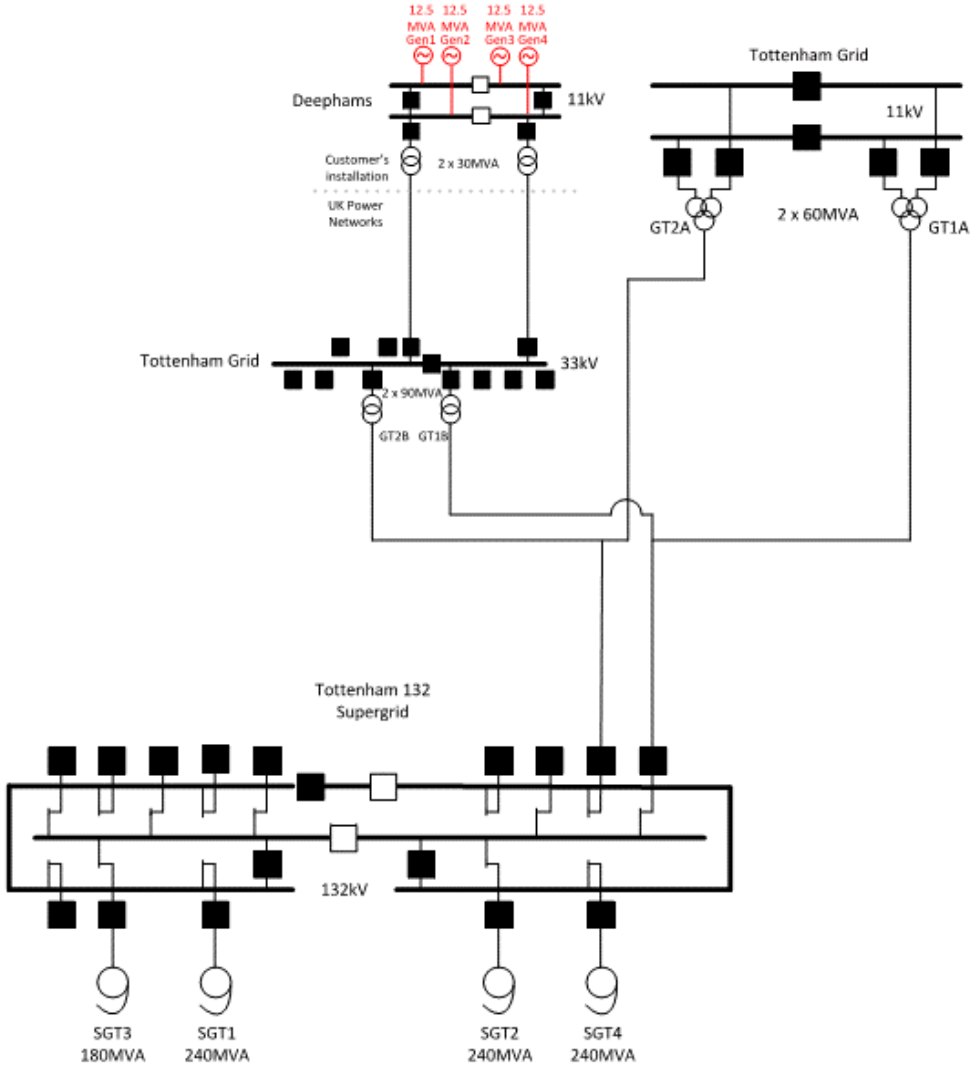


Figure 3.1: Schematic of existing connection from the Edmonton EcoPark to Tottenham Grid and Tottenham 132kV Supergrid (Source: UKPN February 2015)

Figure 3.2: Route of existing grid connection and location of Tottenham Grid Substation (Source: UKPN February 2015)

3.2 Proposed grid connection

3.2.1 During the pre-application period, the Applicant requested the DNO (UKPN) to carry out a feasibility study ('the Study'). The Study investigated the options for upgrading the grid connection to cater for the increase in export to 70MVA (assuming unity power factor i.e. 70MW_e). The UKPN Feasibility Study is included in Appendix C and includes the following options:

a. Option 1: No upgrade to 33kV existing circuits;

b. Option 2: Bypass new polymeric cables over the oil filled sections and disconnect the oil filled sections;

c. Option 3: Parallel the two existing 33kV circuits in order to provide the 70MVA export with a single circuit supply; and

d. Option 4: Install new cables in parallel with the existing ones and (as per Option 2) bypass new polymeric cables over the oil filled sections and disconnect the oil filled sections, to provide a more secure connection.

3.2.2 Following discussion with UKPN and a review of the Study by the NLWA, a preferred option for the grid connection upgrade was selected and is described here (Option 4 in the UKPN Feasibility Study).

3.2.3 New underground cabling would be laid in parallel with the existing two circuits which currently connect to TGS (see Figure 4.2). Figure 3.3 is an indicative schematic of the design which would ensure that the loss of one of the Tottenham Grid 33kV circuit would not affect the capacity to export 70MVA from the Edmonton EcoPark. Note that sections with dashes are oil filled sections in need of overlaying.

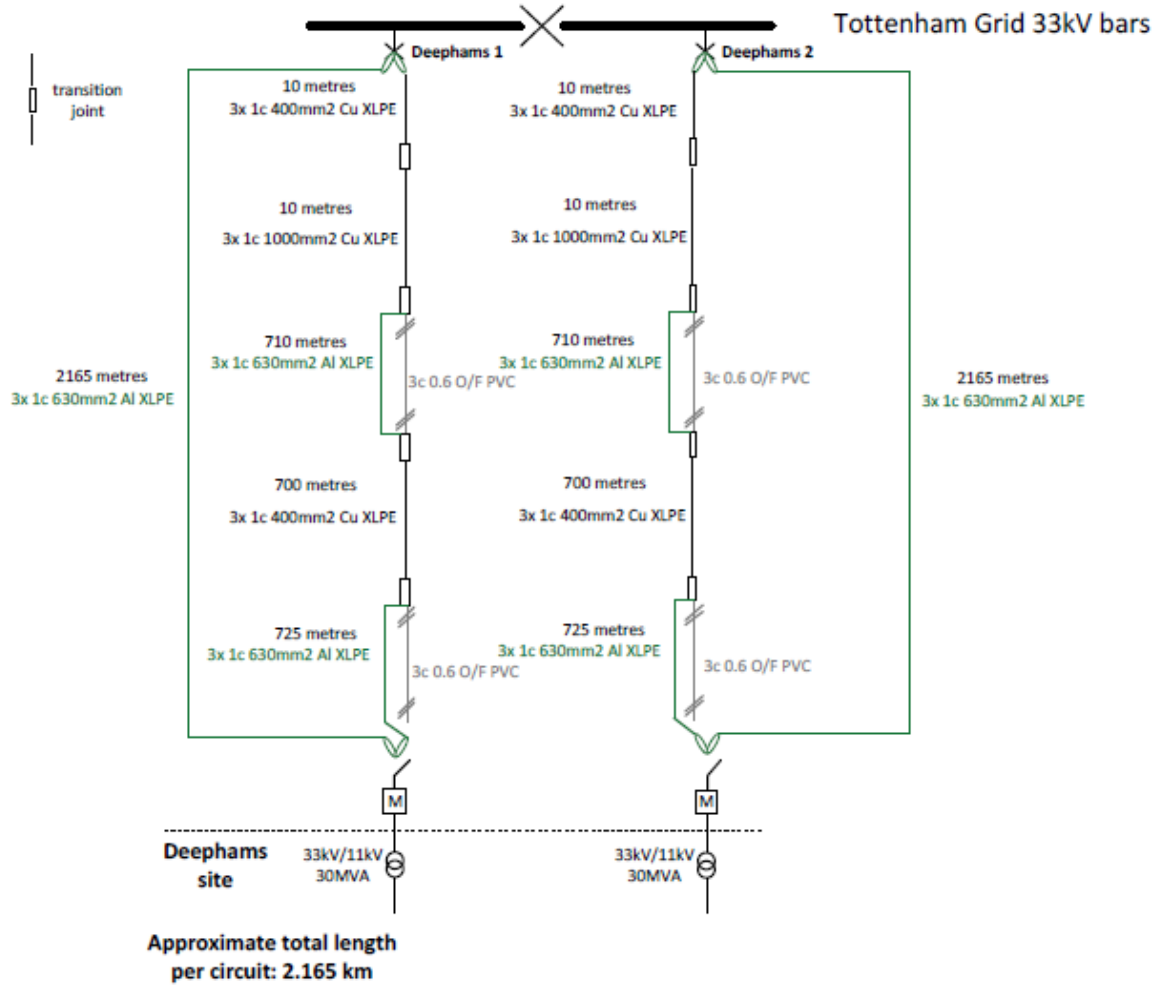


Figure 3.3: Schematic of connection upgrade (Source: UKPN February 2015)

3.2.4 In order to export 70MVA, the existing cable circuits would be upgraded to allow a maximum power flow through each circuit conductor of 36MVA in the summer. Once upgraded both cable circuits would therefore have a capacity 2x36MVA = 72MVA in the summer (underground cabling is rated for worst case high soil temperature). However, the existing UKPN switchgear at TGS has a limiting rating of 71.3MVA per circuit.

3.2.5 The 33kV/132kV transformers at TGS would not need upgrading. In addition, no works would be required to upgrade the connection to the Tottenham Supergrid.

3.2.6 The existing UKPN connection to TGS supports both power export and the power import requirements necessary to supply the ERF balance of plant and other consumers on the Edmonton EcoPark. This arrangement would be maintained for the Project at the capacities envisaged.

3.2.7 The grid connection upgrade works would follow the route of the existing grid connection shown in Figure 3.2 and in detail in Appendix B. Further details of works required along the route are described in Section 4.

3.2.8 It is noted that the study identified other feasible options for a grid connection; however, the selected option (Option 4) offers the least cost solution which meets the Applicant's ongoing requirements for export capacity and resilience of the grid connection.

4 Installation and construction details

4.1.1 The installation and design specifications would be in accordance with UKPN specifications. For details, refer to UKPN's G81 - Design Specification Library to access engineering standards for electrical connections[1].

4.1.2 The main works comprise the installation of circa 4.4km of new cable overlaying the two existing circuits to the TGS. The new cable specification would be of 630mm^2 Al (Aluminium) type as a minimum.

4.1.3 The existing circuits have polymeric and oil filled cable sections. In order to increase the rating of the circuits to allow a 70MVA export, the 0.6in^2 oil filled ("O/F") sections also require overlaying with polymeric ones. Approximately 3km of oil filled cable requires overlaying with 630mm^2 Al cable. These new sections of cable would be laid alongside the existing oil filled sections. The oil filled sections would then be disconnected and left in-situ or removed following the overlay, and all associated oil handling apparatus would be removed.

4.1.4 All upgrade works would be undertaken along the route of the existing grid connection as shown in Figure 3.2 and in detail in Appendix B, requiring new trenches to be dug alongside the existing cables. Two crossings of Pymme's Brook occur on the existing route, but the new cable sections would utilise the existing crossings. Additionally, there is an A406 crossing (Angel Road) on the original route that UKPN advises could require directional drilling works to avoid any traffic disruption.

4.1.5 Whilst the two 70MW$_e$ grid connection cable circuits would terminate onto (as yet undetermined) UKPN assets to be installed within the new ERF step-up transformer compound, in order to operate the existing EfW and new ERF plants during the commissioning phase, it would be necessary to extend the 33kV cabling to maintain an export connection to the existing EfW step-up transformers. The arrangements surrounding such connections, including the order of re-enforcement of the existing grid connection cable circuits, have yet to be discussed with UKPN.

4.1.6 Appendix B includes a detailed utility plan of the existing grid connection including annotations of specific elements of the upgrade works to be undertaken.

[1] UKPN G81 - Design Specification Library http://library.ukpowernetworks.co.uk/library/en/g81/ (accessed 15 September 2015)

5 Responsibilities for the connection

5.1.1 The Applicant would be responsible for proposed works on the Edmonton EcoPark including: the provision of step-up transformers (11kV/33kV); the 11kV connection between the ERF alternator and the transformers; and termination onto the UKPN assets required for connection to the grid connection circuits for export from the Edmonton EcoPark, all located indicatively as shown on Figure 2.2. The details of equipment sizing and circuitry arrangements would be confirmed at detailed design.

5.1.2 UKPN are the relevant DNO pursuant to an electricity distribution licence issued in accordance with the provisions of the Electricity Act 1989 as amended by the Utilities Act 2000. National Grid (NG) owns and operates the electricity transmission system in England and Wales, pursuant to an electricity transmission licence issued in accordance with the provisions of the same legislation.

5.1.3 The existing grid connection is owned by UKPN from the busbars connecting onto the open terminal bushings of the existing transformers, from where the connection is conducted off the Edmonton EcoPark. The future grid connection would replicate this ownership configuration.

5.1.4 The upgrades to the grid connection to export power from the ERF would require an amendment to the Connection Agreement with authority to include for increased export capacity. It is anticipated that prior to commissioning, UKPN would also add an appendix to its contract at Tottenham 132kV Super Grid substation with NG to re-classify the power generation activities at the Edmonton EcoPark as a License Exempt Embedded Medium Power Station.

5.1.5 The new classification introduces technical requirements which the ERF power export equipment would need to fulfil, as defined by the Grid Code[2]. These include voltage control requirements. The Project would include relevant equipment to this purpose.

5.1.6 The following elements include a summary of Non-Contestable works which can only be carried out by UKPN:

a. perform G59 witness testing procedures;
b. Watts & Vars transducers at Tottenham Grid x 2;
c. perform required electrical circuit shutdowns;
d. update protection settings as required;
e. cable terminations and 33kV cabling within TGS;
f. removal of oil fluid from oil filled cable sections;
g. removal of buried oil tanks;
h. cable joints including joint bays; and
i. project management.

[2] National Grid, Grid Code, available from http://www2.nationalgrid.com/uk/industry-information/electricity-codes/grid-code/the-grid-code/

5.1.7 The following elements include a summary of Contestable works that could be carried out by UKPN or by accredited contractors which could be appointed by the Applicant:

Overlay oil filled sections:

a. lay circa 3km of 630mm^2 Al 33kV cable;
b. excavate and reinstate cable route; and
c. directional drilling as required.

Lay new cables alongside existing ones:

a. lay circa 4.4 km of 630mm^2 Al 33kV cable;
b. excavate / reinstate cable route; and
c. directional drilling as required.

6 Consenting of grid connection

6.1.1 UKPN would make use of its statutory undertaker's rights to install new cabling under the provisions of easements and wayleaves obtained for previous work along the circuit routes. These works would not require a further planning permission and are not included in the Project.

7 Conclusion

7.1.1 The proposed ERF would require upgrade works to the existing grid connection to support the performance requirements to export 70MVA on two separate circuits to the Tottenham Grid Substation, with the export capacity maintained in the event of failure of either circuit.

7.1.2 Works on the Edmonton EcoPark to be undertaken by the Applicant would include connection of the ERF generating plant to new step-up transformers (11kV/33kV) located indicatively as shown on Figure 2.2 and the provision of temporary 33kV interlinking cables to connect onto the existing 33kV step-up transformers for the duration of the commissioning period.

7.1.3 Works between the new UKPN assets at the Edmonton EcoPark and TGS would include replacing the oil filled sections with 630mm^2 Al cable, and installing two new underground circuits of similar cable overlaying the existing circuits. No new transmission infrastructure would be required at the Tottenham Grid Substation.

Appendix A: Existing utilities drawing

A1.1.1 This Appendix includes drawing number 35180/LON/CVD/004/F as appended to the Utilities Strategy (AD05.10) and shows existing EfW facility, electrical cables, transformer compound location and main power cable route on the Edmonton EcoPark.

0m 25m 50m 75m 100m

SCALE 1:1,250

Original Drawing Size – A1

DESCRIPTION

REV	DATE		DWN	CHK	APP
A	06/08 2014	FIRST ISSUE	AC	EGA	JA

REVISIONS

REV	DATE		DWN	CHK	APP
B	02/10 2014	.	AC	EGA	JA
C	02/04 2015	ADDITION OF NEW MAIN GAS PIPE	MS	EGA	JA
D	15/04 2015	ADDITION OF EXISTING GAS MAIN AND REMOVAL OF PROPOSED WORKS	MS	EGA	JA
E	24/06 2015	AMENDED NOTES	MS	EGA	JA
F	03/08 2015	AMENDED GAS MAIN	MS	AD	EGA

NOTES:

1. SERVICES INFORMATION SHOWN HAS BEEN INTERPRETED FROM SERVICE UNDERTAKER'S INFORMATION, COPIES OF THE ORIGINAL DRAWINGS ARE AVAILABLE.
2. MAIN POWER CABLES ARE UKPN PROPERTY
3. GAS PIPES ARE NATIONAL GRID PROPERTY

LEGEND:

- SITE BOUNDARY
- MAIN GAS PIPE–LP (OWNED BY NATIONAL GRID)
- ELECTRICAL CABLE (OWNED BY LWL)
- POWER CABLE CIRCUITS (X2) (OWNED BY UKPN)
- ELECTRICITY CABLES

SCALES: 1:1250

PROJECT TITLE:

NORTH LONDON HEAT AND POWER PROJECT

DRAWING TITLE:

EXISTING EDMONTON ECOPARK SERVICES GAS AND ELECTRICAL CABLES

CLIENT:

nlwa north london waste authority

NLWA
1B BEROL HOUSE
25 ASHLEY ROAD
TOTTENHAM HALE
N17 9LJ
TEL: (0208) 4895730

DCO APPLICATION REF:

DOC REF No:

60 LONDON WALL,
LONDON
EC2M 5TQ
TEL: (0203) 2151700
FAX: (0203) 2151701

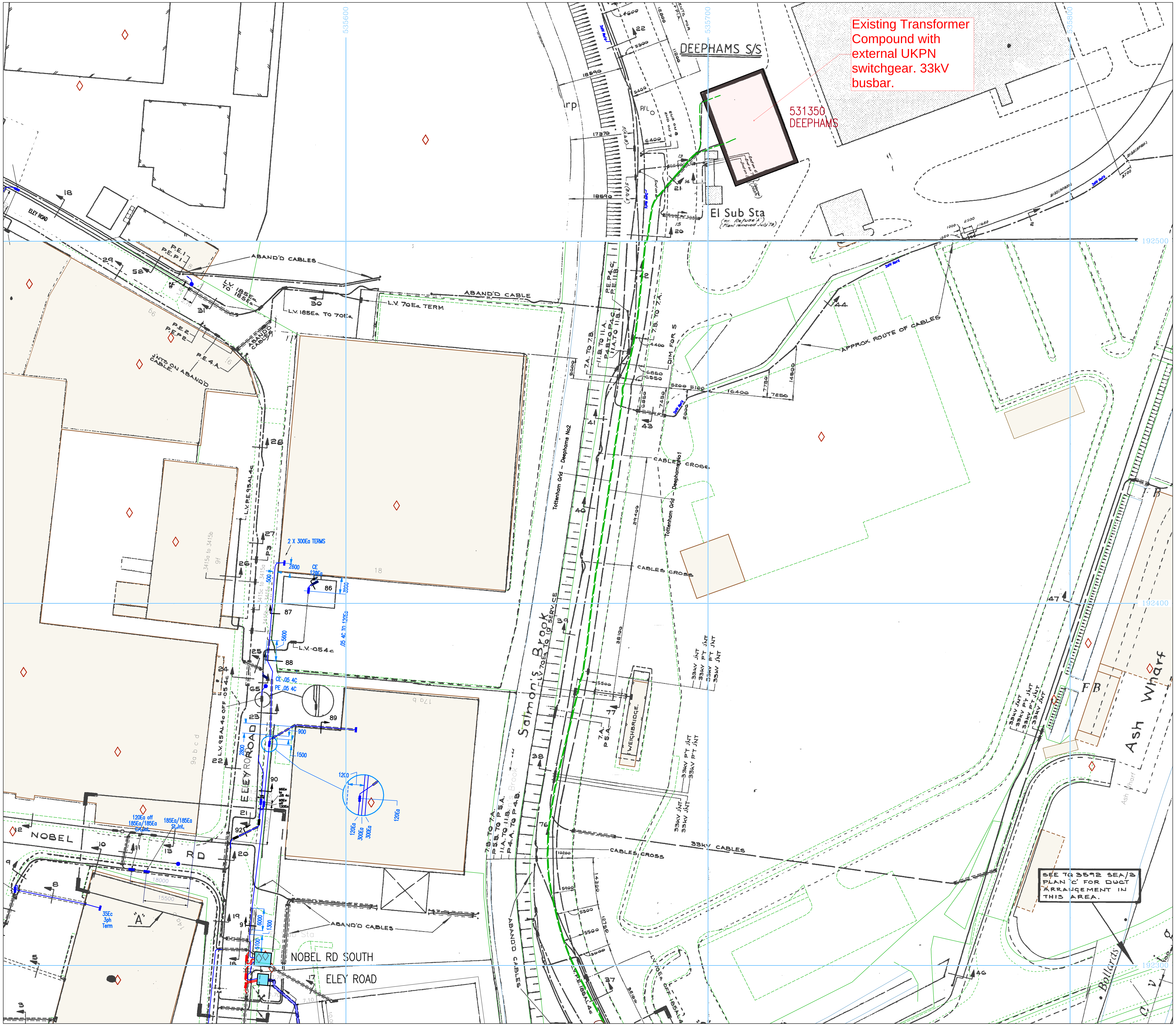
amec foster wheeler

DRAWING No.

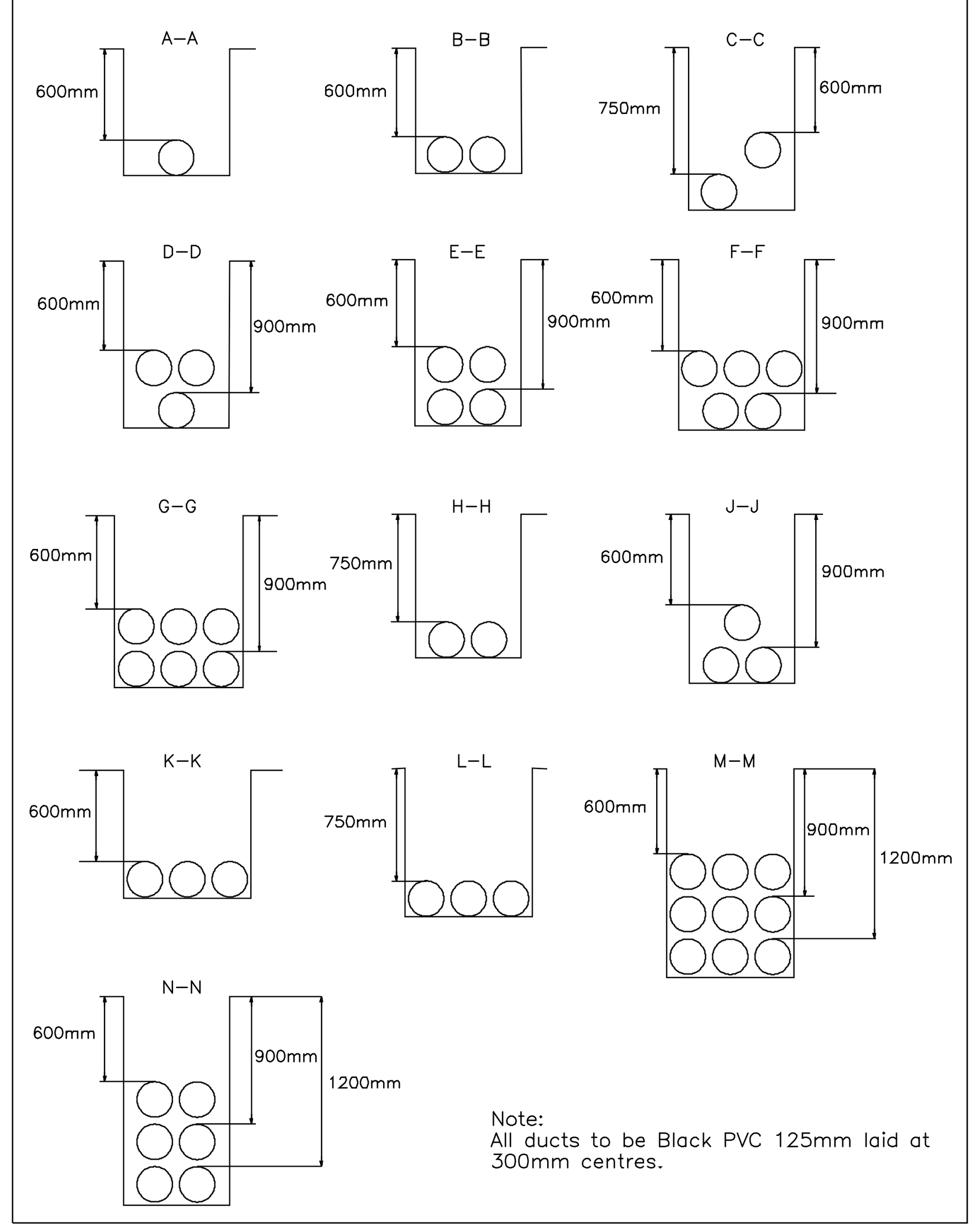
35180/LON/CVD/004/F

Appendix B: Existing grid connection utility drawing

B1.1.1 The following drawing is a detailed utility drawings of the existing grid connection between the Edmonton EcoPark (referred to by UKPN as Deephams) and the Tottenham Grid Substation. It includes annotations made by Arup of significant elements of work as identified by the UKPN Feasibility Study (February 2015).



STANDARD CROSS SECTIONS FOR ROAD CROSSINGS



Note:
All ducts to be Black PVC 125mm laid at 300mm centres.

Legend

	Existing (Old)	Existing (New)	Proposed
Service U/G			
Low Voltage U/G			
HV (11Kv) U/G			
EHV (33Kv) U/G			
EHV (132Kv) U/G			
LV Overhead			
HV Overhead			

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UK Power Networks

Proposals For : NLWA 33kV Cable Route

Sheet 1

Plotted By: Keir Spiller

Scale 1:500
(When plotted at A1)

Plotted On: 06/07/2015

Map Centre : TQ3592SE

Bedding Works

NOBEL RD SOUTH

ELEY ROAD

BANKSIA ROAD

ABAND'D CABLE

ABAND'D CABLES

Enfield Ditch crossing required

ENVIRONMENT AGENCY (N.T.S.)

COOKS FERRY

Weir

SEE ENL.-B TQ3592 SEA/2 FOR CABLE DETAILS IN THIS AREA.

Unit 6

Unit 7

Unit 8

Unit 9

Unit 5

Unit 4

Unit 3

Unit 10

Unit 11

Warehouse

BYSSC

ALLER

ADVENT WAY

The UKPN Feasibility Study indicates that the overlay works crossing A406 are likely to require directional drilling under the highway so as not to disrupt traffic.

33kV CABLES

APPROX ROUTE

BOOTS ANGEL ROAD

BOOTS ANGEL RD S/S

RAVENSIDE

RAVENSIDE RETAIL PARK

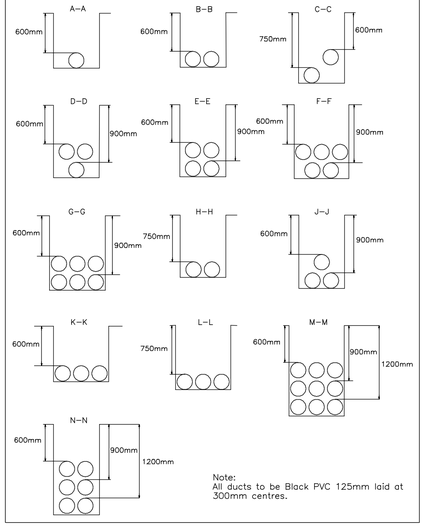
SITE LINE EAST BLDING LINE OF COOKS FERRY S/S

Tottenham Grid – Deephams No2

Telephone

FB

STANDARD CROSS SECTIONS FOR ROAD CROSSINGS



Note:
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Legend

	Existing (Old)	Existing (New)	Proposed
Service U/G			
Low Voltage U/G			
HV (11Kv) U/G			
EHV (33Kv) U/G			
EHV (132Kv) U/G			
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Proposals For : NLWA 33kV Cable Route

Sheet 2

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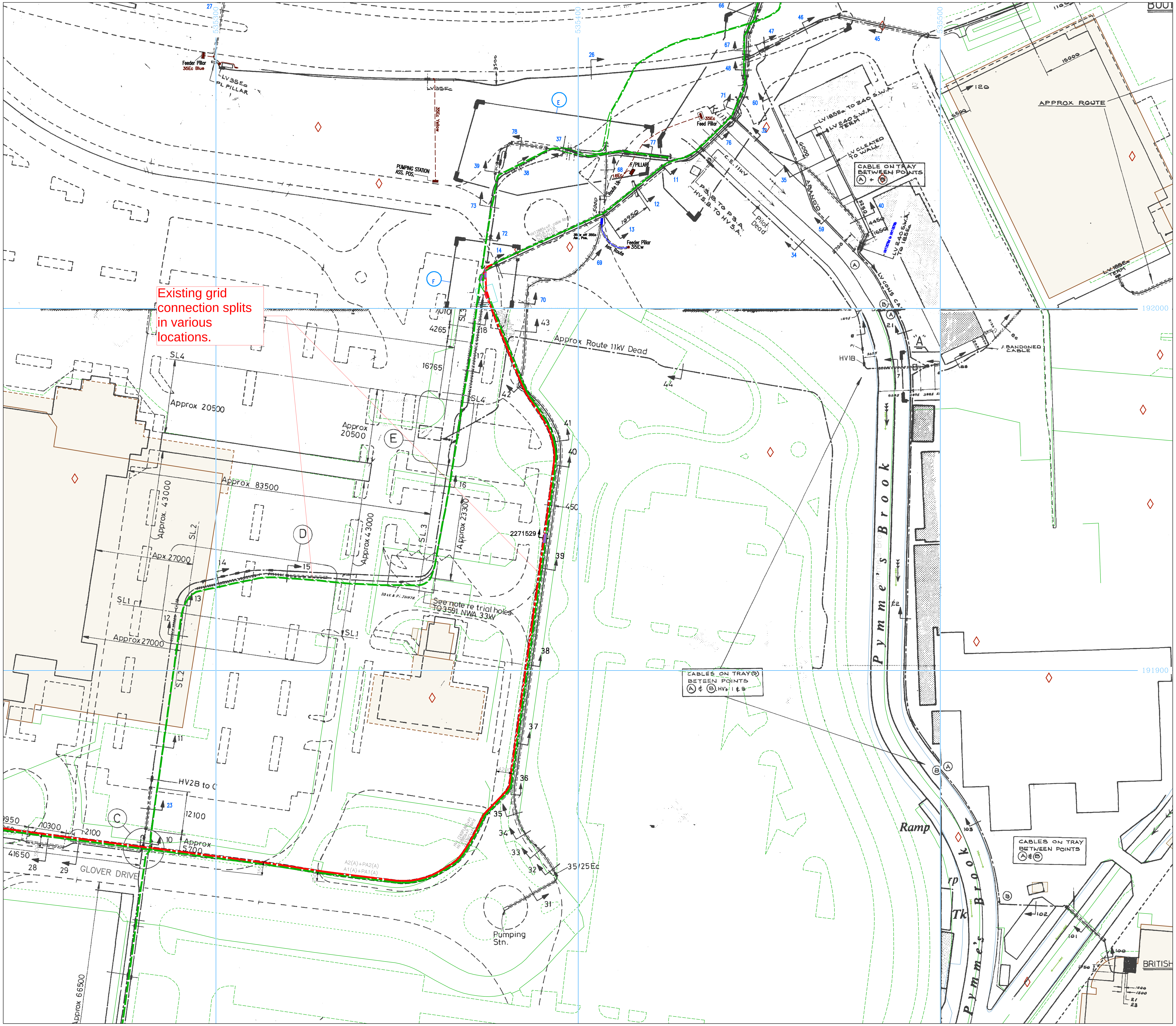
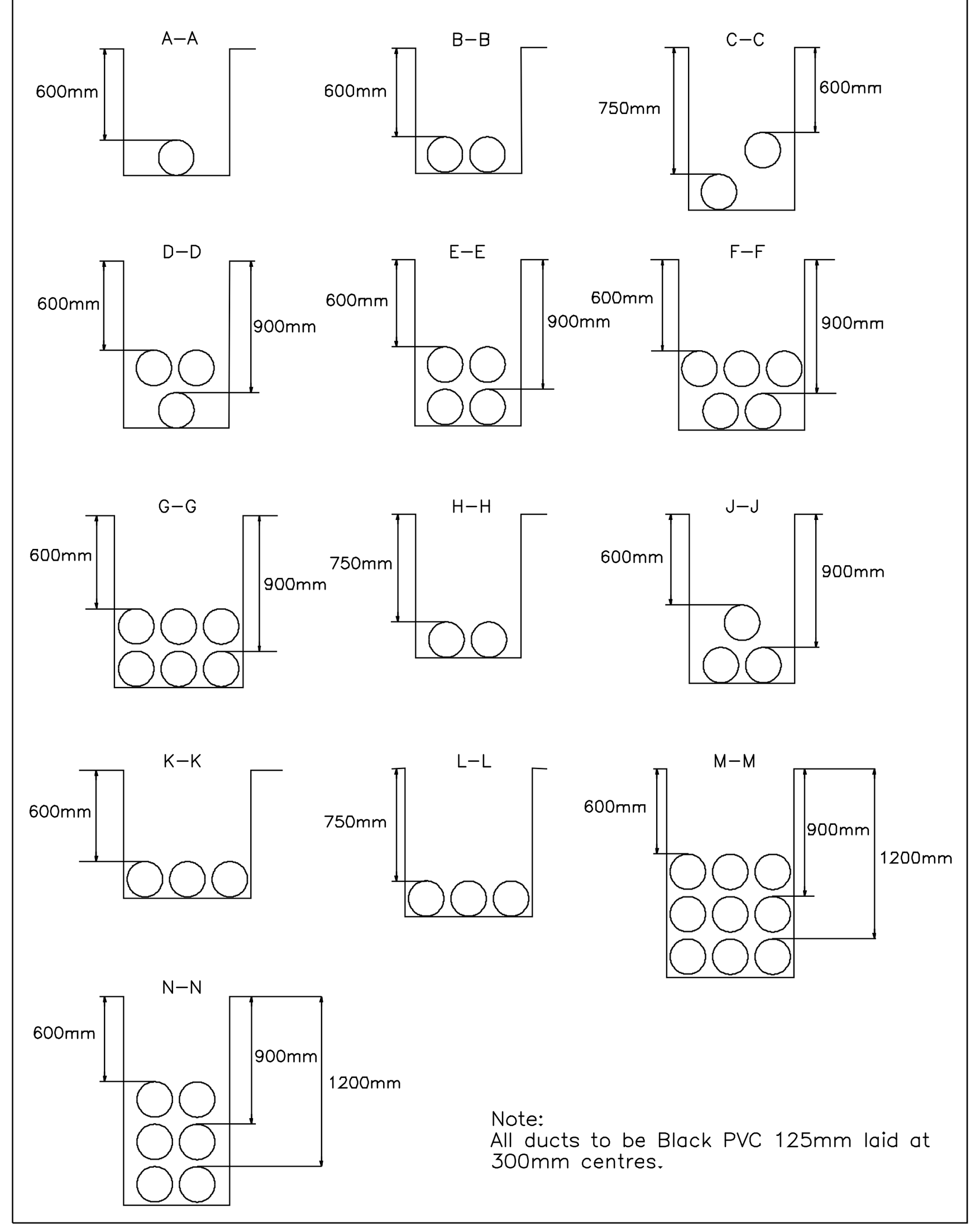
Scale 1:500 (When plotted at A1)

Plotted On: 06/07/2015

Map Centre : TQ3592SE



STANDARD CROSS SECTIONS FOR ROAD CROSSINGS



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Legend

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UK Power Networks

Proposals For : NLWA 33kV Cable Route

Sheet 1

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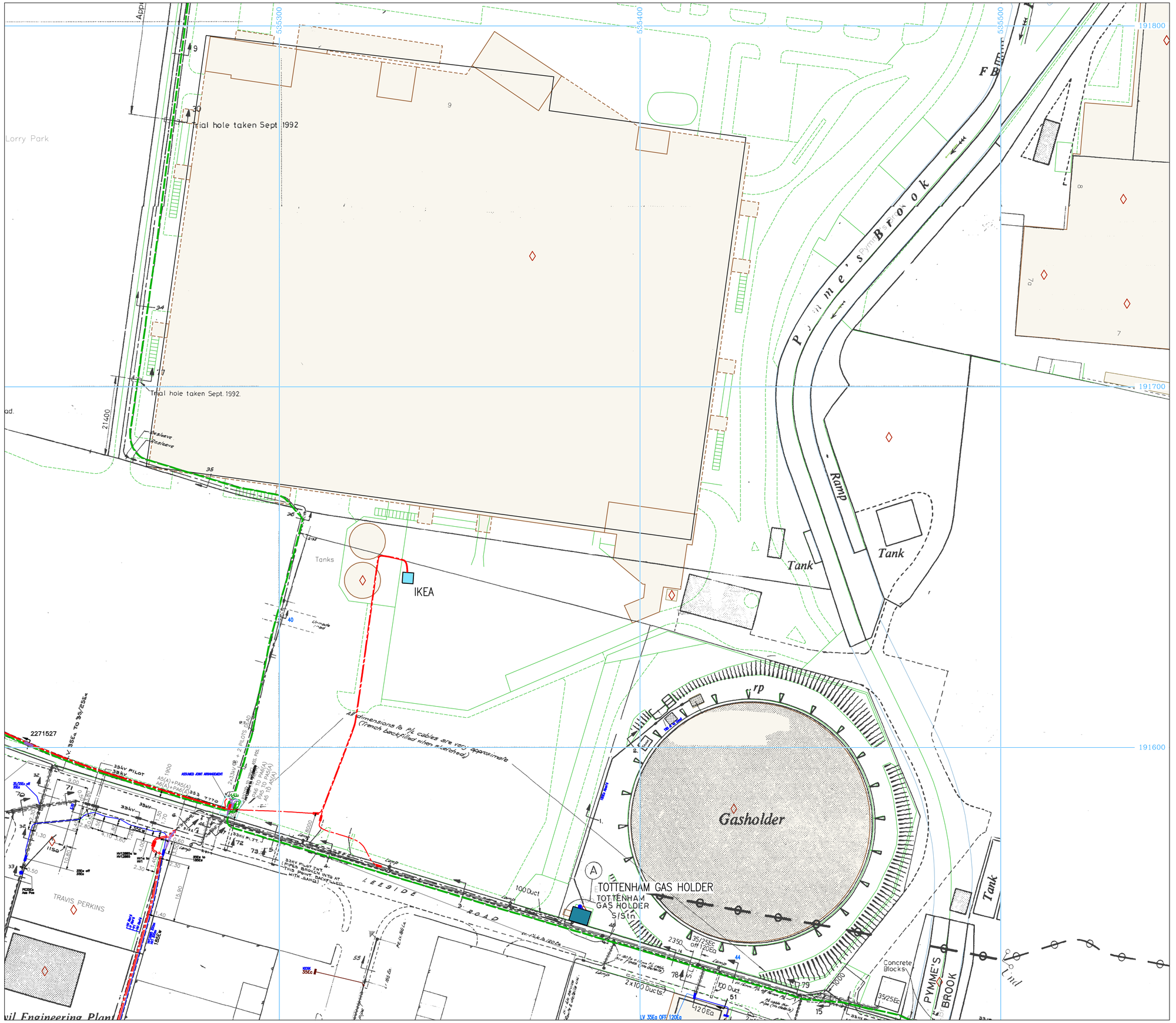
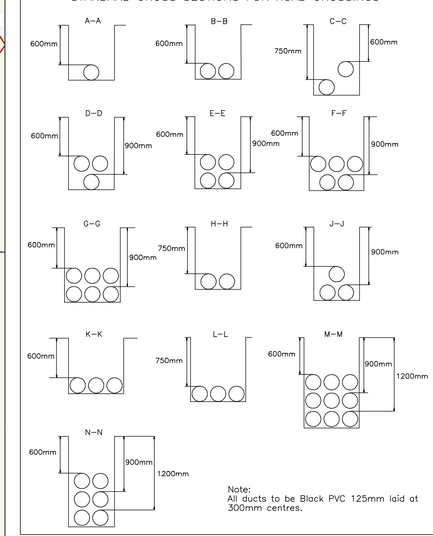
Scale 1:500
(When plotted at A1)

Plotted On: 06/07/2015

Map Centre : TQ3591NW



STANDARD CROSS SECTIONS FOR ROAD CROSSINGS



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(When plotted at A1)

Plotted On: 06/07/2015

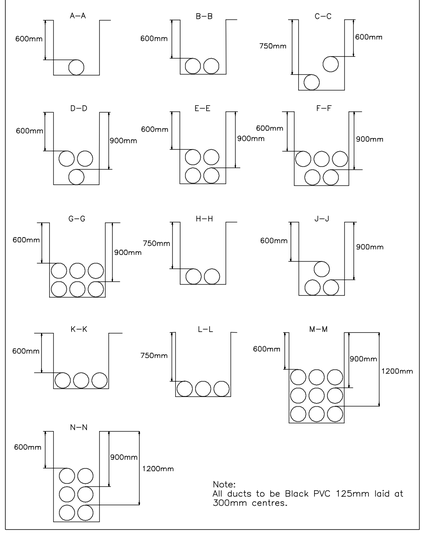
Map Centre : TQ3591NW

TOTTENHAM GAS HOLDER

Pymme's Brook crossing 1/2 would re-use the existing utility bridge.

Tottenham Marshes

STANDARD CROSS SECTIONS FOR ROAD CROSSINGS



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Scale 1:500
(When plotted at A1)

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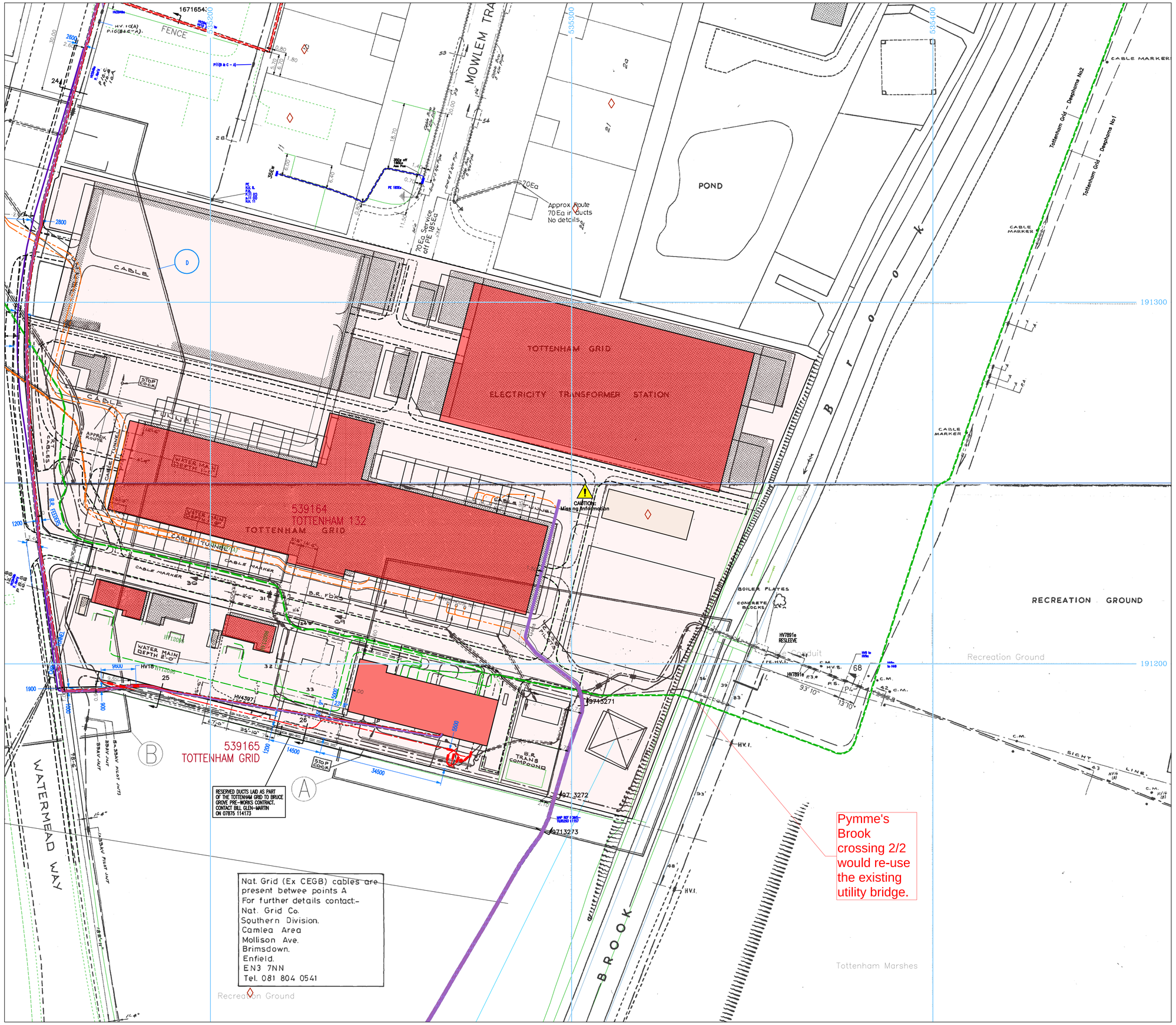

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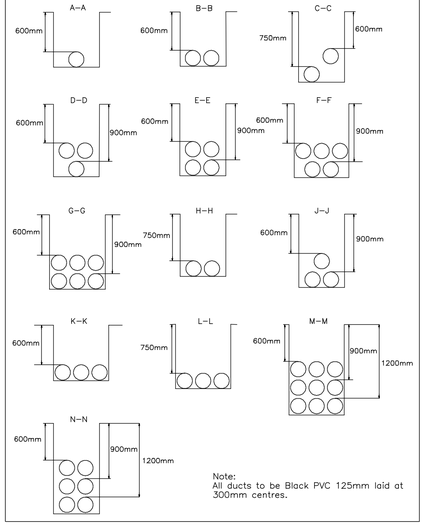

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Plotted On: 06/07/2015	Map Centre : TQ3591SW

Appendix C: UKPN Feasibility Study

C1.1.1 Feasibility Study 25 February 2015

C1.1.2 Tottenham Grid Power Quality Report 2015

C1.1.3 Budget Estimate 24 March 2015.

Feasibility study

Internal reference: 401620280

Customer:

North London Waste Authority
Edmonton EcoPark, substation name: “Deephams”
Advent Way
London
N18 3AG

Date of issue: 25th February 2015

UK Power Networks
Delivering your electricity

Contents

Acronyms

Term	Definition
NG	National Grid
NLWA	North London Waste Authority
MPAN	Metering Point Administration Number

1. Deephams connection to UK Power Networks

1.1 Context

North London Waste Authority (NLWA) approached UK Power Networks in June 2014 to query about the increase of the export agreement of its Deephams site, sited at the Edmonton EcoPark (postcode: N18 3AG). For clarity, the site will be referred to as "Deephams" in this feasibility report. The increase in export agreement is expected to occur in two phases, according to NLWA: initially, an increase from 60 MVA to 70 MVA is envisaged; at a later stage, NWLA are looking to increase their export agreement to 90 MVA. No upgrade works are expected to start before 2020.

A number of options to facilitate the increase in export agreement from 60 MVA to 70 MVA and 90 MVA are presented in this report. Considering the level of export being requested and the potential impact on the NG system, UK Power Networks were obliged to request two Statements of Works on the customer's behalf: Tottenham 132 and Brimsdown 132. Initially Brimsdown 132 was considered for a 90 MVA connection at 132kV, as a connection to Tottenham 132 appeared not to be available at the time this study was initiated. A connection to Brimsdown 132 was eventually discarded because it is now assumed to be physically possible to connect to Tottenham 132 (which is closer to the customer's site and would provide a more cost effective solution). Only a 70 MVA export through Tottenham 132 was assessed by National Grid though. A 90 MVA export through Tottenham 132 will require confirmation from National Grid following a formal application.

National Grid has issued Statements of Works for Tottenham 132 and Brimsdown 132 grid supply points on 09/12/2014 (see Appendix A). The "Statement of Works" process was only initiated by NG on 08/10/2014 after additional information provided by UK Power Networks on the customer's installation, following confirmation from NWLA (06/10/2014). The outcome of the Statements of Works indicated that no works on the interconnections (Tottenham 132 and Brimsdown 132) or the transmission network are required following the requested increases in export. The Statements of Works are only valid for 90 working days after the date of issue (date of lapse: 20/04/2015). These should thus be interpreted as an indication of current network conditions to accommodate the potential upgrade(s).

1.2 Assumptions of this study

- **For simulation purposes only, the Deephams site is assumed to operate at unity power factor (MW export only). Restrictions may apply when a formal application is assessed, either applied by UK Power Networks or National Grid.**
- Fault contribution from spinning load onsite included in the analysis (figures supplied by the North London Waste Authority on 12/08/2014).
- Measurements collected are half-hourly averages. Therefore, some granularity on maximum/minimum values may have been lost.
- Balanced export through each of the 33kV feeders ("Deephams 1", "Deephams 2").
- Directional overcurrent protection is not a limitation in Tottenham Grid.

- Optioneering excludes works on the customer's side of the metering point.
- Future utilisation of the 33kV circuits is assumed to follow the utilisation profile illustrated in Figure 1.

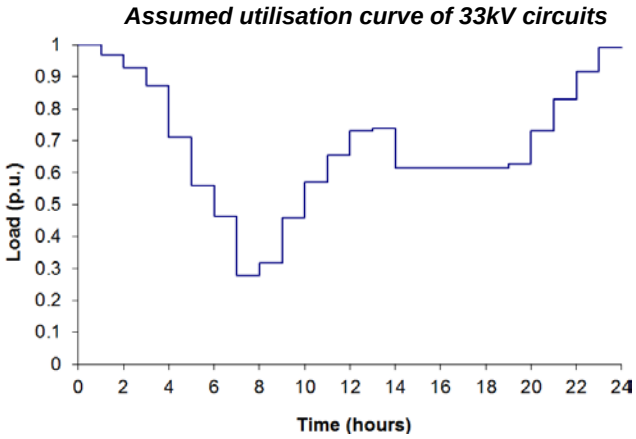

Figure 1 - Assumed future utilisation profile of the 33kV circuits. "Load (p.u.)" (*y*-axis) refers to the utilisation level of the thermal limits

The calculated ratings in this study are based on a 10-day cycle of the utilisation profile illustrated in Figure 1 and on the operating conditions shown in Figure 2. Cable grouping factors are also considered where applicable (based on three ducts in trefoil, one cable per duct).

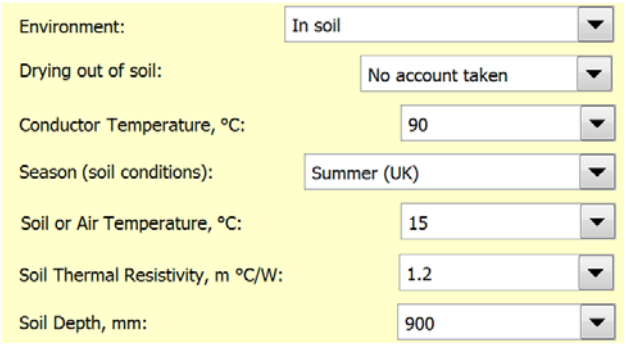

Figure 2 – Assumed key operating conditions of the cable installation

Should planned utilisation of the circuits be more onerous than reported (i.e., a more sustained higher utilisation of the circuits is expected), more conservative cable ratings need to be adopted. This might mean further cable overlays or increasing the cross section of the new cables to be installed (if applicable).

1.3 Deephams 33kV connection to Tottenham Grid at present

The generation infrastructure of the North London Waste Authority site (referred to as "Deephams" in this document) consists of four sets of generators (4x 12.5 MVA, two on each side of the double 11kV busbars), see Figure 3. The double 11kV busbars (customer owned) are run with the bus section breakers open.

The Deephams site is fed from Tottenham Grid (33kV) by two dedicated 33kV circuits of approx. 2.2 km each. An aerial view of both sites and the 33kV circuits is provided in Figure 4. On the customer's side of the metering point (thus customer owned) there are two 30 MVA 33kV/11kV transformers.

The export agreement (MPAN: 1023479109093) between Eastern Electricity PLC and London Waste Ltd., dated 15 January 1999, is for 60 MVA at present. Import agreement (MPAN: 1023497360519) at present is for 4 MVA (amount exceeded in periods, with maximum value of 6.62 MVA @ 22 April 2014).

The maximum recorded export to date (i.e. generation on site minus demand on site) is 38.49 MVA (21 June 2014). Similar export figures are also found in winter months (e.g.: 37.77 MVA @ 4th December 2013).

Export figures above 30 MVA in total (a frequent occurrence) mean that in case of an outage in one of the two 33kV Tottenham Grid – Deephams circuits, export would have to be reduced in order not to exceed the rating of the transformer on the other circuit (30 MVA) following the closure of the 11kV bus section breakers at Deephams.

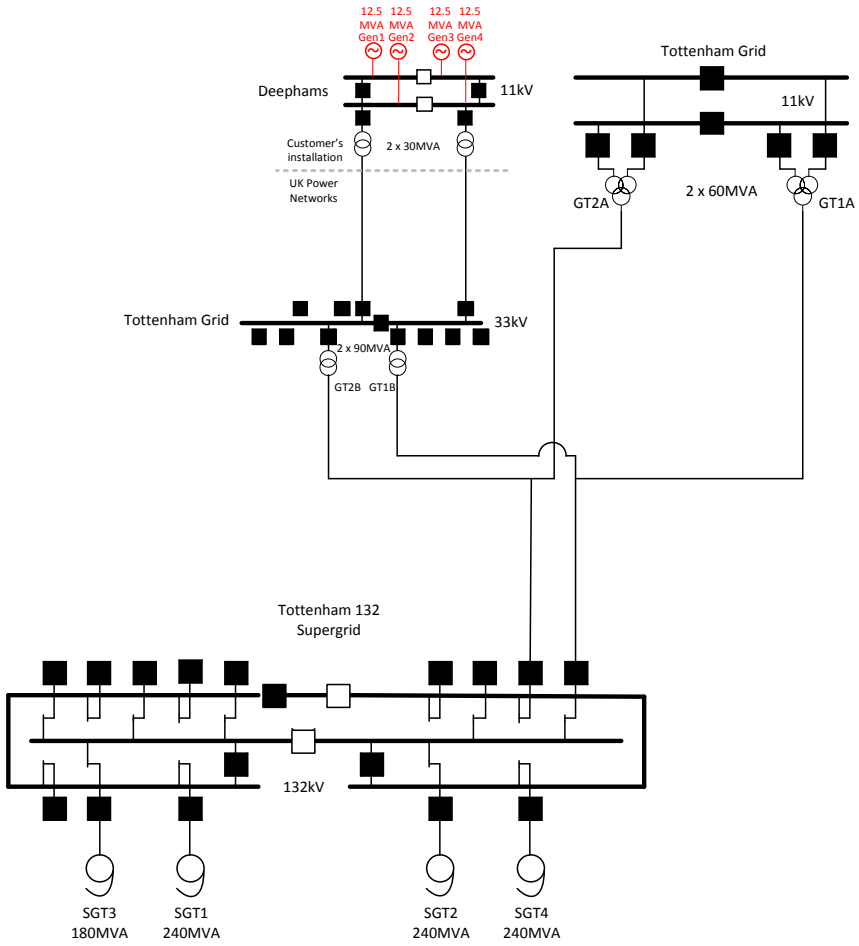

Figure 3 - Deephams connection at present

Figure 4 - Aerial view of the Deephams connection at present

2. Options for upgrading Deephams site

2.1 Upgrade to 70 MVA export (phase 1)

2.1.1 Option 1 – Not change the 33kV Tottenham Grid - Deephams circuits

A detailed layout of the two 33kV circuits feeding the Deephams site from Tottenham Grid is shown in Figure 5. Both circuits have polymeric and oil filled cable sections. The sections that limit the maximum power flow are the oil filled sections: three core 0.6 in^2 oil filled cables with copper conductors (3c 0.6 O/F). The distribution rating of these oil filled cables in summer conditions (in accordance with Engineering Recommendation P17) is given in Table I. Summer conditions are usually the most limiting for power flow in circuits.

Table I - Distribution rating of 0.6 in^2 O/F cables in summer conditions

Conductor area in^2 / type	Distributed Current Rating per Conductor 900mm depth of cover, soil thermal resistivity= 1.2°C m/watt, ground/air temp= 15°C	
	Installed in Ducts	
	Amps	MVA
0.60 in^2 / Copper	604	34.48

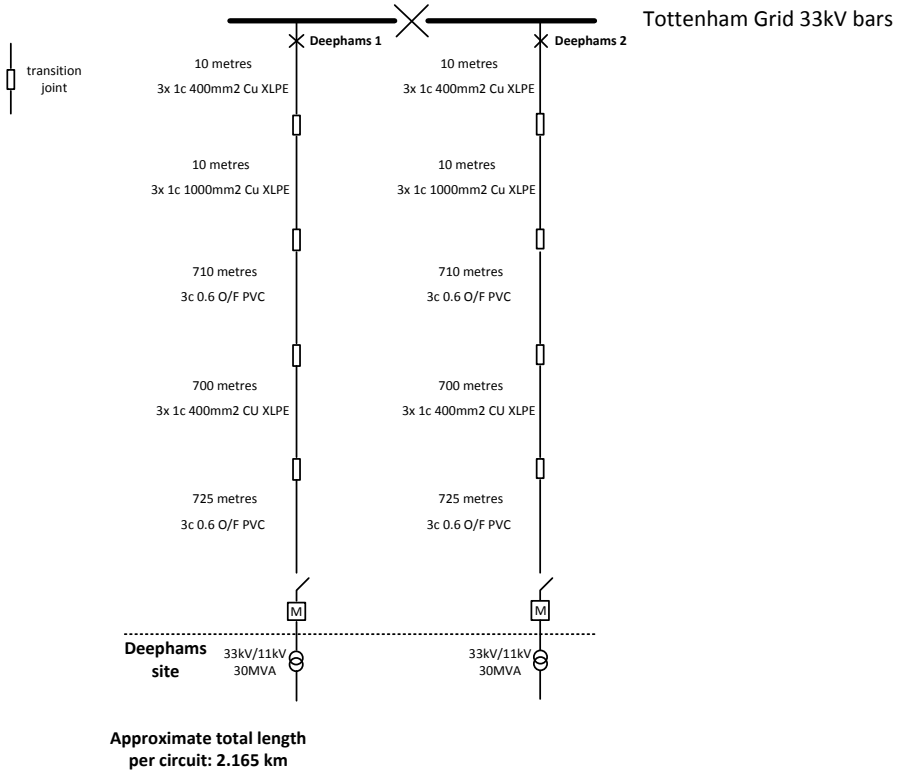

Figure 5 - Detailed layout of the two Deephams – Tottenham Grid 33kV circuits

The values in Table I do not account for two circuits on the same trench (a grouping factor should be applied in these cases), the rate of utilisation of the circuits (continuous), other power cables in the vicinity, crossings with water pipes, differences in soil conditions along the route (urban area) and the ageing of the cables. These factors reduce the current rating of the cable presented in Table I. On the other hand, the figures are also based on 900mm depth of cover, which is a more onerous situation than the installation of the cable at present. The layout of the installation of one of the oil filled sections is presented in Figure 6. A7 and A8 are "Deephams 1" and "Deephams 2" and PA7 and PA8 are the respective pilot (communication) cables. The depth of cover is approximately 600mm (1ft 6in or 460mm, plus the diameter of "cable+duct").

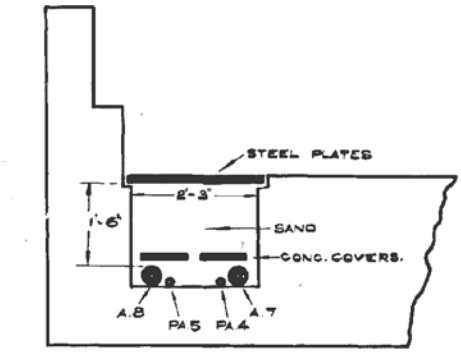

Figure 6 - Layout of installation of one of the 33kV oil filled sections

The grouping factor adopted for this installation is 0.88 and therefore the continuous rating of each circuit in summer conditions (most onerous) is assumed to be 535 A / 30.51 MVA. This means that the maximum power flow through both circuits is limited to 2x 30.51 MVA= 61.02 MVA in the summer. This is insufficient for a potential 70 MVA export from Deephams.

Estimated price for connection (as of February 2015)

Summary of Non-Contestable Works (assuming site upgrade but export limited to 60MVA)

- G59 witness testing;
- Watts & Vars transducers at Tottenham Grid x 2;
- Project Management;

Total estimated price: £21,393.70.

2.1.2 Option 2 - Bypass new polymeric cables over the oil filled sections and disconnect the oil filled sections

In order to increase the rating of the circuits to allow a 70 MVA export, the oil filled sections require overlaying with polymeric ones. The minimum conductor cross section required for the new polymeric sections is 630mm^2 Al in order to uprate the circuit. The high-level layout of this option is presented in Figure 7.

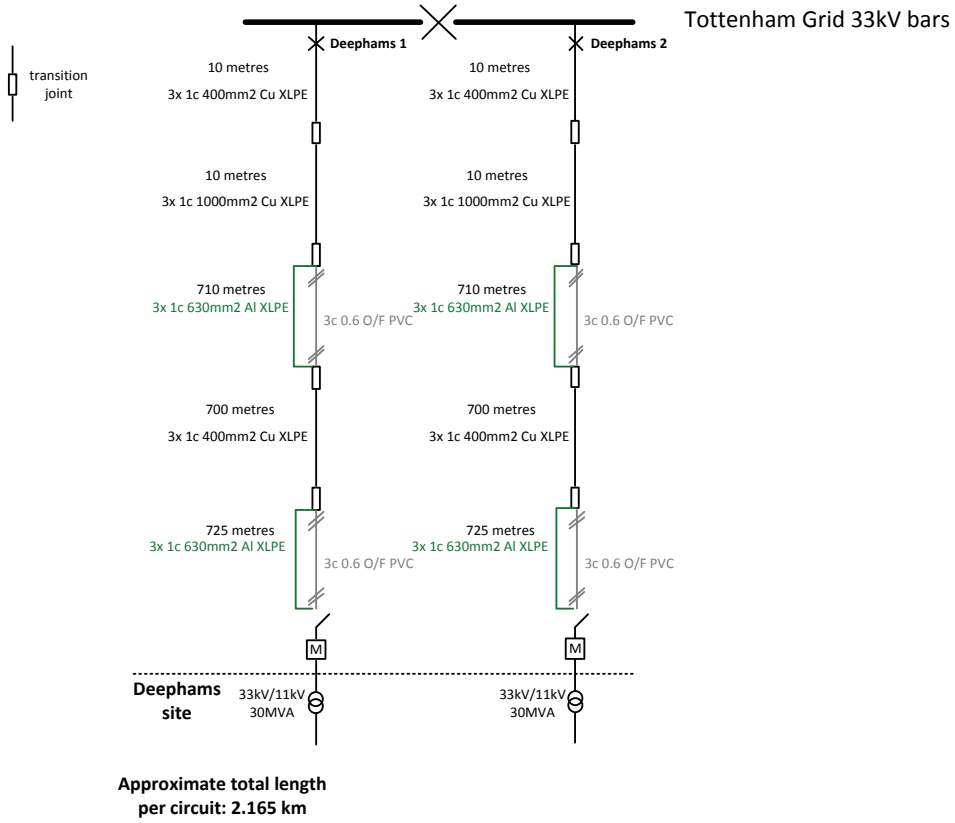

Figure 7 - Overlay of oil filled cables with polymeric cables

Approx. 3 km of 0.6 O/F cable requires overlaying with 630mm^2 Al cable. Based on a desktop assessment, it is expected that the new sections of cable can be laid roughly alongside the existing oil filled sections. The oil filled sections will be disconnected and abandoned following the overlay. An 80% hard digging / 20% soft digging proportion has been considered. There is an A406 crossing (Angel Road) on the original route that may require an additional directional drill. Civil works for this have been included in the price estimate. A few river crossings exist on the existing route, but it has been assumed that new cable sections will utilise the existing river crossings (therefore no special allowance has been made for river crossings).

Existing protection settings will have to be updated.

Following this overlay, the limiting cable sections will be the 400mm^2 Cu XLPE ones. The capacity of each circuit is expected to be limited to approximately 36MVA in summer conditions with this option (figure obtained with a grouping factor of 0.92 to capture the effect of these two sections in the same trench). This means that the maximum power flow through both circuits is now limited to 2x 36 MVA= 72 MVA in the summer (assuming the 33/11kV transformers on the customer's side of the metering point have been upgraded).

Supporting system studies

Historical data

Maximum reverse power flow at Tottenham Grid with the present configuration at Deephams

The maximum recorded reverse power flow at Tottenham Grid coincides with the maximum export to date from the Deephams site: 38.49 MVA. The results in Table II were retrieved from metering data (21/06/2014 @ 05.00). The minus sign means power flow from the 33kV to the 132kV network.

Table II - Power flow measurments in Deephams and Tottenham Grid (historical data, 21/06/2014 @ 05.00)

Deephams 1 (MVA)	Deephams 2 (MVA)	Tottenham Grid GT1B (MW)	Tottenham Grid GT1B (MVAR)	Tottenham Grid GT1B (MVA)	Tottenham Grid GT2B (MW)	Tottenham Grid GT2B (MVAR)	Tottenham Grid GT2B (MVA)
18.70	19.79	-8.42	1.63	8.58	-8.20	1.97	8.43

Power flow measurements from the last three years (01/10/2011 to 30/09/2014) have been collated to analyse the impact of the Deephams export (in MW) on the power flows at Tottenham Grid 33kV. The minimum load (in MW) in Tottenham Grid and the maximum export from Deephams (in MW) in each day of the selected timespan has been selected. The daily minimum load at Tottenham Grid and daily maximum export from Deephams for the last three years is shown in Figure 8. A statistical analysis on the coincidence of minimum daily load at Tottenham Grid and maximum daily export at Deephams for the last three years is shown in Figure 9.

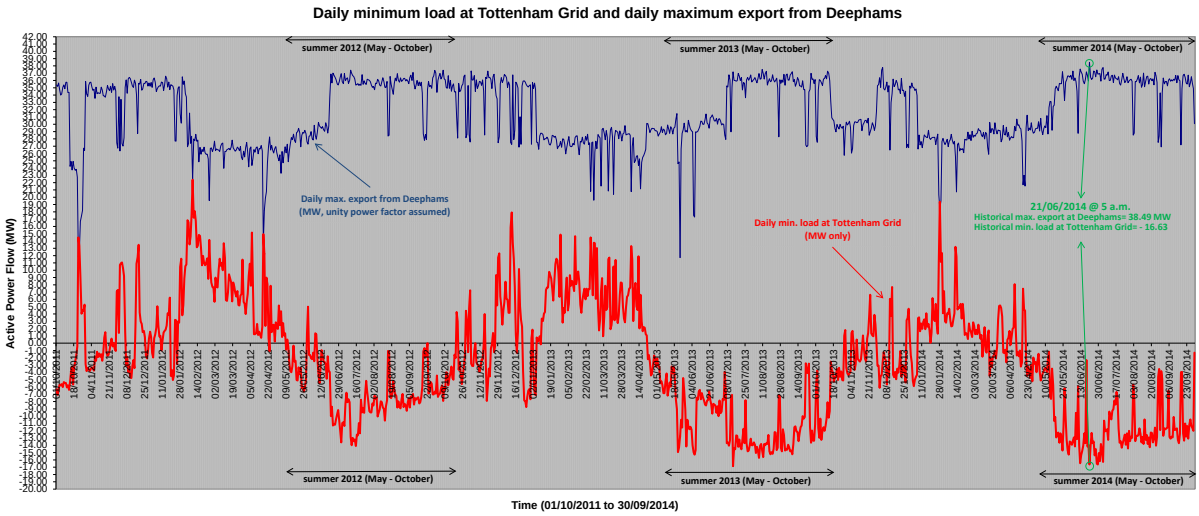

Figure 8 - Daily minimum load at Tottenham Grid and daily maximum export from Deephams for the last three years

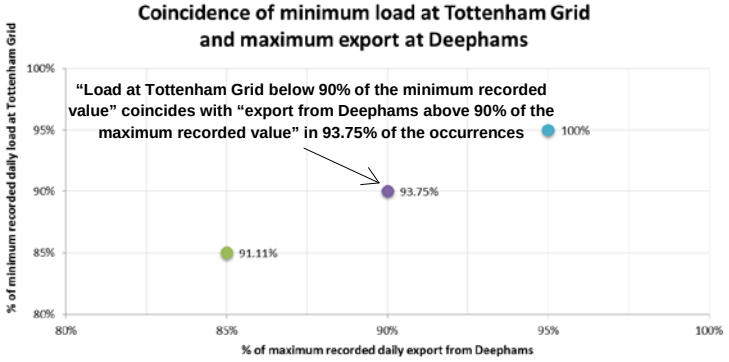

Figure 9 - Coincidence of minimum daily load at Tottenham Grid and maximum daily export at Deephams for the last three years

Simulation with 70MVA export from Deephams

Assumptions:

- Minimum load conditions maintained (21/06/2014 @ 05.00), but the expected increase in smaller scale generation (below 200kVA of installed capacity) in the next 20 years is factored in the simulations. This type of generation will connect to the low voltage network. It is currently perceived as not controllable by UK Power Networks and will therefore "mask" existing load. As a conservative approach, the full output of this additional smaller scale generation has been considered in the results.
- A 70 MVA generator has been modelled as shown in Figure 10. This model has been agreed with the customer on 06/10/2014 as a "working model" for the purpose of running these technical studies.

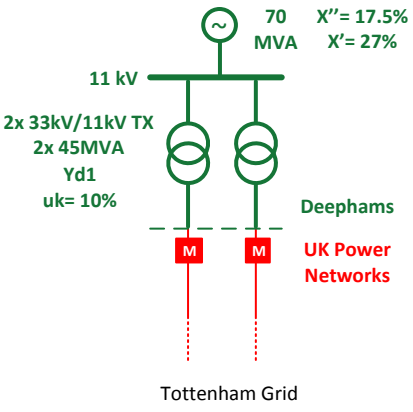

Figure 10 - Working model for the 70 MVA export from Deephams

Intact running arrangement

Power flow results in Table III are for a 70 MVA export from Deephams with the loading conditions of 21/06/2014 @ 05.00.

Table III - Power flow results for a 70 MVA export from Deephams with the loading conditions of 21/06/2014 @ 05.00

Deephams 1 (MVA)	Deephams 2 (MVA)	Tottenham Grid GT1B (MW)	Tottenham Grid GT1B (MVAR)	Tottenham Grid GT1B (MVA)	Tottenham Grid GT2B (MW)	Tottenham Grid GT2B (MVAR)	Tottenham Grid GT2B (MVA)
35	35	-37.62	4.66	37.91	-38.05	4.75	38.35

Voltage magnitudes on the Deephams 11kV and Tottenham Grid 33kV busbars in the conditions of Table III are shown in Table IV.

Table IV - Voltage magnitudes on the Deephams 11kV and Tottenham Grid 33kV busbars with the loading conditions of 21/06/2014 @ 05.00

Deephams 11kV (customer bars, p.u.)	Tottenham Grid 33kV (p.u.)	Statutory limits (p.u.)
1.01 p.u.	0.99 p.u.	[0.94 p.u., 1.06 p.u.]

The change in voltage magnitude at the Point of Common Coupling (Tottenham Grid 33kV bars) with the 70 MVA export, commonly known as "step voltage", is presented in Table V.

Table V - Change in voltage magnitude at the Point of Common Coupling (Tottenham Grid 33kV bars) with 70 MVA export with the loading conditions of 21/06/2014 @ 05.00

Tottenham Grid 33kV (p.u.)	Statutory limits (p.u.)
-0.01 p.u.	[-0.02 p.u., +0.02 p.u.]

For a zero impedance three phase fault close to the bars at Tottenham Grid and with all generators paralleled at Deephams, the results in Table VI are obtained:

Table VI - Zero impedance three phase fault close to the bars at Tottenham Grid and with all generators paralleled at Deephams (intact running arrangement)

Simulation conditions: zero impedance three-phase fault at the 33kV busbars of Tottenham Grid with an intact network arrangement (70 MVA case)		
	Simulation result	Rating
Peak short-circuit current *ip* (kA)	54.38	62.50
RMS initial short-circuit current *Ik"* (kA)	20.28	25.00

The results for a zero impedance single phase to ground fault close to the bars at Tottenham Grid in the intact running arrangement are given in Table VII.

Table VII - Zero impedance single phase to ground fault close to the bars at Tottenham Grid and with all generators paralleled at Deephams (intact running arrangement)

Simulation conditions: zero impedance single phase to ground fault at the 33kV busbars (phase A) of Tottenham Grid with an intact network arrangement (70 MVA case)		
	Simulation result	Rating
Peak short-circuit current *ip* (kA)	4.11	62.50
RMS initial short-circuit current *Ik"* (kA)	2.84	25.00

Contingent running arrangements

One Tottenham Grid – Deephams 33kV circuit (Deephams 1 or Deephams 2) out of service

The described overlay of the oil filled sections would allow 70MVA export only when both 33kV circuits feeding the site are in operation. When one of the circuits ("Deephams 1" or "Deephams 2") is out of service, the export from the site (generation onsite minus load onsite) would have to be limited to 36 MVA (action to be managed by the customer). 36 MVA is the rating in the summer of limiting section of the healthy circuit (400mm^2 Cu XLPE). It is assumed that the generators actioned to bring the export down to 36 MVA are turned off and therefore have no contribution for a prospective fault in the distribution network.

The power flow results in Table VIII are for a 36 MVA export from "Deephams 1" with the loading conditions of 21/06/2014 @ 05.00. "Deephams 2" is simulated to be out of service. The effect of having "Deephams 1" out of service would be analogous.

Table VIII - Power flow results for a 36 MVA export with the loading conditions of 21/06/2014 @ 05.00 (Deephams 2 out of service)

Deephams 1 (MVA)	Tottenham Grid GT1B (MW)	Tottenham Grid GT1B (MVAR)	Tottenham Grid GT1B (MVA)	Tottenham Grid GT2B (MW)	Tottenham Grid GT2B (MVAR)	Tottenham Grid GT2B (MVA)
36	-20.85	3.13	21.09	-21.09	3.19	21.33

Voltage magnitudes on the Deephams 11kV and Tottenham Grid 33kV busbars in the conditions of Table VIII are shown in Table IX.

Table IX - Voltage magnitudes on the Deephams 11kV and Tottenham Grid 33kV busbars with the loading conditions of 21/06/2014 @ 05.00 ("Deephams 2" circuit out of service)

Deephams 11kV (customer bars, p.u.)	Tottenham Grid 33kV (p.u.)	Statutory limits (p.u.)
1.02 p.u.	0.99 p.u.	[0.94 p.u., 1.06 p.u.]

The change in voltage magnitude at the Point of Common Coupling (Tottenham Grid 33kV bars) with the 36 MVA export, commonly known as "step voltage", with "Deephams 2" out of service is presented in Table X.

Table X - Change in voltage magnitude at the Point of Common Coupling (Tottenham Grid 33kV bars) with 36 MVA export with the loading conditions of 21/06/2014 @ 05.00 (Deephams 2 out of service)

Tottenham Grid 33kV (p.u.)	Statutory limits (p.u.)
-0.01 p.u.	[-0.02 p.u., +0.02 p.u.]

For the condition of having one of the 33kV circuits feeding Deephams out of service (for simulation purposes, "Deephams 2") and a zero impedance three phase fault close to the bars at Tottenham Grid, the results in Table XI are obtained:

Table XI - Zero impedance three phase fault close to the bars at Tottenham Grid and with all generators paralleled at Deephams ("Deephams 2" circuit out of service)

Simulation conditions: zero impedance three-phase fault at the 33kV busbars of Tottenham Grid with "Deephams 2" circuit out of service (36 MVA case)		
	Simulation result	Rating
Peak short-circuit current *ip* (kA)	46.66	62.50
RMS initial short-circuit current *Ik"* (kA)	17.46	25.00

The results for a zero impedance single phase to ground fault close to the bars at Tottenham Grid with "Deephams 2" circuit out of service is given in Table XII.

Table XII - Zero impedance single phase to ground fault close to the bars at Tottenham Grid and with all generators paralleled at Deephams ("Deephams 2" circuit out of service)

Simulation conditions: zero impedance single phase to ground fault at the 33kV busbars (phase A) of Tottenham Grid with "Deephams 2" circuit out of service (36 MVA case)		
	Simulation result	Rating
Peak short-circuit current *ip* (kA)	4.13	62.50
RMS initial short-circuit current *Ik"* (kA)	2.85	25.00

One grid transformer out of service in Tottenham Grid

Following the loss of one of the grid transformers in Tottenham Grid (GT1B, for simulation purposes) it is expected that the Deephams site would still be able to export the full 70 MW.

The power flow results in Table XIII are for a 70 MVA export from Deephams, with the loading conditions of 21/06/2014 @ 05.00, when GT1B is out of service. The effect of having GT2B out of service would be analogous.

Table XIII - Power flow results for a 70 MVA export with the loading conditions of 21/06/2014 @ 05.00 (GT1B out of service)

Deephams 1 (MVA)	Deephams 2 (MVA)	Tottenham Grid GT2B (MW)	Tottenham Grid GT2B (MVAR)	Tottenham Grid GT2B (MVA)
35	35	-75.67	8.65	76.18

Voltage magnitudes on the Deephams 11kV and Tottenham Grid 33kV busbars with GT1B out of service are shown in Table XIV.

Table XIV - Voltage magnitudes on the Deephams 11kV and Tottenham Grid 33kV busbars with the loading conditions of 21/06/2014 @ 05.00 (GT1B out of service)

Deephams 11kV (customer bars, p.u.)	Tottenham Grid 33kV (p.u.)	Statutory limits (p.u.)
1.01 p.u.	0.99 p.u.	[0.94, 1.06] p.u.

The change in voltage magnitude at the Point of Common Coupling (Tottenham Grid 33kV bars) with the 70 MVA export, commonly known as "step voltage", with GT1B out of service is presented in Table XV.

Table XV - Change in voltage magnitude at the Point of Common Coupling (Tottenham Grid 33kV bars) with 70 MVA export with the loading conditions of 21/06/2014 @ 05.00 (GT1B out of service)

Tottenham Grid 33kV (p.u.)	Statutory limits (p.u.)
-0.01	[-0.02 p.u., +0.02 p.u.]

For the condition of having one grid transformer out of service at Tottenham Grid (GT1B, for illustration) and a zero impedance three phase fault close to the bars at Tottenham Grid, the results in Table XVI are obtained:

Table XVI - Zero impedance three phase fault close to the bars at Tottenham Grid and with all generators paralleled at Deephams (GT1B out of service)

Simulation conditions: zero impedance three-phase fault at the 33kV busbars of Tottenham Grid with grid transformer GT1B out of service		
	Simulation result	Rating
Peak short-circuit current *ip* (kA)	39.84	62.50
RMS initial short-circuit current *Ik"* (kA)	14.95	25.00

The results for a zero impedance single phase to ground fault close to the bars at Tottenham Grid with GT1B out of service are given in Table XVII.

Table XVII - Zero impedance single phase to ground fault close to the bars at Tottenham Grid and with all generators paralleled at Deephams (GT1B out of service)

Simulation conditions: zero impedance single phase to ground fault at the 33kV busbars (phase A) of Tottenham Grid with grid transformer GT1B out of service		
	Simulation result	Rating
Peak short-circuit current *ip* (kA)	2.04	62.50
RMS initial short-circuit current *Ik"* (kA)	1.41	25.00

Estimated price for connection (as of February 2015)

Summary of Non-Contestable Works

- G59 witness testing;
- Watts & Vars transducers at Tottenham Grid x 2;
- Protection settings change;
- Project Management;
- De-oil fluid filled cable route per tank x 4;
- Remove buried oil tanks x4;
- Cable joints (including Joint bays) x 8

Summary of Contestable Works

- Lay 3 km (2x 1.5 km) of 630mm^2 Al 33kV cable - material only;
- Excavate 1.5 km of 33kV cable route (80% hard dig, 20% soft dig);
- Feasibility and Site Setup for 1.5km of cable route;
- Directional Drill - Survey, Site Setup and a 100 metres drill;

Total estimated price: £1,146,758.39.

2.1.3 Option 3 - Parallel the two existing 33kV circuits (Deephams 1 and Deephams 2) in order to provide the 70MVA export with a single circuit supply

Paralleling the two Tottenham Grid - Deephams 33kV circuits (by connecting together two cores per circuit in both extremes) is expected to be possible but the overlay described in section "2.1.2 - Option 2" will still have to be fully completed in order to meet the 70 MVA export objective.

It is expected that this paralleled and overlaid circuit would be rated to approximately 72 MVA. The 33kV feeder breakers in Tottenham Grid are rated for up to 1250 A (approx. 71.3 MVA). However, security of supply would be reduced: for a fault in any of the circuits, the circuit breaker at Tottenham Grid would have to be opened to isolate the fault. This would mean that the Deephams site would be fully disconnected for such an event. The price of this option has not been determined as Option 2 is assumed to provide the same benefit at a lower cost.

2.1.4 Option 4 - Install new cables in parallel with the existing ones (overlaid as described in section "2.1.2 - Option 2") to provide a more secure connection

This option consists of laying new cables in order to allow a 70MW export in the event of the loss of one of the Tottenham Grid – Deephams 33kV circuits. The new cables would be laid in parallel with the existing ones, which would still have to be overlaid as described in section "2.1.2 - Option 2". The new cables should be of 630mm^2 Al type as a minimum. It is assumed that the 33kV feeder breakers at Tottenham Grid (ABB BEU21) can connect two cores per phase (630mm^2 Al and 400mm^2 Cu). The new circuit layout would be as presented in Figure 11. It is assumed that the new cables will follow the same route of the existing ones, but additional trenches would have to be excavated. Current transformers will be installed on both overlaid and new cables of each Deephams circuit for balance protection, in order to prevent overloads in case of a fault in one of the cables.

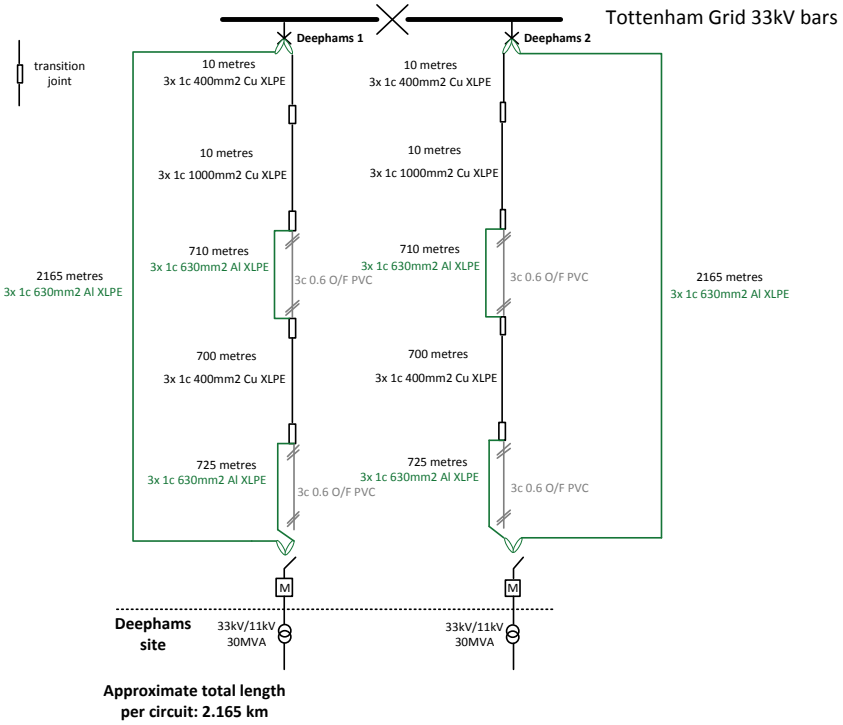

Figure 11 – Lay new cables alongside existing circuits and overlay of oil filled cables with polymeric cables

Each circuit ("Deephams 1" and "Deephams 2") is expected to be able to take up to 74 MVA with the installation of new cables and overlay (value considering cable grouping). The 33kV feeder breakers in Tottenham Grid are rated for up to 1250 A operation (approx. 71.3 MVA). This means that a 70MW export could be achieved even for the loss of one of the Deephams circuits ("Deephams 1" or "Deephams 2"). Measurements taken in the last five years indicate that this situation occurred for an amount of time approximately equivalent to 141 days (7.7% of the time).

Supporting system studies

Only contingent scenarios are assessed. Results for intact network conditions are expected to be similar or less onerous than the ones reported for similar conditions in Option 2.

Contingent running arrangements

One of the Tottenham – Deephams 33kV circuits ("Deephams 1" or "Deephams 2") out of service

The power flow results in Table XVIII are for a 70 MVA export from Deephams with the loading conditions of 21/06/2014 @ 05.00, when "Deephams 2" circuit is out of service. The effect of having "Deephams 1" circuit out of service would be analogous.

Table XVIII - Power flow results for a 70 MVA export with the loading conditions of 21/06/2014 @ 05.00 ("Deephams 2" circuit out of service)

Deephams 1 (MVA)	Tottenham Grid GT1B (MW)	Tottenham Grid GT1B (MVAR)	Tottenham Grid GT1B (MVA)	Tottenham Grid GT2B (MW)	Tottenham Grid GT2B (MVAR)	Tottenham Grid GT2B (MVA)
70	-37.60	4.55	37.88	-38.03	4.64	38.31

Voltage magnitudes on the Deephams 11kV and Tottenham Grid 33kV busbars with "Deephams 2" out of service are shown in Table XIX.

Table XIX - Voltage magnitudes on the Deephams 11kV and Tottenham Grid 33kV busbars with the loading conditions of 21/06/2014 @ 05.00 ("Deephams 2" circuit out of service)

Deephams 11kV (customer bars, p.u.)	Tottenham Grid 33kV (p.u.)	Statutory limits (p.u.)
1.01 p.u.	0.99 p.u.	[0.94, 1.06] p.u.

The change in voltage magnitude at the Point of Common Coupling (Tottenham Grid 33kV bars) with the 70 MVA export, commonly known as "step voltage", with "Deephams 2" out of service is presented in Table XX.

Table XX - Change in voltage magnitude at the Point of Common Coupling (Tottenham Grid 33kV bars) with 70 MVA export with the loading conditions of 21/06/2014 @ 05.00 ("Deephams 2" circuit out of service)

Tottenham Grid 33kV (p.u.)	Statutory limits (p.u.)
-0.01	[-0.02 p.u., +0.02 p.u.]

For the condition of having one of the Tottenham Grid - Deephams 33kV circuits out of service ("Deephams 2", for simulation purposes) and a zero impedance three phase fault close to the bars at Tottenham Grid, the results in Table XXI are obtained:

Table XXI - Zero impedance three phase fault close to the bars at Tottenham Grid and with all generators paralleled at Deephams ("Deephams 2" circuit out of service)

Simulation conditions: zero impedance three-phase fault at the 33kV busbars of Tottenham Grid with one Tottenham – Deephams 33kV circuit out of service (70 MVA case)		
	Simulation result	Rating
Peak short-circuit current *ip* (kA)	54.25	62.50
RMS initial short-circuit current *Ik"* (kA)	20.26	25.00

The results for a zero impedance single phase to ground fault close to the bars at Tottenham Grid with "Deephams 2" circuit out of service are given in Table XXII.

Table XXII - Zero impedance single phase to ground fault close to the bars at Tottenham Grid and with all generators paralleled at Deephams ("Deephams 2" circuit out of service)

Simulation conditions: zero impedance single phase to ground fault at the 33kV busbars (phase A) of Tottenham Grid with one Tottenham – Deephams 33kV circuit out of service (70 MVA case)		
	Simulation result	Rating
Peak short-circuit current *ip* (kA)	4.11	62.50
RMS initial short-circuit current *Ik"* (kA)	2.85	25.00

Estimated price for connection (as of February 2015)

Summary of Non-Contestable Works

- G59 witness testing;
- Watts & Vars transducers at Tottenham Grid x 2;
- Shutdown x 2;
- Protection settings change;
- Cable terminations and 33kV cabling within Tottenham Grid;
- De-oil fluid filled cable route per tank x 4;
- Remove buried oil tanks x4;
- Cable joints (including Joint bays) x 8;
- Project Management;

Summary of Contestable Works

Overlay oil filled sections

- Lay 3 km (2x 1.5 km) of 630mm^2 Al 33kV cable - material only;
- Excavate 1.5 km of 33kV cable route (80% hard dig, 20% soft dig);
- Feasibility and Site Setup for 1.5km of cable route;
- Directional Drill - Survey, Site Setup and a 100 metres drill;

Lay new cables alongside existing ones (economies of scale may be obtained when proceeding with the overlay of oil filled sections at the same time)

- Lay 4.4 km (2x 2.2 km) of 630mm^2 Al 33kV cable - material only;
- Excavate / Reinstate 2.2 km of cable route (80% hard dig, 20% soft dig);
- Feasibility and Site Setup for 2.2km of cable route;
- Directional Drill - Survey, Site Setup and a 100 metres drill;

Total estimated price: £2,425,408.07

2.2 Upgrade to 90 MVA export (phase 2)

2.2.1 Option 5 - 132kV connection at Tottenham 132 on a spare bay (to be confirmed)

An export of 90 MVA would not be acceptable at Tottenham Grid 33kV due to excess reverse power flow in the event of a grid transformer outage. A 90 MVA export through existing 33kV feeder breakers at Tottenham Grid would in any case be limited by their rating of 1250 A per breaker, approx. 71.3 MVA. A 132kV connection is therefore offered at Tottenham 132 substation (NG interconnection). This connection at 132kV is offered on the condition of the disconnection of the existing 33kV agreement at Tottenham Grid.

The 132kV point of connection is subject to space being available/suitable onsite to install a new bay (outdoor gas insulated breaker, isolators and associated gear). In Figures 12 and 13 are shown examples of utilised and spare bays in Tottenham 132 respectively, for illustration purposes only.

Figure 12 - Example of an utilised 132kV bay at Tottenham 132

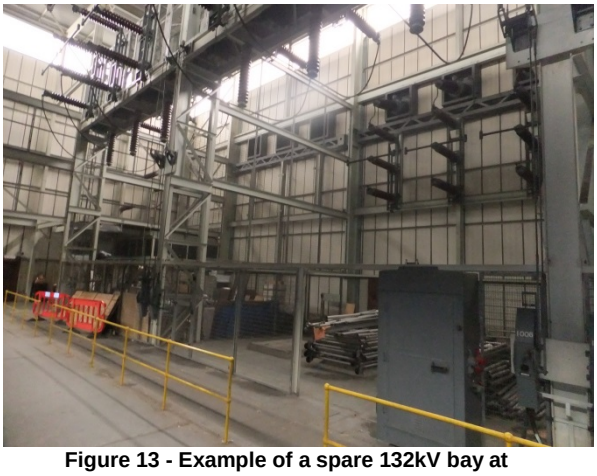

Figure 13 - Example of a spare 132kV bay at Tottenham 132 (availability/suitability to be confirmed)

The connection will be metered at 132kV at the customer's site, as there is no space available to install a new 132/33kV transformer within Tottenham 132 or Tottenham Grid.

Providing a 132kV connection at Tottenham 132 is technically feasible, 132kV cabling would be laid until the customer's site. The new 132kV cables would be of 300mm^2 Al type (single core) as a minimum. This is likely to include one directional drill as a minimum (A406 crossing). The customer is expected to install transformation on his side of the metering breaker. For simulation purposes only, the working model of Figure 14 has been assumed.

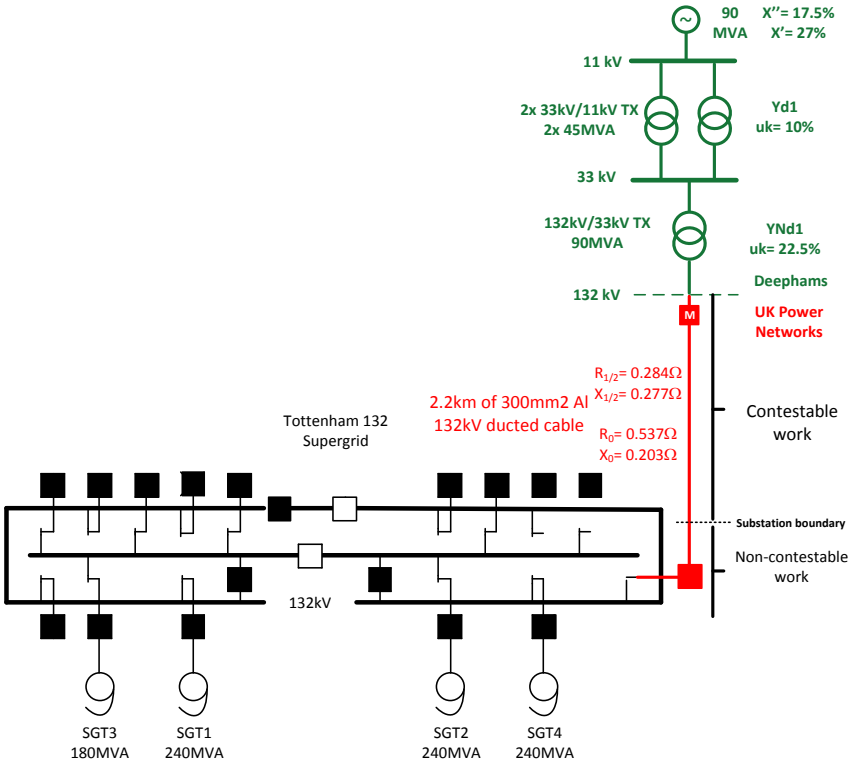

Figure 14 - Working model for the 90 MVA export from Deephams

Supporting system studies

Only the intact running arrangement scenario is considered given that the connection solution is a single circuit supply. In addition, National Grid has not identified any constraints on their side of Tottenham 132 (see Appendix A, Tottenham 132 Statement of Works).

Intact running arrangement

The power flow results in Table XXIII are for a 90 MVA export from Deephams with the loading conditions of 18/07/2014 @ 04.00, which correspond to minimum load conditions for the whole Tottenham 132 group. Deephams agreement at Tottenham Grid (33kV) is disconnected.

Table XXIII - Power flow results for a 90 MVA export with the loading conditions of 18/07/2014 @ 04.00 (intact network running conditions)

Deephams 132kV metering breaker (MVA)	Tottenham Grid SGT1 (MVA)	Tottenham Grid SGT2 (MVA)	Tottenham Grid SGT3 (MVA)	Tottenham Grid SGT4 (MVA)
90	17.67	24.31	36.18	23.96

Voltage magnitudes on the Deephams 11kV and Tottenham 132 busbars in intact network running conditions are shown in Table XXIV.

Table XXIV - Voltage magnitudes on the Deephams 11kV and Tottenham 132 busbars with the loading conditions of 18/07/2014 @ 04.00 (intact network running conditions)

Deephams 11kV (customer bars, p.u.)	Statutory limits (p.u.)	Tottenham 132 - left side of the split (p.u.)	Tottenham 132 - right side of the split (p.u.)	Statutory limits (p.u.)
1.01 p.u.	[0.94, 1.06] p.u.	1.01 p.u.	1.00 p.u.	[0.90, 1.10] p.u.

The change in voltage magnitude at the Point of Common Coupling (Tottenham 132 - right side of the split) with the 90 MVA export, commonly known as "step voltage", in this running arrangement is presented in Table XXV.

Table XXV - Change in voltage magnitude at the Point of Common Coupling (Tottenham 132 - right side of the split) with 90 MVA export with the loading conditions of 18/07/2014 @ 04.00 (intact network running conditions)

Tottenham 132 - right side of the split (p.u.)	Statutory limits (p.u.)
-0.01 p.u.	[-0.02 p.u., +0.02 p.u.]

For the condition of having a zero impedance three phase fault close to the bars at Tottenham 132, the results in Table XXVI are obtained:

Table XXVI - Zero impedance three phase fault close to the bars at Tottenham 132 and with all generators paralleled at Deephams (intact running conditions)

Simulation conditions: zero impedance three-phase fault at the bars at Tottenham 132 (right side of the split)		
	Simulation result	Rating
Peak short-circuit current *ip* (kA)	31.01	40.00
RMS initial short-circuit current *Ik"* (kA)	11.65	15.30

The results for a zero impedance single phase to ground fault close to the bars at Tottenham 132 in the same scenario are given in Table XXVII.

Table XXVII - Zero impedance single phase to ground fault close to the bars at Tottenham 132 and with all generators paralleled at Deephams (intact running conditions)

Simulation conditions: zero impedance single phase to ground fault at the bars at Tottenham 132 (phase A, right side of the split)		
	Simulation result	Rating
Peak short-circuit current *ip* (kA)	39.32	40
RMS initial short-circuit current *Ik"* (kA)	14.83	15.30

Estimated price for connection (as of February 2015)

Summary of Non-Contestable Works

- G59 witness testing;
- Watts & Vars transducers at Tottenham 132;
- Shutdown;
- Protection settings change;
- Detailed voltage studies;
- New 132kV gas insulated circuit breaker – materials, installation, cabling and cable terminations within Tottenham 132;
- Project Management;

Summary of Contestable Works

- Lay 2.2 km of 300mm^2 Al 132kV cable - material only;
- Excavate 2.2 km of 132kV cable route (80% hard dig, 20% soft dig);
- Feasibility and Site Setup for 2.2km of cable route;
- Directional Drill - Survey, Site Setup and a 100 metres drill;

Total estimated price: £3,350,489.84.

Price excludes decommissioning of the existing 33kV connection to Tottenham Grid.

3. Additional Information

3.1 Power Quality Requirements

Harmonic distortion due to the connection of non-linear loads should be kept within the planning levels recommended in ENA Engineering Recommendation G5/4.

Pre and post fault harmonic levels will be monitored to determine if the connection of the generation site results in **Total Harmonic Distortion** and any individual harmonic values (up to the 50th) exceeding the planning limits given in ER G5/4.

If this increase in harmonic distortion is shown to be attributable to the Deephams upgrade, then it will be necessary for the customer to fund/ undertake mitigation measures to bring any exceeded values back within **Planning Limits** without any undue delay. Where any measured values exceed **Compatibility Limits** then it may be necessary to disconnect all or part of the site until such time as remedial work takes place.

UK Power Networks will provide background harmonic measurements at the nearest suitable measurement point to allow the customer (or the customers consultant) to undertake a harmonic assessment of the connection. These values will be provided shortly, once harmonic readings have been taken.

3.2 Amendment to Connection Agreement following Deephams upgrade

National Grid identified site specific terms applied to Deephams, see Appendix A. Should the upgrade go ahead (70 MVA or 90 MVA), Deephams should be classified as **License Exempt Embedded Medium Power Station**.

As a matter of course, UK Power Networks is obliged to add an appendix to its contract at Tottenham 132 with NG and the Deephams Connection Agreement should be updated accordingly. The new classification introduces technical requirements which Deephams should be able to fulfil, as defined by the Grid Code. These include voltage control requirements.

4. Next Steps

The set of options presented in this document is exclusively aimed to help the customer in future decisions on Deephams. UK Power Networks has no preference for any of the options presented.

Options and respective prices are only valid at the date of issue of this document. Future changes in the local network (such as new connections) may preclude some of the options presented. Availability / suitability of the options, as well as their price, will need to be reassessed following a formal application.

Appendix A - Statements of Works for Tottenham 132 and Brimsdown 132

nationalgrid

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Gallows Hill, Warwick
CV34 6DA

Jonathan Purdy
Eastern Power Networks plc
Energy House
Hazelwick Avenue
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RH10 1EX

Nicola Paton
Head of Customer Service

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Direct fax +44 (0)1926 656605

www.nationalgrid.com

9th December 2014

For the attention of Jonathan Purdy

Dear Sir

Re: Request for Statement of Works received on 8th October 2014
Deephams – North London Waste Authority at Tottenham 132kV Substation
User Agreement Reference No. A/EE/90/4-17EX

I refer to your **Request for a Statement of Works** in relation to the possible export capacity increase of the above Deephams North London Waste Authority to your **Distribution System** (the "Project"). **The Company** started processing this request on 10th November 2014.

We have now undertaken an initial assessment of the significance of the Project and believe the **Power Station** does not have a significant impact on the **National Electricity Transmission System** (for the avoidance of doubt, such significant impact involves either party in an expenditure of more than £10,000) and would advise you of the following implications:-

i. Requirement for works on the **National Electricity Transmission System** where such works are not at a **Connection Site**

NO

ii. Requirement for works to the **National Electricity Transmission System** at a **Connection Site (Grid Supply Point)**

NO

iii. Necessity for **Site Specific Requirements** (at the site of connection) of the **Power Station**

YES

Based on a proposed generation of 70MW, the generator will be classified as LEEMPS (Licensed Exempt Embedded Medium Power Station). As a result, should your customer decide to proceed with the increase in export capacity, there will be a requirement to add an Appendix E into your existing Bilateral Connection Agreement for Tottenham.

This **Statement of Works** will remain valid for a period of 90 **Business Days** from the date hereof, i.e. until 20th April 2015 **("Expiry Date").** After the Expiry Date this Statement of Works will lapse.

Should your customer wish to progress the Project, you will need to advise us of this fact by signing and returning to **The Company** the **Confirmation of Progression** form attached hereto by the **Expiry Date.**

All communication in relation to this **Statement of Works** should, in the first instance, be directed for the attention of Steve Dugmore, who can be contacted by telephone on 01926 655214 or by email at steve.dugmore@nationalgrid.com

Yours faithfully

NICOLA PATON
HEAD OF CUSTOMER SERVICE

FOR AND ON BEHALF OF
NATIONAL GRID ELECTRICITY TRANSMISSION PLC

nationalgrid

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www.nationalgrid.com

9th December 2014

For the attention of Jonathan Purdy

Dear Sir

Re: Request for Statement of Works received on 8th October 2014
Deephams – North London Waste Authority at Brimsdown 132kV Substation
User Agreement Reference No. A/EE90/4-6EX(2)

I refer to your **Request for a Statement of Works** in relation to the possible connection of the above Deephams North London Waste Authority to your **Distribution System** (the "Project"). **The Company** started processing this request on 10th November 2014.

We have now undertaken an initial assessment of the significance of the Project and believe the **Power Station** does not have a significant impact on the **National Electricity Transmission System** (for the avoidance of doubt, such significant impact involves either party in an expenditure of more than £10,000) and would advise you of the following implications:-

i. Requirement for works on the **National Electricity Transmission System** where such works are not at a **Connection Site**

NO

ii. Requirement for works to the **National Electricity Transmission System** at a **Connection Site (Grid Supply Point)**

NO

iii. Necessity for **Site Specific Requirements** (at the site of connection) of the **Power Station**

YES

Based on a proposed generation of 90MW, the generator will be classified as LEEMPS (Licensed Exempt Embedded Medium Power Station). As a result, should your customer decide to proceed with the increase in export capacity, there will be a requirement to add an Appendix E into your existing Bilateral Connection Agreement for Brimsdown.

In addition, please note that should you wish to progress with the solution to connect a new circuit from Brimsdown North Grid into National Grid's spare 132kV bay at Brimsdown, a formal **Modification Application** will be required.

This **Statement of Works** will remain valid for a period of 90 **Business Days** from the date hereof, i.e. until 20th April 2015 **("Expiry Date").** After the Expiry Date this Statement of Works will lapse.

Should your customer wish to progress the Project, you will need to advise us of this fact by signing and returning to **The Company** the **Confirmation of Progression** form attached hereto by the **Expiry Date**.

All communication in relation to this **Statement of Works** should, in the first instance, be directed for the attention of Steve Dugmore, who can be contacted by telephone on 01926 655214 or by email at steve.dugmore@nationalgrid.com

Yours faithfully

NICOLA PATON
HEAD OF CUSTOMER SERVICE

FOR AND ON BEHALF OF
NATIONAL GRID ELECTRICITY TRANSMISSION PLC

Tottenham Grid Power Quality Report

Data taken 11/02/15 – 24/02/15

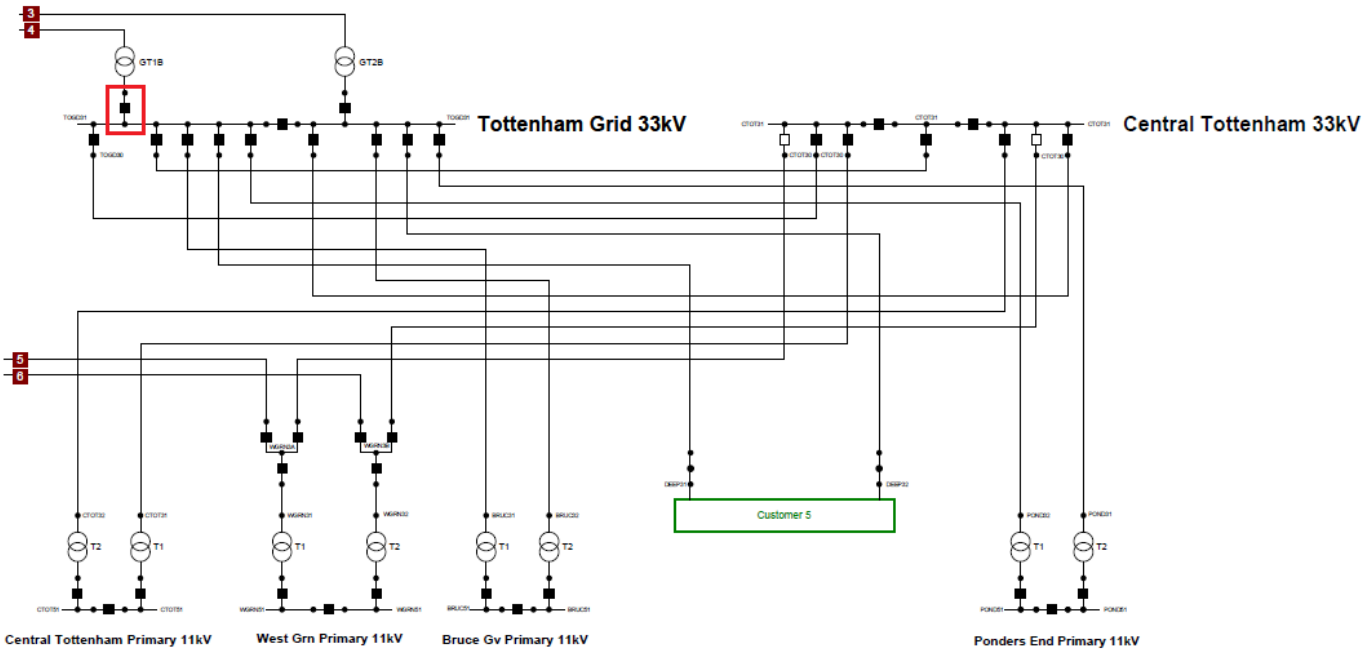
UK Power Networks
Delivering your electricity

Contents

1 Report Overview

The enclosed power quality information was taken at the site detailed in section 2 of this report between the date range shown on the front page. Impedance information for the site can be taken from UK Power Networks' Long Term Development Statement (LTDS) which is available upon request. Measurements were taken using Dranetz-BMI measuring equipment and the machine settings are shown in section 7 of this report. The intention of the report is to provide background harmonic information in accordance with the requirements of Engineering Recommendation G5/4.

2 Point of measurement



Measurements were taken at the LV side of the 132/33kV GT1B transformer at Tottenham grid site; shown above in red.

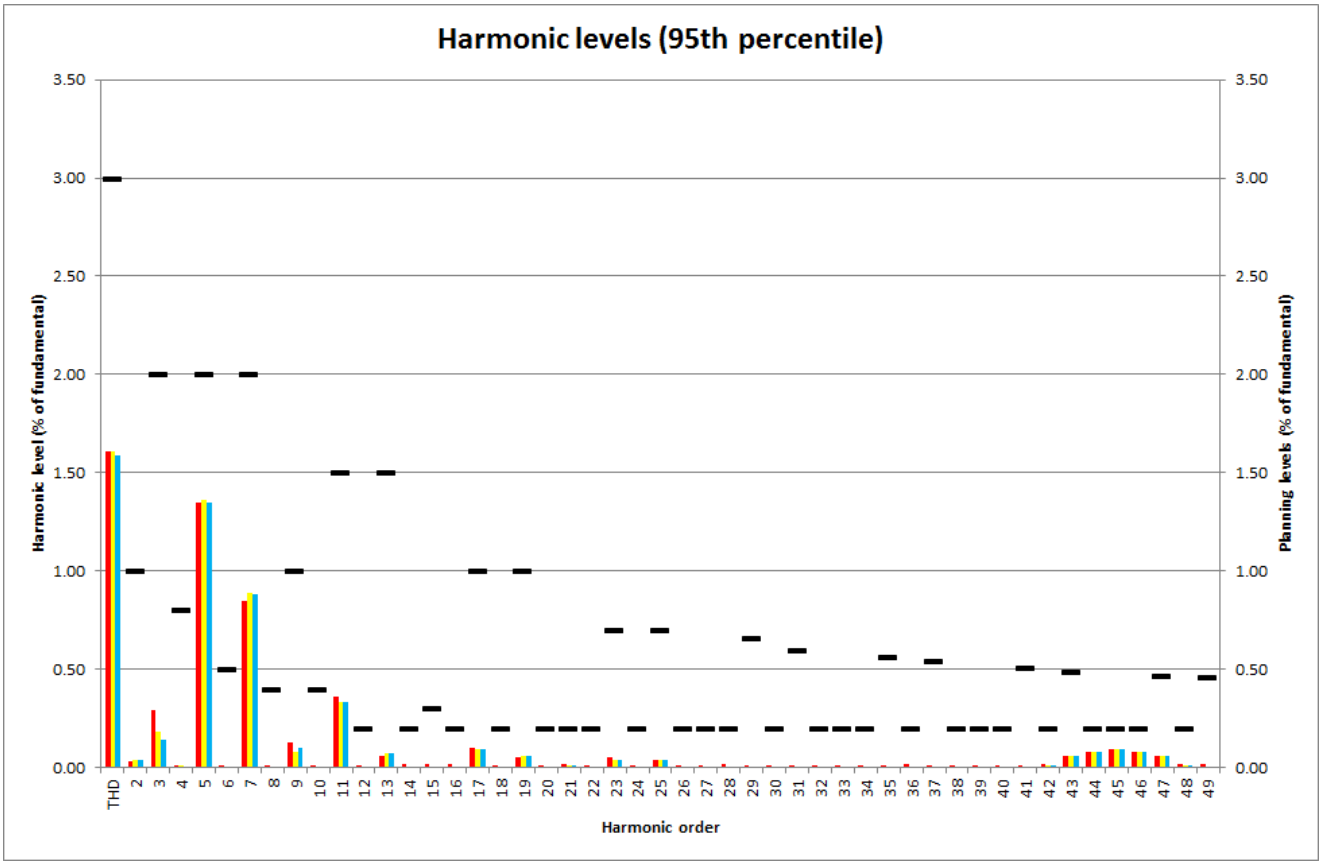
3 Voltage harmonics

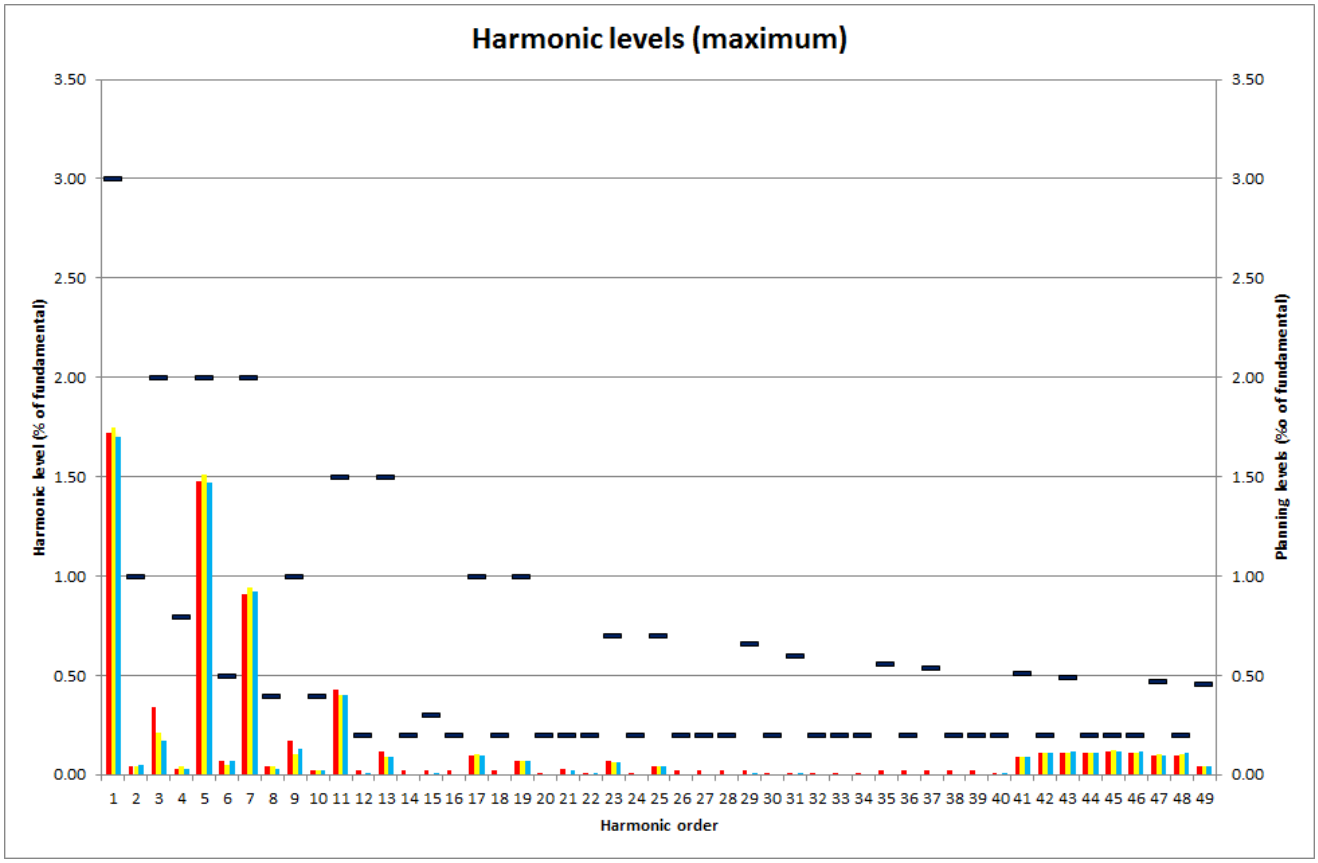
Shown below are the maximum and 95th percentile voltage harmonics measured on site. These measurements are compared with the G5/4 planning limits associated with the nominal voltage of the site.

3.1 Voltage harmonic results

		95% percentile			Maximum			
Harmonic order	G5/4 planning limit (% of fundamental)	Red	Yellow	Blue	Red	Yellow	Blue	
THD	3.00	1.61	1.61	1.59	1.72	1.75	1.70	PASSED
2	1.00	0.03	0.04	0.04	0.04	0.04	0.05	PASSED
3	2.00	0.29	0.18	0.14	0.34	0.21	0.17	PASSED
4	0.80	0.01	0.01	0.00	0.03	0.04	0.03	PASSED
5	2.00	1.35	1.36	1.35	1.48	1.51	1.47	PASSED
6	0.50	0.01	0.00	0.00	0.07	0.05	0.07	PASSED
7	2.00	0.85	0.89	0.88	0.91	0.94	0.92	PASSED
8	0.40	0.01	0.00	0.00	0.04	0.04	0.03	PASSED
9	1.00	0.13	0.08	0.10	0.17	0.10	0.13	PASSED
10	0.40	0.01	0.00	0.00	0.02	0.02	0.02	PASSED
11	1.50	0.36	0.33	0.33	0.43	0.40	0.40	PASSED
12	0.20	0.01	0.00	0.00	0.02	0.01	0.01	PASSED
13	1.50	0.06	0.07	0.07	0.12	0.09	0.09	PASSED
14	0.20	0.02	0.00	0.00	0.02	0.00	0.00	PASSED
15	0.30	0.02	0.00	0.00	0.02	0.01	0.01	PASSED
16	0.20	0.02	0.00	0.00	0.02	0.00	0.00	PASSED
17	1.00	0.10	0.09	0.09	0.10	0.10	0.10	PASSED
18	0.20	0.01	0.00	0.00	0.02	0.00	0.00	PASSED
19	1.00	0.05	0.06	0.06	0.07	0.07	0.07	PASSED
20	0.20	0.01	0.00	0.00	0.01	0.00	0.00	PASSED
21	0.20	0.02	0.01	0.01	0.03	0.01	0.02	PASSED
22	0.20	0.01	0.00	0.00	0.01	0.01	0.01	PASSED
23	0.70	0.05	0.04	0.04	0.07	0.06	0.06	PASSED
24	0.20	0.01	0.00	0.00	0.01	0.00	0.00	PASSED
25	0.70	0.04	0.04	0.04	0.04	0.04	0.04	PASSED
26	0.20	0.01	0.00	0.00	0.02	0.00	0.00	PASSED
27	0.20	0.01	0.00	0.00	0.02	0.00	0.00	PASSED
28	0.20	0.02	0.00	0.00	0.02	0.00	0.00	PASSED
29	0.66	0.01	0.00	0.00	0.02	0.01	0.01	PASSED
30	0.20	0.01	0.00	0.00	0.01	0.00	0.00	PASSED
31	0.60	0.01	0.00	0.00	0.01	0.01	0.01	PASSED
32	0.20	0.01	0.00	0.00	0.01	0.00	0.00	PASSED
33	0.20	0.01	0.00	0.00	0.01	0.00	0.00	PASSED
34	0.20	0.01	0.00	0.00	0.01	0.00	0.00	PASSED
35	0.56	0.01	0.00	0.00	0.02	0.00	0.00	PASSED
36	0.20	0.02	0.00	0.00	0.02	0.00	0.00	PASSED
37	0.54	0.01	0.00	0.00	0.02	0.00	0.00	PASSED
38	0.20	0.01	0.00	0.00	0.02	0.00	0.00	PASSED
39	0.20	0.01	0.00	0.00	0.02	0.00	0.00	PASSED
40	0.20	0.01	0.00	0.00	0.01	0.01	0.01	PASSED
41	0.51	0.01	0.00	0.00	0.09	0.09	0.09	PASSED
42	0.20	0.02	0.01	0.01	0.11	0.11	0.11	PASSED
43	0.49	0.06	0.06	0.06	0.11	0.11	0.12	PASSED
44	0.20	0.08	0.08	0.08	0.11	0.11	0.11	PASSED
45	0.20	0.09	0.09	0.09	0.12	0.12	0.12	PASSED
46	0.20	0.08	0.08	0.08	0.11	0.11	0.12	PASSED
47	0.47	0.06	0.06	0.06	0.10	0.10	0.10	PASSED
48	0.20	0.02	0.01	0.01	0.10	0.10	0.11	PASSED
49	0.46	0.02	0.00	0.00	0.04	0.04	0.04	PASSED

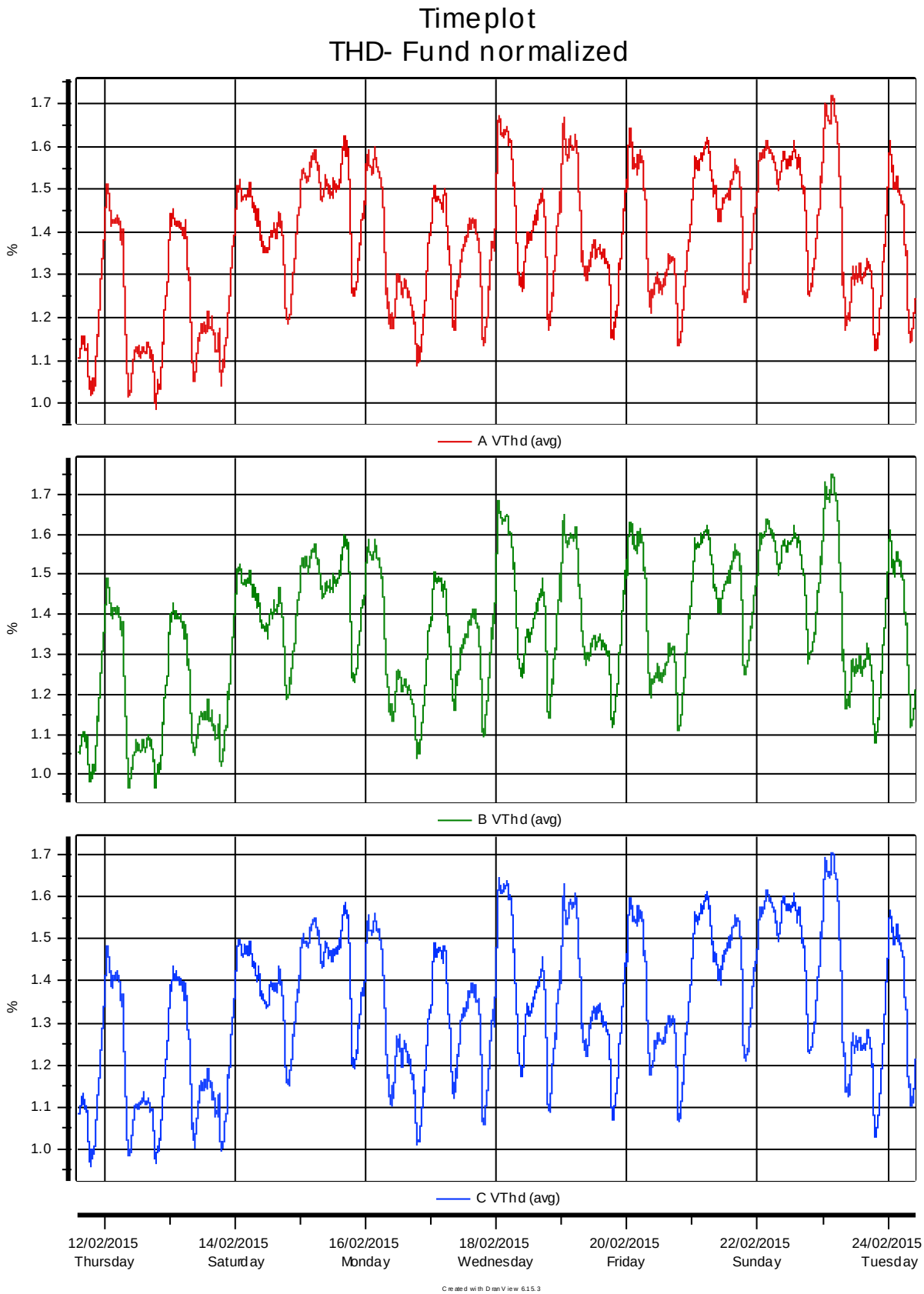
3.2 Harmonic order spectrum diagram





3.3 VTHD TIMEPLOTS

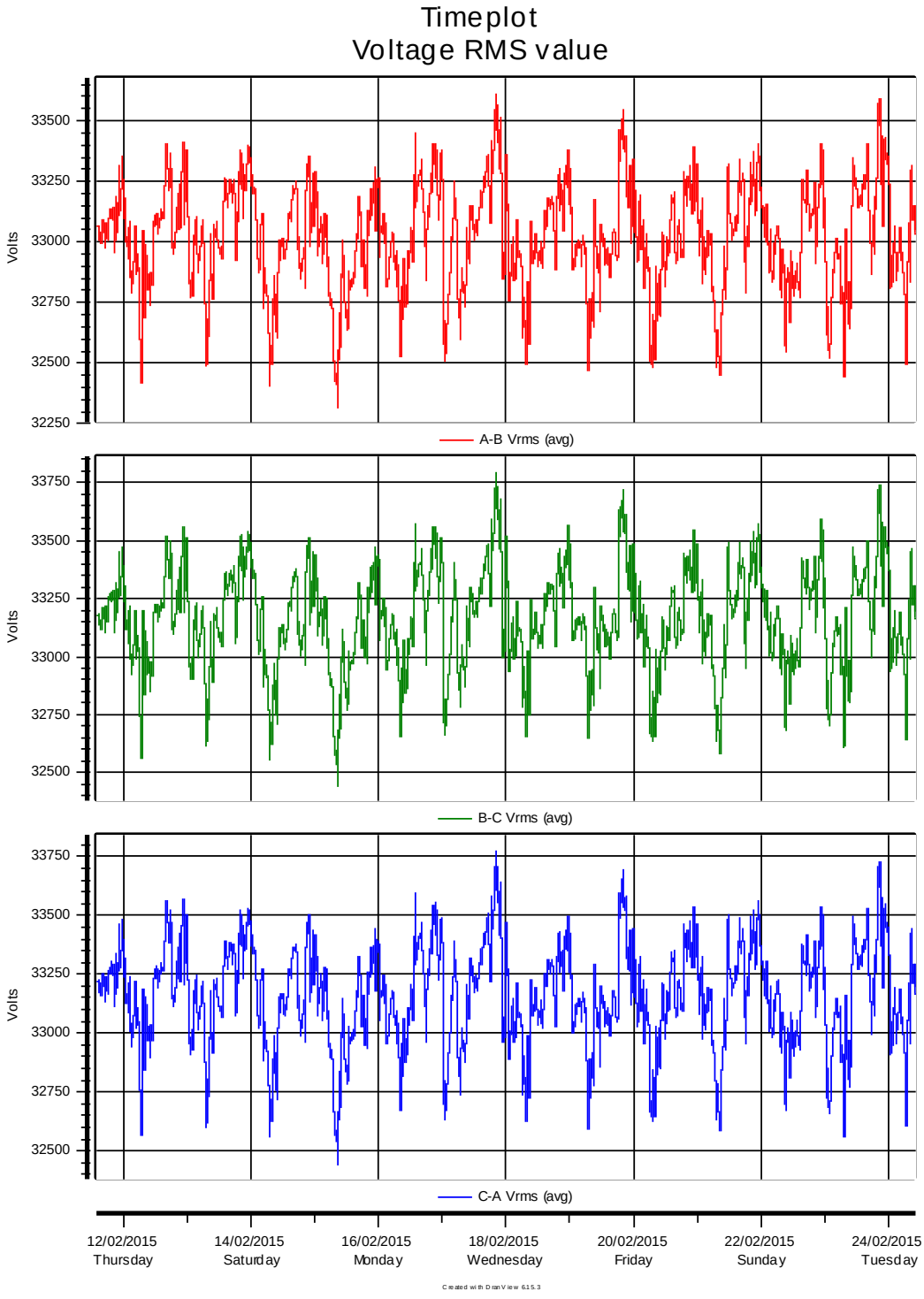
Site: Tottenham Grid GT1B 33kV star
Measured from 11/02/2015 14:20:00.0 to 24/02/2015 10:30:00.0



4 RMS voltage information

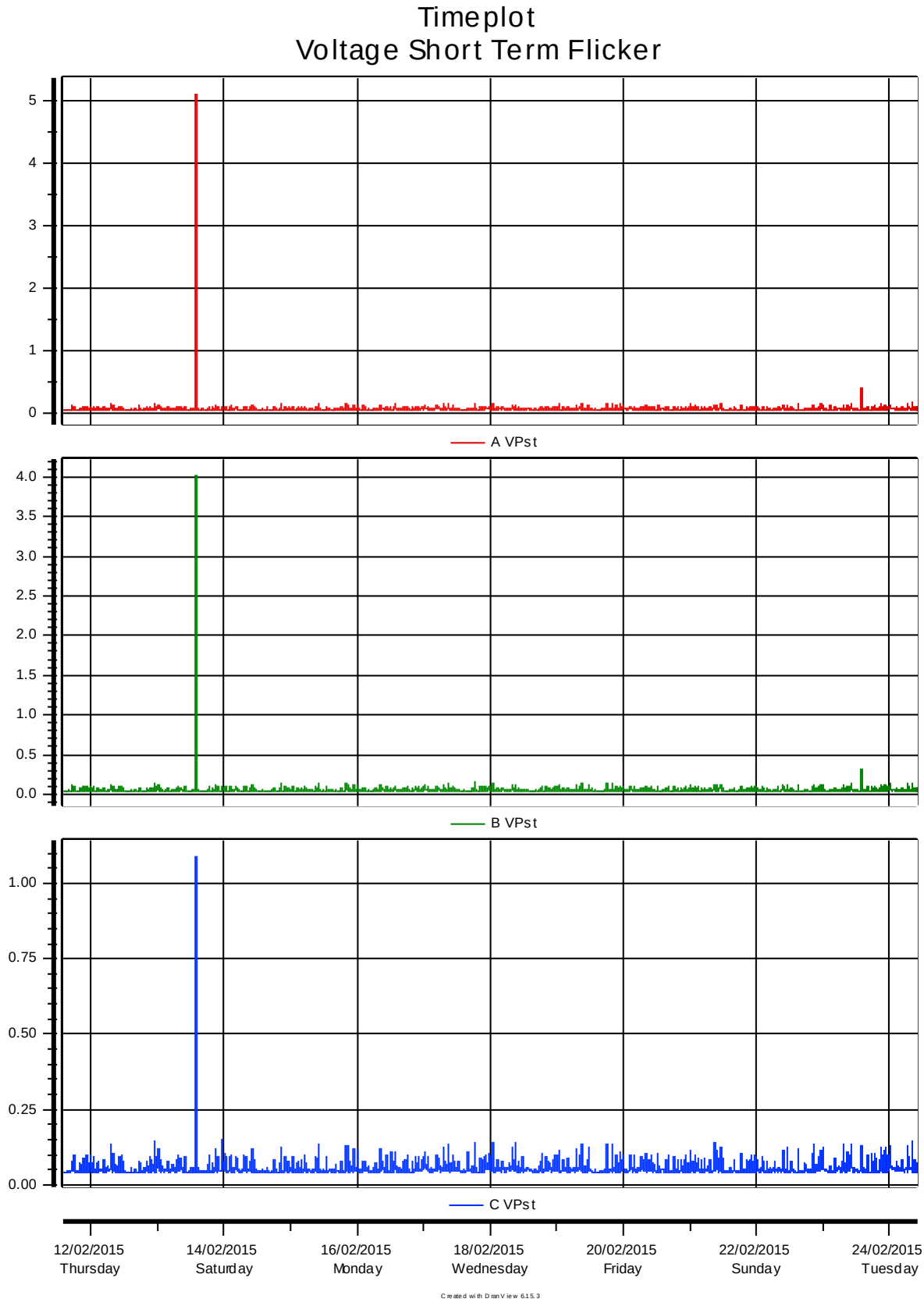
RMS voltage information and corresponding voltage timeplots are shown below:

	RMS max	RMS min	RMS average	99th percentile	1st percentile
A - B	33609	32317	33018	33463	32467
B - C	33792	32442	33161	33630	32617
C - A	33772	32442	33158	33602	32599

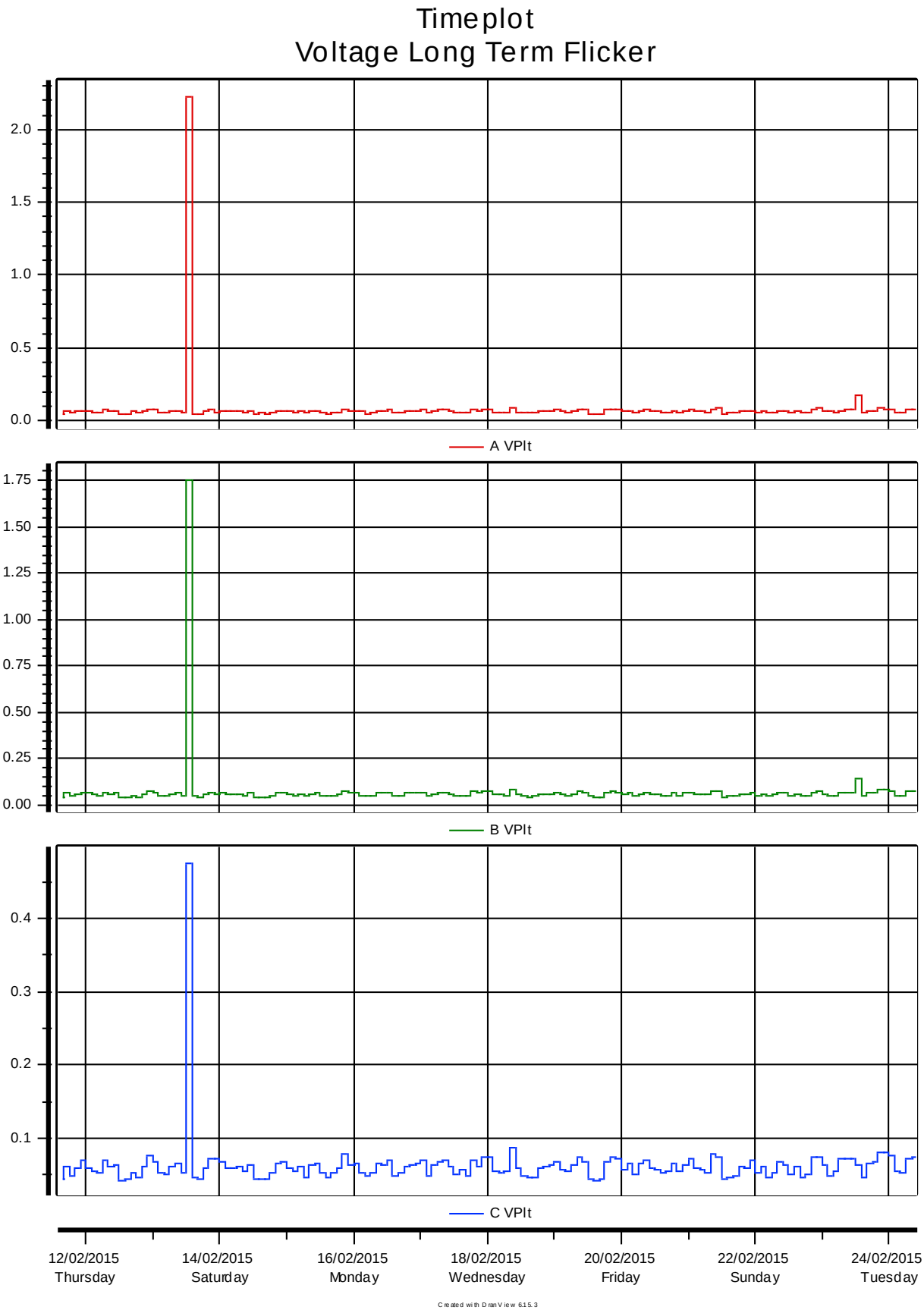


5 Flicker

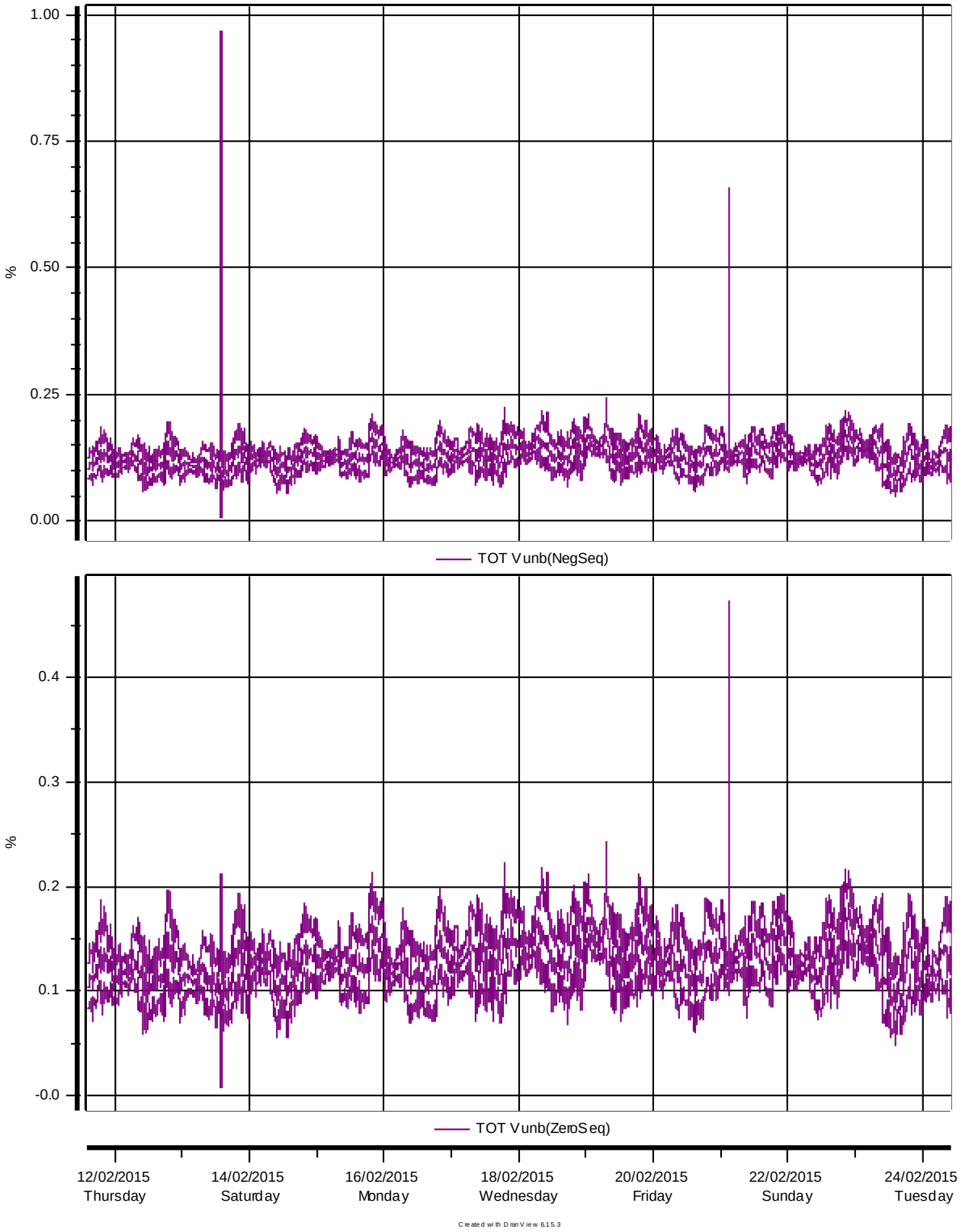
5.1 Short term flicker (Pst)



5.2 Long term flicker (Plt)



6 Voltage unbalance



7 Equipment settings

Site/Filename	Tottenham Grid GT1B 33kV star
Measured from	11/02/2015 14:06:07
Measured to	24/02/2015 10:33:47
File ending	OK
Synchronization	Standard A
Configuration	4 WIRE / 3 PROBE (WYE)
Monitoring type	EN50160
Nominal voltage	19108.4 V
Nominal current	0.0 A
Nominal frequency	50.0 Hz
Use inverse sequence	No
Using currents	No
Characterizer mode	IEC 61000-4-30

Current probes

Chan A	TR2510, TR2510A 0A-10A RMS (Scale=6.67)
Chan B	TR2510, TR2510A 0A-10A RMS (Scale=6.67)
Chan C	TR2510, TR2510A 0A-10A RMS (Scale=6.67)
Chan D	TR2510, TR2510A 0A-10A RMS (Scale=6.67)

Voltage scale factors

Chan A	300.000
Chan B	300.000
Chan C	300.000
Chan D	300.000

Trigger Response Setups

Summary Pre-trigger cycles	1 cycles
Summary Post-trigger cycles IN-TO-OUT	1 cycles
Summary Post-trigger cycles OUT-TO-IN	1 cycles
Waveform Pre-trigger cycles	1 cycles
Waveform Post-trigger cycles	2 cycles

Trigger-	Saved waveforms										
channel	Va	Vb	Vc	Vd	Ia	Ib	Ic	Id	AB	BC	CA
Volts A	Va	Vb	Vc	-	-	-	-	-	-	-	-
Volts B	Va	Vb	Vc	-	-	-	-	-	-	-	-
Volts C	Va	Vb	Vc	-	-	-	-	-	-	-	-
Volts D	-	-	-	Vd	-	-	-	-	-	-	-
Amps A	-	-	-	-	-	-	-	-	-	-	-
Amps B	-	-	-	-	-	-	-	-	-	-	-
Amps C	-	-	-	-	-	-	-	-	-	-	-
Amps D	-	-	-	-	-	-	-	-	-	-	-
Volts A-B	-	-	-	-	-	-	-	-	-	-	-
Volts B-C	-	-	-	-	-	-	-	-	-	-	-
Volts C-A	-	-	-	-	-	-	-	-	-	-	-

Timed waveform savings: NOT active
After recording: REARM

Limit Setups

Voltages	A	B	C	D	A-B	B-C	C-A
RMS High:	21019.2	21019.2	21019.2	0.0	0.0	0.0	0.0
RMS Low:	17197.6	17197.6	17197.6	0.0	0.0	0.0	0.0
RMS Very Low:	191.1	191.1	191.1	0.0	0.0	0.0	0.0
Crest:	32484.3	32484.3	32484.3	0.0	0.0	0.0	0.0
Wave:	1337.6	1337.6	1337.6	0.0	0.0	0.0	0.0
DC:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEG:	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WAVE Window Mag:	1910.8	1910.8	1910.8	0.0	0.0	0.0	0.0
WAVE Window Dur:	10.0	10.0	10.0	0.0	0.0	0.0	0.0
HF:	19108.4	19108.4	19108.4	0.0	0.0	0.0	0.0

Currents	A	B	C	D
RMS High:	0.0	0.0	0.0	0.0
RMS Low:	0.0	0.0	0.0	0.0
RMS Very Low:	0.0	0.0	0.0	0.0
Crest:	0.0	0.0	0.0	0.0
Wave:	0.0	0.0	0.0	0.0
DC:	0.0	0.0	0.0	0.0
DEG:	0.0	0.0	0.0	0.0
WAVE Window Mag:	0.0	0.0	0.0	0.0
WAVE Window Dur:	0.0	0.0	0.0	0.0
HF:	0.0	0.0	0.0	0.0

Periodic Journal Intervals

Voltage	10.0 minutes
Current	10.0 minutes
Power	10.0 minutes
Harmonics	10.0 minutes
Demand	5.0 minutes, Subintervals/Intervals: 3
Energy	10.0 minutes
Inst. flicker	10.0 minutes
Short term flicker	10.0 minutes
Long term flicker	120.0 minutes
EN50160 compliance	10.0 minutes
Voltage	10.0 minutes

Journal Limits

Voltage	VeryHi	High	Low	VeryLo	Sens.	Hyst.	Nom.
RMS_PhAN	22930	21019	17198	15287	-	-	-
RMS_PhBN	22930	21019	17198	15287	-	-	-
RMS_PhCN	22930	21019	17198	15287	-	-	-
CycRMS_PhAN	22930	21019	17198	15287	-	-	-
CycRMS_PhBN	22930	21019	17198	15287	-	-	-
CycRMS_PhCN	22930	21019	17198	15287	-	-	-
NegUnbalTotal	-	2.0	-	-	-	-	-

Harmonics	VeryHi	High	Low	VeryLo	Sens.	Hyst.	Nom.
VoltageFundNormTHD_PhA	8.0	5.0	-	-	-	-	-
VoltageFundNormTHD_PhB	8.0	5.0	-	-	-	-	-
VoltageFundNormTHD_PhC	8.0	5.0	-	-	-	-	-

Short term flicker	VeryHi	High	Low	VeryLo	Sens.	Hyst.	Nom.
Pst_PhA	-	1.0	-	-	-	-	-
Pst_PhB	-	1.0	-	-	-	-	-
Pst_PhC	-	1.0	-	-	-	-	-

Registered Office:
Newington House
237 Southwark Bridge Road
London SE1 6NP

Company:
UK Power Networks
(Operations) Limited

Registered in England and Wales No: 3870728

Mr Euston Ling
North London Waste Authority
Unit 1B, Berol House
25 Ashley Road
London
N17 9LJ

24th March 2015
Our Ref: 401750418/QID240152

Dear Mr Ling

Site Address: Eco Park, Advent Way, London, N18 3AG

Thank you for your recent enquiry regarding the above premises. I am writing to you on behalf of Eastern Power Networks PLC the licensed distributor of electricity for the above address trading as UK Power Networks.

I am pleased to be able to provide you with a budget estimate for the work.
It is important to note that this budget estimate is intended as a guide only. It may have been prepared without carrying out a site visit or system studies. No enquiry has been made as to the availability of consents or the existence of any ground conditions that may affect the works. It is not an offer to provide the connection and nor does it reserve any capacity on UK Power Networks' electricity distribution system.

1. Budget estimate

The budget estimate for this work is: **£3,320,000.00** (exclusive of VAT)

Summary of Budget Estimate connection:
Non Contestable
- £220,000.00

Contestable
- £3,100,000.00

Export Capacity
- 71.3MW

Location of the Point of Connection (POC) to the Distribution System
- TQ35789252 (Eco Park / Deephams 33kV metering breakers)

Cable route length POC to generation substation
- Circa 2 x 2 circuits of 2.25km (approximately 9km)

Connection to DNO network voltage
- 33kV

Entry point voltage (consumer metering supply connection point)
- 33kV

Scope of Works

This budget estimate is based on option 4 as part of the earlier feasibility study (401620280).

In this option, the proposed Works include:

- **Installing new cables in parallel with the existing ones**
- **Overlaying the oil filled sections within the existing cables**

This option was presented taking into account a defined level of utilisation of the circuits which is similar to the current level at Eco Park/ Deephams. The future utilisation profile of the Eco Park/ Deephams 33kV circuits is subject to confirmation from You, the customer. This level will determine the cable cross section required and the requirement of further cable overlays. Until further information is received, it is proposed, as a conservative approach, to lay two new pairs of 800mm^2 Cu circuits and disconnect the existing 33kV circuits between Tottenham Grid and Eco Park. Total length of cable to be laid is approximately 9km (2x two circuits of 2.25km).

It should be noted that the feasibility report was for 70MVA export at unity power factor. The requested 71.3MVA export at unity power may not be possible due to switchgear limitations at Tottenham Grid.

Please bear in mind the possibility of future export restrictions applied by National Grid given the contractual change to License Exempt Embedded Medium Power Stations.

2. Budget estimate assumptions

This budget estimate is based on the following assumptions:

- The most appropriate Point of Connection (POC) is as described above.
- A viable cable or overhead line route exists along the route we have assumed between the Point of Connection (POC) and your site.
- In cases where the Point of Connection (POC) is to be at High Voltage, that a substation can be located on your premises at or close to the position we have assumed.
- Where electric lines are to be installed in private land UK Power Networks will require an easement in perpetuity for its electric lines and in the case of electrical plant the freehold interest in the substation site, on UK Power Networks terms, without charge and before any work commences.
- You will carry out, at no charge to UK Power Networks, all the civil works within the site boundary, including substation bases, substation buildings where applicable and the excavation/reinstatement of cable trenches.
- Unless stated in your application, all loads are assumed to be of a resistive nature. Should you intend to install equipment that may cause disturbances on UK Power Networks' electricity distribution system (e.g. motors; welders; etc.) this may affect the estimate considerably.
- All UK Power Networks' work is to be carried out as a continuous programme of work that can be completed substantially within 12 months from the acceptance of the formal offer.

Please note that if any of the assumptions prove to be incorrect, this may have a significant impact on the price in any subsequent quotation. You should note also that UK Power Networks' formal connection offer may vary considerably from the budget estimate. If you place reliance upon the budget estimate for budgeting or other planning purposes, you do so at your own risk.

If you would like to proceed to a formal offer of connection then you should apply for a quotation, Please refer to our website http://www.ukpowernetworks.co.uk/internet/en/help-and-advice/documents/the_connection_process.pdf for '**The connection process'** which details our application process. To help us progress any future enquiry as quickly as possible please quote the UK Power Networks Reference Number from this letter on all correspondence.

If you have any questions about your budget estimate or need more information, please do not hesitate to contact me. The best time to call is between the hours of 9am and 4pm, Monday to Friday. If the person you need to speak to is unavailable or engaged on another call when you ring, you may like to leave a message or call back later.

Yours sincerely

Keir Spiller
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Series 05 Technical Documents

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