Giffnock SGT1 and SGT2 replacement– OFGEM justification paper	
Name of Scheme/Programme	Giffnock SGT1 and SGT2 replacement
Primary Investment Driver	Asset Health (Lead asset – Transformer)
Scheme reference/ mechanism or category	SPNLT 2066 (Transformer replacement) SPNLT20139 (Transformer replacement)
Output references/type	NLRT2SP2066 (275kV Transformer / 275kV Switchgear other) NLRTSP20139 (275kV Transformer / 275kV Switchgear other)
Cost	SPNLT 2066: £ 5.87 m (RIIO T2 investment for SGT1 replacement: £ 4.678 m / RIIO T3 investment - £ 1.20 m) SPNLT20139: £ 5.87 m (RIIO T2 investment for SGT2 replacement: £ 4.678 m / RIIO T3 investment - £ 1.20 m) Total combined investment between the two projects: £ 11.74 m
Delivery Year	SPNLT2066 – 2026 (For SGT1) SPNLT20139 – 2027 (For SGT2)
Reporting Table	C0.7 / C2.2a_CI / C2.2a_AP / C2.3 / C2.4b / C2.5 / C2.5a
Outputs included in RIIO T1 Business Plan	No

Issue Date	Issue no.	Amendment details
23/07/2020	1	First issue, superseding EJP_SPT_SPNLT2066 by including the scope of project SPNLT20139

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1 Introduction

Giffnock 275/33kV substation is an outdoor GSP located on the Berryhill road in Giffnock, Glasgow and is responsible for supplying the distribution network in the area. The 2 supergrid transformers at Giffnock are fed from Busby 275kV substation, which in turn are connected to Neilston 275kV and Strathaven 275kV substations. The 33kV indoor switchboard at Giffnock was recently replaced by SP Distribution.

SGT1 and SGT2 (275/33kV, 120MVA units) are installed within noise/fire enclosures due to their proximity to adjacent properties.

Condition assessment carried out on the transformers have shown that both have widespread, extensive, long term oil leakage, which has caused oil contamination to the transformer main tank and surrounding plinth. The oil leak repair works carried out in RIIO-T1 have only been partially effective and intervention is required within the RIIO T2 period.

DGA analysis on the units has shown moisture ingress which has compromised the dielectric properties of the oil and aged the paper insulation. For any refurbishment option, extensive remediation works will be required to extend the life of transformer.

Considering the inherent issues, SGT1 and SGT2 are now being proposed for replacement, with SGT1 proposed to be replaced in 2026 (end of RIIO T2), and SGT2 in 2027 (start of RIIO T3). The replacement works have been considered in consecutive years to gain efficiency from contracting and site costs.

For this submission, the costs are profiled considering the 2 units replaced in subsequent years, while the volume replacement considers one-unit (SGT1) unit proposed to be replaced in RIIO-T2 period, and the other unit (SGT2) proposed to be replaced in RIIO-T3 period.

As only SGT1 replacement is considered in RIIO T2, CBA analysis is based on the expected cost for this replacement only.

In line with the above, and considering only SGT1 replacement proposed during RIIO T2 price control period (SGT2 in RIIO T3), the proposed lead asset outputs for the selected option in RIIO T2 are:

- 275kV Transformer disposal – 1 unit
- 275kV Transformer addition – 1 unit

Further the proposed lead asset output for the selected option in RIIO T3 are:

- 275kV Transformer disposal – 1 unit
- 275kV Transformer addition – 1 unit

SP Transmission has carried out a detailed technical review for all 275/33kV 120MVA units proposed to be replaced during RIIO T2 /RIIO T3 period. The study has shown that due to the increased levels of embedded generation, replacing these transformers on a like for like basis (120MVA units) results in fault level and voltage regulation issues.

Hence, considering that the 33kV present demand at Giffnock substation being 64.4MW, and embedded generation not expected to exceed 15.7MW, the new units are proposed to be 90MVA. This alleviates any future fault level / voltage regulation issues.

2 Background Information

Based on the values determined in accordance with the NARM methodology, SGT1 and SGT2 at Giffnock 275kV substation both have an EoL modifier score of 10.12 (at end of RIIO-T2 period without any intervention) and based on ongoing issues detected during condition assessment has been identified for replacement. SGT1 is proposed for replacement during RIIO T2 period (2025), while SGT2 is proposed for replacement during RIIO T3 (2026) subsequently and presented here as a common project for efficiency purpose.

Accordingly, this paper supports a proposal to replace the existing SGT1 (120MVA) and SGT2 (120MVA) units with new 90MVA units instead at Giffnock 275kV substation, with the works proposed to be over RIIO T2 and T3 period.

This is also in line with the SP Transmission investment strategy for transformers to replace assets at or approaching end of life, particularly those with high Dissolved Gas Analysis (DGA) readings and poor site specific, condition-based assessment ranked through our type based operational adequacy methodology TRAN-02-002[1].

Please find details of the lead asset proposed to be replaced:

Asset Description	Manufacturer	Year of Manufacture	EoL (Transformer) (End of RIIO T2)	Monetised risk
GIFF275TRXSGT2	HACKBRIDGE & HEWITTIC	1964	10.12	£ 809,745.87
GIFF275TRXSGT1	HACKBRIDGE & HEWITTIC	1964	10.12	£ 809,745.87

Figure 1: Giffnock SGT1 transformer bay

[1] Assessment of Operational Adequacy of Transformers & Reactors (33kV & Above)

Figure 2: SGT1 internal view

A detailed site review and technical assessment of the condition of the non-lead assets has been carried out by SP Transmission as part of this project's development.

Site condition assessment carried out on respective plant items have shown these to be in a poor condition requiring intervention along with the transformer. In line with this, the associated Earthing auxiliary transformers, NER and 33kV plant assets (Post insulator / 33kV outdoor termination kit) have also been considered for replacement in this proposal.

Site condition assessment of 275kV RCP Disconnector H23 (SGT2 bay) has shown operational and mechanical issues requiring major intervention. The recommendation for H23 is that it would be possible to refurbish it and make it operational for the expected design life of refurbished bays (40 years). However, to refurbish and reuse the existing disconnector, a substantial amount of work is required to be carried out by a specialist contractor. This involves rebuilding main contacts, sand blasting arcing rings, painting, replacing earth cables, rewiring and painting mechanism boxes, replacing contactors, relays, fuses, heaters and mechanism boxes to be tested in workshops. There is an element of added cost and time for refurbishment that needs to be reflected in the overall project timescales and costs. The costs and timescales to refurbish the disconnectors and mechanism boxes when compared with the costs and timescales to replace them indicate that replacement is the most economic option.

Accordingly, H23 has been considered for replacement.

After further assessment on 275kV RCP Disconnector located in SGT1 bay (H13), it has been decided to reuse this asset with minimal intervention.

No Surge arresters are currently installed around the transformer. In line with SPEN Surge arrester application policy[2], new sets of 275kV and 33kV Surge arresters would be considered on either side of bushings in the new arrangement.

Visual survey carried out on respective civil assets (Transformer bund, plinth etc.) has shown the requirement of intervention in all cases. Accordingly, new concrete assets have been considered for replacement.

Giffnock SGT1 and SGT2 have experienced major oil leaks for a number of years resulting in extensive contamination of the ground below and around the transformer plinth. Repeated efforts to repair the leaks have had very limited success. Removal of the oil contamination via remedial works or excavation and disposal of the soil around the transformer plinth has been considered within the costing.

A site condition assessment report for these non-lead assets, along with condition assessment of other assets at the site is available. Recommendations from this report have been included within the options considered.

Considering the limited space available and the residential properties nearby by a new fire / noise enclosure would be required at Giffnock substation.

Based on site condition assessment carried out, existing auxiliary supply system is being considered to be reused with minimal intervention around upgrading fuse sizes only required.

The existing 275kV control building has been surveyed to determine if repair or refurbishment works are necessary and to assess the space available to accommodate replacement protection and control equipment. In line with the survey carried out, only minor repair works and building service upgrades are envisaged within the options considered.

[2] SUB-01-020 SA application policy

3 Optioneering

The following is a summary of the options considered for this project. The respective associated drawings for each of these options are available.

	Option	Status	Reason for rejection
	Baseline option: Do nothing in RIIO-T2 period with investment deferred to RIIO-T3 period. Scope of works similar to option 1.	Proposed	-
1	In situ online replacements of existing 275/33kV 120MVA SGT1 and SGT2 units with new SGT1 (2025) and SGT2 (2026) 275/33kV 90MVA transformers. SGT1 replacement planned in 2026 (RIIO T2) / SGT2 replacement in 2027 (RIIO T3)	Proposed	-
2	Offline replacement of existing 275/33kV 120MVA SGT1 and SGT2 units with new SGT1 and SGT2 a 275/33kV 90MVA transformer.	Rejected	- Detailed review has shown there is no space for an offline build of a new transformer bay at Giffnock 275kV substation. - With existing infrastructure around the substation there is no scope for extending the site boundary for an offline build
3	In situ refurbishment of existing 275/33kV 120MVA SGT1 and SGT2 units	Rejected	Extensive refurbishment would be required to extend the service life of the units with the high costs not justifying the limited increase in service life. Oil repair works carried out in RIIO T2 has only been marginally effective with no guarantees that future refurbishment works to stop the oil leak would lead to a permanent solution.
4	Remove SGT1 / SGT2 from Giffnock 275kV substation	Rejected	The transformer rating has been reviewed against the SP Transmission demand and generation scenarios and it has been confirmed that the replacement with a transformer of the same rating is appropriate. Also the transformers are required to supply the existing base load at Giffnock 275kV substation

Based on engineering design studies to determine the costs of the options identified as addressing the asset condition issues, the following 2 options have been considered for further review for this project:

- Baseline option: Do nothing in RIIO-T2 period with investment deferred to RIIO-T3 period. Scope of works similar to Option 1.

- Option 1: In situ online replacements of existing 275/33kV 120MVA SGT1 and SGT2 units with new SGT1 and SGT2 a 275/33kV 90MVA transformer. SGT1 replacement planned in 2025 (RIIO-T2) / SGT2 replacement in 2026 (RIIO-T3)

4 Detailed analysis

Both the options considered achieve the main objective of replacing SGT1 and SGT2 while intervening on non-lead assets and thereby reducing the overall risks to the network.

As the scope of works is identical for the two options with the only difference being the timing of investment, a common description has been included below which refer to both the options:

4.1 Year 1 – RIIO-T2 scope of works (2026)

- Replace the existing 275/33kV 120 MVA SGT1 along with respective bund/noise enclosure with new 275/33kV 90 MVA transformer and new bund & fire / noise enclosure.
- Carry out remedial works on (excavate up to 2m and dispose of) the ground below the SGT1 bund, EAT bund and other areas affected.
- Reuse H13 along with associated structure and foundation.
- Replace associated EAT and NER with new 200kVA EAT and dry type NER.
- Replace associated busbars / clamps/connectors
- New transformer protection P&C panels / cabling
- New 33kV cabling jointed into section of existing 33kV cabling.
- Refurbish and reuse 275kV cable sealing end. Loading to be checked with new busbars.
- Reuse of existing cable trenches and access road. This will be an online build.
- New 275kV and 33kV Surge arresters added

4.2 Year 2 – RIIO-T3 scope of works (2027)

- Replace the existing 275/33kV 120 MVA SGT2 along with respective bund/noise enclosure with new 275/33kV 90 MVA transformer and new bund & fire / noise enclosure.
- Carry out remedial works on (or excavate up to 2m and dispose of) the ground below the SGT2 bund, EAT bund and other areas affected.
- Replace associated EAT and NER with new 200kVA EAT and 12.1 ohms dry type NER.
- Replace associated busbars / clamps/connectors
- Replace existing disconnector H23 with respective earth switches.
- New transformer protection P&C panels / cabling
- New 33kV cabling jointed into section of existing 33kV cabling.
- Refurbish associated 275kV cable sealing end. Loading to be checked with new busbars.
- Reuse of existing cable trenches and access road. This will be an online build.
- New 275kV and 33kV Surge arresters added

4.3 Specific factors contributing to additional cost

The following factors were identified specifically for this project which is resulting in additional cost:

- Remedial measures for ground contamination from oil leaks below and around SGT1 and SGT2 bund / transformer bays.
- Based on the existing ground condition, piling works considered for the new transformer bunds.
- Replacement of existing drainage system including removal of contaminated material
- Noise / fire enclosure proposed around SGT1 and SGT2. Note the requirement of a noise enclosure is subject to further noise survey assessment.
- Asbestos contamination in existing infrastructure viz. noise enclosure, concrete assets.

4.4 Selected option

Please find below a cost and construction timescale summary of all the options reviewed:

	Baseline option – Do nothing in RIIO-T2 with investment deferred to RIIO-T3 period. Scope of works similar to Option 1.	Option 1 - In situ online replacements of existing 275/33kV 120MVA SGT1 and SGT2 units with new SGT1 and SGT2 275/33kV 90MVA transformers.
Complete project cost (RIIO T2 and RIIO T3 works) (£ m)	£ 11.81 m	£ 11.74 m
RIIO T2 standalone incidental project cost	£ 9.32 m	£ 9.34 m
RIIO T3 standalone incidental project cost	£ 2.48 m	£ 2.41 m
Construction timescales	2 outage seasons	

Please also find below a summary of the CBA analysis carried out on the 2-options considered. Note only the costs for project SPNLT2066 (SGT1 replacement) that has been planned in RIIO T2 period has been considered for this CBA.

Options	**Deferral**	**NPV (£m)**
Baseline	Do nothing - works deferred to RIIO-T3. Scope of works similar to option 1.	£ 29.67
1	In situ online replacement of existing 275/33kV 120MVA SGT1 unit with new 90 MVA 275/33kV unit. (2026)..	£ 31.98

Based on the technical review carried out, CBA analysis and in line with SP Transmission sustainability policy, option 1 is the selected option.

Note that the costs have been built up from individual costs for each element and included in a bill of quantities. The bill of quantities has been engineered from the design layouts developed for each option. The basis of individual unit costs has been the SP Transmission MoSC (Manual of Standard Costs) tool which makes reference to costs incurred during previous similar projects.

4.5 Environment & Sustainability

Major oil leaks have been recorded in the past from the existing SGT units installed. The oil leaks have contaminated the area around the transformer bund requiring intervention.

As part of this project, we are removing the transformers which were the source of these oil leaks and replacing with a new unit. Further ground remedial works below and around the existing transformer bund have also been considered in this project.

This option removes SGT1 and SGT2 from the network thereby reducing the environmental risks associated with these assets.

5 Conclusion

Both the options proposed have been reviewed in terms of scope, costs, timescales, construction risk, and sustainability requirements and have been found to be deliverable.

They also achieve the main objective of reducing the network risks due to existing 275/33kV 120MVA units and so are acceptable.

Based on the CBA analysis carried out, Option 1 with a higher NPV has been considered as the preferred option.

- Total project forecast costs for SGT1 / SGT2 replacement: £ 11.74 m
- Total project forecast cost for SGT1 replacement: £ 5.87 m
- Total project forecast cost for SGT2 replacement: £ 5.87 m
- Total RIIO-T2 project cost: £ 9.34m
- Total RIIO-T3 forecast: £ 2.41m
- Timing of investment: 2026 (RIIO-T2) / 2027 (RIIO-T3)
- Monetised risk benefit: 67.225R£m (Considering both SGT1 and SGT2 being replaced)
- Declared lead asset output in RIIO T2 period: Addition – 1 units / Disposal – 1 units (SGT1)
- Declared lead asset output in RIIO T3 period: Addition – 1 unit / Disposal – 1 unit (SGT2)

6 Future Pathways – Net Zero

6.1 Primary Economic Driver

The primary driver for this investment is asset condition and risk. The investment does not have a strong reliance on environmental benefits.

6.2 Payback Periods

The CBA indicates that a positive NPV results in all assessment periods (10, 20, 30 & 45 years) which is consistent with the lifetime of the intervention. Consumers benefit from reduced network risk immediately on completion of the project.

6.3 Pathways and End Points

The network capacity and capability that result from the proposed option has been tested against and has been found to be consistent with the network requirements determined from the ETYS and NOA processes. Additionally, the proposed option is consistent with the site-specific capacity requirements from SPT's Energy Scenarios.

6.4 Asset Stranding Risks

Electricity generation, demand and system transfers are forecast to increase under all scenarios. The stranding risk is therefore considered to be very low.

6.5 Sensitivity to Carbon Prices

Carbon price sensitivities have been applied using the higher case CBA template. The CBA outcome is influenced by losses and is sensitive to carbon prices.

6.6 Future Asset Utilisation

It has been assessed that the preferred option is consistent with the future generation and demand scenarios and that the risk of stranding is very low.

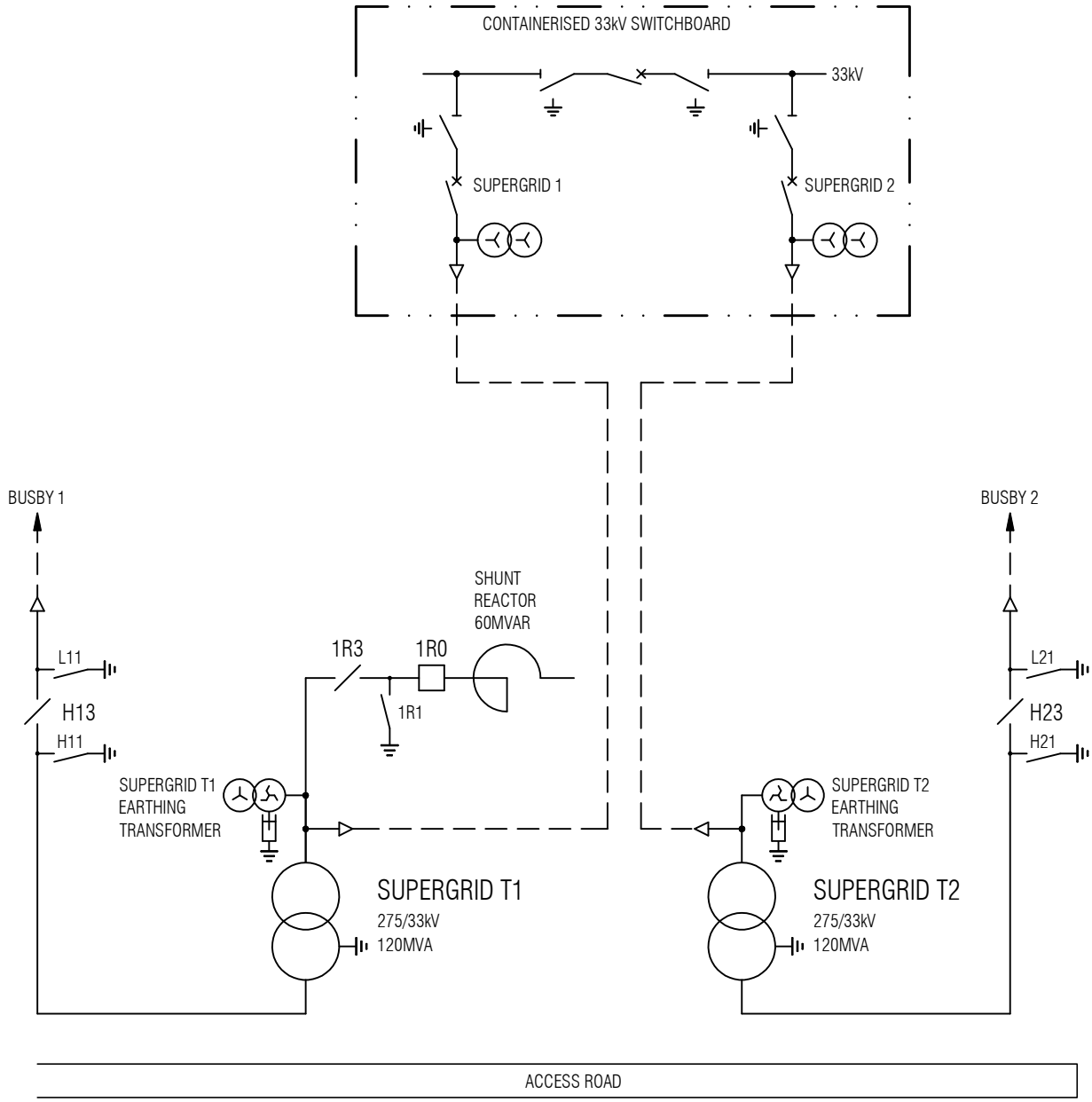
6.7 Whole Systems Benefits

Whole system benefits have been considered as part of this proposal. The capacity and capability of the preferred option is consistent with the provision of whole system solutions.

7 Outputs included in RIIO T1 Plans

The replacement of SGT1 was deferred in RIIO-T1 due to their condition not deteriorating as quickly as expected at the time when the investment was being progressed by internal approval.

There was an additional deferral at Kilmarnock Town for a similar reason. However, we have added units at Charlotte Street and Shrubhill which were not in the RIIO-T1 plan which can be considered substitutes for the deferrals. It is expected that if the substitutions lead to under-delivery against targets, the NARM incentive mechanism will return the associated allowance to consumers.



Rev.	Date	Drawn	Reviewed	Approved	Reason / Description of changes.
1	01/12/2017	PMR	GS	RMcE	33kV SWITCHGEAR REPLACED.

SP ENERGY NETWORKS

Drawing State: Approved

Project:

Location: GIFFNOCK

Voltage: 275KV

Approval Status: For Issue

Drg. Title: SWITCHGEAR NUMBERING FOR GIFFNOCK 275KV SUBSTATION GSN75(B)

Drawn	Rev'd	App'd
PMR	GS	RMcE

Drg. No.: SP2071658

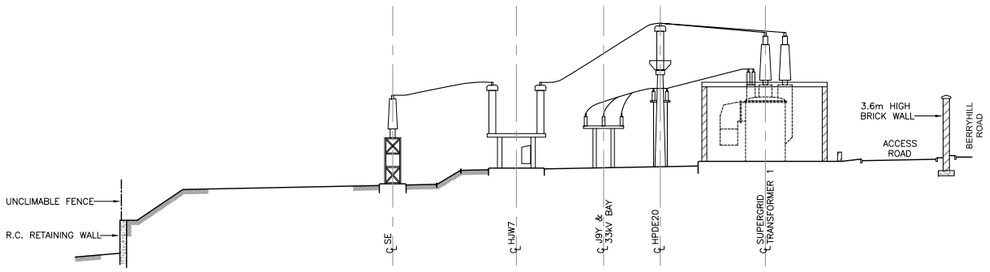
Sheet:

Next:

Scale:

Rev: 1

Size: A4



SECTION A – A
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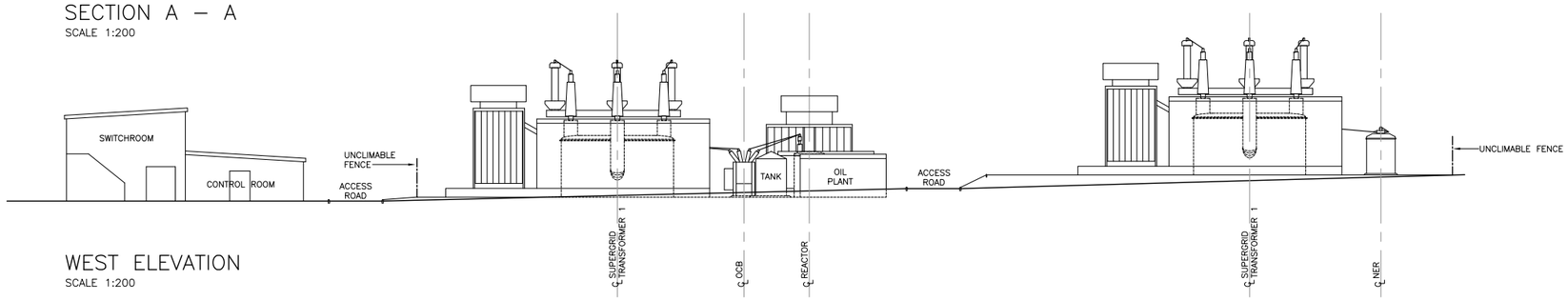

WEST ELEVATION
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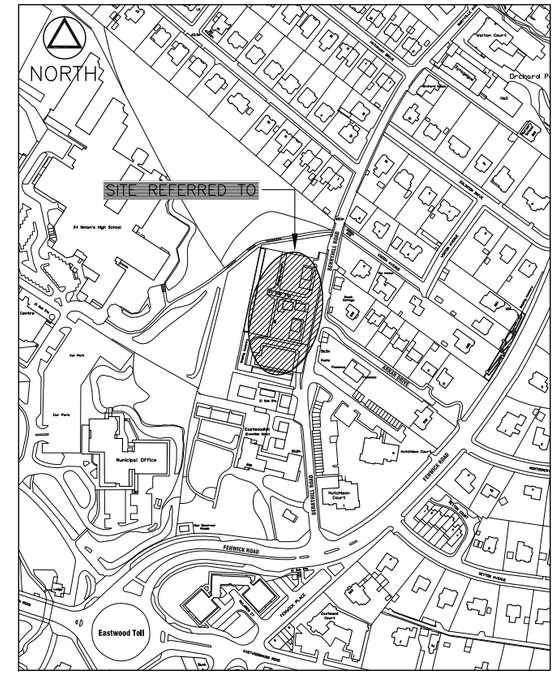

LOCATION PLAN
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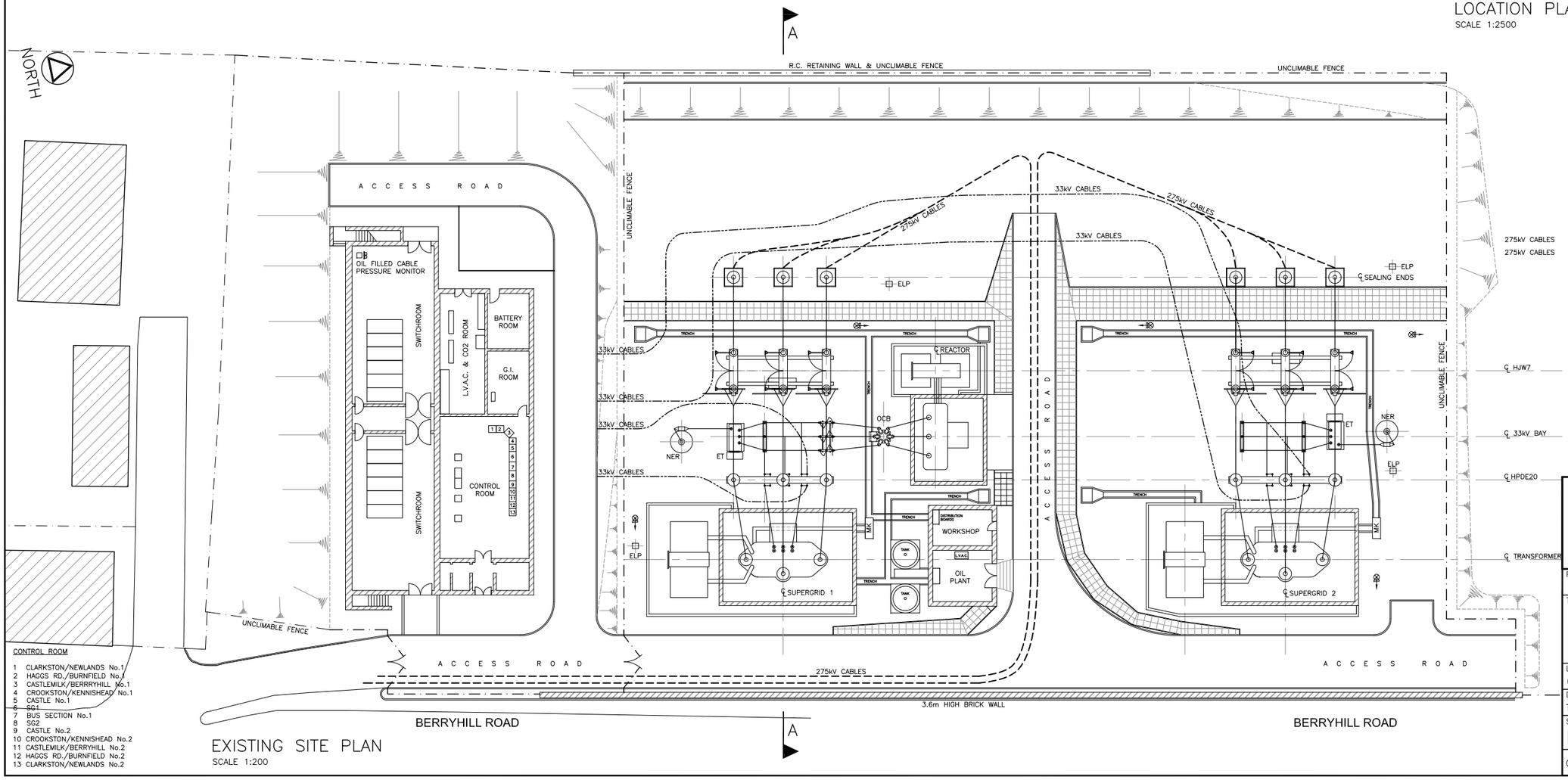

CONTROL ROOM

1 CLARKSTON/NEWLANDS No.1
2 HAGGS RD./BURNFIELD No.1
3 CASTLEMILK/BERRYHILL No.1
4 CROOKSTON/KENNISHEAD No.1
5 CASTLE No.1
6 SG1
7 BUS SECTION No.1
8 SG2
9 CASTLE No.2
10 CROOKSTON/KENNISHEAD No.2
11 CASTLEMILK/BERRYHILL No.2
12 HAGGS RD./BURNFIELD No.2
13 CLARKSTON/NEWLANDS No.2

EXISTING SITE PLAN
SCALE 1:200

SP ENERGY NETWORKS

Project						TRS No.
Title: GIFFNOCK 275KV SUBSTATION EXISTING SITE LAYOUT, ELEVATION & SECTION NOVEMBER 2008						
Location: GIFFNOCK				Voltage: 275kV		
Drawn: THN	Date	Checked	Date	Approved	Date	
Status: PRELIMINARY		Drg. No.: SP4050082			Rev.: 1.0	
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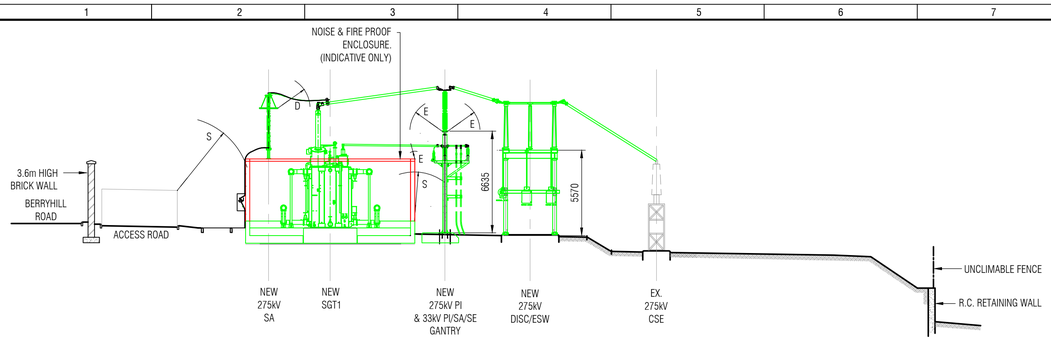

SECTION A-A
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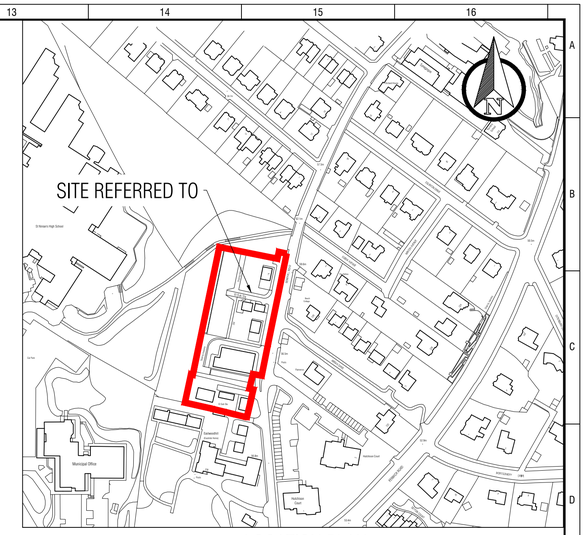
THIS DRAWING HAS BEEN PRODUCED FOR DISCUSSION / DESIGN DEVELOPMENT PURPOSES ONLY



LOCATION PLAN
SCALE 1:2500

BASED UPON THE ORDNANCE SURVEY MAP WITH THE PERMISSION OF H.M.S.O

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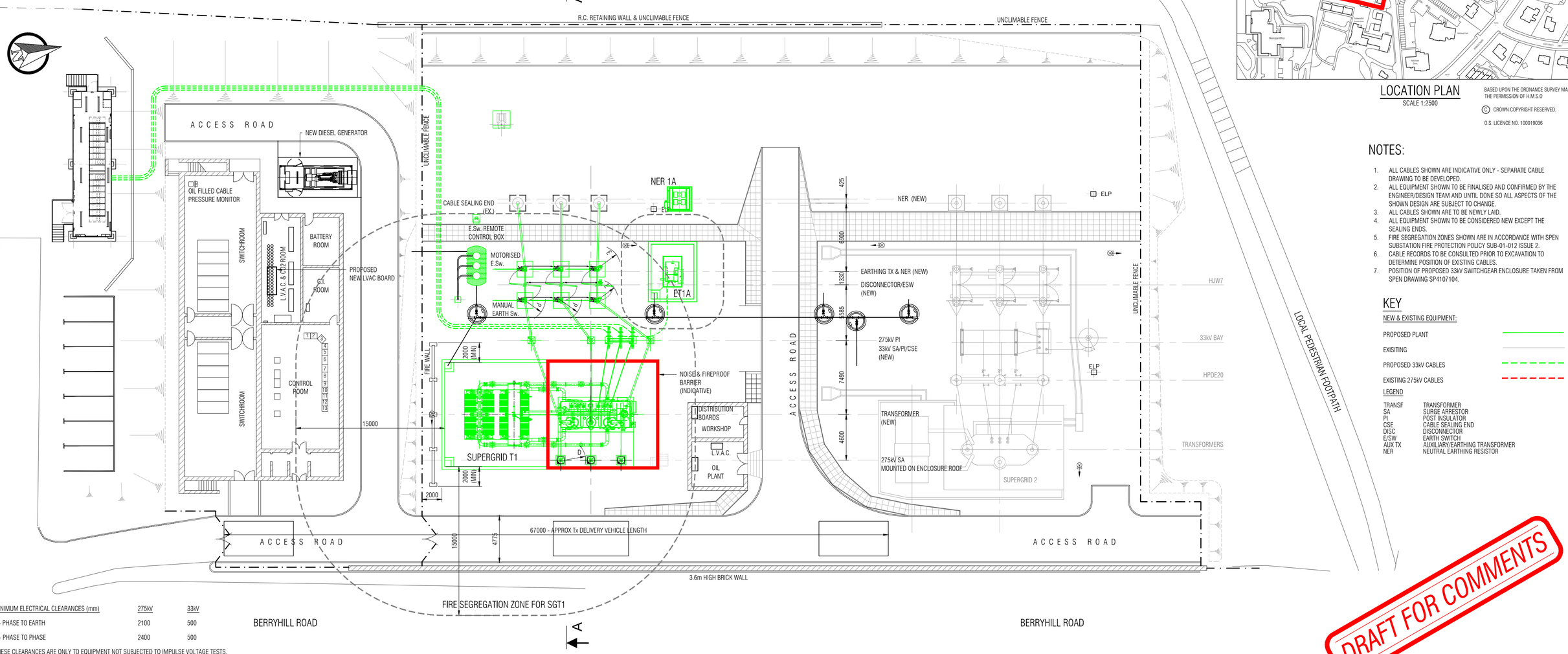
O.S. LICENCE NO. 100019036



PLAN LAYOUT
SCALE 1:200

NOTES:

1. ALL CABLES SHOWN ARE INDICATIVE ONLY - SEPARATE CABLE DRAWING TO BE DEVELOPED.
2. ALL EQUIPMENT SHOWN TO BE FINALISED AND CONFIRMED BY THE ENGINEER/DESIGN TEAM AND UNTIL DONE SO ALL ASPECTS OF THE SHOWN DESIGN ARE SUBJECT TO CHANGE.
3. ALL CABLES SHOWN ARE TO BE NEWLY LAID.
4. ALL EQUIPMENT SHOWN TO BE CONSIDERED NEW EXCEPT THE SEALING ENDS.
5. FIRE SEGREGATION ZONES SHOWN ARE IN ACCORDANCE WITH SPEN SUBSTATION FIRE PROTECTION POLICY SUB-01-012 ISSUE 2.
6. CABLE RECORDS TO BE CONSULTED PRIOR TO EXCAVATION TO DETERMINE POSITION OF EXISTING CABLES.
7. POSITION OF PROPOSED 33kV SWITCHGEAR ENCLOSURE TAKEN FROM SPEN DRAWING SP4107104.

KEY

NEW & EXISTING EQUIPMENT:

PROPOSED PLANT

EXISITING

PROPOSED 33kV CABLES

EXISTING 275kV CABLES

LEGEND

TRANSF	TRANSFORMER
SA	SURGE ARRESTOR
PI	POST INSULATOR
CSE	CABLE SEALING END
DISC	DISCONNECTOR
E/SW	EARTH SWITCH
AUX TX	AUXILIARY/EARTHING TRANSFORMER
NER	NEUTRAL EARTHING RESISTOR

MINIMUM ELECTRICAL CLEARANCES (mm)	275kV	33kV
E - PHASE TO EARTH	2100	500
P - PHASE TO PHASE	2400	500

THESE CLEARANCES ARE ONLY TO EQUIPMENT NOT SUBJECTED TO IMPULSE VOLTAGE TESTS. THEY APPLY UNDER CONDITIONS OF MAXIMUM SWING AND SAG.

SURGE ARRESTER CLEARANCES (mm)	275kV	33kV
D1 - ARRESTER TO LIVE METAL OF SAME PHASE	2100	500
D2 - ARRESTER TO EARTH	2100	500
D3 - ARRESTER TO ARRESTER, BETWEEN PHASES	2400	500
SAFETY CLEARANCES (mm)	275kV	33kV
SD - SAFETY DISTANCE (E+300mm)	2400	800
MINIMUM INSULATION HEIGHT	2700	2700

*INCLUDES ADDITIONAL 300mm TO COMPLY WITH SCOTTISH POWER SAFETY RULES PART A2.3

S - SECTION CLEARANCE (SD+2400mm)	4800	3200

A DISTANCE OF 300mm SHALL ALSO BE MAINTAINED, AT ALL SYSTEM VOLTAGES, FROM THE PORTION OF INSULATORS SUPPORTING LIVE HIGH VOLTAGE CONDUCTORS WHICH IS OUTSIDE THE APPROPIATE SAFETY DISTANCE FROM THE CONDUCTORS

CURRENT RATING 3150A, FAULT RATING FOR 3PH/1PH IS 31.5/40KA FOR 1 SEC.

REFERENCE DRAWINGS:

SP4124910 SPEN FEASIBILITY DRAWING PROPOSED ELECTRICAL LAYOUT

DRAFT FOR COMMENTS

Rev.	Date	Drawn	Reviewed	Approved	Reason / Description of changes.
0C	12/12/2018	JM	SD		UPDATED PROPOSED & EXISTING EQUIPMENT
0B	03/12/2018	EM	SD		UPDATED PROPOSED & EXISTING EQUIPMENT
0A	06/03/2015	PR	SRS		ISSUED FOR INTERNAL COMMENTS/APPROVALS ONLY

SP ENERGY NETWORKS

Status Stamp:

Project: GIFFNOCK TRANSFORMER REPLACEMENT

Location: GIFFNOCK

Drg. Title: PROPOSED ELECTRICAL LAYOUT

Drawn	Revd	Appd

Drg. No.: 1ATA-2-32JA-DA-IECES-0002 | Sheet: 1 | Rev: 0C

SPEN Ref. No. : #### | Scale: 1:200 | Size: A1