Galashiels 132kV switchgear replacement project - OFGEM justification paper	
Name of Scheme/Programme	Galashiels 132kV switchgear replacement project
Primary Investment Driver	Asset Health (Lead asset – Circuit Breaker)
Scheme reference/ mechanism or category	SPNLT 2039 (Circuit-Breaker replacement)
Output references/type	NLRT2SP2039 (132kV Circuit-breaker air insulated (OD) / 132kV Switchgear others)
Cost	Total forecast: £ 7.92 m **RIIO T2 spend: £ 0.22 m** RIIO T3 spend: £ 7.70 m
Delivery Year	2029
Reporting Table	C0.7 / C2.2a_AP / C2.2a_CI / C2.3 / C2.4b / C2.5 / C2.5a
Outputs included in RIIO T1 Business Plan	No

Issue Date	Issue no.	Amendment details
July 2020	1	First issue

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1 Introduction

Galashiels 132/33kV substation is an outdoor 5 bay mesh substation located on the Melrose Road in Galashiels. The substation is an important transmission and distribution asset for the supply in borders area and has got the following 132kV bays:

1. Eccles 1
2. Eccles 2
3. Hawick
4. Dunlaw extension
5. GT1
6. GT2

Galashiels 132kV s/s feeds into Galashiels 33kV outdoor s/s located within the same perimeter through GT1 and GT2.

GT1 and GT2 transformer along with respective NER / EAT were recently replaced in RIIO T1 period.

The principal driver for the proposal is the condition of the 5 off OW410 bulk oil Circuit Breaker which all have EoL modifier scores of 9.67 or higher at end of RIIO-T2 period (without any intervention) with critical operational and maintenance issues, and so has been identified for replacement in the RIIO-T3 period. The circuit-breakers are located in an existing 5 corner 132kV mesh arrangement.

The condition of the non-lead assets – disconnectors/earthing switches, busbars, instrument transformers, insulators and structures – have also been assessed and in all cases, intervention is required.

In line with above, the proposed 132kV outputs to be delivered in this project for the selected option are:

- 132kV Circuit Breaker disposal: 5 units
- 132kV Circuit Breaker addition: 5 units (Considering selected AIS option)

The delivery of the project is staged over 2 outage seasons with 3 circuit-breakers (along with respective non-lead assets) being replaced in the first year followed by 2 circuit-breakers / respective non-lead asset in next year.

A full CBA and refresh of the proposed options will be carried out in the preparation of the RIIO-T3 business plan. This paper demonstrates that the feasible options have been considered and that the funding required in RIIO-T2 to enable timely and efficient delivery of the outputs in RIIO-T3 is similar for both options. It is considered that these costs will contribute to the RIIO-T2/T3 fixed pot bridging fund as indicated in the draft determination.

2 Background Information

This paper supports a proposal to replace the existing 5 off OW410 bulk oil circuit-breakers and associated non-lead assets at Galashiels 132kV substation. Based on the values determined in accordance with the NOMS methodology, the circuit-breakers all have an EoL modifier score of 9.67 or higher (at end of RIIO-T2 period without any intervention), have significant operational and maintenance issues and are identified for replacement during the RIIO-T2 period.

The options for retaining and refurbishing the circuit-breakers has been assessed and determined not to be technically or economically viable, as detailed in report SWG-05-090.

Please find below details of the circuit-breakers identified for replacement.

SPEN corporate asset ID	Asset Description	Manufacturer	Model	Year of manufacture	EoL	Risk £
14229137	GALA132OCB320	AEI/BTH	OW410 TRANS	1958	9.89	£ 72,339.26
14229171	GALA132OCB420	AEI/BTH	OW410 TRANS	1958	9.89	£ 72,339.26
14229663	GALA132OCB220	AEI/BTH	OW410 TRANS	1952	9.70	£ 68,790.20
14229737	GALA132OCB120	AEI/BTH	OW410 TRANS	1967	10.26	£ 48,976.58
14229787	GALA132OCB620	AEI/BTH	OW410 TRANS	1951	9.67	£ 68,199.12

Figure 1: Galashiels 132kV substation

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.

The assessment for voltage transformers has shown critical maintenance issues requiring the units to be replaced within the RIIO-T3 period.

Condition assessment of the associated 132kV disconnectors have shown that the mechanical components are at a level of deterioration where intervention will be required and the electrical components will be at the end of their serviceable life. A significant level of corrosion has also been observed on the operating mechanism and operating rods.

The recommendation for 132kV disconnectors is that it would be possible to refurbish them and make them operational for the expected design life of refurbished bays (40 years). However for refurbishing and reusing existing disconnectors, 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 the associated RCP Disconnectors on these 4 bays (584, 484, 314, 214, 313A & 213A) along with other busbar disconnectors (124, 128, 614, 754 & 714) installed in the same period have been considered for replacement within all the options considered

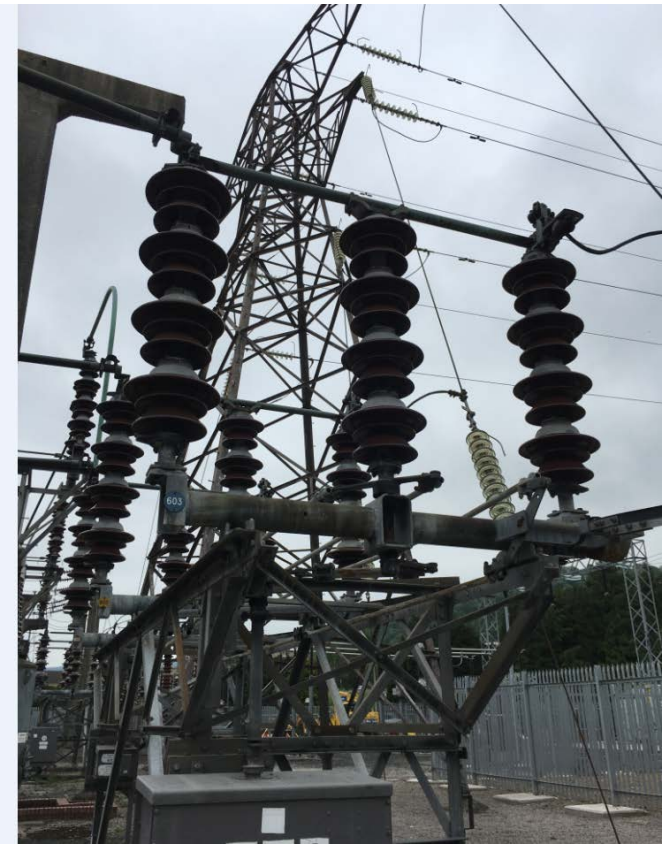


Figure 2: 132kV RCP Disconnector at Galashiels 132kV substation

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

Similar to the assessment of primary plant, a visual inspection has been carried out on the existing civil assets, including existing concrete structures and foundations, to determine the condition of these assets. To complement this data, and to determine the remaining life and costs associated with any immediate and future remedial works, SP Transmission commissioned a specialist concrete contractor to carry out concrete testing and analysis on a representative sample of these assets (a 132kV concrete gantry and a 132kV disconnector structure). The results of these tests show that it would be possible to reuse the existing civil assets subject to a defined level of refurbishment carried out during the project cycle. These refurbishment works would extend the service life of these assets by 15 years after which another round of refurbishment would be necessary.

The costs of refurbishing these civil assets for their extended design life (40 years to match the expected life of the electrical assets) and the cost of replacing with new steel structures has been included within the options considered.

The condition of the existing high level busbar conductor (Holtom) has deteriorated requiring intervention in the RIIO-T2 period.

The existing 132kV 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.

The LVAC board along with Battery chargers have recently been replaced as part of the GT1 / GT2 transformer replacement project in RIIO T1 period. Considering the condition of existing batteries / DC distribution board, and respective building service boards these have been considered for replacement in this project.

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 for review if required.

	Option	**Status**	**Reason for rejection**
1	Option 1: In situ replacement of 5 of OW410 CB and respective disconnectors with similar AIS switchgear in a mesh arrangement reusing existing civil assets (OW410CB foundations)	Proposed	-
2	Option 2: 7 bay double busbar offline GIS replacement	Proposed	-
3	Offline 132kV AIS replacement	Rejected	No space available for offline AIS build

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:

- Option 1: Insitu AIS replacement
- Option 2: Offline GIS replacement

4 Detailed analysis

All the 5 options considered achieve the main objective of replacing OW410 circuit-breakers while refurbishing or replacing non-lead assets and thereby reducing the overall risks to the network.

The options have been analysed in terms of construction deliverability, outage requirements and thereby impact on network, safety and costs.

As the scope of works is almost identical, the detailed description included below has been based on this fundamental difference around the reuse of civil assets. Use of different technology switchgear is considered within the description for each alternative.

4.1 Option 1: Insitu replacement with reuse of existing civil assets

This option considers online insitu AIS replacement of the circuit-breakers.

Based on the site condition assessment carried out on the non-lead assets, the possibility of reusing exiting civil assets has been identified and reviewed in detail in this option.

The following civil assets related to the 5 off OW410 CB bays are proposed to be refurbished and reused within this option:

- 5 off OW410 CB foundations
- 132kV control building
- Cable trenches

Except replacing the busbar connections no works have been considered on the Dunlaw extension, GT1 and GT2 circuits.

For reuse of the circuit breaker foundation, it has been considered that any remedial works carried out on this foundation would extend their service life for 40 years and that no further remedial /refurbishment works would be required on these. Note the cost considered is an indicative estimate of likely costs based on previous similar projects. If the concrete test results proposed to be carried in advance of any works indicate that the actual level of refurbishment required is more than anticipated than the costing for this option would be revised accordingly.

The works have been split over a 2 year construction period

4.1.1 Year 1 works:

- Outage on GT1 / Hawick / Eccles 1 and Dunlaw extension bays for the outage period.
- During this period Eccles 2 would be feeding GT2 and thereby the distribution network in the borders area. This will be the arrangement for the complete outage season.
- Demolish existing gantries / foundations / busbars – PI. Circuit Breaker to be removed.
- Existing oil and air piping ring for OW410 to be maintained with suitable care during demolition period
- Existing battery system to be replaced during the first outage
- Building service boards to be replaced.
- Install new Circuit Breakers. Kindly note that as part of the substation reconfiguration CB 220 would be removed, and instead a new CB has been considered in the spare area between CB 320 and 420. This helps reconfiguring the mesh such that GT1 and GT2 are now on the same mesh corner with CB 520 located between them. This has been discussed and agreed with system design.

- Minor refurbishment works considered in control building. No changes to cable trenches except new trench covers where it is damaged.
- Hawick circuit configuration is also updated now with addition of a new earth switch, instrument transformer and Surge arresters. Note the existing gantry in Hawick circuit is proposed to be reused for this configuration. Existing road near Hawick terminal tower within substation compound to be diverted for making space for the new switchgear.
- Install new plant items.
- Commission and energise complete mesh corner.

4.1.2 Year 2 works

- Outage on GT2 and Eccles 2 circuit.
- Break the mesh / demolish and remaining existing redundant plant items.
- Install new circuit breakers 520 & 620 reusing the gantry foundation
- Commission and energise the complete mesh corner.

SP Transmission has developed a detailed layout showing the proposed arrangement which can be submitted for review if required.

4.1.3 Factors resulting in incremental costs / construction timescales

- Reuse of existing civil assets is an unknown risks that can affect the construction timescales / costs.
- Galashiels substation has been identified as being at risk of surface water flooding from SEPA flood maps.

4.2 Option 2: Offline 132kV GIS build

This option considers offline build of a 7 bay double busbar 132kV GIS located in the Distribution storage area located North West of the existing substation. As this land is owned by the company, in the event of this proposal being considered the most feasible, the distribution storage compound would be relocated to an area next to existing distribution building.

Please find below the bays considered for this proposal:

1. Eccles 1
2. Eccles 2
3. Hawick
4. GT1
5. GT2
6. Dunlaw extension
7. Bus coupler

Note considering the limited no. of circuits, no bus section Circuit Breaker or disconnectors have been considered for this option.

Please find below the yearly works for this option:

4.2.1 Year 1 works

- Enabling works – relocate the distribution compound moving the material to new location
- Start building up the GIS building offline. Conventional single storey 132kV GIS building (similar to Currie, Windyhill etc.) with 132kV cable connections considered.

- Install 132kV cable ducts where possible.
- Outage on Hawick, Dunlaw extension, GT1 and Eccles 1. Start demolishing bays / removing Circuit breakers other plant items.
- Install new 132kV plant items / sealing end. Lay and commission 132kV cable.
- Commission and energise the new GIS building.

4.2.2 Year 2 works

- Outage on GT2 and Eccles 2 circuits
- Demolish and remove existing Circuit Breakers along with plant items
- Install new 132kV plant items / sealing end. Lay and commission 132kV cable.
- Commission and energise the new GIS circuits.

4.2.3 Factors resulting in incremental costs / construction timescales

- Substation located within floodplain
- Existing slope in the area proposed for building the new 132kV GIS
- Due to previous flooding history, risk of high water table thereby requiting piling.

4.3 Sustainability:

Both the options include removal of oil filled GT1 132kV cables from the network thereby reducing the associated environmental risks with these assets.

Use of SF6 free 132kV live tank AIS switchgear, and use of SF6 free insulating gas for option 2 GIS has also been considered for the project.

4.4 Innovation:

The following innovation schemes were considered for this option:

Serial no.	Description	Associated project (s)	Conclusion
1.2.4.2	Reuse of existing concrete assets	NIA_SPT_1606	Considered for further review
-	132kV Disconnecting Circuit Breaker (DCB)	-	Considered for further review

4.4.1 Reuse of existing concrete assets

As described earlier within this option reuse of existing OW410CB foundations have been considered. Note this is subject to results of concrete testing and further analysis in regards to the expected loading on the civil structures with the new arrangement within the substation.

4.4.2 Disconnecting Circuit Breaker (DCB)

Use of Disconnecting Circuit Breaker has been reviewed for this specific project and considering the additional cost of separate current transformers / additional operational maintenance cost has been deemed to be not viable commercially.

4.5 Selected option

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

	Option 1: Insitu AIS rebuild	Option 2: Offline 132kV GIS build
Cost	Total forecast: £ 7.92 m **RIIO T2 spend: £ 0.22 m**	Total forecast: £ 11.94 m **RIIO T2 spend: £ 0.22 m**
Construction timescales	2 years	2 years

Based on technical / commercial review carried out, option 1: Insitu AIS rebuild is the proposed 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.

5 Conclusion

Replacement of the OW410 units is part of an ongoing strategy aimed at replacing end of life bulk oil circuit breakers on the network and reducing the risks associated. Considering the existing OW410 bulk oil units on the SP Transmission network this would be a staged replacement over different price control periods.

The 2 options proposed have been reviewed in terms of scope, costs, timescales, construction risk, and innovation / sustainability requirements and have been found to be deliverable. All the options achieve the main objective of reducing the network risks due to OW410 bulk Oil Circuit Breakers and so are acceptable.

Based on the detailed technical review completed on all the options, and the associated costs, **Option 1:** 'In situ AIS replacement with 132kV live tank SF6 free Circuit Breaker and reuse of existing concrete assets' is the preferred option.

This is also in line with SP Transmission's commitment for the RIIO-T2 submission regarding use of sustainable SF6 free alternatives where technically feasible, and in line with the company's innovation policy.

- Forecast costs: £ 7.92m (Total)
- **Forecast RIIO T2 cost: £ 0.22m**
- Output delivery year: 2029
- Declared outputs: Addition – 5 units / Disposal – 5 units

From the scope of work presented, all cost items in the Transmission Glossary definition of 132kV Circuit-breaker air insulated (OD) are incurred in this project. Therefore this should be taken account in post-benchmarking engineering reviews.

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

A full CBA that would indicate the NPV results for all assessment periods will be carried out in the preparation of the RIIO-T3 business plan. 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 will be applied to CBA proposed to be carried out for RIIO T3. The CBA outcome will be influenced by losses and will be sensitive to carbon prices.

6.6 Future Asset Utilisation

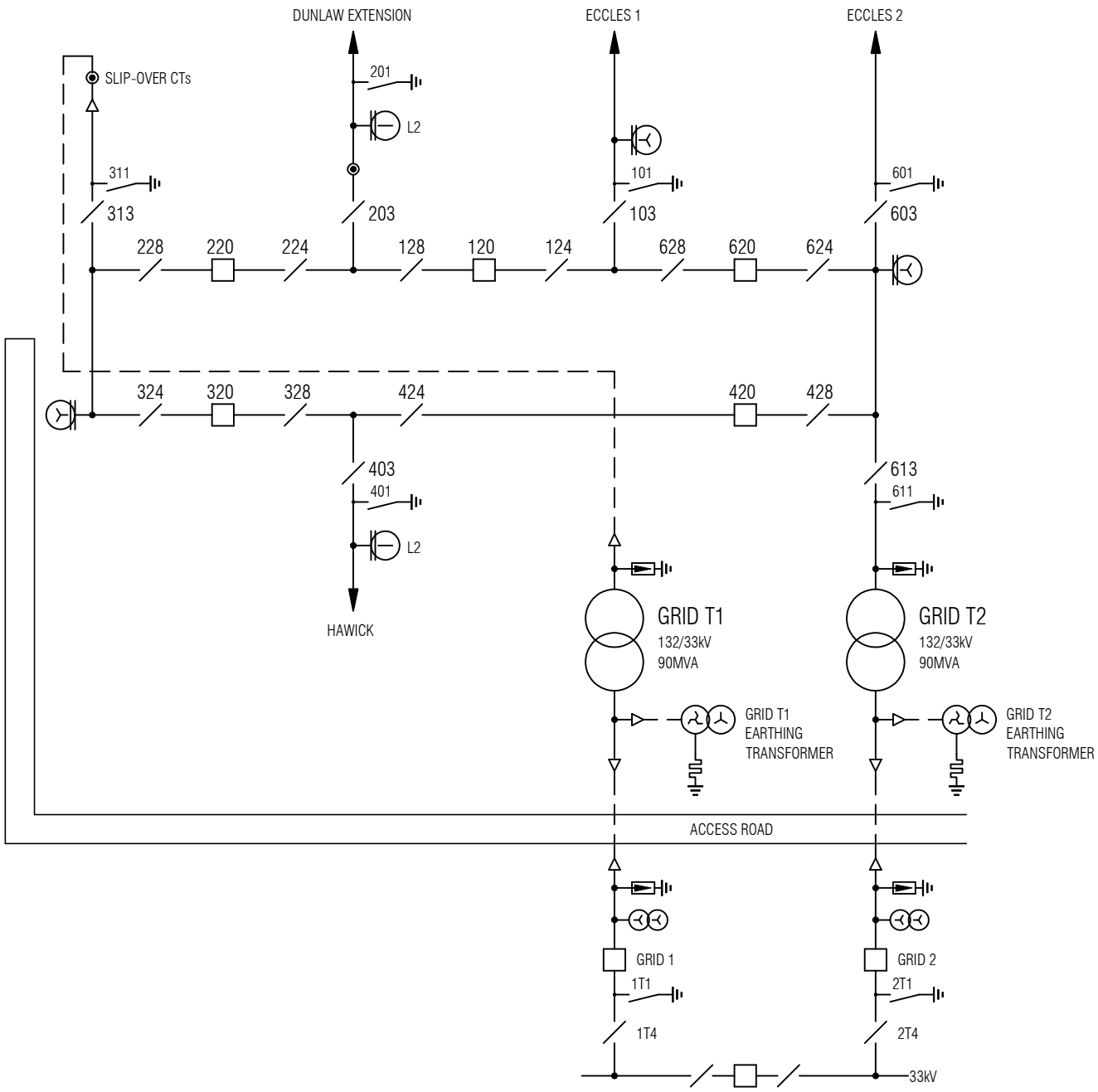
It has been assessed that the preferred option is consistent with the future generation and demand scenarios and that the risk of stranding is very low.

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

N/A



Rev.	Date	Drawn	Reviewed	Approved	Reason / Description of changes.
9	02/11/2018	PMR	GS	JB	GRID T1 REPLACED. CHANGED FROM 45MVA TO 90MVA. FAULT THROWER REMOVED.

SP ENERGY NETWORKS

Drawing State: Approved

Project:

Location: GALASHIELS

Voltage: 132KV

Approval Status: For Issue

Drg. Title: SWITCHGEAR NUMBERING FOR GALASHIELS 132KV SUBSTATION GSN64(A)

Drawn	Rev'd	App'd
PMR	GS	JB

Drg. No.: SP2143831

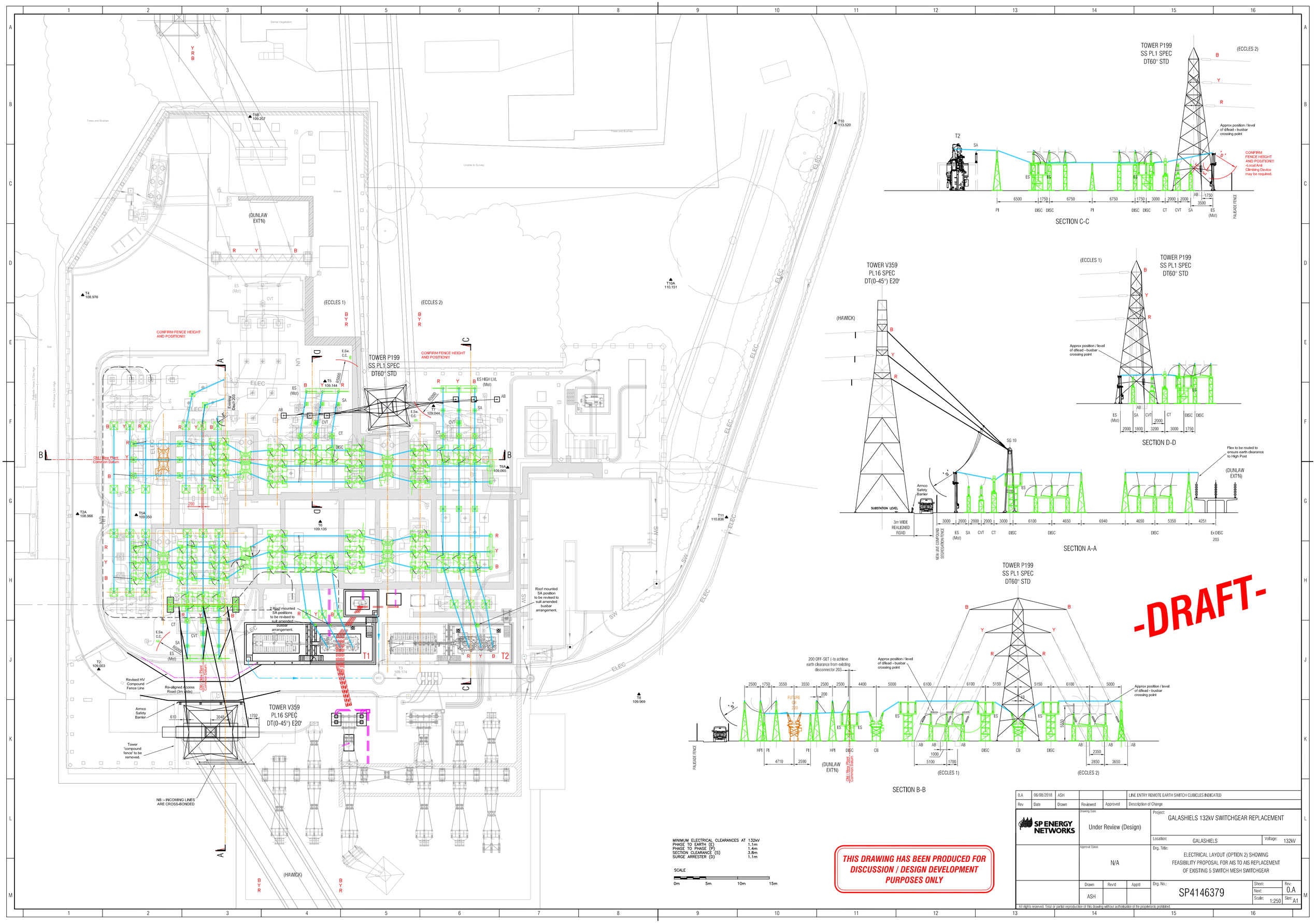
Sheet:

Next:

Rev: 9

Scale:

Size: A4



MINIMUM ELECTRICAL CLEARANCES AT 132kV

PHASE TO EARTH (E)	1.1m
PHASE TO PHASE (P)	1.4m
SECTION CLEARANCE (S)	3.8m
SURGE ARRESTER (D)	1.1m

SCALE

0m 5m 10m 15m

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

-DRAFT-

Rev	Date	Drawn	Reviewed	Approved	Description of Change
0.A	06/08/2018	ASH			LINE ENTRY REMOTE EARTH SWITCH CUBICLES INDICATED

SP ENERGY NETWORKS

Drawing Stare: Under Review (Design)

Approval Status: N/A

Project: GALASHIELS 132kV SWITCHGEAR REPLACEMENT

Location: GALASHIELS Voltage: 132kV

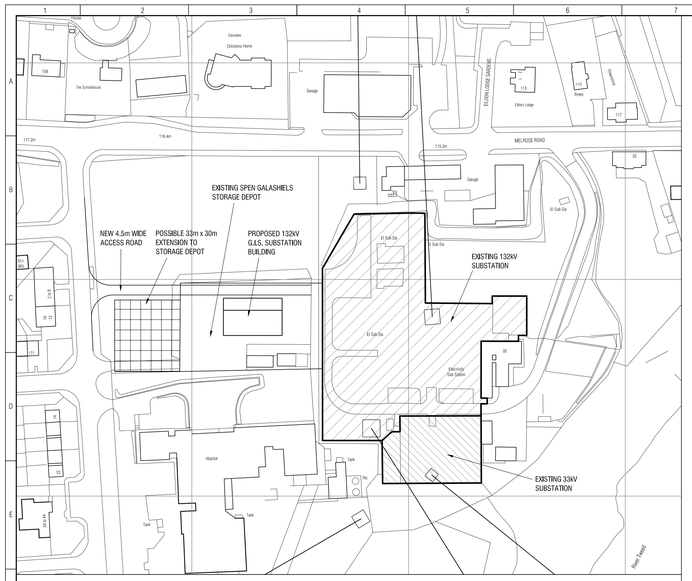
Drg. Title: ELECTRICAL LAYOUT (OPTION 2) SHOWING FEASIBILITY PROPOSAL FOR AIS TO AIS REPLACEMENT OF EXISTING 5 SWITCH MESH SWITCHGEAR

Drawn	Revd	Apprd
ASH		

Drg. No.: SP4146379

Sheet: Next: Rev: 0.A

Scale: 1:250 Size: A1



KEY PLAN ON SUBSTATION

SCALE 1:1000

NEW 3.0m HIGH UNCLIMBABLE FENCE

4.5m WIDE ACCESS ROAD

NEW 132kV G.I.S. SUBSTATION BUILDING

TELECOMMS ROOM

132 kV RELAY / BATTERY / UPAC ROOM

NEW 132kV CABLES

NEW 132kV CABLES

NEW 132kV CABLES

NEW 132kV CABLES

PARKING

NEW 3.0m HIGH UNCLIMBABLE FENCE

PERSONNEL GATE

NEW 132kV CABLES (2 CABLES / PHASE)

INSUL. FENCE PANEL

INSUL. FENCE PANEL

FENCE HEIGHT GAUGE

INSUL. FENCE PANEL

POSSIBLE EXTENSION TO EXISTING STORAGE DEPOT TO COMPENSATE FOR LOSS OF LARGHAN AREA

EXISTING ACCESS TO DEPOT

EXISTING GATES

EXISTING SPEN GALASHIELS STORAGE DEPOT

EXISTING METAL-CLAD BUILDING

EXISTING BRICK BUILDING

EXISTING UNCLIMBABLE FENCE

EXISTING UNCLIMBABLE FENCE

EXISTING UNCLIMBABLE FENCE

DUNLAW EXT'N

TOP -Y
MID - R
BTM - B

R Y B

4800

Mot. E.Sw. (Existing)

3000

C.V.T. (Existing)

3000

C.T.s (Existing)

2500

S.A.s

3000

S.E.s

ECCLES 1

TOP -B
MID - Y
BTM - R

ECCLES 2

TOP -B
MID - Y
BTM - R

TOWER P199
SS PL1 SPEC
DT60° STD

NEW 132kV CABLES

12500

12500

E.Sw. C.C.

E.Sw. C.C.

BUSBAR

1500

2000

E.Sw. (Mot)

S.A.s

3000

S.E.s

C.V.T.s

S.A.s

1700

2500

3000

S.E.s

EXISTING 132kV COMPOUND

NEW 132kV CABLES

NEW 132kV CABLES

NEW 132kV CABLES

NEW 132kV CABLES

EXISTING 132kV CONTROL BUILDING

E.Sw. C.C.

S.E.s

3000

E.Sw. (Mot)

S.A.s

2500

GANTRY

S.E.s

Roof mounted SA positions to be revised to suit amended busbar arrangement.

HYBRID S.E./DISC./E.Sw.

Roof mounted SA position to be revised to suit amended busbar arrangement.

T1

T2

5500

2000

2000

109.174

TOWER V359
PL16 SPEC
DT(0-45°) E20'

EXISTING 33kV COMPOUND

EXISTING 33kV CONTROL BUILDING

NB :- INCOMING LINES ARE CROSS-BONDED

TOP -B
MID - Y
BTM - R

HAWICK

TOP -B
MID - Y
BTM - R

(HAWICK)

B
Y
R

B
Y
R

ELECTRICAL CLEARANCES per ENA TS 2.1

MINIMUM ELECTRICAL CLEARANCES @ 132kV	
PHASE TO EARTH (E)	1.1m
PHASE TO PHASE (P)	1.4m
SECTION CLEARANCE (S)	3.8m
SURGE ARRESTER (D)	1.1m

NOTES:

1. ALL EXISTING CABLE ROUTES SHOWN ARE TAKEN FROM EXISTING RECORDS BUT ACCURACY CANNOT BE GUARANTEED.
2. CARE TO BE EXERCISED DURING ANY EXCAVATION AS ALL UNDERGROUND SERVICES MAY NOT BE SHOWN.
3. THE ACTUAL LOCATION AND DEPTH TO ALL EXISTING CABLES MUST BE CONFIRMED PRIOR TO COMMENCEMENT OF ANY EXCAVATION WORKS.
4. ROUTES OF PROPOSED 132kV CABLES ARE INDICATIVE ONLY.

ASSOCIATED DRAWINGS

SP4067532	EXISTING ELECTRICAL LAYOUT OF 132kV SUBSTATION, GALASHIELS
SP4145340	PROPOSED ELECTRICAL LAYOUT OF 132kV SUBSTATION, GALASHIELS
SP4145379	PROPOSED ELECTRICAL LAYOUT OF 132kV SUBSTATION, GALASHIELS - OPTION 2

SCALE @ 1:200

0m 5m 10m 15m 20m

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

Rev	Date	Drawn	Reviewed	Approved	Description of Change
0.B	27/09/2018	J.F.M.			T1 AND T2 CONNECTIONS NOW BY HYBRID S.E. / E.Sw UNITS.
0					

SP ENERGY NETWORKS

Drawing Stage: Under Review (Design)

Approval Status: N/A

Project: GALASHIELS 132kV SWITCHGEAR REPLACEMENT

Location: GALASHIELS

Voltage: 132kV

Drg. Title: PROPOSED ELECTRICAL LAYOUT OF GALASHIELS G.I.S. 132kV SUBSTATION FEASIBILITY STUDY FOR FINAL STAGE OF WORKS.

Drawn	Revd	Appd
J.F.M.		

Drg. No.: SP4102173

Sheet: Rev: 0.B

Scale: 1:250 Size: A0