Peterhead Substation Works

Engineering Justification Paper

1 Executive Summary

Our paper A Risk Based Approach to Asset Management[1] sets out our approach to network risk and how we subsequently identify assets that require intervention to limit the rise of the risk over the RIIO-T2 period.

This paper identifies the need for intervention on the 275/132kV Super Grid Transformers (SGTs) at Peterhead Substation. The primary driver for the scheme is the asset condition with a secondary driver of network resilience.

Following a process of optioneering and detailed analysis, the proposed scope of works is:

- Create new compound 100m west of the existing Peterhead Substation and install two new 275/132kV, 120/240MVA ONAN/OFAF Super Grid Transformers
- Construct two new buildings to house each the new SGT
- Install 0.45km 132kV and 0.4km of 275kV cables to connect to the transformers to the existing feeder bay.
- Install two new 275kV Circuit Breakers on the new SGT HV terminals
- Disconnect, remove and dispose existing SGTs and associated oil filled cables.

This scheme delivers the following outputs and benefits:

- An immediate reduction of total network risk calculated as R£4.931m
- Improved operational resilience in line with our goal of 100% network reliability
- Replacing assets which are deteriorating on critical infrastructure

This scheme delivers an immediate risk reduction of R£4.931m at a cost of £36.7m and the works are planned to be completed within the RIIO T2 period. The Long Term Monetised Risk benefit is calculated as R£40.706m.

The Peterhead scheme is not flagged as eligible for early or late competition due it being under Ofgem's £50m and £100m thresholds respectively.

[1] A Risk Based Approach to Asset Management

Name of Scheme/Programme	Peterhead 275/132kV Substation
Primary Investment Driver	Asset Health (Non-Load)
Scheme reference/ mechanism or category	SHNLT2020
Output references/type	NLRT2SH2020
Cost	£36.7m
Delivery Year	RIIO T2
Reporting Table	C0.7 Non-Load Master Data
Outputs included in RIIO T1 Business Plan	No

2 Introduction

This Engineering Justification Paper sets out our plans to undertake condition-related work during the RIIO-T2 period (April 2021 to March 2026). The planned work is at Peterhead substation as shown on the map on the next page.

The Engineering Justification Paper is structured as follows:

Section 3: Need

This section provides an explanation of the need for the planned works. It provides evidence of the primary and, where applicable, secondary drivers for undertaking the planned works. Where appropriate it provides background information and/or process outputs that generate or support the need.

Section 4: Optioneering

This section presents all the options considered to address the need that is described in Section 3. Each option considered here is either discounted at this Optioneering stage with supporting reasoning provided or is taken forward for Detailed Analysis in Section 5.

Section 5: Detailed Analysis

This section considers in more detail each of the options taken forward from the Optioneering section. Where appropriate the results of Cost Benefit Analysis are discussed and together with supporting objective and engineering judgement contribute toward the identification of a selected option. The section continues by setting out the costs for the selected option.

Section 6: Conclusion

This section provides summary detail of the selected option. It sets out the scope and outputs, costs and timing of investment and where applicable other key supporting information.

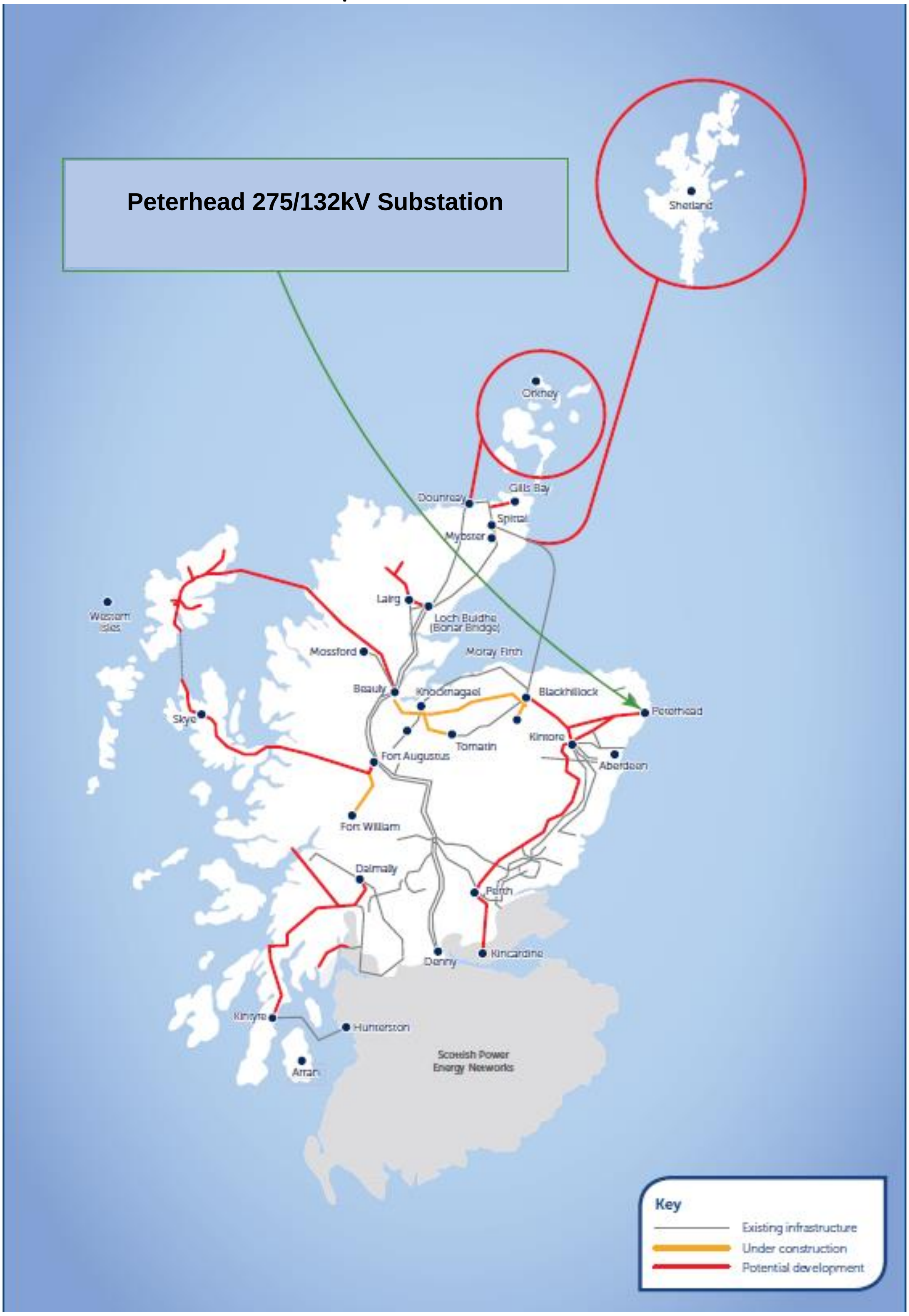
Section 7: Price Control Deliverables and Ring Fencing

This section provides a view of whether the proposed scheme should be ring-fenced or subject to other funding mechanisms.

Section 8: Outputs included in RIIO-T1 Business Plan

This section identifies if some or all the outputs were included in the RIIO-T1 Business Plan and provides explanation and justification as to why such outputs are planned to be undertaken in the RIIO-T2 period.

Figure 1: SHE Transmission Network Map and Location of Works



3 Need

This section provides an explanation of the need for the planned works. It provides evidence of the primary and, where applicable, secondary drivers for undertaking the planned works. Where appropriate it provides background information and/or process outputs that generate or support the need.

3.1 Background

The Peterhead Grid 275/132 kV substation is situated to the south of Peterhead, Aberdeenshire on the opposite side of the A90 to Peterhead Power Station. The AIS indoor substation was constructed in circa 1975, approximately 1-mile inland from the North-East coastline (See Aerial image in Appendix A). The substation was initially constructed with two 275/132kV SGTs. In 2010, a third SGT was installed at Peterhead Substation and a single 132kV circuit was constructed between Peterhead and St Fergus to accommodate the increase in demand at St Fergus and retain compliance with Chapter 3, Demand Connection Criteria of the National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS).

The Single Line Diagrams (SLD) in Appendices B and C show how the Peterhead 132/275kV substation is electrically connected in the context of the wider east coast transmission system and the connectivity of the busbars and associated transmission circuits.

The Peterhead 275kV double busbar and mesh corner arrangement connects the Peterhead Power Station (Transmission Entry Capacity of 1180MW) via five 275kV cables. Also connected to the 275kV busbar are two 275kV double circuit overhead lines; one between Peterhead and Kintore with one side teeing off to Persley and the second between Peterhead and a new substation being constructed at New Deer for January 2021 to accommodate the 900MW, Moray East Offshore windfarm.

Peterhead 132kV is a double busbar arrangement (a main busbar plus two reserves) including two bus couplers. All 132kV feeder connections are busbar selectable. The Peterhead 132kV busbar connects to the Peterhead 275kV busbar network via three 275/132kV, 120/240MVA (ONAN/OFAF) Super Grid Transformers (SGT1, SGT2 & SGT3). Both SGT1 and SGT2 are currently teed onto the Kintore and Persley OHLs via short oil-filled cables and therefore do not have dedicated feeder bays at 275 kV. Between the cable sealing ends and SGT terminals are a set of disconnectors and earth switches connected by aluminium busbars. This configuration means that in both cases a transformer fault will initiate a persistent trip on the circuit, and with no auto-isolation scheme present this will not DAR back in.

Due to the location of SGT1 and SGT2 within the site, the 132 kV connections are slightly different. SGT1 is busbar connected onto through-wall bushings into the main 132 kV substation building while SGT2 is connected via 132kV cables.

All three transformers are ground mounted indoor units with freestanding radiators that are situated outdoors. SGT1 and SGT3 are housed within individual rooms that form part of the main substation building while SGT2 is housed in a separate standalone building.

Peterhead Shell GSP is a self-contained AIS outdoor site located in the north west corner of the Peterhead substation and directly connects to the Peterhead 132kV busbar via a single 132/11kV, 15MVA Grid Transformer.

Three 132kV circuits connect onto the Peterhead 132kV busbar, these comprise of: the double circuit overhead line between Peterhead-Inverugie Tee-Peterhead Grange and St Fergus (constructed in 1977) and a single circuit between Peterhead and St Fergus (constructed in 2010). These circuits connect the north east Grid Supply Points (GSPs) namely; St Fergus Gas, St Fergus Mobil, Strichen and Fraserburgh back to the Main Integrated Transmission System (MITS) at the Peterhead.

In addition to supplying these distribution networks which supply customers involved in UK gas production, there is also directly transmission connected demand at St Fergus VSD compressor station. A number of the aforementioned sites are classed as critical national infrastructure (CNI) as between them, they supply a large percentage of UK gas supplies. CNI is defined in the UK National Risk Register of Civil Emergencies as, “the buildings and other systems and networks needed to keep the UK running and provide the essential services that we rely on”. The main gas feed for Peterhead Power Station is also directly fed from St Fergus Gas GSP, therefore Peterhead Power Station would also be out of service for loss of supply to this GSP. Peterhead Power Station is key to the GB blackstart strategy.

Construction works within Peterhead Substation are made significantly challenging due to the historic development and extension of the site, the limited space available on the existing substation footprint and the substation equipment being housed in buildings.

3.2 Asset Need

The network asset risk methodology is detailed in the Asset Management Strategy Paper A Risk-Based approach to Asset Management[1]. In this case and in line with the recommendations in the Asset Condition Report**Error! Bookmark not defined.**, Non-Load related intervention is required during the RIIO T2 price control period on the Peterhead 275/132kV SGTs.

The Asset Condition Report[2] for Peterhead SGT1 & SGT2 documents the results of: the maintenance records, visual inspection, transformer oil analysis, partial discharge survey, infra-red thermovision survey and historic records. These results are used to inform recommendations for asset intervention.

Both SGT1 and SGT2 are 275/132kV, 120/240 MVA (ONAN/OFAF) transformers manufactured by GEC and Parsons Peebles in 1974 and 1976 respectively making them 50 and 52 years old respectively at the end of the RIIO T2 period. Attached to the units are freestanding panel type radiators and tapchangers.

[2] Peterhead Asset Condition Report (SGT1 SGT2)

The associated cooler banks are located outdoors within cement/concrete block bunds. Both radiators are formed of two banks ('Cooler Bank A' and 'Cooler Bank B') and share a similar design but are not identical. The associated earthing transformers and NERs are also situated within the bunds.

There are concerns regarding the condition of SGT1 and SGT2. An external visual inspection and oil analysis review for SGT1 and SGT2 has reported the following key findings;

- Oil analysis shows that SGT1 has elevated furan content which is consistent with moderate paper insulation ageing.

- Fault gas concentrations (including acetylene) have been slowly increasing in the blue phase selector tank of SGT2 – a low energy discharge (D1) fault is suspected.

- Exposure to harsh coastal environmental conditions has led to severe corrosion of SGT1 and SGT2 cooler bank frames, radiator panels, pipework and fans.

- Maintenance personnel have recent experience of oil leaks and stopgap measures have been taken to keep the units in service, this has included the removal of radiator panel sections from SGT2 following an oil leak.

- Cooling fins/radiators are rated as a having serious deterioration or damage. Seven 'faults' associated with SGT1 and SGT2 cooling fins/radiator, fans and bunds have been logged. The need for immediate action is noted in the corresponding 'fault' descriptions. In addition, due to defects with the bunds, concerns are raised about their ability to contain oil in the event of a leak.

- Condition assessment reports highlight rusting of the cooler banks over a long period of time.

- A second significant oil leak from the cooler bank of SGT2 occurred in October 2018 which led to the removal of further radiator panels and an instruction to de-rate SGT2 by 50% to 120 MVA.

From both the desktop assessment and site survey, it can be concluded:

- An immediate intervention is required to replace the cooler banks of SGT1. Without intervention, the condition of the cooler banks is expected to further deteriorate and ultimately lead to the temporary or permanent loss of these units.

- The medium to long-term life of SGT1 and SGT2 is limited due to evidence of incipient faults from oil analysis.

3.3 Growth Need

Peterhead 275/132kV substation was historically connected via two SGTs (SGT 1 & SGT2) until a third SGT (SGT3) was installed in 2010. Peterhead SGT3 and the 132kV circuit between Peterhead and St Fergus were installed to increase surety to the demand group in the north east in line with Demand Connection Criteria of the NETS SQSS.

The current contracted generation background (Total Connected & Contracted 101MW) for the north east 132kV network and Peterhead Shell is shown in Table 1 and the maximum 2018/19 group demand is 137MVA. The NETS SQSS Chapter 2, Generation Connections and Chapter 3 Demand Connection Criteria do not currently justify a project primary based on load. However, it is prudent to consider the prospective future load capacity requirements when undertaking condition-based intervention on the transmission system.

As there are three SGTs connecting the Peterhead 132kV Busbar to the Peterhead 275kV Busbar, it is prudent to plan for two circuits being out of service (a planned outage followed by a fault outage) to determine both the thermal import and export capacity requirements for the group in line with the NETS SQSS. Based on the current generation and demand backgrounds, it is recommended that three SGTs are retained and that a minimum rating of any replacement SGT be 120/240MVA (ONAN/OFAF). This allows for a level of generation and demand growth anticipated in this region which has been an area of customer interest for the connection of battery storage, wind and solar schemes.

Table 1: Connected & Contracted Generation

GSP	Transformers	Connected (MW)	Contracted (MW)	Total (MW)
Strichen	2x 90MVA, 132/33kV	44.76	3.20	47.96
Fraserburgh	2x 45MVA, 132/33kV	3.60	0.00	3.60
St Fergus Gas	2x 40MVA, 132/33kV	19.00	0.33	19.33
Peterhead Grange	2x 45MVA, 132/33kV	30.98	0.00	30.98
Peterhead Shell	1x 15MVA, 132/33kV	0	0	0
Total		98.33	3.53	101.86

4 Optioneering

This section presents all the options considered to address the need that is described in Section 3. Each option considered here is either discounted at this Optioneering stage with supporting reasoning provided or is taken forward for Detailed Analysis in Section 5.

The option to do nothing would mean that no intervention is undertaken on the SGTs and associated plant. This option has been discounted at this stage as the network asset risk and asset condition assessment have concluded a need to intervene and upgrade/replace assets.

The option to refurbish SGT1 and SGT2 is impractical due to the location and substation layout. SGT1 is in a transformer room within the main substation building and has restricted operational access. A major refurbishment overhaul of the main unit will require partial dismantling of the building fabric to fully access SGT1. Transformer SGT2 is in a separate free-standing building with restricted operational access. A major refurbishment overhaul of the SGT2 will require an external crane to be positioned external to the building and due to the proximity of adjacent terminal towers will require extended double circuit proximity outages to facilitate refurbishment access. On this basis, transformer replacement options have been considered.

Photograph 1 – depicting SGT2 building situated between adjacent tower circuits

There are challenges associated with each option, including but not limited to the following:

- Transformers and associated AIS equipment housed in buildings to protect from salt-laden environment

Both SGT1 and SGT2 are currently teed onto the Kintore and Persley OHLs via short oil-filled cables and therefore do not have dedicated feeder bays at 275 kV. This configuration means that an SGT1 or SGT2 transformer fault will initiate a persistent trip on the circuit, and with no auto-isolation scheme present, the healthy circuit will not automatically reclose to secure the network. It is recommended 275kV circuit breakers are included in the optioneering process to improve network security

- Building construction to allow for adequate ventilation
- Civil construction on made-up ground with presence of rock

- Proximity of 400 and 275kV cables associated with the proposed Peterhead 400kV substation
- Cable crossings associated with 275kV cables to proposed Peterhead 400kV substation

The Peterhead 275/132kV Substation options for asset intervention are shown in Table 2.

Table 2: Table of Options

Option	Option Detail	Cost (£m)	Taken forward to Detailed Analysis?
0	In situ replacement of SGT1 & SGT2	-	No
1	Part offline, part in situ build in south west of existing Substation	-	No
2	Part offline, part in situ build in north west of existing Substation	-	No
3a	Offline build new SGT compound west of existing Substation	£36.7m	Yes
3b	Offline build new SGT compound west of existing Substation, defer SGT2 replacement	-	No
4	Extension of new Peterhead North 400kV Substation	-	No

Common to all options is the requirement to coordinate the construction and outage programmes to interface with the proposed north east transmission upgrade projects planned during the RIIO T2 Period. This includes the non-load intervention works proposed on the 132kV double Circuit OHL between Peterhead and Inverugie Tee[3] and the North East 400kV Upgrade[4] which includes the construction of a new Peterhead 400kV busbar.

Also common to all options is the requirement to replace the existing oil filled 275kV cables between the SGTs HV terminal and the 275kV busbar and the installation of new 132kV and 275kV cables to connect the new SGTs to the 132kV and 275kV busbars.

New circuit breakers will also be installed on the 275kV terminals as shown in Appendix D. The 275kV circuit breakers improve the operability and resilience of the north east network. For a planned or

[3] Peterhead to Inverugie Tee 132kV Overhead Line Upgrade, RIIO T2 Engineering Justification Paper
[4] North East 400kV Upgrade RIIO T2 Engineering Justification Paper

unplanned outage of a 275/132kV SGT, the banked 275kV overhead line remains in service. This is also pertinent when the Peterhead 400kV Busbar is complete and the 400/275kV and 275/132kV SGTs are banked as also shown in Appendix D.

Option 0 - In situ replacement of each SGT

This option is to replace each SGT in situ with two new 275/132kV, 120/240 ONAN/OFAF SGTs. This has been discounted as these works would require an approximate 6-month outage for each transformer and the existing footprint does not allow current engineering standards to be met.

Not Progressed

Option 1 - Part offline, part in situ build in South West of existing Substation

This option involves constructing a new building to house a replacement SGT in the south west corner of the existing Peterhead Substation. The new SGT would replace SGT2 which will be decommissioned and removed from site. A new building and SGT would be constructed in the current location of SGT2 to replace the existing SGT1. This option enables the phased offline construction of both SGTs thus minimising the duration of construction outages to 4-8 weeks per SGT. This option also has the benefit of minimising the extent of the increase in substation footprint by utilising the existing SGT 2 location to locate one of the new SGTs.

This option involves land take outwith the current perimeter fence which will require planning permission, however this is not anticipated to be contentious. Major earthworks will be required due to a steep bank just outside the existing fence. Furthermore, this option would involve relocating fire suppression equipment.

Installing a replacement for SGT1 first was ruled out as this doesn't make the existing location of SGT2 available to construct the second new SGT bay offline and would result in a significant SGT outage to construct the new SGT2.

The current SGT2 building only provides the minimum direct electrical clearances required but does not provide adequate space and working access for operational maintenance. Mobile Working Elevated Platforms (MEWP's) are unable to be used within the existing SGT2 building. Constructing a replacement SGT within this existing building will not remove the operational maintenance constraints and still leave an unsafe working environment.

Demolishing and rebuilding a new SGT building in this existing location presents challenges to construction works adjacent to the overhead line circuit towers near the existing building. Extended duration proximity outages on adjacent circuits will be required to demolish and re-construct in this location with resultant reduction in network security

Due to the spatial and operational constraints, the use of the space vacated by the current SGT2 makes this option unviable and it has not been progressed to detailed analysis.

Not progressed

Option 2 - Part offline, part in situ build in North West of existing Substation

This option involves constructing a new building to house a replacement SGT in the north west corner of the existing Peterhead Substation. The new SGT would replace SGT2 which will be decommissioned and removed from site. A new building and SGT would be constructed in the current location of SGT2 to replace the existing SGT1. This option enables the phased offline construction of both SGTs thus minimising the duration of construction outages to 4-8 weeks per SGT. This option also has the benefit of minimising the extent of the increase in substation footprint by utilising the existing SGT 2 location to locate one of the new SGTs.

Similar issues to Option 1 are present in the form of land take, planning permission, fire suppression, sequencing and required civil works however, Option 2 has an increased number of cable crossings.

Installing a replacement for SGT1 first was ruled out as this doesn't make the existing location of SGT2 available to construct the second new SGT bay offline and would result in a significant SGT outage to construct the new SGT2.

The current SGT2 building only provides the minimum direct electrical clearances required but does not provide adequate space and working access for operational maintenance. Mobile Working Elevated Platforms (MEWP's) are unable to be used within the existing SGT2 building. Constructing a replacement SGT within this existing building will not remove the operational maintenance constraints and still leave an unsafe working environment.

Demolishing and rebuilding a new SGT building in this existing location presents challenges to construction works adjacent to the overhead line circuit towers near the existing building. Extended duration proximity outages on adjacent circuits will be required to demolish and re-construct in this location with resultant reduction in network security

Due to the aforementioned spatial and operational constraints, the use of the space vacated by the current SGT2 makes this option unviable and it has not been progressed to detailed analysis.

Not progressed

Option 3a - Offline build in a new compound West of existing Substation

This option consists of an extension of the compound to the west of the existing substation. This option will require a new planning application to be submitted for the proposed site and will require major civil works.

This proposal will install two new 275/132kV, 120/240MVA ONAN/OFAF Super Grid Transformers, construct two new buildings to house each the new SGT and install 0.45km 132kV and 0.4km of 275kV cables to connect to the transformers to the existing feeder bay. Works will also be required to disconnect, remove and dispose of existing SGTs and associated oil filled cables.

This option involves the offline construction of SGT1 and SGT2, minimising construction outages to 4-8 weeks per SGT.

This option fulfills the asset need by addressing the condition based issues identified with both SGT1 and SGT2, provides an engineering and operational working and access spatial solution to install the new assets, reduces the number of cable crossings and facilitates the coordination of interfacing projects in the North East.

Progressed to detail analysis

Option 3b - Offline build in a new compound West of existing Substation and deferred replacement of SGT2

Similar to Option 3a, however based on the recommendations in the Condition Assessment report, replacement of SGT2 could potentially be deferred to a later date (RIIO T3). Building offline at a new site removes the sequencing restrictions highlighted for options 1 and 2, providing the opportunity to consider deferral of SGT2 which has a less pressing need for replacement.

This proposal will install one new 275/132kV, 120/240MVA ONAN/OFAF Super Grid Transformer to replace SGT1, leaving SGT2 in service, construct one new individual building to house the new SGT and install 132kV and 275kV cables to connect to the transformer to the existing feeder bay. Works will also be required to disconnect, remove and dispose of existing SGT1 and associated Oil filled cables.

Whilst preparing the new site it is intended to complete civil works required for the second SGT and return at a later date (RIIO T3) to install the new SGT and disconnect, remove and dispose of SGT

Postponing the replacement of SGT2 to RIIO T3 has a number of disadvantages and inefficiencies.

- The replacement SGTs and installation will need to be procured separately requiring additional resource to prepare the tenders, evaluate submissions, review design etc.
- The SGT will be procured at a later date and likely have a different design. Additional design costs will be incurred for the layout and building designs as a result.
- The installation contractor will have to remobilise incurring additional cost.
- The ability to co-ordinate construction works with the replacement of SGT1, in particular the cable routes will make the construction of SGT2 more challenging resulting in a longer total programme.

Not Progressed

Option 4 - Extension of new Peterhead North 400kV Substation

This option extends the proposed new Peterhead 400kV substation compound and connects two new 400/132kV, 120/240MVA. ONAN/OFAF SGTs. Construct two new buildings to house each of the new SGTs and install 132kV cables to connect to the transformers to the existing 132kV feeder bays at Peterhead substation. Works will also be required to disconnect, remove and dispose existing SGTs and associated oil filled cables.

This option would parallel the 132kV network through the 400kV and 275kV networks which could result in circulating currents, poor load sharing across the 132kV circuits and increased fault levels on the 132kV network. Transmission System Planning do not recommend this network configuration and recommend that space provision for future bays on the 400kV busbar is better used for future large offshore windfarm connections, interconnectors and MITS reinforcements.

This would require either new or modified Planning Permission to be sought which would impact negatively on the current program for the new 400kV substation. This option would also involve extensive UGC works involving the crossing of major national infrastructure on the route.

Not Progressed

5 Detailed analysis

This section considers in more detail each of the options taken forward from the Optioneering section. Where appropriate the results of Cost Benefit Analysis are discussed and together with supporting objective and engineering judgement contribute toward the identification of a selected option. The section continues by setting out the costs for the selected option.

5.1 Cost Benefit Analysis

No CBA has been carried out for this scheme. Of the options considered, Option 3a is the only option that is progressed to detailed analysis since it accommodates the offline construction of two new SGTs, coordinates with the proposed North East 400kV Upgrade and space provision for the new assets and the presents the most efficient overall delivery.

5.2 Proposed Solution

The scope of the proposed solution is the offline build of a new transformer compound as follows:

- Create new compound 100m West of the existing Peterhead Substation and install two new 275/132kV, 120/240MVA ONAN/OFAF Super Grid Transformers
- Construct two new buildings to house each the new SGT
- Install 0.45km 132kV and 0.4km of 275kV cables to connect to the transformers to the existing feeder bay.
- Install two new 275kV Circuit Breakers on the new SGT terminals
- Disconnect, remove and dispose existing SGTs and associated oil filled cables.

This option presents efficiencies and benefits associated with completing a single construction project, cost saving on future re-mobilisation, reducing the impact on local landowners from construction activities and the coordination of interfacing projects.

5.3 Risk Benefit

A Risk Benefit Analysis has been carried out in order to compare “no intervention” against the selected “with intervention” option. Please note that while monetised risk is denoted as a financial figure, it is important to note that it is not “real” money and does not correspond to the cost that SHE Transmission would incur if an asset was to fail and these values are thus identified with R£ prefix (for more details please refer to A Network For Net Zero – A Risk Based Approach to Asset Management[5]).

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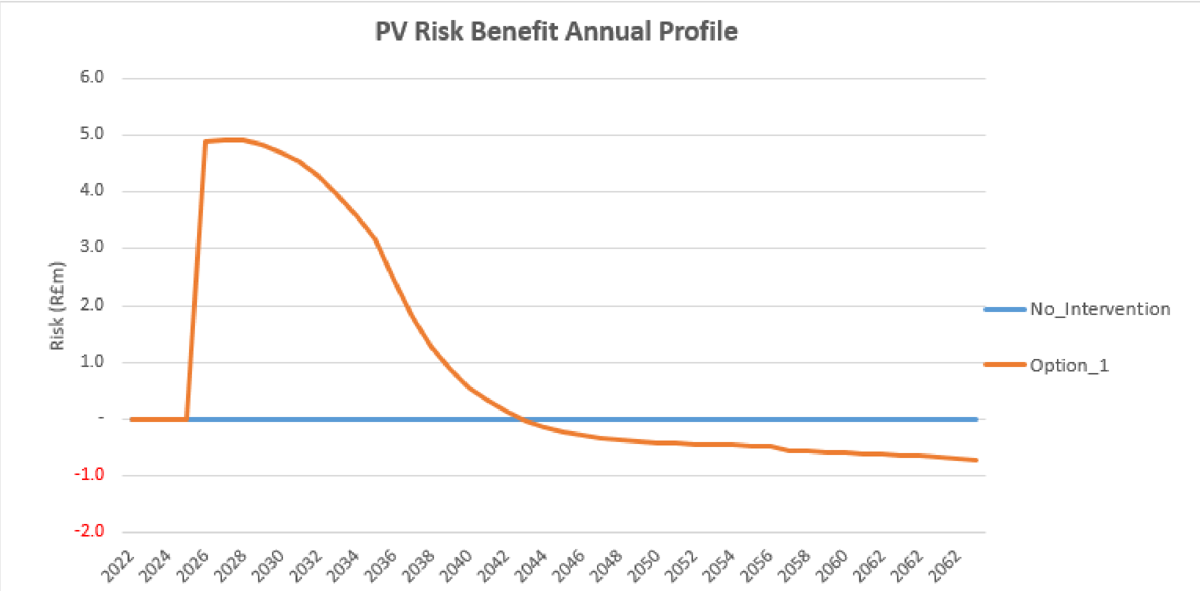
[5] A Network For Net Zero – A Risk Based Approach to Asset Management

The immediate monetised risk benefit which would be realised through the completion of this project is R£4.931m.

In addition to assessing the immediate risk reduction achieved, a long-term benefit has also been determined. The long-term benefit is derived by consideration of the risk of the asset experiencing a catastrophic failure weighted by the probability that the asset will survive for the Options and “no intervention” scenarios. The long-term benefit is an aggregation of the risk of all assets being considered within the option. The risk of each Option is then compared with the “no intervention” scenario. The “no intervention” scenario assumes that when the asset experiences a catastrophic failure the asset is replaced. The long-term benefit of this project is R£40.706m.

Figure 2 - Long Term Benefit of Proposed Intervention



5.4 Project Sensitivity

As outlined in our core RIIO-T2 business plan document, “A Network for Net Zero”, we believe we have a critical role to play in delivering Net Zero ambitions in both the UK and Scotland. Therefore our plan has been carefully designed with the flexibility to deliver pathways to Net Zero. Our policy paper “A Risk-Based Approach to Asset Management” outlines our approach to monitoring and assessing the condition of our assets to maintain the reliable and resilient network that is expected by our stakeholders. Where asset condition deteriorates, we undertake a programme of cost-effective, risk-based interventions to maintain the longevity and performance of the transmission network. Each of our non-load related projects for T2 is underpinned by Asset Condition Reports which clearly outline that the works are necessary and driven for reliability.

Table 3: Sensitivity Analysis table

Sensitivity	Test and impact observed – switching inputs
Asset Performance / deterioration rates	Switching deterioration assumption: The asset performance / deterioration rates can only improve or deteriorate. As the need for this project is driven by an asset condition report (as outlined in Section 3), the asset condition will not improve in the intervening period. The second option is for the asset performance to deteriorate and therefore the need remains, and the project would be considered for advancement within available outages.
Ongoing efficiency assumptions	Switching efficiency assumption: increased or decreased. Test would have no impact on (feasible) option selection, only one option was taken forward to detailed analysis and therefore there is no impact on the preferred solution.
Demand variations	No significant demand forecast
Energy scenarios	Sensitivity considered in Section 3 (Need) already. As this is a non-load project and the need is driven by the asset condition, the work would be required regardless of any changes to the energy scenarios.
Asset utilisation	Our policy paper "A Risk-Based Approach to Asset Management" outlines our approach to monitoring and assessing the condition of our assets to maintain the reliable and resilient network that is expected by our stakeholders. Where asset condition deteriorates, we undertake a programme of cost-effective, risk-based interventions to maintain the longevity and performance of the transmission network. Each of our non-load related projects for T2 is underpinned by Asset Condition Reports which clearly outline that the works are necessary and driven for reliability.
Timing / delivery	We have considered timing of investments as part of our CBAs.
Consenting / stakeholders	Where applicable we have considered consenting and stakeholder engagement as part of section 5 (Detailed Analysis) and the impact which this has had on the selection of the preferred solution.
Public policy / Government legislation	We have considered the impact of public policy, government legislation and regulations as part of the need (section 3), optioneering (section 4) and detailed analysis (section 5) and the impacts this has on the selection of the

	preferred solution. For example, the projects have considered the impact of the UK Governments' Net Zero emission by 2050 target, SQSS and ESQCR.

5.5 Carbon Modelling

We are committed to managing resources over the whole asset lifecycle – i.e. including the manufacturing of assets, construction, operations and decommissioning activities – to reduce our greenhouse gas emissions in line with climate science and become a climate resilient business. It is our aspiration that the carbon lifecycle cost of investment options plays a key role within our project development and is considered in the selection of a preferred solution. We have therefore developed an internal carbon pricing model that estimates a carbon cost for each option considered in our CBA through deriving values for:

1. Embodied carbon, which relates to the carbon emissions associated with the manufacturing and production of the materials use in production of the lead assets (transformer, reactors, underground cables and Overhead lines. Overhead line is made up of tower/wood pole/composite pole, conductor and fittings) procured and installed as part of the project.
2. The carbon emissions associated with the main stages of the project lifecycle (construction, operations and decommissioning).

It is our vision to embed carbon considerations within our strategic optioneering and project development processes, which will require us to determine a way of flagging high carbon options within our CBA outputs. We will continue to develop our thinking in this space, which will involve our model being validated by a third party, so the results included in this EJP are indicative and subject to change.

The results of analysis for this project, are captured in the carbon footprint results table.

Table 4: Carbon Modelling

	Project Information	Baseline (Option 3)
Project info	Project Name/number	**Option 3**
	Construction Start Year	2026
	Construction End Year	2028
Cost estimate £GBP	Embedded carbon	£ 554,281
	Construction	£ 443,665
	Operations	£ 306,343
	Decommissioning	£ 203,121
	Total Project Carbon Cost Estimate	**£ 1,507,410**
Carbon footprint tCO2e	Embedded carbon	7,401

	Construction	5,836
	Operations	1,339
	Decommissioning	584
	Total Project Carbon (tCO2e)	**15,160**
Project Carbon Footprint by Emission Category	Total Scope 1 (tCO2e)	1,226
	Total Scope 2 (tCO2e)	114
	Total Scope 3 (tCO2e)	13,820
SF6 Emissions	Total SF6 Emissions 3 (tCO2e)	1,210

5.6 Cost Estimate

The cost of the preferred option for works at Peterhead has been developed using rates from existing substation framework contracts and benchmarks from delivered RIIO-T1 projects. These have been applied to indicative quantities obtained from layout drawings. The total cost for delivering the scope of works for the proposed solution is £36.7m.

6 Conclusion

This Engineering Justification Paper details the need for replacing the Peterhead 275/132kV SGT1 and SGT2 within the RIIO T2 period. Asset intervention is recommended by the Asset Condition Report[2] to ensure the safe and reliant operation of our network.

The results of the options appraisal, coordination of North East projects during the RIIO T2 period and an objective to minimise outages have concluded that the build of a new compound to the west of the existing Peterhead Substation and offline installation of two new SGTs is the preferred solution.

The proposed scope of works is:

- Create new compound 100m West of the existing Peterhead Substation and install two new 275/132kV, 120/240MVA ONAN/OFAF Super Grid Transformers
- Construct two new buildings to house each the new SGT
- Install 0.45km 132kV and 0.4km of 275kV cables to connect to the transformers to the existing feeder bay.
- Install two new 275kV Circuit Breakers on the new SGT terminals
- Disconnect, remove and dispose existing SGTs and associated oil filled cables.

This scheme delivers the following outputs and benefits:

- Improved operational resilience in line with our goal of 100% network reliability

This scheme will deliver an immediate reduction of total network risk of R£4.931m for a cost of £36.7m and the works are planned to be completed within the RIIO-T2 period. The Long Term Monetised Risk Benefit is calculated as R£40.706m.

The Peterhead scheme is not flagged as eligible for early or late competition due it being under Ofgem’s £50m and £100m thresholds respectively.

7 Price Control Deliverables and Ring Fencing

As set out in our Regulatory Framework paper (section 1.12 and Appendix 3) we support a key principle from Citizens Advice – one that guarantees delivery of outcomes equivalent to the funding received - to ensure that RIIO-T2 really deliver for consumers.

For our core non-load projects this means that we commit to delivering our overarching NARMs target. If we do not deliver the NARMS target, or a materially equivalent target, then we should be subject to a penalty. Equally, if we over-deliver against our target and are able to justify that the over-delivery is in the consumers interests and could not have been reasonably factored into our business plan at the time of target setting then we should be made cost neutral for this work.

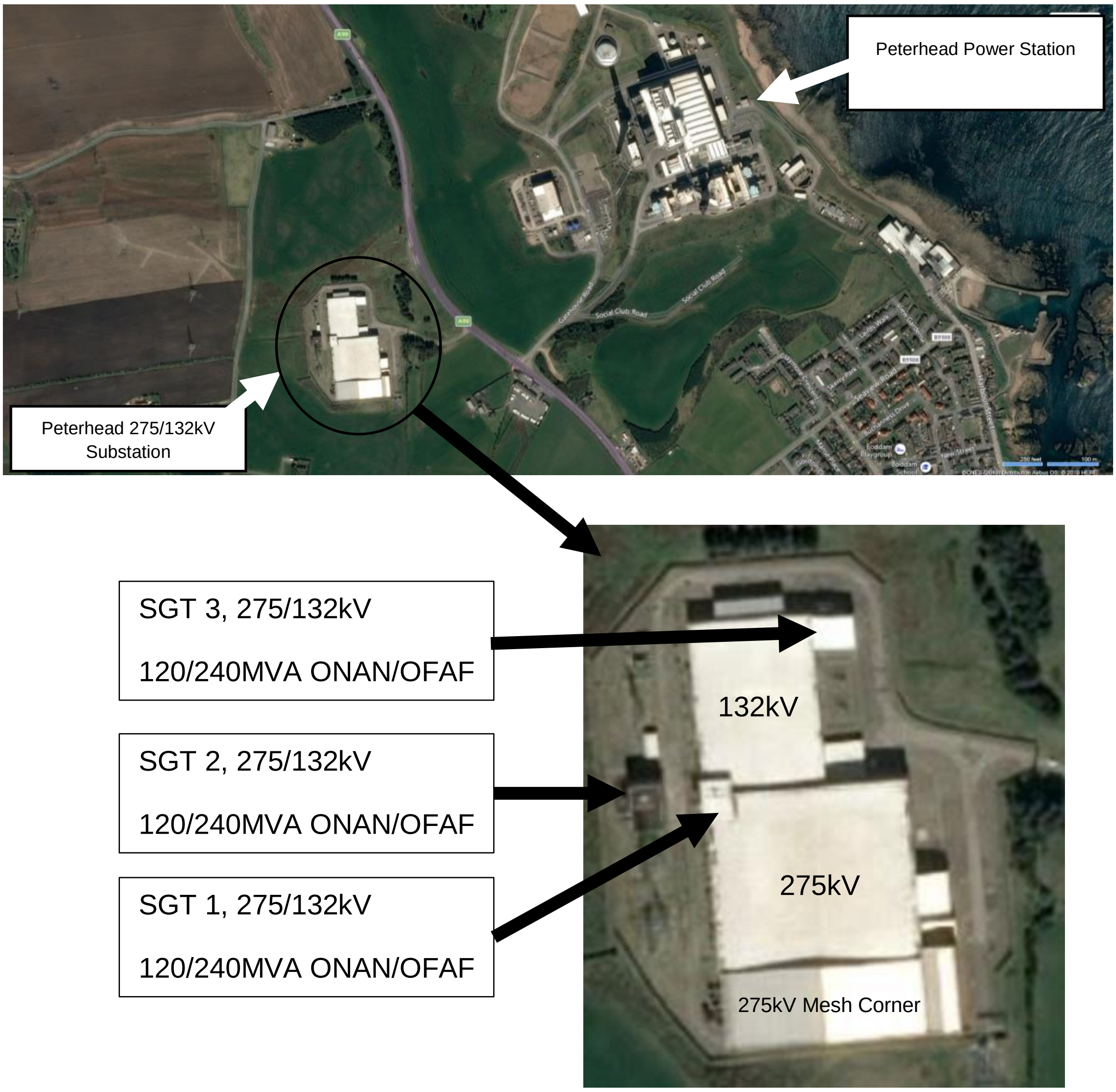
Core non load projects should not be ring fenced. This is to allow for substitution of projects in order to meet that NARMs target. We need flexibility to respond to up to date asset data information or external influences on our network during the price control; this information might drive us to substitute one project for another in order to ensure a reliable and resilient network. Ring fencing projects may result in sub-optimal decisions, having adverse consequences for the health of our network, which will ultimately be reflected in the NARMs target.

8 Outputs included in RIIO-T1 Plans

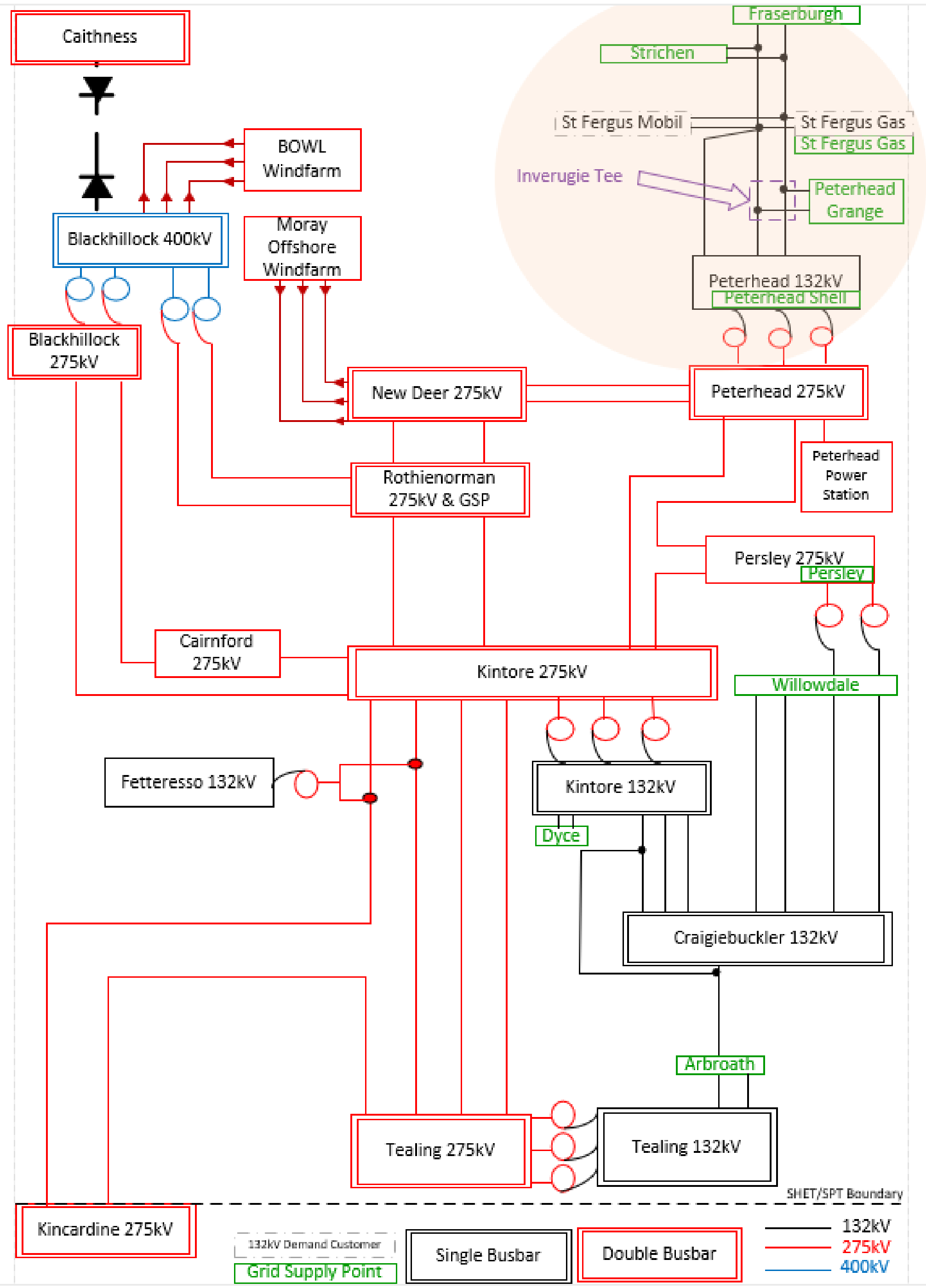
There are no outputs associated with this scheme included in our RIIO-T1 plans.

Appendices

Appendix A: Peterhead Substation Geographic



Appendix B: North East 132kV Network and East Coast MITS



Appendix C: Peterhead 275kV and 132kV Busbar Single Line Diagram

Figure C1: Peterhead 275kV Busbar

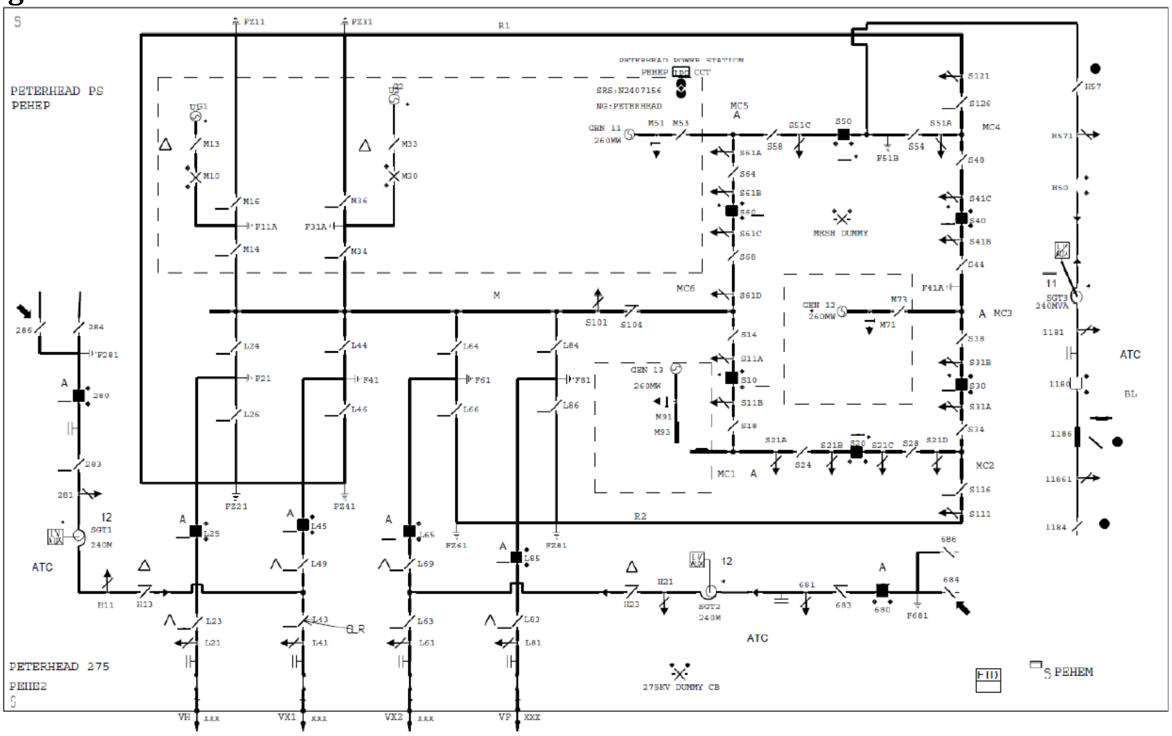
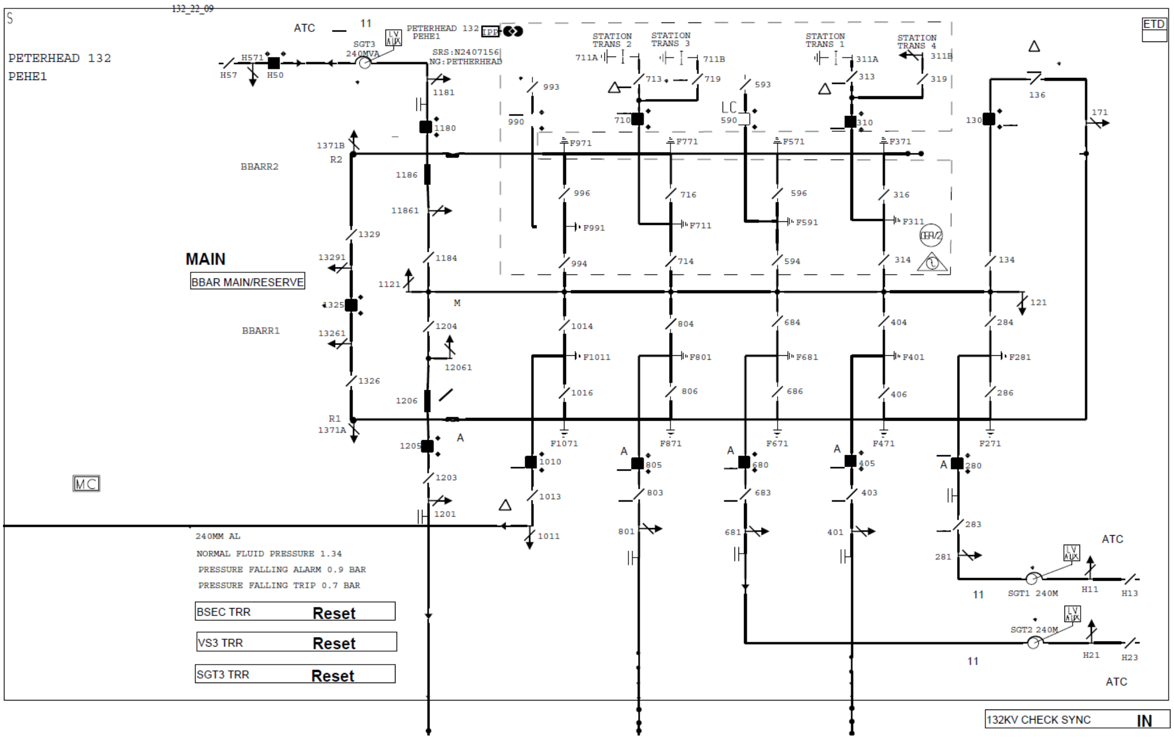
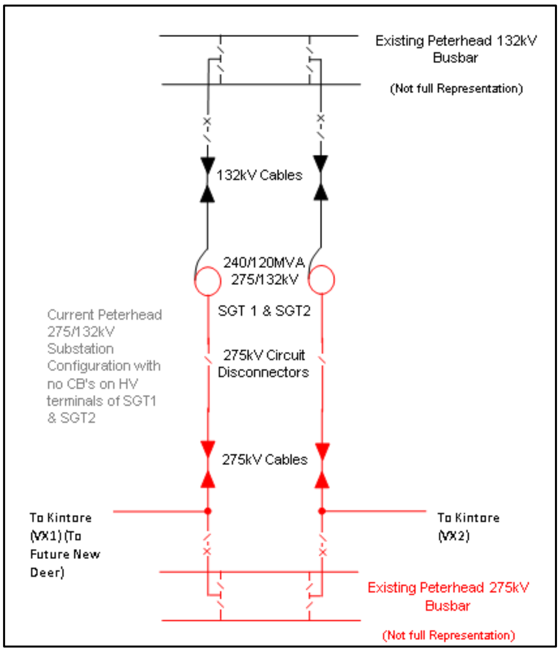


Figure C2: Peterhead 132kV Busbar

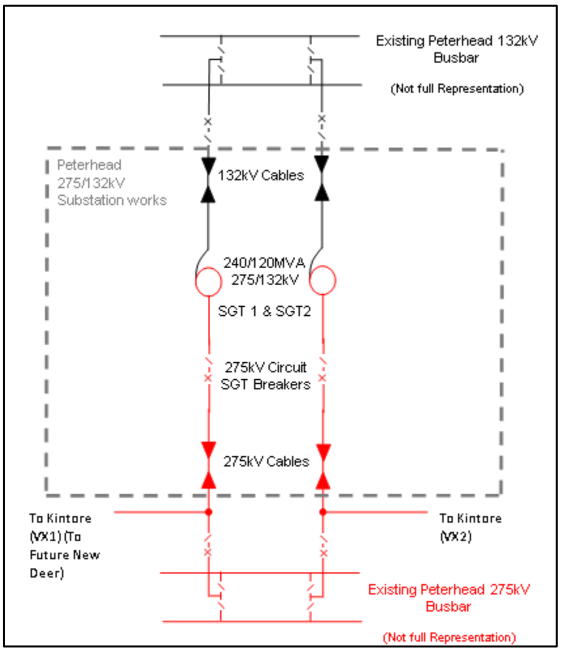


Appendix D: Existing and Upgraded Peterhead 275/132kV Single Line Diagram

Existing Peterhead 275/132kV Substation



Peterhead 275/132kV Substation Upgrade



Peterhead 400/275/132kV Substation