Longannet 275kV series reactor refurbishment – OFGEM justification paper	
Name of Scheme/Programme	Longannet 275kV series reactor refurbishment
Primary Investment Driver	Asset Health (Lead asset – Series reactor)
Scheme reference/ mechanism or category	SPNLT 2063
Output references/type	NLRT2SP2063 (275kV Transformer)
Cost	£ 3.06 m
Delivery Year	2026
Reporting Table	C0.7 / C2.3 / C2.4b / C2.2a_CI / C2.2a_AP / C2.5 / C2.5a / 5.18
Outputs included in RIIO T1 Business Plan	No

Issue Date	Issue No	Amendment Details
July 2019	Issue 1	First issue of document
December 2019	Issue 2	Gross cost / Delivery year update and future pathways – Net zero text updated.

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1 Introduction

Longannet 275kV substation is an indoor AIS substation located in vicinity of the now decommissioned Longannet power station in Fife area. With connections to Kincardine 275kV substation, Windyhill 275kV substation, Denny North 275kV substation and Westfield 275kV substation, the substation plays an important role in the North – South and East – West power flow, and is part of the main interconnected transmission system (MITS).

The existing 275kV 620MVA series reactors have been installed on the Kincardine 1 & Kincardine 2 circuits with equal objectives of limiting the fault level and managing post-fault power flows. The reactors are physically located outside the main substation building near the Kincardine circuits' terminal tower, and are connected via 275kV cables to the indoor switchgear bay. These circuits also have a bypass disconnector arrangement which can be used to either bypass the series reactors or have the reactors in circuit as required.

SP Transmission has carried out oil sample tests on the reactors R1 and R2. DGA analysis indicate that thermal gases are present in oil, however all dissolved gases remain below 'typical concentration levels' as defined in IEC60599. Assessment of the paper insulation has shown a residual life of more than 75% remaining. Also the main tank oil has good dielectric properties exhibited by a high dielectric withstand.

Continuous oil leakage from both the reactors, with particular concern over the turrets, is one of the main reasons for this intervention during RIIO T2 period. Accordingly limited intervention has been considered on these reactors during RIIO T2 period, whereby the main areas would be managing the oil leaks, oil conditioning, replacing the bushings, cooler banks and in general paint work / rewiring work etc where required. As such no internal refurbishment works on the core windings within the reactor tank is envisaged. Exact scope of works would be finalised prior to project delivery based on further assessment carried out on both the units.

Due to the existing layout of the two reactors installed alongside each other on the Longannet – Kincardine 1 & 2 circuits, it would not be possible to carry out refurbishment on one reactor with the other circuit energised. As any insitu refurbishment works would require a considerably long outage on both circuits, it has been considered to relocate the reactors to an offline location such that the refurbishment activity can be carried out without any impact on the other circuit. Cost for relocation / rebuild has been considered part of this project.

For minimising the outage requirements, the refurbishment works would also require being co-ordinated with the project 'SPNLT2099 Longannet 275kV switchgear replacement'. Kindly refer respective engineering justification paper being submitted for SPNLT2099 for further details.

In line with the above, the proposed lead asset outputs for the selected option are:

- 275kV Transformer disposal – 0 units
- 275kV Transformer addition (activity volume) – 2 unit

The refurbishment and relocation works are proposed to be completed over 1 outage season however this is dependent on external factors (land purchase, planning permission, outage constraints) and will be co-ordinated with SPNLT2099.

2 Background Information

Based on the values determined in accordance with the NARM methodology, Reactor R1 and R2 at Longannet 275kV substation will have EoL modifier scores of 8.26 each (at end of RIIO-T2 period without any intervention), and based on ongoing issues detected during condition assessment have been identified for refurbishment.

Accordingly this paper supports a proposal to refurbish these reactors within the RIIO T2 period. The reactors are also proposed to be relocated to a new offline location with the works required to be co-ordinated with SPNLT2099 Longannet switchgear replacement project.

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

Asset Description	Manufacturer	Year of Manufacture	EoL score (Transformer) (End of RIIO T2)	Monetised risk
LREA275SERR1	Bruce Peebles	1969	8.26	£ 183,827.68
LREA275SERR2	Bruce Peebles	1969	8.26	£ 183,827.68

Figure 1: Longannet 275kV series reactor

Condition assessment of the associated 275kV disconnectors has shown that the mechanical components are at a level of deterioration where intervention is required and the electrical components are at the end of their serviceable life.

The recommendation for the 275kV Disconnectors / Disconnector structures 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 disconnector and mechanism box when compared with the costs and timescales to replace them at the new location indicate that replacement is the most economic option.

Further as the reactors are being replaced to a new location, the existing civil infrastructure / structures cannot be reused.

Accordingly the 275kV Disconnectors are being considered to be replaced.

As the intention is to relocate these units, new civil infrastructure viz. drainage, oily water management system, below ground earth mat, transformer bund, plinth and access road have been considered for this project. New foundations would also be required for the new plant items viz. RCP Disconnectors and Post insulators. Considering the proximity of residential properties near the proposed location, noise enclosure has also been considered although this would be subject to confirmation via noise survey.

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.	Rejected	This option is not possible as any intervention works on these reactors would require being co-ordinated with SPNLT2099 Longannet 275kV switchgear replacement works. As already proven by the CBA carried out for SPNLT2099, delaying the switchgear replacement works to RIIO T3 is not a viable alternative thereby making this option non-viable.
1	Relocate and online refurbishment of the reactors R1 and R2	Proposed	-
2	Replacement of the 275kV series reactors R1 and R2 on a like for like basis	Rejected	Condition assessment has shown the possibility of refurbishing and reusing existing assets making this option technically and economically unjustified.
3	Remove the reactors R1 and R2 from system	Rejected	System design studies carried out have shown that the reactors are required to manage the high fault level and post fault scenario power flows and cannot be removed.

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

- Option 1: Online refurbishment of the reactors R1 and R2

As only one feasible option has been identified, no CBA has been considered for this project.

4 Detailed analysis

4.1 Scope of works

Please find below a brief summary of the scope of works:

- Carry out further detailed condition assessment on the units to finalise the level of intervention.
- Project to be co-ordinated with SPNLT2099 works with Civil assets to be installed offline.
- 275kV RCP disconnectors / post insulators – busbar arrangement also to be installed offline and in advance of the actual outage start on either reactor.
- With the circuits on outage, decommission, dismantle, transport, assemble, refurbish and commission the reactors in their final location.
- Requirements of noise enclosure to be checked based on noise survey recommendations.
- Energise the circuit once the reactor refurbishment works, OHL circuit transfer completed.

4.2 Specific factors contributing to additional cost

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

- The project includes the costs associated with decommission, dismantle, transport and assemble both the reactors in their revised location.
- Noise enclosure is likely to be required subject to further noise survey assessment.
- Asbestos contamination in existing infrastructure.
- Land purchase / planning permission for the new location
- Additional infrastructure cost associated with relocation

4.3 Selected option

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

	Option 1 - Relocate and online refurbishment of the reactors R1 and R2
Cost (£m)	£ 3.06 m
Construction timescales	1 outage season

Based on the technical review carried out and this being the only feasible option, option 1 is the preferred solution. .

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.

4.4 Environment & Sustainability

Oil leaks have been recorded in the past from the existing R1 and R2 reactors installed.

As part of this project, we are removing the reactors which were the source of these oil leaks and replacing with a new unit thereby reducing the environmental risks associated with these assets.

5 Conclusion

The option proposed has been reviewed in terms of scope, costs, timescales, construction risk, and sustainability requirements and have been found to be deliverable.

It also achieves the main objective of reducing the network risks due to existing 275kV 620MVAR series reactors R1 / R2 and so is acceptable.

- Total project forecast costs for R1 / R2 refurbishment - £ 3.06mn
- Timing of investment: 2026
- Declared 275kV lead asset (Transformer output in RIIO T2 period: Addition (Activity) – 2 units / Disposal – 0 units
- Lifetime risk benefit – Lr£9.85m (Total for R1 and R2)

Note that considering the uncertainties associated with land purchase, planning permission and S37 consents, this project along with SPNLT2099 are being proposed as a Price Control Deliverable for the RIIO T2 business plan. It is proposed that the costs are excluded from baseline allowances and that a trigger mechanism is implemented. This would allow the required allowances to be applied when there is an appropriate degree of certainty of timing of the works.

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

As only feasible option was identified no CBA was carried out. Note 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

As no CBA is carried out for this project, the option considered is not 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