SF6 repair works – OFGEM Justification Paper	
Name of Scheme/Programme	SF6 repair works
Primary Investment Driver	Asset Health
Scheme reference/ mechanism or category	SPNLT20140/ Circuit Breaker
Output references/type	NLRT2SP20140 / (33kV CB OD / 132kV CB OD / 275kV CB OD / 275kV CT / 400kV CB OD / 400kV CB ID)
Cost	£4.77m
Delivery Year	2026
Reporting Table	C0.7 / C2.2a_CI / C2.2a_AP / C2.3 /C2.4b / C2.5a / C2.5
Outputs included in RIIO T1 Business Plan	No

Issue Date	Issue No	Amendment Details
December 2019	Issue 1	First issue of document
July 2020	Issue 2	ANNEX B SPT response

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1 Introduction

SPT has identified a number of SF_6 circuit-breakers and SF_6 current transformers which have had instances of SF_6 leakage which have required repair and so it is anticipated that further efforts to prevent or minimise leakage will be necessary in the RIIO-T2 period. The forecast repair works identified are specific to the site and exclusive to the type of electrical equipment.

Based on a detailed technical and commercial review, some of the units have been considered for refurbishment as the most effective means of minimising leakage while on some units considering the source and nature of the leakage, replacement is solution that best minimises leakage.

Please find below the number of units on which intervention has been forecast:

	400kV CB ID	**400kV CB OD**	**275kV CB OD**	**275kV CT**	**132kV CB OD**	**33kV CB OD**
Asset addition / activity units	4	9	2	6	4	1
Asset disposal units	0	4	1	0	4	1

Please note intervention is also being considered on a number of non-lead SF_6 filled GIS components viz. GIS disconnectors and earthing switches at Torness 400kV substation and the SF_6 switching disconnectors at Hunterston 400kV substation.

2 Selection criteria:

The intervention on each asset has been engineered based on the type of electrical equipment and historical specific gas leakage issues, while also considering the most economic and efficient means of minimising leakage (refurbish vs replace).

Please find the list of circuit-breakers forecast for intervention along with the site detail and scope of works involved in appendix A.

3 Optioneering

As reduction in SF_6 leakage on the SP Transmission network is one of the key priorities for SPT in RIIO-T2, no other option has been considered for the forecast interventions. The works have been considered to be those that will be required during the RIIO-T2 period.

In case of 132kV Circuit breaker replacement, the units are proposed to be replaced with a 132kV SF_6-free alternative in line with SPT's environmental strategy for RIIO-T2.

4 CBA results

No CBA has been carried out considering that intervention on these units in RIIO-T2 is necessary in the event of recurrence of SF_6 leaks.

5 Conclusion

Please find below the total cost for this project. Note that this programme forecasts necessary interventions throughout the RIIO-T2 period.

- Total cost: £ 4.77m
- Delivery year: 2026

6 Future Pathways – Net Zero

6.1 Primary Economic Driver

We have reviewed these activities against the criteria set out within the business plan guidance and have assessed that it does not prevent achievement of our Net Zero plans or lead to stranded assets.

7 Outputs included in RIIO T1 Plans

This scheme does not contain any outputs or costs included in the RIIO-T1 business plan.

8 Annexes:

Annex A: List of Circuit breakers identified for intervention

8.1 Annex A: RIIO-T2 SF6 repair works

Substation	Asset	RIIO-ET2 planned intervention
Eccles 400kV substation	Eccles 400kV-X1005	Replace
Torness 400kV substation	Torness 400kV-MC1-B	Maintain
Torness 400kV substation	Torness 400kV-X103SV-B	Maintain
Torness 400kV substation	Torness 400kV-X103SV-R	Maintain
Torness 400kV substation	Torness 400kV-X113	Maintain
Longannet 275kV substation	Longannet 275kV -W60 - W64 CT Yellow	Refurbish
Torness 400kV substation	Torness 400kV-X143V-Y	Maintain
Torness 400kV substation	Torness 400kV-X120	Maintain
Fallago 400kV substation	FALLAGO 400-X410	Maintain
Longannet 275kV substation	Longannet 275kV -F75-F74 Blue CT	Refurbish
Longannet 275kV substation	Longannet 275kV -F44 Bϕ CT	Refurbish
Longannet 275kV substation	Longannet 275kV -F35-F36 YELLOW	Refurbish
Longannet 275kV substation	Longannet 275kV -W86 Red Phase	Refurbish
Longannet 275kV substation	Longannet 275kV -L40/L44CT Y PHASE	Refurbish
Grangemouth 275kV substation	Grangemouth 275kV-S10	Maintain
Strathaven 400kV substation	Strathaven 400kV-X1110	Maintain
Torness 400kV substation	Torness 400kV-X103SR-R	Maintain
Torness 400kV substation	Torness 400kV-X103SV-Y	Maintain
Eccles 4000kV substation	Eccles 400kV-X805	Replace
Torness 400kV substation	Torness 400kV-MC2-R	Maintain
Torness 400kV substation	Torness 400kV-X293	Maintain
Hunterston 400kV substation	Hunterston 400kV-X318	Maintain until replacement
Hunterston 400kV substation	Hunterston 400kV-X518 Pole 5	Maintain until replacement
Torness 400kV substation	Torness 400kV-MC2-B	Maintain
Strathaven 400kV substation	Strathaven 400kV-X905	Maintain
Torness 400kV substation	Torness 400kV-MC4-B	Maintain
Torness 400kV substation	Torness 400kV-X343V-Y	Maintain
Torness 400kV substation	Torness 400kV-X493V-Y	Maintain
Torness 400kV substation	Torness 400kV-MC4-Y	Maintain
Torness 400kV substation	Torness 400kV-MC4-R	Maintain
Torness 400kV substation	Torness 400kV-X493V-B	Maintain
Torness 400kV substation	Torness 400kV-X343V-R	Maintain
Torness 400kV substation	Torness 400kV-X424	Maintain
Torness 400kV substation	Torness 400kV-X313	Maintain
Eccles 400kV substation	Eccles 400kV-X130	Replace
Torness 400kV substation	Torness 400kV-X520	Maintain
Smeaton 275kV substation	Smeaton 275kV-S40	Replace
Torness 400kV substation	Torness 400kV-X503SV-R	Maintain
Torness 400kV substation	Torness 400kV-MC5(X420)-Y	Maintain
Torness 400kV substation	Torness 400kV-X624	Maintain
Torness 400kV substation	Torness 400kV-X526	Maintain
Torness 400kV substation	Torness 400kV-X503SV-Y	Maintain
Glenluce 33kV substation	Glenluce 33kV-Grid 2 CB	Replace
Torness 400kV substation	Torness 400kV-X820	Maintain
Torness 400kV substation	Torness 400kV-X720	Maintain
Torness 400kV substation	Torness 400kV-MC8-R	Maintain
Torness 400kV substation	Torness 400kV-X703SV-B	Maintain
Torness 400kV substation	Torness 400kV-X628	Maintain
Torness 400kV substation	Torness 400kV-X893	Maintain
Torness 400kV substation	Torness 400kV-X828	Maintain
Eccles 400kV substation	Eccles 400kV-X405	Replace
Mossmoran 132kV substation	Mossmorran 132KV-120	Replace
Devonside 132kV substation	Devonside 132kV	Replace
Eccles 132kV substation	Eccles (GALA 2) 132kV	Replace
Eccles 132kV substation	Eccles (SGT2W) 132kV	Replace

8.2 Annex B SPT Response to Atkins Analysis of EJP_SPT_SPNLT20140 Issue 1

SPNLT_20140
SF_6 Repair Works

CONTENTS

1.0 INTRODUCTION

SPT have a duty to minimise the leakage of SF_6 from their electrical assets. SPT's approach is 2-fold, for new assets we have gas tightness requirements of our suppliers more stringent than international standards (acknowledged by Ofgem in the Draft Determination) and for existing assets we have an ongoing plan to repair/replace leaking assets. SPT also have an ongoing commitment to no longer install SF_6 filled equipment, where practicable, and will instead use equipment which is SF_6 free. SPT's SF_6 repair plan for the RIIO-T2 period is a mixture of asset replacement and leak repairs. This leads to a planned intervention on 32 assets with a planned investment of £4.77m which was supported by engineering justification paper EJP_SPT_SPNLT_20140 Issue 1. Ofgem have rejected the proposed replacement of 6 circuit breakers within this plan leading to a reduction in the planned investment by £0.66m. The replacement of these 6 circuit breakers was rejected on the basis the case had not been sufficiently justified and SPT optioneering had not shown repair/refurbishment was impossible or uneconomic. SPT believe the most economic and practical solution for these circuit breakers is asset replacement and this document will set out SPT's response to Ofgem's decision.

2.0 OFGEM ANALYSIS

Ofgem's consultant Atkins have presented their findings, when reviewing the need case for investment, in document 'RIIO-T2 TO submission review summary report' which summarises the review of all 3 Transmission Owner's (TO) investment justification papers and also comprises a company specific annex for each company in the case of SPT this is Annex A. To support the replacement of these reactors SPT submitted EJP_SPT_SPNLT_20140 which was supplemented by SPT response as requested in SPTL_SQ_EN29.

Following the assessment of these documents Atkins analysis excluded the following circuit breakers: S40 Smeaton 275kV s/s, Grid 2 Glenluce 132kV s/s, 120 Mossmorran 132kV s/s, 120 Devonside 132kV s/s, 205 and 280 at Eccles 132kV s/s on the basis a replacement should only be carried out if a repair proved to be uneconomical or impossible.

3.0 SPT ANALYSIS

SPT have a responsibility to lower the global warming impact of our activities to ensure we can facilitate net zero by 2045 in line with the target set by the Scottish Government. It is SPT's view that in our strive to facilitate net zero, where possible, we should be installing SF_6 free assets to lower the global warming potential of electrical assets, if SF_6 free assets are not available, installing assets with as low as possible design leakage. The exclusion of the replacement of these assets from SPT plan will ensure these assets can be expected to leak annually 3% of their installed mass of gas due to standards in place at time of installation. The plan to replace these leaking units would remove 137kg of SF_6 from the SPT inventory and the replacement SF_6 filled units design leakage rate would be reduced to 0.25%. This would lead to a reduction in carbon contribution from SF6 leaks of over 98% using the Ofgem published global warming potential for SF_6 of 23900.

	Mass of SF_6 (kg)	Annual leakage (kg)	CO_2 (kg)	% difference
Repair	180	5.4	129060	
Replace	43	0.1075	2569.25	1.99%

The additional CO_2 equivalent of SF_6 and associated global warming potential could be avoided with minimum additional expenditure as requested by SPT.

SPT believe the SF_6 repair plan has shown that a pragmatic approach has been taken to building the plan. SPT have demonstrated they will repair where possible, they are willing to relocate legacy SF_6 assets to replace leaking assets rather than replace with new, which is consistent with the approach taken in RIIO-T1. All assets in the SF_6 repair plan have been assessed using the same criteria.

SPT have significant experience in managing SF_6 leaks, we therefore have assets identified for repair within the SF_6 plan where we have experience of repairing gas leaks and the associated cost. This has allowed SPT to make an economic assessment on a practical repair strategy. SPT also have experience of assets where multiple repairs are required over a number of years with little or no success. SPT have considered each circuit breaker and the options available in terms of a repair that may be available, and the potential cost associated with each repair.

3.1 S40 Smeaton 275kV substation

S40 installed at Smeaton is a GEC FE2 circuit breaker and was commissioned in 1986. The variant of the FE2 is unique in the SPT network at this substation although SPT have a more modern but incompatible variant at other sites. This circuit breaker is now considered obsolete and support from the manufacturer is limited to minor repairs. From SPT's experience of managing and repairing SF_6 leaks the cause and the disassembly required to facilitate repairs can be difficult to locate and complicated to repair. For circuit breakers of this vintage it is not uncommon for moisture ingress to occur at the cement joint between the insulator and the mounting casting which then migrates across the insulator O-ring causing a leak. Typically, when such a repair is attempted it is also carried out on the non-leaking poles as this is a sign of long term degradation and good engineering practice dictates that intervention should be carried out to prevent potential future issues. This is also good practice with regards to SPT's responsibilities under the Fluorinated gas regulations.

It is the view of SPT, in line with Atkins findings, that we should be allowed investment of £0.05m to facilitate the repair.

3.2 Grid 2 Glenluce 132kV substation

Grid 2 installed at Glenluce is a Hawker Siddeley HG36 circuit breaker and was commissioned in 1995. This circuit breaker is now considered obsolete and support from the manufacturer is limited. The chevron seals on this circuit breaker type are known to leak along with some other very minor items which can be repaired at site. Repairs associated with the bushing would require the unit to be removed from site and tooling and set up established which make repair uneconomic.

It is the view of SPT, in line with Atkins findings, that we should be allowed investment of £0.01m to allow repairs to be undertaken

3.3 120 Mossmorran 132kV substation

120 installed at Mossmorran 132kV substation is an ABB LTB circuit breaker and was commissioned in 1997. A variant of this circuit breaker is still a current ABB product and therefore support is available albeit this design is now obsolete. It is SPT's experience that gas leakage can occur on this vintage of ABB circuit breaker between the support insulator and the interrupter chamber which requires the pole to be dissembled. The OEM require pole disassembly to be carried out at workshop facilities, which

leads to very long outage times and increased costs, the most economical solution is replacement of the leaking circuit breaker pole. A repair that requires this degree of intervention indicates long term degradation of the circuit breaker. Good engineering practice dictates that intervention should be carried out on all poles to prevent future leakage. This is also good practice with regards to SPT's responsibilities under the Fluorinated gas regulations

It is the view of SPT, in line with Atkins findings, that they should be allowed investment of £0.055m to facilitate the repair

3.4 120 Devonside 132kV substation

120 installed at Devonside is a GEC FX11 circuit breaker and was commissioned in 1996. This circuit breaker in now considered obsolete and support from the manufacturer is limited to minor repairs. From SPT's experience of managing and repairing SF_6 leaks the cause and the disassembly required to facilitate repairs can be difficult to locate and complicated to repair. For circuit breakers of this vintage it is not uncommon for the moisture ingress to occur at the cement joint between the insulator and the mounting casting which then migrate across the insulator O-ring cause a leak. Typically, when such a repair is attempted it also carried out the non-leaking poles as this is a sign of long term degradation where good engineering practice dictates that intervention should be carried out to prevent potential future issues. This is also good practice with regards to SPT's responsibilities under the Fluorinated gas regulations

It is the view of SPT, in line with Atkins findings, that they should be allowed investment of £0.03m to facilitate the repair

3.5 205 and 280 Eccles 132kV substation

205 and 280 installed at Eccles 132kV substation are Areva DT1 circuit breakers and were commissioned in 2006. A variant of this circuit breaker is still a current GE product and therefore support is available. SPT's experience of gas leaks on this circuit breaker type is limited to more recent variant of the design where repairs were carried out under warranty. There are multiple areas where this circuit breaker could leak and therefore the potential for multiple leaks on the unit.

It is the view of SPT, in line with Atkins findings, they should be allowed investment of £0.03m to facilitate repairs.

4.0 CONCLUSION

SPT have a duty to ensure it manages SF_6 gas and any associated leakage in accordance with The Fluorinated Greenhouse Gases Regulations 2018. SPT have considered the response from Atkins with regards to the circuit breakers discussed in this document.

It is the view of SPT the best overall solution for these assets is replacement with SF6 free assets or if this is not possible with SF6 assets with much lower design leakage rate. These steps would reduce the asset global warming potential and also avoid expenditure on repairs which are uncertain to be successful.

If SPT are disallowed the funding to replace the circuit breakers identified, then we request an additional £0.175m of funding for repairs as outlined in this document and a price control deliverable funding of

£0.66m to ensure if repairs prove to be unsuccessful or uneconomic then SPT have the appropriate funding available to replace the circuit breakers.