CURRIE-GORGIE 132kV CABLE REPLACEMENT	
Name of Scheme/Programme	Currie-Gorgie 132kV Cable Replacement
Primary Investment Driver	Asset Health
Scheme reference/ mechanism or category	SPNLT20112/Cable
Output references/type	NLRT2SP20112/Cable
Cost	£9.6M
Delivery Year	2026
Reporting Table	C0.7/5.18
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, NPV, Monetised Risk, Long Term Risk Benefit and Delivery Year values updated.

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1. Introduction

This paper supports a proposal to carry out the cable system replacement of the Currie-Gorgie 132kV circuits.

The principal drivers for the replacement of underground cables are safety, network security, public safety, environment, condition and compliance with relevant legislation.

Strategic objectives are defined for the management of fluid filled cables based on:

- Effectively manage the risk of fluid loss from cable systems.
- Ensure the security of the Transmission Network.
- Set the criteria for prioritising the refurbishment.

Reliability, public safety and environment of installed fluid filled cables within the Transmission Network are the main aspect within the strategy for the RIIO T2 plan investment:

- Environmental operating code for the management of Fluid Filled Cable System to reduce leakage rates using best available techniques.
- Fluid filled cables are designed to operate at maximum capacity for a period of 40 years. As the majority of cables are not operated at full load for their entire lifetime then it is expected that the life expectancy would exceed this 40 year period.

Whilst the majority of fluid filled cables have not failed electrically, it is recognised the need for the reduction of oil leakage across the SPEN Transmission Network which is further compounded where circuits are located in environmentally sensitive areas and areas of restricted access.

The cable condition can be determined from leak and repair history and diagnostic evidence on the cable fluid condition. Cable accessories such as joints, terminations, tanks/pipe, SVLs, bonding cable and link boxes can all usually be replaced or refurbished to a serviceable condition. However, crystalline or porous lead or aluminium sheath is irreparable and usually not a localised condition making the cable system replacement the only practicable investment option.

SP Energy Networks (SPEN) Cable System inspection strategy in conjunction with route specific investigations including cable sheath test, link box inspections and fluid analysis have been employed to provide a detailed condition analysis rating of the Cable System components.

Information gathered from the survey investigations for each cable system component is translated into component condition ratings from 1 to 5 upon its known condition, deterioration pattern, location and service history. The resultant condition rating value is subsequently input to the Condition Based Risk Management (CBRM) tool to identify its risk and criticality for the prioritisation of Cable System component interventions.

In line with above, the proposed 132kV outputs to be delivered are:

Asset	Type of Activity	Disposal (cct. Km/sets/each)	Addition/Activity (cct. Km/sets/each)
132kV UG Cable (Oil)	Replacement	10 cct. Km	11 cct. Km

2. Background Information

It is a transition circuit consisting of both XLPE and fluid filled cables sections running through urban areas. The circuit has been modified over the years so that there is now an assortment of cable manufacturers and types deployed.

- **Cable type:** XLPE - fluid filled - XLPE - fluid filled.
    - Section 1: Gorgie S/S – Transition Joint 1: XLPE cable 2011 / approx. 200m.
    - Section 2: transition Joint 1 – Old Longstone SEC: fluid filled-lead sheath-bonze tapes cable 1953.
    - Section 3: old Longstone SEC – Old Durd SEC: XLPE 2013 / approx. 1500m.
    - Section 4: old Durd SEC – AC006 transition tower: fluid filled-lead sheath-bonze tapes cable 1967.
- **Route description:** the cable route has been installed along and across some of Edinburgh's main auto routes in/out of the city.

2.1 Data Collection / Data Analysis / Interpretation

The Currie-Gorgie No.1 and No.2 132kV Fluid Filled Cables are part of the Currie-Gorgie-Telford Road No.1 and No.2 circuits that supply Currie and Gorgie substations in Edinburgh. Gorgie-Telford Road No.1 and No.2 circuits and original Currie-Gorgie No.1 and No.2 circuits (Section 2) were manufactured by Pirelli Cable Company and installed in 1954. It is single core oil-filled, impregnated paper insulated, reinforced lead alloy sheathed with a compounded hessian tape, copper conductor.

Gorgie-Telford Road No.1 and No.2 132kV Fluid Filled cables had two major cable fluid leaks in the early 1990's at the junction of Queensferry Road and Craigleith Drive (resulting in a decision being made to replace all the cables crossing Queensferry Road) and since 2005 there have been a further seven leaks:

- Four leaks [redacted] in Wheatfield Road, Edinburgh.
- One leak outside the works in Wheatfield Road.
- One leak in Groathill Avenue (near Telford Rd Substation).
- One leak in Craigleith Drive.

[redacted]These leaks have all been due to deterioration of the copper reinforcing tape surrounding the lead sheath.

The condition information gathered at the Gorgie-Telford Road No.1 and No.2 cables demonstrate the high susceptibility to corrosion of reinforcing bronze tape and PVC oversheath.

Due to the highly sensitive area where Currie-Gorgie No.1 and No.2 cables are installed, experience gathered on Gorgie-Telford Road No.1 and No.2 circuits, the evidence for the corrosion of reinforcing bronze tapes and PVC oversheath and the leaks recorded on the Currie-Gorgie No.1 and No.2 in 2016 of 128 litres and 225 litres in 2017, it is recommended the replacement of the No.1 and No.2 fluid filled cable sections circuits between Currie and Gorgie substations.

Figure 1: Damage [redacted] 2009 (Gorgie-Telford Road circuit)

Figure 2: 2011 Cable Prepared Ready for Repair. (Gorgie-Telford Road circuit)

Figure 3: Craigleith Drive 2012. (Gorgie-Telford Road circuit)

Figure 4: Damage in [redacted] 2011. (Gorgie-Telford Road circuit)

2.2 CBRM Summary

CBRM extract is shown below indicating End of Life (EoL) for each of the identified asset for refurbishment:

Asset Description	Year of Installation	EoL*	Monetised Risk (R£m)*
132kV UG Cable (Oil)	1953/1967	10.58	11,136,037.24

**Values at the end of the RIIO-T2 period with no intervention as per NOMs methodology.*

3. Optioneering

Two options have been considered based on the requirements identified within the condition assessments produced for each of the existing cable routes highlighted within the document. Option 1 has been recognised as the only viable option which meets the project objectives.

Option	Status	Reason for rejection
Baseline - Do Minimum: • Cable system replacement in RIIO-T3 (2031).	Considered	This option is unacceptable due to the overall condition of the existing cable system and no intervention will add considerable risk to the SPT Network. In addition, deferring the investment will accelerate the continual deterioration of the cable system components; in particular the cable which will leak in higher volumes and potential electrical failure.
Option 1 – Cable Replacement • Cable system replacement in RIIO-T2 (2026).	Considered and Proposed	-

4. Detailed analysis

Option 1 achieves the main objective of replacing the cable systems in RIIO-T2 and thereby reducing the overall risks to the network and maximise the use of the asset. Baseline and Option 1 have been considered for a CBA analysis including whole life monetised benefits and comparison of respective project option costs.

4.1 Option 1 - Major Refurbishment

The following works shall form the basis of Option 1 intervention:

- Replacing existing oil filled cables with a SPEN approved XLPE cable system for the Currie-Gorgie No.1 and No.2 circuits.
- Join new cable to existing XLPE sections.
- Drain existing oil filled cable and cap ends.
- Update all cable records to reflect the works carried out.
- Provide report to the Asset manager on the cable system condition.

Specific factors attributable to this option which results in additional costs:

- Potential for cable damage of due to work in close proximity.

The following specific risks have been identified for this option:

- Wayleave, environmental and local authorities' restrictions which impact on the progression of works as planned.
- Network access restrictions.

4.2 Selected Option

Baseline and Option 1 have been considered for a CBA analysis including whole life monetised benefits and comparison of respective project option costs.

Option No.	Description Of Option	Preferred Option	Total NPV (£m) *(Incl. Monetised Risk)*	Delta *(Option to baseline)*
Baseline	Baseline	N	£ 311.36	£ -
1	Full Replacement	Y	£ 362.62	£ 51.26

5. Conclusion

The two options proposed have been reviewed in terms of scope feasibility, cost, timescales and construction risks with Option 1 demonstrating the primary objective of refurbishment the cable system whilst affording greatest reduction in risk to the network.

In line with the costs prepared, the proposed scope of works and CBA analysis, option 1 is the selected option:

- Scheme Total Cost: £9.6M
- Timing of investment: 2022 – 2026
- Declared outputs:

Asset	Type of Activity	Disposal (cct. Km/sets/each)	Addition/Activity (cct. Km/sets/each)
132kV UG Cable (Oil)	Replacement	10 cct. Km	11 cct. Km

- Long term risk benefit (LR£m):

Asset Description	Long Term Risk Benefit (LR£m)
132kV UG Cable (Oil)	369.48

- Price control period of outputs: 2026

6. FUTURE PATHWAYS – NET ZERO

6.1 Primary Economic Driver

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

6.2 Payback Periods

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

6.3 Pathways and End Points

The network capacity and capability that result from the proposed option has been tested against and has been found to be consistent with the network requirements determined from the ETYS and NOA processes. Additionally, the proposed option is consistent with the route-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

The CBA inputs are 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

The supergrid voltage proposals do not inhibit whole system solutions but are more remote from the interfaces.

7. OUTPUTS INCLUDED IN RIIO T1 PLANS

N/A