SPM 33kV RMUs Fault Level Mitigation

ED2 Engineering Justification Paper Addendum

ED2-LRE-SPM-011-CV3-EJP-ADD

Issue	Date	Comments
Issue 0.1	Aug 2022	Internal Draft for Review
Issue 0.2	Aug 2022	Internal Draft with Comments Addressed
Issue 1.0	Aug 2022	First Issue - Draft Determination Response

Scheme Name	SPM 33kV RMUs Fault Level Mitigation		
PCFM Cost Type	Load Related		
Activity	33kV RMU Replacements and Monitoring		
Primary Investment Driver	Fault Level Mitigation		
Reference	ED2-LRE-SPM-011-CV3-EJP-ADD		
Output Type	Fault Level Reinforcement		
Cost	£6.057m		
Delivery Year	2024-28		
Reporting Table	CV3		
Outputs included in ED1	~~Yes~~/No		
Business Plan Section	Develop the Network of the Future		
Primary Annex	Annex 4A.2: Load Related Expenditure Strategy: Engineering Net Zero Annex 4A.6: DFES		
Spend Apportionment	**ED1**	**ED2**	**ED3**
	£m	**£6.057m**	**£m**

	Proposed by	Endorsed by	Approved by
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Signature			
Date	23/08/2022	23/08/2022	23/08/2022

1 Purpose

This addendum has been prepared to provide additional information and justification to ED2-LRE-SPM-011-CV3-EJP SPM 33kV RMUs Fault Level Mitigation EJP following receipt of RIIO ED2 Draft Determination The content of this addendum is in response to comments and feedback provided by Ofgem as to the "Partial Justification" status of the EJP. The purpose of this document is to support Ofgem's assessment for Final Determination including supporting any associated impact on engineering adjustments within Ofgem's financial modelling.

2 Ofgem Comments & Feedback

2.1 RIIO-ED2 Draft Determinations SPEN Annex

The following comments are taken from Table 25 of *"RIIO-ED2 Draft Determination SPEN Annex"*.

Ofgem Comment - Partially Justified. We agree with SPEN's needs case, however, consider the optioneering limited The make/break duty % thresholds applied to determine the optimum solution are inadequately justified, with a number of RTUs proposed for replacement over RTFLM that are marginally over the aforementioned thresholds. We consider the justification for the proposed intervention on these assets needs further work.

Ofgem Identified Risks - We did not believe that the proposed volumes had been sufficiently justified at this stage. Therefore, there is a risk that the out-turn volumes may differ from the proposed volumes.

2 2 Summary of Any Ofgem Supplementary Question Post Final Submission

On 24th January 2022, Ofgem sought further explanation on the criteria applied when deciding to replace legacy 33kV switchgear vs install RTFLM (Ref: SPEN018) SPEN provided a full response, details of which are included in Section 4.1.

3 Additional Justification

3.1 Our Response

The switchgear fault level duty assessments are based on the SP Energy Networks (SPEN) design policies ESDD-02-006[1] (Calculation of system fault levels) and ESDD-02-014[2] (Design for system fault levels and equipment capability), under which the design principles effectively ensure with regards to the equipment duty, the prospective network fault levels shall never be more than 100% of the plant capability However, as per SPEN design policy ESDD-02-014, there is a need to reflect the potential

[1] ESDD-02-006 Calculation of System Fault Levels

[2] ESDD-02-014 Design for system fault levels and equipment capability (available on request)

for under-estimation. The generic assumptions made in global assessment of fault levels will, by nature of the assumptions, have a margin of error which may be more, or less, onerous than reality Consequently, to reflect the potential for under-estimation, the policy states that, sites exceeding 95% of the network design rating are considered for mitigation

Furthermore, the RMU fleet is a legacy asset base with lower fault level ratings, type issues, high health index and high criticality index. Using RTFLM to defer investment, at sites exceeding the policy flag point of 95%, increases the risk of switchgear operating close to equipment ratings. These factors combined, increase the risk associated with disruptive or catastrophic failure We manage this risk by introducing a fault duty threshold, that considers asset health when choosing to:

1) Defer investment with the installation of RTFLM, or,
2) Replace RMUs, investing in modern units.

Overall, the health index-based thresholding is designed to manage the network risk experienced by customers and follows the principles set out in the managing network risk strategy. This is achieved via a targeted and prioritised asset specific approach using asset health and criticality This approach is necessary to effectively manage the business risk and ensure long term sustainability, utilising appropriate engineering interventions and risk management techniques Specifically, the strategy aims to:

1. **Maintain safety, integrity, and performance of the network.** Alleviate overstressing of aging assets: Appropriate fault duty thresholding for intervention planning; based on asset health and criticality indices; Considering, RMU type issues and the possibility of modelling assumption leading to underestimation of fault level.
2. **Intervene before asset failure**: Replace equipment before asset performance and reliability fall below acceptable operational limits or failure and will incur unacceptable system or financial risk exposure.
3. **Target investment based on an assessment of risk through Probability of Failure;** Health Index (HI1-HI5): by intervening in assets at, or approaching, end of life (HI5): Utilising a combination of engineering condition, age and type information, using CNAIM 2.1 within our CBRM system and the results detailed within our supporting Switchgear Assessment document, SWG-02-007.
4. **Prioritise investment based on an assessment of risk through Consequence of Failure;** Criticality Index (C1-C4): Taking account of factors such as public and staff safety, strategic importance, customer sensitivity to supply disturbances, asset performance and environmental considerations.

Annex 4A.4 - Network Asset Risk Strategy, contains details on our long-term risk strategy and our approach to network risk over the RIIO-ED2 period.

Considering the above risks, the Engineering Justification Paper (EJP) proposes to deploy Real Time Fault Level Monitoring (RTFLM) devices, at substations, where the Ring Main Unit (RMU) duties meet the criteria in Table 3 1

Table 3.1 Ring Main Unit fault level criteria for RTFLM selection

Health Index	Peak Make Range	RMS Break Range
1	95.0% < Make Duty <= 100.0%	90.0% < Break Duty <= 95.0%
2		
3		
4	95.0% < Make Duty <= 97.0%	
5		

RTFLM deployment, at the sites meeting these criteria, can give accurate fault level information, thereby the actual fault level headroom For sites, where fault level duty exceeds the criteria specified in Table 3 2, the guidance specified in design policy document ESDD-02-014 is applicable and fault level reinforcement is required.

Table 3.2. Ring Main Unit fault level criteria for reinforcement

Health Index	Peak Make Range	RMS Break Range
1	Make Duty > 100.0%	Break Duty > 95.0%
2		
3		
4	Make Duty > 97.0%	
5		

3 1 1 Real Time Fault Level Monitoring

The proposed option identifies 6 primary substations, shown in Table 3.3, for fault level monitoring. The cost of deploying an RTFLM device is £50k each, so for the 6 proposed sites, the total cost of fault level monitoring is £300k. The costs for these installations are included in our wider fault level innovation rollout scheme ED2-LRE-SPEN-001-CV3-EJP (Fault Level Monitoring and Management) and therefore excluded from this option. A sensitivity analysis (Option 2) shows the cost of this option including RTFLM, to provide the comparison to the baseline that includes all costs

Table 3.3 Primary substations with fault level duties, Risk Indices and driver for RTFLM

Substation Name	Equipment Rating (kA)		Make Duty	Break Duty	Volumes	Risk Index	Asset Age	Driver
	Make	Break	%	%	#	HIx | Cy	Yrs	
Stoneycroft	33.46	13.12	96.34	92.18	1	HI5 | C2	58	HI5 95.0%<Make<=97.0%
Stockton Heath	32.8	13.12	95.62	85.28	2	HI5 | C2	53	HI5 95.0%<Make<=97.0%
North Gate Terrace	33.46	13.12	95.34	93.51	1	HI5 | C3	57	HI5 95.0%<Make<=97.0%
Jacobs	33.46	13.12	95.2	82 29	2	HI4 | C2	57	HI4 95.0%<Make<=97.0%

Substation Name	Equipment Rating (kA)		Make Duty	Break Duty	Volumes	Risk Index	Asset Age	Driver
	Make	Break	%	%	#	HIx | Cy	Yrs	
Hawleys Lane	33.46	13.12	95.18	84.05	1	HI4 | C2	63	HI4 95.0%<Make<=97.0%
Suburban Road	32.8	13.12	95.11	91.38	1	HI5 | C2	65	HI5 95.0%<Make<=97.0%

The EJP identifies 15 primary substations for switchgear replacement. The selection process uses the criteria specified in Table 3.2. The scheme has been co-ordinated with the "non-load" team to ensure no overlap of investment planning.

Table 3.4 lists 15 sites that exceed the criteria for RTFLM. The proposed solution at each site is to replace the legacy assets with modern units.

Table 3.4 Primary substations with fault level duties, Risk Indices, and driver for replacement

Substation Name	Equipment Rating (kA)		Make Duty	Break Duty	Volume	Risk Index	Asset Age	Drivers
	Make	Break	%	%	#	HIx | Cy	Yrs	
Woodend Ave	33.46	13.12	106.96	87.29	1	HI5 | C2	62	HI5 Make Duty > 97%
Mobil Oil (Wallasey)	33.46	13.12	104.17	101.38	1	HI5 | C2	70	HI5 Break Duty > 95%
B R Shore Road	33.46	13.12	102.85	100.5	2	HI5 | C2	65	HI5 Break Duty > 95%
Blundell Street	33.46	13 12	102.84	93 23	1	HI5 | C2	57	HI5 Make Duty > 97%
Hammond Road	33.46	13.12	101.83	93.2	1	HI5 | C2	65	HI5 Make Duty > 97%
Weaver Ind Estate	32.8	13.12	100.61	91.97	1	HI5 | C2	56	HI5 Make Duty > 97%
St James	33.46	13.12	99.64	93.03	2	HI5 | C2	70	HI5 Make Duty > 97%
Regent Road	33.46	13 12	98.89	93.65	1	HI5 | C2	62	HI5 Make Duty > 97%
Dickinsons	33.46	13 12	98.77	91 39	1	HI5 | C2	56	HI5 Make Duty > 97%
St. Ivel Foods	32.8	13.12	98.22	90.97	1	HI5 | C2	65	HI5 Make Duty > 97%
Mannings Lane	33.46	13.12	98.12	95.18	1	HI4 | C2	58	HI4 Break Duty > 95%
Sheil Park	33.46	13 12	97 99	93 29	1	HI4 | C2	57	HI4 Make Duty > 97%
Littlewoods	33.46	13 12	97.83	95.03	1	HI5 | C2	46	HI5 Break Duty > 95%
Gardners Row	33.46	13.12	97.36	93.09	1	HI4 | C2	59	HI4 Make Duty > 97%
Hills Moss	33.46	13.12	95.95	99.36	1	HI5 | C2	70	HI5 Break Duty > 95%

3.2 Supplementary Optioneering – Sensitivity Analysis

Table 3 5 below presents the shortlisted options that are taken forward for detailed analysis and included in the cost-benefit analysis. Option 1, which is a combination of conventional switchgear replacement and innovative fault level monitoring is the "do minimum" option among the considered options.

A long list of options considered for this scheme are presented in the EJP (SPM 33kV RMUs Fault Level Mitigation). A few of the longlist options are rejected based on the technical and commercial restrictions, with reasons provided in the main document

Table 3.5. Options taken forward for detailed analysis and included in the cost-benefit analysis.

Options	Comment	
Baseline - Replace switchgear with fault level above policy threshold.	Baseline – Traditional Reinforcement	Included in EJP
Option 1- Utilise RTFLM at sites with sufficient headroom and appropriate asset health. Replace switchgear at sites where RTFLM criteria is not met.	Proposed Solution "Do minimum" Outcome of Innovation RTFLM trials.	Included in EJP
Option 2 Sensitivity Analysis (Option 1 with inclusion of RTFLM costs)	Sensitivity from Option 1	New
Option 3 – Sensitivity Analysis (Option 1 with inclusion of health driven replacements in RIIO ED3)	Sensitivity from Option 1	New

3.2.1 Option 2 Sensitivity Analysis (Option 1 with inclusion of RTFLM costs)

The total cost of fault level monitoring in the proposed option (Option 1) is £300k. The cost is excluded from this EJP, as the installations are included in our wider fault level innovation rollout scheme ED2-LRE-SPEN-001-CV3-EJP (Fault Level Monitoring and Management). This option is a sensitivity analysis to examine Option 1 with the inclusion of this cost, providing a fair comparison to the baseline option.

In addition to the costs in Option 1, the cost associated with RTFLM (£300k) is added to the replacement RMU costs. The analysis shows that, compared to the baseline, this option has lower forecast capital expenditure, higher NPV and represents a lower-cost option, for all payback periods.

Table 3.6. Option 2 (Sensitivity from Option 1) NPV against baseline

Options	NPVs based on payback periods from 2023/24 (£m)			
	10 years	20 years	30 years	45 years
Baseline - Replace the switchgear with fault level issues.				
Option 2 Sensitivity Analysis (Option 1 with inclusion of RTFLM costs)	1 28	1.81	2 13	2 38

3.2.2 Option 3 Sensitivity Analysis (Option 1 with inclusion of health driven replacements in RIIO-ED3)

This sensitivity from Option 1, considers the potential need to replace RMUs, at RTFLM proposed sites, in RIIO-ED3. The sensitivity analysis shows, that, even if all 8 RMUs are replaced in RIIO-ED3, Option 1 still provides a higher NPV and represents a lower-cost option than the baseline, for all payback periods.

Table 3.7 Option 3 (Sensitivity from option 1) NPV against baseline

Options	NPVs based on payback periods from 2023/24 (£m)			
	10 years	20 years	30 years	45 years
Baseline - Replace the switchgear with fault level issues.				
Option 3 – Sensitivity Analysis (Option 1 with inclusion of health driven replacements in RIIO-ED3)	0.37	0.27	0.21	0.15

3.2.3 Options Cost Summary Table

Summary of the costs for each of the evaluated options is presented in Table 3-8.

Table 3-8: Summary of Cost-Benefit Analysis

Options	Decision	Comment	NPVs based on payback periods from 2023/24 (£m)			
			10 years	20 years	30 years	45 years
Baseline-Replace the switchgear with fault level issues.	Rejected	Rejected based on NPV				
Option 1* Replace legacy switchgear and manage the fault level using RTFLM	Adopted		1.42	2.02	2 38	2 65
Option 2 Sensitivity Analysis (Option 1 with inclusion of RTFLM costs)	Sensitivity from Option 1		1.28	1.81	2.13	2.38
Option 3 Sensitivity Analysis (Option 1 with inclusion of health driven replacements in RIIO-ED3)	Sensitivity from Option 1		0.37	0.27	0.21	0.15

*The cost of the 6 fault level monitoring sites is £300k (£50k/unit) and excluded from Option 1 and NPV is reflective of this. Including these RTFLM costs within CBA under Option 1 does not change the adopted solution, as can be seen in sensitivity analysis Options 2 & 3.

4 Appendix

The content of this appendix has been redacted