

OPTIONS EVALUATION REPORT (OER)



Various Locations Bushing Renewal

OER 000000001525 revision 2.0

Ellipse project no.: P0008807

TRIM file: [TRIM No]

Project reason: Capability - Asset Replacement for end of life condition

Project category: Prescribed - Replacement

Approvals

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Date submitted for approval	3 November 2017	

Change history

Revision	Date	Amendment
0	30 June 2016	Initial issue
1	26 October 2016	Risk cost changed, minor scope change, ALARP tables updated
2	12 December 2016	Update to format
3	3 November 2017	Update to NPV and scope

1. Need/opportunity

TransGrid has a population of bushings installed over a range of voltages and years and that use a variety of technologies. The bushings are installed on transformers across the network and their duty cycle, environmental exposure and loading also varies. Finally the individual impact of their failure varies with location in the network.

Bushings on 13 transformers and two reactors are included in the scope of this OER. Note that these transformers and reactors are not identified for refurbishment or replacement in other Needs.

High Voltage bushings installed on a number of power transformers are approaching end of life in the regulatory period from 2018-2023.

2. Related Needs/opportunities

Programs for other substation assets are being developed and should be considered when packaging work for delivery.

3. Options

All dollar values in this document are expressed in un-escalated 2016/17 dollars.

Base Case

The Base Case is to do nothing and let the transformer continue to run to failure. There is a risk cost of \$0.69m per annum associated with this option.

Option A — Replacement of the bushings with new resin impregnated (RIP) bushings [[OFR 1525A](#), [OFS 1525A](#)]

This option considers the replacement of the transformer with a new unit, including the following works:

- > Procurement of new bushings
- > Replacement of bushings
- > Disposal of the replaced bushings

The outcome of this option is the removal of oil impregnated (OIP) that are now at high risk of failure with RIP type bushings. OIP bushings have a failure mechanism that typically results in loss of the associated transformer whereas the failure mechanism of RIP bushings is not expected to result in transformer loss.

Capex spend estimated in the Option Feasibility Study (OFS) for this option is \$5.55m.

Operating costs have been estimated to be negligible. Within the total risk cost, financial cost is the most significant driver of the residual total risk cost.

4. Evaluation

4.1 Commercial evaluation

The economic evaluation of the technically feasible options are calculated by using the probability of failure curve and therefore shown increasing benefits as the asset ages. The results are set out in Table 1.

Table 1 — Commercial evaluation (\$ million)

Bushings	Option	Description	Total capex	Annual opex	Annual post project risk cost	Economic NPV @10%	Rank
BKH No.1	Base Case	Do nothing	-	-	0.06	-	2
	A	Bushing replacement	0.46	-	0	0.36	1
BKH No.2	Base Case	Do nothing	-	-	0.06	-	2
	A	Bushing replacement	0.46	-	0	0.36	1
MPP No.1	Base Case	Do nothing	-	-	0.06	-	2
	A	Bushing replacement	0.19	-	0	0.60	1
MPP No.2	Base Case	Do nothing	-	-	0.06	-	2
	A	Bushing replacement	0.19	-	0	0.60	1
BRG X5/3	Base Case	Do nothing	-	-	0.54	-	2
	A	Bushing replacement	0.39	-	0	0.21	1
DN2 No.1	Base Case	Do nothing	-	-	0.36	-	2
	A	Bushing replacement	0.20	-	0	0.33	1
DN2 No.2	Base Case	Do nothing	-	-	0.36	-	2
	A	Bushing replacement	0.20	-	0	0.33	1
DNT No.3	Base Case	Do nothing	-	-	0.30	-	2
	A	Bushing replacement	0.60	-	0	0.000067	1
DNT No.4	Base Case	Do nothing	-	-	0.30	-	2
	A	Bushing replacement	0.60	-	0	0.000067	1
DNT X5/1	Base Case	Do nothing	-	-	0.29	-	2
	A	Bushing replacement	0.38	-	-	0.01	1
CA1 No.1	Base Case	Do nothing	-	-	0.80	-	2
	A	Bushing replacement	0.39	-	0	0.59	1
MTP No.3	Base Case	Do nothing	-	-	0.28	-	1
	A	Bushing replacement	0.31	-	0	(0.014)	2
MRK No.1	Base Case	Do nothing	-	-	0.55	-	2
	A	Bushing replacement	0.40	-	0	0.33	1

Bushings	Option	Description	Total capex	Annual opex	Annual post project risk cost	Economic NPV @10%	Rank
DNT No.1	Base Case	Do nothing	-	-	0.34	-	2
	A	Bushing replacement	0.35	-	0	0.0000024	1
DNT No.2	Base Case	Do nothing	-	-	0.34	-	2
	A	Bushing replacement	0.42	-	0	0.12	1

The Net Present Value (NPV) analysis is based on a discount rate of 10%, discounted to June 2018. Table 2 provides a sensitivity analysis based on TransGrid's current AER-determined pre-tax real regulatory Weighted Average Cost of Capital (WACC) of 6.75% and an upper bound of 13%.

Table 2 — Discount rate sensitivities (\$ million)

Option	Description	Economic NPV @13%	Economic NPV @6.75%
A	Bushing replacement	1.26	8.45

4.2 SFAIRP/ALARP evaluation

Options to reduce the network safety risk as per the risk treatment hierarchy have been considered in other lifecycle stages of the asset, and it has been determined that no reasonably practicable options exist to reduce the risk further than those capital investment options listed in Table 1.

Evaluation of the proposed options has been completed against the SFAIRP (So Far As Is Reasonably Practicable)/ALARP (As Low As Reasonably Practical) obligation, as required by the Electricity Supply (Safety and Network Management) Regulation 2014 and the Work Health and Safety Act 2011. The Key Hazardous Events and the disproportionality multipliers considered in the evaluation are as follows:

- > Catastrophic failure of asset/uncontrolled discharge or contact with electricity/ unauthorised access to site - 3 times the safety risk and 10% of the reliability risk (applicable to safety)
- > Unplanned outage of High Voltage (HV) equipment - 10% of the reliability risk (applicable to safety)

The results of this evaluation is summarised in the tables below.

Table 3 – Feasible options (\$ thousand)

Bushings	Option	Description	CAPEX	Expected Life	Annualised CAPEX
Base	Base	Do Nothing	N/A	N/A	N/A
BKH No.1	A	Bushing Replacement	455,259	35 years	34,207
BKH No.2	A	Bushing Replacement	455,259	35 years	34,207
MPP No.1	A	Bushing Replacement	185,060	35 years	13,905
MPP No.2	A	Bushing Replacement	185,060	35 years	13,905
BRG X5/3	A	Bushing Replacement	391,621	35 years	29,426

Bushings	Option	Description	CAPEX	Expected Life	Annualised CAPEX
DN2 No.1	A	Bushing Replacement	202,426	35 years	15,210
DN2 No.2	A	Bushing Replacement	202,426	35 years	15,210
DNT No.3	A	Bushing Replacement	609,036	35 years	45,762
DNT No.4	A	Bushing Replacement	609,036	35 years	45,762
DNT X5/1	A	Bushing Replacement	381,026	35 years	28,630
CA1 No.1	A	Bushing Replacement	391,923	35 years	29,448
MTP No.3	A	Bushing Replacement	312,962	35 years	23,515
MRK No.1	A	Bushing Replacement	394,987	35 years	29,679
DNT No.1	A	Bushing Replacement	345,268	35 years	25,943
DNT No.2	A	Bushing Replacement	424,287	35 years	31,880

Table 4 – Annual risk calculations (\$ thousand)

Bushings	Options	Annual Residual Risk		Annual Risk Savings	
		Safety Risk	Reliability Risk	Safety Risk	Reliability Risk
BKH No.1	Base	11,371	289	N/A	N/A
BKH No.1	A	1	0	11,370	289
BKH No.2	Base	11,371	289	N/A	N/A
BKH No.2	A	1	0	11,370	289
MPP No.1	Base	5,620	2,7468	N/A	N/A
MPP No.1	A	0	2	5,620	27,466
MPP No.2	Base	5,620	2,7468	N/A	N/A
MPP No.2	A	0	2	5,620	27,466
BRG X5/3	Base	2,828	22,474	N/A	N/A
BRG X5/3	A	0	0	2,828	22,474
DN2 No.1	Base	2,156	16,551	N/A	N/A
DN2 No.1	A	0	2	2,156	16,549
DN2 No.2	Base	2,156	16,551	N/A	N/A
DN2 No.2	A	0	2	2,156	16,549

Bushings	Options	Annual Residual Risk		Annual Risk Savings	
		Safety Risk	Reliability Risk	Safety Risk	Reliability Risk
DNT No.3	Base	3,092	2	N/A	N/A
DNT No.3	A	0	0	3,092	2
DNT No.4	Base	3,092	2	N/A	N/A
DNT No.4	A	0	0	3,092	2
DNT X5/1	Base	4,309	1,630	N/A	N/A
DNT X5/1	A	0	0	4,309	1,630
CA1 No.1	Base	10,692	2,468	N/A	N/A
CA1 No.1	A	0	0	10,692	2,468
MTP No.3	Base	3,533	526	N/A	N/A
MTP No.3	A	0	0	3,533	526
MRK No.1	Base	3,424	1,960	N/A	N/A
MRK No.1	A	0	0	3,424	1,960
DNT No.1	Base	3,092	7,148	N/A	N/A
DNT No.1	A	0	1	3,092	7,147
DNT No.2	Base	3,092	7,148	N/A	N/A
DNT No.2	A	0	1	3,092	7,147

Table 5 – Reasonably practicable test (\$ thousand)

Bushings	Option	Description	Network Safety Risk Reduction ¹	Annualised CAPEX	Reasonably practicable ² ?
BKH No.1	A	Bushing Replacement	34,140	34,207	No
BKH No.2	A	Bushing Replacement	34,140	34,207	No
MPP No.1	A	Bushing Replacement	19,606	13,905	Yes
MPP No.2	A	Bushing Replacement	19,606	13,905	Yes
BRG X5/3	A	Bushing Replacement	10,730	29,426	No

¹ The Network Safety Risk Reduction is calculated as 3 x Safety Risk Reduction + 0.1 x Reliability Risk Reduction. No bushfire risk is applicable for the consequences considered.

² Reasonably practicable is defined as whether the annualised CAPEX is less than the Network Safety Risk Reduction.

Bushings	Option	Description	Network Safety Risk Reduction ¹	Annualised CAPEX	Reasonably practicable ² ?
DN2 No.1	A	Bushing Replacement	8,122	15,210	No
DN2 No.2	A	Bushing Replacement	8,122	15,210	No
DNT No.3	A	Bushing Replacement	9,278	45,762	No
DNT No.4	A	Bushing Replacement	9,278	45,762	No
DNT X5/1	A	Bushing Replacement	13,090	28,630	No
CA1 No.1	A	Bushing Replacement	32,324	29,448	Yes
MTP No.3	A	Bushing Replacement	10,653	23,515	No
MRK No.1	A	Bushing Replacement	10,468	29,679	No
DNT No.1	A	Bushing Replacement	9,992	25,943	No
DNT No.2	A	Bushing Replacement	9,992	31,880	No

4.3 Preferred option

Based on the economic and ALARP evaluation the preferred option is Option A for bushings installed on all of the proposed transformers and reactors except MTP No.3 Transformer.

Total Capex spend estimated for this option is \$5.23m.

Capital and operating expenditure

There are no other ongoing capital expenditure considerations beyond the initial asset replacement project.

Regulatory Investment Test

A RIT-T is unlikely to be required but confirmation should be sought from Asset Management.

5. Recommendation

It is recommended that Option A (except bushing replacement for MTP No.3 Transformer) be scoped in detail to allow for implementation.