

OPTIONS EVALUATION REPORT (OER)



Various Locations Bushing Renewal

OER 000000001525 revision 1.0

Ellipse project description:

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	25 October 2016	

Change history

Revision	Date	Amendment
1	12 Oct. 16	Risk cost changed; Minor scope change; Alarp tables updated

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

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 RIP (resin impregnated) 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 OIP (oil impregnated) 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 OFS for this option is \$5.55 million (in un-escalated 2016/17 dollars).

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 Economic 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 below.

Table 1: Economic NPV Comparison of options

Bushings	Option	Description	Capex (16/17 \$)	Opex (16/17 \$)	Post project risk cost (\$)	NPV (\$)	Rank
BKH No.1	Base Case	Do nothing	-	-	63,064	-	-
	A	Bushing replacement	455,259	-	4	359,403	1
BKH No.2	Base Case	Do nothing	-	-	63,064	-	-
	A	Bushing replacement	455,259	-	4	359,403	1
MPP No.1	Base Case	Do nothing	-	-	59,886	-	-
	A	Bushing replacement	185,060	-	5	603,557	1
MPP No.2	Base Case	Do nothing	-	-	59,886	-	-
	A	Bushing replacement	185,060	-	5	603,557	1
BRG X5/3	Base Case	Do nothing	-	-	54,197	-	-
	A	Bushing replacement	391,621	-	1	208,982	1
DN2 No.1	Base Case	Do nothing	-	-	35,557	-	-
	A	Bushing replacement	202,426	-	5	330,599	1
DN2 No.2	Base Case	Do nothing	-	-	35,557	-	-
	A	Bushing replacement	202,426	-	5	330,599	1
DNT No.3	Base Case	Do nothing	-	-	30,058	-	-
	A	Bushing replacement	609,036	-	4	671	1
DNT No.4	Base Case	Do nothing	-	-	30,058	-	-
	A	Bushing replacement	609,036	-	4	671	1
DNT X5/1	Base Case	Do nothing	-	-	28,515	-	-
	A	Bushing replacement	381,026	-	-	(34,395)	1
CA1 No.1	Base Case	Do nothing	-	-	79,738	-	-
	A	Bushing replacement	391,923	-	4	580,914	1
	Base Case	Do nothing	-	-	28,132	-	-

Bushings	Option	Description	Capex (16/17 \$)	Opex (16/17 \$)	Post project risk cost (\$)	NPV (\$)	Rank
MTP No.3	A	Bushing replacement	312,962	-	4	(61,339)	1
	Base Case	Do nothing	-	-	54,602	-	-
MRK No.1	A	Bushing replacement	394,987	-	4	329,797	1
	Base Case	Do nothing	-	-	34,029	-	-
DNT No.1	A	Bushing replacement	345,268	-	4	(52,097)	1
	Base Case	Do nothing	-	-	34,029	-	-
DNT No.2	A	Bushing replacement	424,287	-	4	115,452	1
	Base Case	Do nothing	-	-	34,029	-	-

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

Table 2: Economic NPV Sensitivity Analysis

Option	Description	Economic NPV with Discount Rate of 13% (18/19 \$m)	Economic NPV with Discount Rate of 6.75% (18/19 \$m)
A	Bushing replacement	1.26	8.45

4.2 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 **Error! Reference source not found.**

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 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

Bushings	Option	Description	Capex (\$)	Expected life (yrs)	Annualised CAPEX (\$)
Base	Base	Do Nothing	N/A	N/A	N/A
BKH No.1	A	Bushing Replacement	455,259	35	13,007
BKH No.2	A	Bushing Replacement	455,259	35	13,007
MPP No.1	A	Bushing Replacement	185,060	35	5,287
MPP No.2	A	Bushing Replacement	185,060	35	5,287
BRG X5/3	A	Bushing Replacement	391,621	35	11,189
DN2 No.1	A	Bushing Replacement	202,426	35	5,784
DN2 No.2	A	Bushing Replacement	202,426	35	5,784
DNT No.3	A	Bushing Replacement	609,036	35	17,401
DNT No.4	A	Bushing Replacement	609,036	35	17,401
DNT X5/1	A	Bushing Replacement	381,026	35	10,886
CA1 No.1	A	Bushing Replacement	391,923	35	11,198
MTP No.3	A	Bushing Replacement	312,962	35	8,942
MRK No.1	A	Bushing Replacement	394,987	35	11,285
DNT No.1	A	Bushing Replacement	345,268	35	9,865
DNT No.2	A	Bushing Replacement	424,287	35	12,122

Table 4: Annual Risk Calculation

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
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

Bushings	Options	Annual Residual Risk		Annual Risk Savings	
		Safety Risk (\$)	Reliability Risk (\$)	Safety Risk (\$)	Reliability Risk (\$)
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

Bushings	Option	Description	Network Safety Risk Reduction ¹ (\$)	Annualised CAPEX (\$)	Reasonably practicable ²
BKH No.1	A	Bushing Replacement	34,140	13,007	Yes
BKH No.2	A	Bushing Replacement	34,140	13,007	Yes
MPP No.1	A	Bushing Replacement	19,606	5,287	Yes
MPP No.2	A	Bushing Replacement	19,606	5,287	Yes
BRG X5/3	A	Bushing Replacement	10,730	11,189	No
DN2 No.1	A	Bushing Replacement	8,122	5,784	Yes
DN2 No.2	A	Bushing Replacement	8,122	5,784	Yes
DNT No.3	A	Bushing Replacement	9,278	17,401	No
DNT No.4	A	Bushing Replacement	9,278	17,401	No
DNT X5/1	A	Bushing Replacement	13,090	10,886	Yes
CA1 No.1	A	Bushing Replacement	32,324	11,198	Yes
MTP No.3	A	Bushing Replacement	10,653	8,942	Yes
MRK No.1	A	Bushing Replacement	10,468	11,285	No
DNT No.1	A	Bushing Replacement	9,992	9,865	Yes
DNT No.2	A	Bushing Replacement	9,992	12,122	No

Note 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.

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

4.3 Preferred Option

Based on the economic evaluation the preferred option is Option A for bushings installed on:

- BKH No.1 & 2 transformers
- MPP No.1 & 2 transformers
- BRG x5/3 reactor
- DN2 No.1 & 2 transformers
- DNT No.1, 2, 3 & 4 transformers
- CA1 No.1 transformer
- MRK No.1 transformer

Based on the ALARP evaluation the preferred option is Option A for bushings installed on:

- MRK No.1 transformer
- MTP No.3 transformer
- DNT X5/1 No.1 reactor

Total Capex spend estimated for this option is \$5.55 million (in un-escalated 2016/17 dollars).

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 not required as this is an asset replacement project with no augmentation component.

5. Recommendation

It is recommended that Option A be scoped in detail to allow for implementation.