OPTIONS EVALUATION REPORT (OER)

Armidale 330kV No. 2 Rx Renewal

OER 000000001607 revision 2.0

Ellipse project no.: P0009545
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Project reason: Capability - Asset Replacement for end of life condition
Project category: Prescribed - Replacement

Approvals

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Date submitted for approval	12 December 2016	

Change history

Revision	Date	Amendment
0	11 October 2016	Initial issue
1	26 October 2016	Updated risk costs, Capex, SFAIRP/ALARP methodology, figures and wording throughout.
2	12 December 2016	Update to format

1. Need/opportunity

The Armidale 330kV Substation contains four 330kV shunt reactors. The No.2 reactor is made up of three single-phase oil-filled units with a total capacity of 50 Mega Volt Amps (reactive) (MVAr), and is connected to the 87 Coffs Harbour transmission line.

The No.2 reactor was installed in 1992. A condition assessment has been conducted on the reactor and has confirmed that it is exhibiting signs that it is approaching the end of its useful life. This Need should be addressed by 2023.

2. Related Needs/opportunities

A reactor renewal program has been established under Need 1470 to address the life extension of several reactors. The Armidale No.2 Reactor will be excluded from this refurbishment program.

Separate renewal programs have also been established to address other asset types. These Needs, and their associated delivery strategies, should be considered when determining how to address this Need.

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 reactor continue to run to failure. There is a risk cost of $0.26m per annum associated with this risk.

Option A — Replacement of the reactor [OFR 1607A, OFS 1607A]

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

- Procure and install the new reactor with the same ratings.
- Disposal of the existing No. 2 Reactor.
- All work associated with ensuring the bund complies with current design standards.

This option is expected to require a total capital cost of $3.60m, which has been estimated from a scope of work determined by a limited review of the option. This option is expected to significantly reduce the identified risks.

Option B – Refurbishment of the reactor [OFR 1470A, OFS 1470A]

This option considers the refurbishment of the reactor onsite, targeting defects identified in the condition assessment of the reactor (refer Network Asset Condition Assessment (NACA) NACA DCN117), including the following works:

- Oil filtering and degassing to remove particles and dissolved gases within the reactor oil and windings
- Oil treatment and circulation to remove moisture in the oil and windings
- Eliminating oil leaks and removing stains associated with the white phase CT box, blue phase top pipe flange, and radiator valves
- Corrosion repair and repainting of the reactor
- An internal investigation, if feasible, to attempt to find and rectify the cause of mechanical noises and discharge

This option was included under the Reactor Renewal Program 2019-23 (Need 1470), and the cost estimate was developed as part of the renewal program. This option is expected to require a total capital cost of $556k, which has been estimated from a scope of work determined by a limited review of the option. The expected total residual risk cost is $0.18m per annum.

The modelling of the effectiveness of the costed refurbishment actions (excluding the mechanical noise and discharge investigation) indicates that the maximum amount of life extension that may be achieved would be approximately two or three years. This is because the mechanical faults developed over the past decade, as indicated by the increasing levels of dissolved gases, cannot be repaired through refurbishment and confirms that the reactor is nearing the end of its life. The maximum life extension achieved by the refurbishment in Option B has therefore been determined to be four years.

4. Evaluation

4.1 Commercial evaluation

The result of commercial evaluation for each of the technically feasible options is summarised in Table 1.

Table 1 — Commercial evaluation ($ million)

Option	Description	Total capex	Annual opex	Annual post project risk cost	Economic NPV @10%	Rank
Base Case	Run-to-fail	N/A	N/A	0.26	N/A	3
A	Replacement of the reactor	3.60	-	0	0.58	1
B	Refurbishment of the reactor	0.56	-	0.18	0.45	2

There is a marginal reduction in Opex expected to be achieved by both options due to a reduction in defects. A new reactor installed under Option A will also have a reduced routine maintenance cost. Both of these reductions are less than $2.00k per annum each and are therefore insignificant in the economic evaluation.

The analysis period is 30 years. The Net Present Value (NPV) analysis has been completed assuming this four-year life extension is achieved, modelled through a four-year reduction in the effective age of the reactor as mentioned above in section 3. The corresponding reduction in the probability of failure and risk score has been used to calculate the NPV and post-project risk costs.

The commercial evaluation is based on a discount rate of 10%, discounted to June 2019. Table 2 below 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	Replacement of the reactor	(0.49)	2.76
B	Refurbishment of the reactor	0.18	0.96

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 3.

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 are summarised in the tables below.

Table 3 – Feasible options ($ thousand)

Option	Description	CAPEX	Expected Life	Annualised CAPEX
Base	Run-to-fail	N/A	N/A	N/A
A	Replacement of the reactor	3,600	45 years	80
B	Refurbishment of the reactor	560	25 years	22

Table 4 – Annual risk calculations ($ thousand)

Options	Annual Residual Risk		Annual Risk Savings	
	Safety Risk	Reliability Risk	Safety Risk	Reliability Risk
Base	13	7	N/A	N/A
A	0	0	13	7
B	9	5	4	2

Table 5 – Reasonably practicable test ($ thousand)

Option	Description	Network Safety Risk Reduction[1]	Annualised CAPEX	Reasonably practicable[2]?
A	Replacement of the reactor	39	80	No
B	Refurbishment of the reactor	12	22	No

4.3 Preferred option

Options A and B are not reasonably practicable.

[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.

Option A has the highest NPV and therefore the preferred option is A.

Capital and operating expenditure

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

Regulatory Investment Test

A Regulatory Investment Test for Transmission (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.