OPTIONS EVALUATION REPORT (OER)

Line 31/32 330kV Transmission Lines Renewal

OER 000000001275 revision 3.0

Ellipse project no.: P0005457
TRIM file: [TRIM No]

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

Approvals

Author	Edward Luk	Transmission Lines and Cables Analyst
Endorsed	Steve Stavropoulos	Transmission Lines and Cables Asset Manager
	Azil Khan	Investment Analysis Manager
Approved	Lance Wee	Manager/Asset Strategy
Date submitted for approval	8 December 2016	

Change history

Revision	Date	Amendment
0	19 June 2016	Initial issue
1	20 September 2016	Revised for Updated Risk Cost
2	27 October 2016	Revised for New SFAIRP/ALARP Methodology
3	8 December 2016	Update to format

1. Need/opportunity

Line 31/32 is a double circuit steel tower 330kV transmission line between Bayswater and Regentville 330kV Substations, with a route length of 171 km. The transmission line is a key link between the Sydney metropolitan area and the Hunter Valley generators. This transmission line was originally constructed in 1969 and consists of 456 structures. It mostly traverses through Wollemi National Park and timbered ridgetops. Within the Sydney basin, the line runs through rural properties and backs onto residential areas.

Network Asset Condition Assessment (NACA) NACA 1275 performed in October/November 2015 has identified a number of corrosion related issues with Transmission Line 31/32 which require rectification in the short – medium term (within the 2018-2023 Regulatory Control Period) to ensure that asset risk levels remain within an acceptable level in the longer term.

2. Related Needs/opportunities

No related Needs/opportunities have been identified.

3. Options

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

Base Case

Network Asset Condition Assessment (NACA) NACA 1275 has identified existing issues with the line which require rectification. A summary of these can be found in Need/Opportunity Statement (NOS) NS 1275.

Under a Base Case 'run-to-fail' option, the associated risk cost from the issues identified in Table 1 is $7.33m per annum. A breakdown of the Base Case risk cost by category is shown in Table 1.

Table 1 – Base Case risk cost by category ($ million)

Risk Category	Annual Risk Cost
Reliability (System)	3.52
Financial	0.04
Operational/Compliance	0
People (Safety)	1.00
Environment	2.76
Reputation	0.01
Total	**7.33**

It can be seen from Table 1 that the highest risk cost is associated with the 'reliability (system)' category due to the criticality of the line in linking the Hunter Valley generators to the Sydney metropolitan area. Other significant contributors to the overall risk cost are the 'environment' and 'people (safety)' categories, due to the significant consequences of a bushfire event resulting from conductor drop failure and faulty tower earthing.

The risk cost per kilometre of line is $0.043m per annum.

Option A — Line Refurbishment [OFR 1275A, OFS 1275A]

This option involves the refurbishment of Line 31/32 including corrosion treatment and replacement of components which have reached end of life and could lead to asset failure due to corrosion. The scope of this option is summarised in Table 2.

Table 2 – Transmission Line 31/32 Option A scope of works

Issue	Qty	Remediation
Ground line corrosion of steel at footing	9 towers	> Abrasive blast cleaning of steelwork to remove any corrosion product, application of Zinga paint and concrete encasement to prevent future corrosion
Buried concrete foundations	47 towers	> Dig out tower legs, abrasive blast cleaning of steelwork to remove any corrosion product, application of Zinga paint and establishment of drainage channel
Corrosion of earth strap	47 towers	> Replacement of earth straps in line with current standard
Rusting of tower steel members	47 towers	> Replacement of members > Assume 2% of minor members per tower
Corrosion of fasteners	47 towers	> Replacement of fasteners > Assume 5% of fasteners per tower
Corrosion of insulators	1905 insulator strings	> Replacement with composite longrod insulators
Damaged conductor dampers	5% of line 1092 dampers	> Replacement of Stockbridge vibration dampers > Assumed 16 vibration dampers per full tension span per phase
Damaged earthwire dampers	5% of line 91 dampers	> Replacement of spiral vibration dampers > Assumed 2 vibration dampers per full tension span per wire

It is estimated that the capital expenditure associated with the refurbishment outlined in this option is $4.60m ±25%. Details can be found in Section 6 of Option Feasibility Study (OFS) OFS 1275A.

Following the refurbishment under this option, the risk cost associated with the remediated line is $5.97m per annum. A breakdown of the Option A risk cost by category is shown in Table 3.

Table 3 – Option A Risk cost by category (million $)

Risk Category	Annual Risk Cost
Reliability (System)	2.60
Financial	0.03
Operational/Compliance	0

Risk Category	Annual Risk Cost
People (Safety)	0.86
Environment	2.46
Reputation	0.01
Total	**5.97**

The total projected risk reduction as a result of implementing Option A is $1.37m per annum. It can be seen from Table 3 that these risk reductions are expected to come from the 'reliability (system)', 'environment' and 'people (safety)' categories.

The total projected risk reduction per kilometre of line is $0.008m per annum.

Both the base case option and Option A outlined in Section 3 are considered to be technically feasible[1].

4. Evaluation

4.1 Commercial evaluation

The commercial evaluation of the technically feasible options is set out in Table 4. Details of the Net Present Value (NPV) calculation for Option A are provided in Attachment 1.

Table 4 — Commercial evaluation ($ million)

Option	Description	Total capex	Annual opex	Annual post project risk cost	Economic NPV @10%	Financial NPV @10%	Rank
Base Case	Run-to-fail	N/A	N/A	7.33	N/A	N/A	2
A	Line refurbishment	4.60	-	5.97	5.25	(0.60)	1

The commercial evaluation is based on:

- A 10% discount rate
- A life of the investment of 20 years and a corresponding residual/terminal value

Discount rate sensitivities based on TransGrid's current AER-determined pre-tax real regulatory Weighted Average Cost of Capital (WACC) of 6.75% and 13% appear in Table 5.

Table 5 — Discount rate sensitivities ($ million)

Option	Description	Economic NPV @13%	Economic NPV @6.75%
A	Line refurbishment	3.43	8.33

[1] An option is technically feasible if TransGrid reasonably considers that there is a high likelihood that the option, if developed, will provide the relevant service while complying with all relevant laws.

4.2 SFAIRP/ALARP evaluation

In the context of the Network Asset Risk Assessment Methodology, the SFAIRP (So Far As Is Reasonably Practicable)/ALARP (As Low As Reasonably Practical) principle is applicable to the following Key Hazardous Events:

- Structure failure
- Conductor / earthwire drop
- Uncontrolled discharge or contact with electricity (faulty earthing)

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 6.

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:

- Structure failure – 6 times the environment (bushfire) risk, 6 times the safety risk and 10% of the reliability risk (applicable to safety)
- Conductor / earthwire drop – 6 times the environment (bushfire) risk, 6 times the safety risk and 10% of the reliability risk (applicable to safety)
- Uncontrolled discharge or contact with electricity (faulty earthing) – 6 times the environment (bushfire) risk, 6 times the safety risk and 10% of the reliability risk (applicable to safety)

Table 6 – Feasible options ($ thousand)

Option	Description	CAPEX	Expected Life	Annualised CAPEX
Base	Run-to-fail	N/A	N/A	N/A
A	Line refurbishment	4,600	20 years	230

Table 7 – Annual risk calculations ($ thousand)

Option	Annual Residual Risk			Annual Risk Savings		
	Safety Risk	Reliability Risk	Bushfire Risk	Safety Risk	Reliability Risk	Bushfire Risk
Base	999	3,518	2,760	N/A	N/A	N/A
A	858	2,604	2,461	141	914	299

Table 8 – Reasonably practicable test ($ thousand)

Option	Network Safety Risk Reduction[2]	Annualised CAPEX	Reasonably practicable[3]?
A	2,731	230	Yes

From the above evaluation, it is considered that Option A is reasonably practicable.

4.3 Preferred option

From the SFAIRP/ALARP evaluation, Option A is considered to be reasonably practicable and is required to be undertaken in order to satisfy the organisation's SFAIRP/ALARP obligations.

Option A is also considered to be commercially viable (as per the commercial evaluation). For the aforementioned reasons, it is proposed that Option A be scoped in further detail.

Capital and operating expenditure

The estimated capital expenditure associated with the refurbishment outlined in this option is $4.60m ±25%. The vast majority of this expenditure is proposed to be carried out in 2022-2023.

Should the Option A (Line Refurbishment) works not occur by the Need date, an increase in corrective maintenance and subsequent operating expenditure is expected.

Regulatory Investment Test

No Regulatory Investment Test for Transmission (RIT-T) analysis is required as the works are condition based.

5. Recommendation

From the above SFAIRP/ALARP evaluation in accordance with the regulatory requirements, and the commercial and technical evaluation of the available options, it is recommended that detailed scoping for the refurbishment of Line 31/32 as outlined under Option A is undertaken.

[2] The Network Safety Risk Reduction is calculated as 6 x Bushfire Risk Reduction + 6 x Safety Risk Reduction + 0.1 x Reliability Risk Reduction

[3] Reasonably practicable is defined as whether the annualised CAPEX is less than the Network Safety Risk Reduction

Attachment 1 – Commercial evaluation report

Option A NPV calculation

Project_Option Name	Line 31/32 Refurbishment

1. Financial Evaluation (excludes VCR benefits)				
NPV @ standard discount rate	10.00%	-$0.60m	*NPV / Capital (Ratio)*	*-0.13*
NPV @ upper bound rate	13.00%	-$1.03m	*Pay Back Period (Yrs)*	*0.07 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$0.22m	*IRR%*	*7.46%*

2. Economic Evaluation (includes VCR benefits but excludes tax benefits from non-cash transactions, ENS penalty and overall tax cost)				
NPV @ standard discount rate	10.00%	$5.25m	*NPV / Capital (Ratio)*	*-1.75*
NPV @ upper bound rate	13.00%	$3.42m	*Pay Back Period (Yrs)*	*3.36 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$8.33m	*IRR%*	*28.45%*

Benefits					
Risk cost	As Is	To Be	Benefit	*VCR Benefit*	*$0.91m*
Systems (reliability)	*$3.52m*	*$2.60m*	*$0.91m*	*ENS Penalty*	*$0.00m*
Financial	*$0.04m*	*$0.03m*	*$0.01m*	*All other risk benefits*	*$0.45m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	Total Risk benefits	$1.37m
People (safety)	*$1.00m*	*$0.86m*	*$0.14m*		
Environment	*$2.76m*	*$2.46m*	*$0.30m*	Benefits in the financial NPV*	$0.45m
Reputation	*$0.01m*	*$0.01m*	*$0.00m*	**excludes VCR benefits*	
Total Risk benefits	$7.33m	$5.97m	$1.37m		
Cost savings and other benefits			$0.00m	Benefits in the economic NPV**	$1.37m
Total Benefits			$1.37m	***excludes ENS penalty*	

Other Financial Drivers			
Incremental opex cost pa (no depreciation)	$0.00m	Write-off cost	$0.00m
Capital - initial $m	-$4.60m	Major Asset Life (Yrs)	20.00 Yrs
Residual Value - initial investment	$0.00m	Re-investment capital	$0.00m
Capitalisation period	3.00 Yrs	Start of the re-investment period	0.00 Yrs