OPTIONS EVALUATION REPORT (OER)

Line 25/26 330kV Transmission Line (S/C) Renewal

OER 000000001350 revision 5.0

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

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Date submitted for approval	2 December 2016	

Change history

Revision	Date	Amendment
0	19 June 2016	Initial Issue
1	22 June 2016	Revised for Updated Commercial Evaluation
2	20 September 2016	Revised for Updated Risk Cost
3	28 October 2016	Revised for New SFAIRP/ALARP Methodology
4	2 December 2016	Update to format
5	7 December 2016	Amendment to Related Needs, requested by Author

1. Need/opportunity

Line 25 is a 330kV transmission line between Eraring and Vineyard 330kV Substations, with a total route length of 109km. Line 26 is a 330kV transmission line between Munmorah and Sydney West 330kV Substations, with a total route length of 123km. The two lines run together as a double circuit for the majority of their routes, and are key links between the Central Coast generators and the Sydney metropolitan area. This document covers the single circuit section of Line 26 and the double circuit section of Line 25/26 between Structure 11 and Vineyard only.

The single circuit section of Line 26 between Munmorah and Vales Point, a route length of 7km, was constructed in 1962 and consists of 24 structures. The transmission line traverses land in close vicinity to the Pacific Ocean, lakes and power stations. The double circuit section between Structure 11 and Vineyard, a route length of 93km, was constructed in 1965 and consists of 262 structures. It was constructed originally as the Vales Point to Sydney West 330kV Double Circuit Transmission Line before various re-arrangements with connections to Eraring, Munmorah and Vineyard. The transmission line traverses National Parks, heavily timbered ridgetops, rural areas and suburban areas as it enters the Sydney basin. There are several major road and rail crossings as well as numerous local road crossings.

Network Asset Condition Assessment (NACA) NACA 4020[1] performed in February 2011 and NACA 1350 performed in March 2016 have identified a number of corrosion related issues with the single circuit section of Line 26 and the double circuit section of Line 25/26 respectively 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.

In addition to the condition issues identified, the transmission line structures used on the single circuit section of Line 26 are known to contain particular deficiencies due to the design philosophies used at the time of its installation. Although the structures were designed to the standards at that time, following a number of structure failures in extreme wind events, investigations found that the towers were designed to a lower set of criteria with inadequacies in the governing load combinations when compared to more recent design philosophies and standards. A program to strengthen structures with utilisation over 85% at road crossings and public areas has occurred; however, not all structures have been strengthened. Due to this, it is considered essential that condition issues on these towers be addressed so that their capacity, and as a consequence, the security of supply, are not further reduced.

2. Related Needs/opportunities

Pre-requisite

> There are no pre-requisite Needs.

Related

> There are no related Needs.

Dependent

> There are no dependent Needs.

[1] NACA 4020 on Network Asset Condition Assessment Site. Although conducted over 5 years ago, Field Services have advised it remains relevant.

3. Options

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

Base Case

Network Asset Condition Assessment (NACA) NACA 4020 and NACA 1350 have identified existing issues on the line which require rectification. A summary of these can be found in Needs Statement NS 1350.

Under a Base Case 'run-to-fail' option, the associated risk cost from the issues identified in Table 1 is $3.14m 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)	0.58
Financial	0.05
Operational/Compliance	0
People (Safety)	0.94
Environment	1.57
Reputation	0.01
Total	**3.14**

It can be seen from Table 1 that the category with the highest risk cost is 'environment', mainly due to the considerable consequences of a bushfire event resulting from conductor drop. Other substantial contributors to the overall risk cost are the 'people (safety)' and 'reliability (system)' categories, again mostly due to the consequences of conductor drop failure and its associated outage.

The risk cost per kilometre of line is $0.030m per annum.

Option A — Line Refurbishment [OFR 1350A, OFS 1350A]

This option involves the refurbishment of Line 25/26 including treatment of corrosion of tower steelwork which could lead to asset failure and replacement of components which have reached end of life due to corrosion. The scope of the single circuit section of Line 26 and the double circuit section of Line 25/26 under this option are summarised in Tables 2 and 3 respectively.

Table 2 – Single Circuit (S/C) Transmission Line 26 Option A scope of works

Issue	Qty	Remediation
Ground line corrosion of steel at footing	11 towers	> Abrasive blast cleaning of steelwork to remove any corrosion product, application of Zinga paint and concrete encasement to prevent future corrosion
Corrosion of tower members	11 towers	> Abrasive blast cleaning of steelwork to remove any corrosion product, application of Zinga paint – entire tower

Issue	Qty	Remediation
Corrosion of tower fasteners	11 towers	> Replacement of fasteners > Assume 7% of fasteners per tower
Insulator pin corrosion – suspension insulators	11 insulator strings	> Replacement with composite longrod insulators
Insulator pin corrosion – tension insulators	66 insulators strings	> Replacement with composite longrod insulators Replacement of tension hot and cold end fittings

Table 3 – Double Circuit (D/C) Transmission Line 25/26 Option A scope of works

Issue	Qty	Remediation
Ground line corrosion of steel at footing	13 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	42 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 straps	26 towers	> Replacement of earth straps in line with current standard
Corrosion of tower fasteners	55 towers	> Replacement of fasteners > Assume 3% of fasteners per tower
Insulator pin corrosion – suspension insulators	79 insulator strings	> Replacement with composite longrod insulators
Damaged conductor vibration dampers	5% of line 626 dampers	> Replacement of Stockbridge vibration dampers > Assumed 8 vibration dampers per full tension span per phase
Damaged earthwire vibration dampers	5% of line 52 dampers	> Replacement of Stockbridge vibration dampers > Assumed 2 vibration dampers per full tension span per phase

It is estimated that the total capital expenditure associated with the refurbishment outlined in this option is $5.90m ±25%. Details can be found in Section 6 of Option Feasibility Study (OFS) OFS 1350A.

Following the refurbishment under this option, the risk cost associated with the remediated line is $1.11m per annum. A breakdown of the Option A risk cost by category is shown in Table 4.

Table 4 – Option A Risk cost by category (million $)

Risk Category	Annual Risk Cost
Reliability (System)	0.26
Financial	0.02
Operational/Compliance	0
People (Safety)	0.52
Environment	0.30
Reputation	0
Total	**1.11**

The total projected risk reduction as a result of implementing Option A is $2.04m per annum. It can be seen from Table 4 that the largest component of the reduction is in the 'environment' category, due to the reduced likelihood of conductor drop failure. Reductions are also expected in the 'people (safety)' and 'reliability (system)' categories.

The total projected risk reduction per kilometre of line is $0.020m per annum.

Both the Base Case option and Option A outlined in Section 3 are considered to be technically feasible[2].

4. Evaluation

4.1 Commercial evaluation

The commercial evaluation of the technically feasible options is set out in Table 5. Details of the Net Present Value (NPV) calculation for Option A are provided in Attachment 1.

Table 5 — 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	3.14	N/A	N/A	2
A	Line refurbishment	5.90	-	1.11	8.55	6.53	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 6.

[2] 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.

Table 6 — Discount rate sensitivities ($ million)

Option	Description	Economic NPV @13%	Economic NPV @6.75%
A	Line refurbishment	5.77	13.2

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 7.

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 7 – Feasible options ($ thousand)

Option	Description	CAPEX	Expected Life	Annualised CAPEX
Base	Run-to-fail	N/A	N/A	N/A
A	Line refurbishment	5,900	20 years	295

Table 8 – Annual risk calculations ($ thousand)

Option	Annual Residual Risk			Annual Risk Savings		
	Safety Risk	Reliability Risk	Bushfire Risk	Safety Risk	Reliability Risk	Bushfire Risk
Base	939	577	1,571	N/A	N/A	N/A
A	525	262	297	415	315	1,275

Table 9 – Reasonably practicable test ($ thousand)

Option	Network Safety Risk Reduction[3]	Annualised CAPEX	Reasonably practicable[4]?
A	10,168	295	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 $5.90m ±25%. The vast majority of this expenditure is proposed to be carried out in 2020-2021.

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 25/26 as outlined under Option A is undertaken.

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

[4] 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 25/26 Refurbishment

1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	$6.53m		*NPV / Capital (Ratio)*	*1.11*
NPV @ upper bound rate	13.00%	$4.23m		*Pay Back Period (Yrs)*	*0.28 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$10.41m		*IRR%*	*28.04%*

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%	$8.55m		*NPV / Capital (Ratio)*	*-2.85*
NPV @ upper bound rate	13.00%	$5.77m		*Pay Back Period (Yrs)*	*2.90 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$13.20m		*IRR%*	*33.10%*

Benefits					
Risk cost	As Is	To Be	Benefit	*VCR Benefit*	*$0.31m*
Systems (reliability)	*$0.58m*	*$0.26m*	*$0.31m*	*ENS Penalty*	*$0.00m*
Financial	*$0.05m*	*$0.02m*	*$0.03m*	*All other risk benefits*	*$1.72m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	Total Risk benefits	$2.04m
People (safety)	*$0.94m*	*$0.52m*	*$0.41m*		
Environment	*$1.57m*	*$0.30m*	*$1.27m*	Benefits in the financial NPV*	$1.72m
Reputation	*$0.01m*	*$0.00m*	*$0.01m*	**excludes VCR benefits*	
Total Risk benefits	$3.14m	$1.11m	$2.04m		
Cost savings and other benefits			$0.00m	Benefits in the economic NPV**	$2.04m
Total Benefits			$2.04m	***excludes ENS penalty*	

Other Financial Drivers			
Incremental opex cost pa (no depreciation)	$0.00m	Write-off cost	$0.00m
Capital - initial $m	-$5.90m	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