OPTIONS EVALUATION REPORT (OER)

Line 22 330kV Transmission Line Renewal

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

Approvals

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Date submitted for approval	7 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	7 December 2016	Update to format

1. Need/opportunity

Line 22 is a single circuit steel tower 330kV transmission line between Vales Point and Sydney North 330kV Substations, with a route length of 86 km. The transmission line is a key link between the Central Coast generators and the Sydney metropolitan area. It was constructed as the Vales Point to Sydney North No.1 Line in 1962 and consists of 190 structures. The transmission line mainly traverses small rural holdings, heavily timbered ridgetops and National Parks. It crosses the M1 Motorway, Pacific Highway and Main Northern Railway as well as numerous local roads.

Network Asset Condition Assessment (NACA) NACA 1349 performed in March 2016 and Tower Inspection Report conducted by Dennis Richards (DMR 216) have identified a number of corrosion related issues with Line 22 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 single circuit transmission line structures used on Line 22 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.

3. Options

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

Base Case

Network Asset Condition Assessment (NACA) NACA 1349 and the Tower Inspection Report conducted by Dennis Richards (DMR 216) have identified existing issues with the line which require rectification. A summary of these can be found in Need/Opportunity Statement (NOS) NS 1349.

Under a Base Case 'run-to-fail' option, the associated risk cost from the issues identified in Table 1 is $2.89m per year. 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

Risk Category	Annual Risk Cost
Financial	0.15
Operational/Compliance	0
People (Safety)	0.11
Environment	2.63
Reputation	0.01
Total	**2.89**

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. The next highest contributors to the overall risk cost are the 'financial' and 'people (safety)' categories.

The risk cost per kilometre of line is $0.034m per annum.

Option A — Line Refurbishment [OFR 1349A, OFS 1349A]

This option involves the refurbishment of Line 22 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 this option is summarised in Table 2.

Table 2 – Transmission Line 22 Option A scope of works

Issue	Qty	Remediation
Ground line corrosion of steel at footing	67 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	86 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	10 towers	> Replacement of earth straps in line with current standard
Corrosion of tower members	60 tension towers	> Abrasive blast cleaning of steelwork to remove any corrosion product, application of Zinga paint – assume 5% of main members per tower
	6 tension towers	> Abrasive blast cleaning of steelwork to remove any corrosion product, application of Zinga paint – entire tower
Corrosion of tower fasteners	86 towers	> Replacement of fasteners > Assume 1% of fasteners per tower
Insulator pin corrosion – suspension insulators	117 insulators strings	> Replacement with composite longrod insulators

Issue	Qty		Remediation
Insulator pin corrosion – tension insulators	42 insulators strings	>	Replacement with composite longrod insulators
		>	Replacement of tension hot and cold end fittings
Corrosion of conductor fittings	163 fittings	>	Replacement of hot and cold end fittings
Corrosion of earthwire fittings	76 fittings	>	Replacement of earthwire fittings
Corrosion of earthwire	70km (35km route length)	>	Like for like replacement of SC/GZ earthwire
Damaged conductor vibration dampers	10% of line	>	Replacement of Stockbridge vibration dampers
	454 dampers	>	Assumed 8 vibration dampers per full tension span per phase
Damaged of earthwire vibration dampers	20% of line	>	Replacement of spiral vibration dampers
	151 dampers	>	Assumed 2 vibration dampers per full tension span per phase

It is estimated that the capital expenditure associated with the refurbishment outlined in this option is $8.78m ±25%. Details can be found in Section 6 of Option Feasibility Study (OFS) OFS 1349A.

Following the refurbishment under this option, the risk cost associated with the remediated line is $0.381m per year. 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)	0
Financial	0.02
Operational/Compliance	0
People (Safety)	0.01
Environment	0.34
Reputation	0
Total	**0.38**

The total projected risk reduction as a result of implementing Option A is $2.51m per year. It can be seen from Table 3 that the largest component of the reduction is in the 'environment' category, due to the reduced likelihood of conductor drop failure. Reductions in the 'financial' and 'people (safety)' categories are also evident.

The total projected risk reduction per kilometre of line is $0.029m 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	2.89	N/A	N/A	2
A	Line refurbishment	8.78	-	0.38	9.39	9.36	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	6.05	15.03

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)

[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.

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	8,780	20 years	439

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	106	4	2,631	N/A	N/A	N/A
A	13	1	343	93	4	2,288

Table 8 – Reasonably practicable test ($ thousand)

Option	Network Safety Risk Reduction[2]	Annualised CAPEX	Reasonably practicable[3]?
A	14,282	439	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.

[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

Capital and operating expenditure

The estimated capital expenditure associated with the refurbishment outlined in this option is $8.78m ±25%. The vast majority of this expenditure is proposed to be carried out in 2021-2022.

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 22 as outlined under Option A is undertaken.

Attachment 1 – Commercial evaluation report

Option A NPV calculation

Project_Option Name	Line 22 Line Refurbishment

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	$9.36m	*NPV / Capital (Ratio)*	*1.07*
NPV @ upper bound rate	13.00%	$6.03m	*Pay Back Period (Yrs)*	*0.27 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$14.99m	*IRR%*	*27.43%*

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%	$9.39m	*NPV / Capital (Ratio)*	*-3.13*
NPV @ upper bound rate	13.00%	$6.05m	*Pay Back Period (Yrs)*	*3.50 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$15.03m	*IRR%*	*27.47%*

Benefits

Risk cost	As Is	To Be	Benefit
Systems (reliability)	*$0.00m*	*$0.00m*	*$0.00m*
Financial	*$0.15m*	*$0.02m*	*$0.12m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*
People (safety)	*$0.11m*	*$0.01m*	*$0.09m*
Environment	*$2.63m*	*$0.34m*	*$2.29m*
Reputation	*$0.00m*	*$0.00m*	*$0.00m*
Total Risk benefits	$2.89m	$0.38m	$2.51m
Cost savings and other benefits			$0.00m
Total Benefits			$2.51m

VCR Benefit	*$0.00m*
ENS Penalty	*$0.00m*
All other risk benefits	*$2.51m*
Total Risk benefits	$2.51m
Benefits in the financial NPV* *excludes VCR benefits	$2.51m
Benefits in the economic NPV** **excludes ENS penalty	$2.51m

Other Financial Drivers

Incremental opex cost pa (no depreciation)	$0.00m	Write-off cost	$0.00m
Capital - initial $m	-$8.78m	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