

OPTIONS EVALUATION REPORT (OER)

Line 2M 330kV Transmission Line Renewal

OER 000000001411 revision 3.0



Ellipse project no.: P0008173

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	2 December 2016	

Change History

Revision	Date	Amendment
0	17 June 2016	Initial Issue
1	21 October 2016	Revised for Updated Risk Cost and New SFAIRP/ALARP Methodology
2	2 December 2016	Update to format
3	2 December 2016	Minor amendment to format

1. Need/opportunity

Line 2M is a single circuit steel tower 330kV transmission line between Munmorah and Tuggerah (Sterland) 330kV Substations, with a route length of 39.5km. The transmission line is a key link between the Central Coast generators and Central Coast load area. This transmission line was originally constructed in 1959 as a double circuit 132kV line between Sydney North and Dora Creek. The section between Munmorah and Jilliby was built in 1965 and it was subsequently upgraded as Line 21 to single circuit 330kV. A tee section was added in 1986 to connect Tuggerah Substation into Line 21 at Sterland. Line 21 was divided into two circuits in 2004 – Line 21 now connects Sydney North and Tuggerah and Line 2M connects Munmorah with Tuggerah. The transmission line mainly traverses through national park, ridgetop, residential and industrial areas. This document covers the single circuit section of the line only, a length of 26.5km totalling 64 structures.

Network Asset Condition Assessment (NACA) [NACA 1411](#) performed in January 2016 has identified a number of corrosion related issues with Line 2M 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 2M 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

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 1411](#) has identified existing issues with the line which require rectification. A summary of these can be found in Need/Opportunity Statement (NOS) [NS 1411](#).

Under a Base Case 'run-to-fail' option, the associated risk cost from the issues identified in Table 1 is \$7.25m 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)	0.22
Financial	0.09
Operational/Compliance	0
People (Safety)	0.2
Environment	6.72

Risk Category	Annual Risk Cost
Reputation	0.01
Total	7.25

It can be seen from Table 1 that the category with the highest risk cost is 'environment', mainly due to the significant consequences of a bushfire event resulting from conductor drop. The other considerable 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 associated outage.

The risk cost per kilometre of line is \$0.274m per annum.

Option A — Line Refurbishment [[OFR 1411A](#), [OFS 1411A](#)]

This option involves the refurbishment of Line 2M preventing corrosion to 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 2M Option A scope of works

Issue	Qty	Remediation
Corrosion of tower members	12 tension towers	> Abrasive blast cleaning of steelwork to remove any corrosion product, application of Zinga paint – assume 5% of main members per tower (tower waist diaphragm / arm support chord)
	4 tension towers	> Abrasive blast cleaning of steelwork to remove any corrosion product, application of Zinga paint – entire tower
Corrosion of tower fasteners	36 towers	> Replacement of fasteners
		> Assume 10% of fasteners per tower
Corrosion of conductor fittings	50 fittings	> Replacement of hot and cold end fittings
Corrosion of earthwire fittings	8 fittings	> Replacement of earthwire fittings
Corrosion of insulators – suspension strings	27 insulator strings	> Replacement with composite longrod insulators
Corrosion of insulators and fittings – tension strings and fittings assemblies between Munmorah and Structure 50	78 insulator strings	> Replacement with composite longrod insulators
		> Replacement of tension hot and cold end fittings
Replacement of earthwire	11 km (11km of route length)	> Like for like replacement of SC/GZ earthwire
Replacement of conductor vibration dampers	10% of line	> Replacement of Stockbridge vibration dampers
	76 dampers	> Assumed 4 vibration dampers per full tension span per phase

Issue	Qty	Remediation
Replacement of earthwire vibration dampers	20% of line	> Replacement of spiral vibration dampers
	50 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 \$2.89m \pm 25%. Details can be found in Section 6 of [OFS 1411A](#).

Following the refurbishment under this option, the risk cost associated with the remediated line is \$0.23m 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)	0.05
Financial	0.02
Operational/Compliance	0
People (Safety)	0.03
Environment	0.14
Reputation	0
Total	0.23

The total projected risk reduction as a result of implementing Option A is \$7.02m per annum. 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 are also expected in the 'people (safety)' and 'reliability (system)' categories.

The total projected risk reduction per kilometre of line is \$0.265m per annum.

Both the Base Case option and Option A as detailed above are considered to be technically feasible¹.

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.

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.

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	7.25	N/A	N/A	2
A	Line refurbishment	2.89	-	0.23	46.94	45.76	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	36.30	63.95

4.2 SFAIRP/ALARP evaluation

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
- > Conductor / earthwire drop

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)

The results of this evaluation are summarised in the tables below.

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	2,890	20 years	145

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	21	213	6,720	N/A	N/A	N/A
A	3	45	135	18	168	6,585

Table 8 – Reasonably practicable test (\$ thousand)

Option	Network Safety Risk Reduction ²	Annualised CAPEX	Reasonably practicable ³ ?
A	40,596	145	Yes

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

4.3 Preferred option

From the SFAIRP/ALARP evaluation, it is considered that Option A is reasonably practicable and in order to satisfy the organisation's SFAIRP/ALARP obligations, is required to be undertaken. Option A is also considered to be commercially viable (as per the commercial evaluation), and it is proposed that detailed scoping be undertaken.

Capital and operating expenditure

The estimated capital expenditure associated with the refurbishment outlined in this option is \$2.89m ±25%. The vast majority of this expenditure is proposed to be carried out in 2018-2019.

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 2M 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 2M (SC Only) Refurbishment		
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	\$45.76m	NPV / Capital (Ratio)	15.83	
NPV @ upper bound rate	13.00%	\$35.37m	Pay Back Period (Yrs)	Not measurable	
NPV @ lower bound rate (WACC)	6.75%	\$62.35m	IRR%	192.25%	
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%	\$46.94m	NPV / Capital (Ratio)	-15.65	
NPV @ upper bound rate	13.00%	\$36.30m	Pay Back Period (Yrs)	Not measurable	
NPV @ lower bound rate (WACC)	6.75%	\$63.95m	IRR%	196.18%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$0.17m
Systems (reliability)	\$0.21m	\$0.04m	\$0.17m	ENS Penalty	\$0.00m
Financial	\$0.09m	\$0.02m	\$0.07m	All other risk benefits	\$6.85m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$7.02m
People (safety)	\$0.21m	\$0.03m	\$0.18m	Benefits in the financial NPV*	\$6.85m
Environment	\$6.72m	\$0.14m	\$6.58m	*excludes VCR benefits	
Reputation	\$0.01m	\$0.00m	\$0.01m	Benefits in the economic NPV**	\$7.02m
Total Risk benefits	\$7.25m	\$0.23m	\$7.02m	**excludes ENS penalty	
Cost savings and other benefits			\$0.00m		
Total Benefits			\$7.02m		
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m			-\$2.89m	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