

OPTIONS EVALUATION REPORT (OER)



Line 28 330kV Transmission Line Renewal

OER 000000001274 revision 3.0

Ellipse project no.: P0005455

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	6 December 2016	

Change history

Revision	Date	Amendment
0	19 June 2016	Initial issue
1	16 September 2016	Revised for Updated Risk Cost
2	27 October 2016	Revised for New SFAIRP/ALARP Methodology
3	6 December 2016	Update to format

1. Need/opportunity

Line 28 is a steel tower 330kV transmission line between Sydney North and Sydney East 330kV Substations, with a route length of 21.7 km. The transmission line links generation to the North-Eastern Sydney metro area. This transmission line was constructed in 1976 and consists of 51 structures. The majority of this line passes through National Park with sections in urban areas of Sydney.

Network Asset Condition Assessment (NACA) [NACA 1274](#) performed in January 2016 has identified a number of corrosion related issues with Line 28 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 28 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 1274](#) has identified existing issues with the line which require rectification. A summary of these can be found in Need/Opportunity Statement (NOS) [NS 1274](#).

Under a Base Case 'run-to-fail' option, the associated risk cost from the issues identified in Table 1 is \$0.79m 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)	0.31
Financial	0.01
Operational/Compliance	0
People (Safety)	0.11
Environment	0.35
Reputation	0
Total	0.79

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

The risk cost per kilometre of line is \$0.036m per annum.

Option A — Line Refurbishment [[OFR 1274A](#), [OFS 1274A](#)]

This option involves the refurbishment of Line 28 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 28 Option A scope of works

Issue	Qty	Remediation
Ground line corrosion of steel at footing	1 tower	> Abrasive blast cleaning of steelwork to remove any corrosion product, application of Zinga paint and concrete encasement to prevent future corrosion
Buried concrete foundations	3 towers	> Dig out tower legs, abrasive blast cleaning of steelwork to remove any corrosion product, application of Zinga paint and establishment of drainage channel
Earth strap corrosion	5 towers	> Replacement of earth straps in line with current standard
Corroded conductor attachment fittings	81 fittings	> Replacement of hot and cold end fittings
Corrosion of earth wire attachment fittings	80 fittings	> Replacement of earthwire fittings
Insulator pin corrosion	43 insulator strings	> Replacement with composite longrod insulators
Earth wire dampers	15% of line 31 dampers	> Replacement of spiral vibration dampers

It is estimated that the capital expenditure associated with the refurbishment outlined in this option is \$0.80m ±25%. Details can be found in Section 6 of Option Feasibility Study (OFS) [OFS 1274A](#).

Following the refurbishment under this option, the risk cost associated with the remediated line is \$0.49m 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)	0.17
Financial	0.01
Operational/Compliance	0

Risk Category	Annual Risk Cost
People (Safety)	0.07
Environment	0.24
Reputation	0
Total	\$0.49

The total projected risk reduction as a result of implementing Option A is \$0.30m per annum. It can be seen from Table 3 that the largest components of the risk reduction are the 'reliability (system)' and 'environment' categories, due to the reduced likelihood of conductor drop failure and associated outages. Some reduction in risk cost in the 'people (safety)' category is also expected.

The total projected risk reduction per kilometre of line is \$0.014m per annum.

Both the Base Case option and Option A outlined in Section 3 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.

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	0.79	N/A	N/A	2
A	Line refurbishment	0.80	-	0.49	1.31	0.38	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.

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 5 — Discount rate sensitivities (\$ million)

Option	Description	Economic NPV @13%	Economic NPV @6.75%
A	Line refurbishment	0.90	2.01

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	800	20 years	40

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	108	311	352	N/A	N/A	N/A
A	72	165	242	37	146	110

Table 8 – Reasonably practicable test (\$ thousand)

Option	Network Safety Risk Reduction ²	Annualised CAPEX	Reasonably practicable ³ ?
A	894	40	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 \$0.80m ±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 28 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 28 Refurbishment		
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	\$0.38m	NPV / Capital (Ratio)	0.47	
NPV @ upper bound rate	13.00%	\$0.19m	Pay Back Period (Yrs)	0.18 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$0.71m	IRR%	18.14%	
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%	\$1.31m	NPV / Capital (Ratio)	-0.44	
NPV @ upper bound rate	13.00%	\$0.90m	Pay Back Period (Yrs)	2.67 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$2.01m	IRR%	35.73%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$0.15m
Systems (reliability)	\$0.31m	\$0.16m	\$0.15m	ENS Penalty	\$0.00m
Financial	\$0.01m	\$0.01m	\$0.01m	All other risk benefits	\$0.15m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$0.30m
People (safety)	\$0.11m	\$0.07m	\$0.04m	Benefits in the financial NPV*	\$0.15m
Environment	\$0.35m	\$0.24m	\$0.11m	*excludes VCR benefits	
Reputation	\$0.00m	\$0.00m	\$0.00m	Benefits in the economic NPV**	\$0.30m
Total Risk benefits	\$0.79m	\$0.49m	\$0.30m	**excludes ENS penalty	
Cost savings and other benefits			\$0.00m		
Total Benefits			\$0.30m		
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m			-\$0.80m	Major Asset Life (Yrs)	20.00 Yrs
Residual Value - initial investment			\$0.04m	Re-investment capital	\$0.00m
Capitalisation period			3.00 Yrs	Start of the re-investment period	0.00 Yrs