

OPTIONS EVALUATION REPORT (OER)



Line 11 Suspension Structure Renewal

OER 000000001600 revision 1.0

Ellipse project no.: P0009497

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	28 October 2016	Initial issue
1	8 December 2016	Update to format

1. Need/opportunity

Line 11 is a single circuit steel tower 330kV transmission line between Dapto and Sydney South Substations. It is considered to have the highest level of corrosion among TransGrid's transmission lines and has a history of corrosion related defects affecting tower members, conductor/earthwire fittings, insulators and fasteners (nuts and bolts). It is considered to have the highest level of corrosion among TransGrid's transmission lines. This has led to a high and increasing requirement for inspection and maintenance along this transmission line to assess the structures' ability to withstand weather events that are the most likely cause of structure failure.

Network Asset Condition Assessment (NACA) of Line 11 [NACA DCN 220](#) undertaken in early 2016 and the assessment report by Inspection and Consultancy Services (ICS) completed in November/December 2015 have identified that all structures are showing varying signs of corrosion on numerous areas of the tower, ranging from minor first rust to over 50% rust and flaking rust in some cases. The detailed steelwork condition assessment (Line 11 Special Purpose Condition Assessment (SPCA)) conducted by ICS inspected all tension (25) and a selection of suspension towers (26). In most severe locations, closest to the coast, rust is widespread and is seen to be bleeding through epoxy painted steelwork. Detailed findings from ICS are contained in the report "ICS TG-Line11 Surface Prep" available as a supporting document under the Need Site, DCN 220, on TransGrid's [Project Document Governance System \(PDGS\)](#).

There has been a very extensive history of repair/replacement works on Line 11. A number of towers have been painted pre 1990, while 20 towers were painted with epoxy paint in 1995. In 2006, seven structures were painted with Zinga in a trial in 2006 for proof of concept. In 2010 a project was initiated to paint steel towers on this line. Around 30 towers were partially painted before the contract was terminated in 2011 due to poor contractor performance. At contract termination there were 11 structures where the contractor had commenced surface preparation by removing rust and galvanising to bare metal.

Due to priority in addressing the aforementioned condition issues, 25 tension structures and 2 suspension structures deemed too difficult to replace for constructability reasons are being remediated under Need DCN 220.

The general view from the ICS report was that all towers, previously painted or otherwise, would need to be addressed in the short – medium term (within the next 10 years) to ensure that the asset remains operational in the longer term. Corrosion of steel is the main contributing factor leading to a decline in the health of the asset.

2. Related Needs/opportunities

Pre-requisite

The following transmission line life extension projects are currently being undertaken:

- > Need ID DCN 220 – Line 11 Condition
- > Need ID 1481 – Line 11 Steel Earthwire Renewal

Related

The following related Needs require coordination:

- > Need 0595 – Remediation of Low Spans on Central Region Tower Lines
- > Need 1164 – Transmission Line Asbestos Paint
- > M1 South Expansion – Mount Ousley Rd Towers 65 and 66 May Require Modification

The following transmission line life extension projects may have outage clashes and require coordination:

- > Need ID 1341 – 8 MRN (Marulan) to DPT (Dapto) 330kV Line Renewal
- > Need ID DCN 219 – Line 10 – 330kV Transmission Line - Dapto to Avon

- > Need ID 1271 – 12 330kV Transmission Line Renewal (Liverpool to Sydney South)
- > Need ID 1353 – 16 330kV Transmission Line Renewal (Marulan to Avon)
- > Need ID 1352 – 17 330kV Transmission Line Renewal (Avon to Macarthur)
- > Need ID 1351 – 18 330kV Transmission Line Renewal (Kangaroo Valley to Dapto)
- > Need ID 1276 – 39 330kV Transmission Line Renewal (Bannaby to Sydney West)

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 DCN 220](#) and the assessment report by ICS completed in November/December 2015 have identified existing issues with the line which require rectification. The recommendation was that if there were to be no painting in the short – medium term (within the next 10 years), the condition of the towers would deteriorate such that more substantial blasting of corrosion products would be involved and some significant metal loss of steel and bolts with replacements probable. As the line falls in a higher corrosion zone and due to its proximity to the coast, the Net Present Value (NPV) analysis has indicated that from a cost perspective it will be more beneficial to remediate the towers within the next 5 to 10 years, based on the increased risk of failure as the condition deteriorates over time. Details can be found in Need/Opportunity Statement (NOS) [NS 1600](#).

Under a Base Case ‘run-to-fail’ option, the risk cost associated with the condition issues on Line 11 is \$2.03m 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)	0.01
Financial	0.07
Operational/Compliance	0
People (Safety)	1.10
Environment	0.83
Reputation	0.01
Total	2.03

It can be seen from Table 1 that the categories with the highest risk cost are ‘people (safety)’ and ‘environment’, mainly due to the considerable consequences of conductor drop and structure failure events.

Option A — Replacement of Suspension Structures [[OFR 1600A](#), [OFS 1600A](#)]

This option involves the replacement of suspension structures on Line 11 which are affected by corrosion to tower steelwork. The replacement option has been chosen based on previous independent financial analysis which indicated that it was more economical to replace suspension towers at end of life than to enter into a painting

regime¹. Note the suspension towers covered under this Need are those remaining on Line 11 which have not been covered under Need DCN 220; those were deemed too difficult to replace for constructability reasons.

The scope of this option is summarised in Table 2. Note the scope includes the replacement of all associated insulators and conductor/earthwire fittings on these towers.

Table 2 – Transmission Line 11 Option A scope of works

Issue	Qty	Remediation
Replacement of suspension structures	127 towers	> Replacement with “H-Type” concrete pole structures

It is estimated that the capital expenditure associated with the refurbishment outlined in this option is \$21.20m ±25%. Details can be found in Section 6 of Option Feasibility Study (OFS) [OFS 1600A](#).

Following the replacement of all structures under this option, the risk cost associated with the remediated line is \$0.26m 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
Financial	0.01
Operational/Compliance	0
People (Safety)	0.24
Environment	0.02
Reputation	0
Total	0.26

The total projected risk reduction as a result of implementing Option A is \$1.77m per annum. It can be seen from Table 3 that the largest components of the reduction are in the ‘people (safety)’ and ‘environment’ categories, due to the reduced likelihood of conductor drop and structure failure events.

Both the Base Case option and Option A outlined in Section 3 are considered to be technically feasible².

4. Evaluation

4.1 Commercial evaluation

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

¹ Refer to the report, [Feeder 11 - Steel Tower Refurbishment \(16 May 2014\)](#), on the PDGS.

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 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	N/A	N/A	N/A	2
A	Replacement of suspension structures	21.2	-	0.26	(2.95)	(3.02)	1

The commercial evaluation is based on:

- > A 10% discount rate
- > A life of the investment of 50 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	Replacement of suspension structures	(4.88)	1.49

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

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)

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	21,200	50 years	424

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	1,102	13	829	N/A	N/A	N/A
A	235	1	16	868	11	813

Table 8 – Reasonably practicable test (\$ thousand)

Option	Network Safety Risk Reduction ³	Annualised CAPEX	Reasonably practicable ⁴ ?
A	10,082	424	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. From the commercial evaluation, Option A is not considered to be commercially viable at a discount rate of 10%, but returns a positive NPV at the lower bound discount rate of 6.75% (see sensitivities in Table 5). The IRR for the option is higher than the WACC rate.

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 \$21.20m ±25%. The vast majority of this expenditure is proposed to be carried out in 2022-2023.

Should the Option A (Suspension Tower Replacement) works not occur by the Need date, an increase in future corrective maintenance and subsequent operating expenditure is expected as the condition of the existing towers deteriorates further. As the benefits have not been quantified at this stage, no OPEX savings have been included in the above commercial evaluation.

Regulatory Investment Test

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

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

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 replacement of suspension structures on Line 11, as outlined under Option A, is undertaken.

Attachment 1 – Commercial evaluation report

Option A NPV calculation

Project_Option Name			Line 11 Suspension Structure Replacement		
1. Financial Evaluation (excludes VCR benefits)					
NPV @ standard discount rate	10.00%	-\$3.02m	NPV / Capital (Ratio)	-0.14	
NPV @ upper bound rate	13.00%	-\$4.93m	Pay Back Period (Yrs)	0.08 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$1.38m	IRR%	7.53%	
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%	-\$2.95m	NPV / Capital (Ratio)	0.74	
NPV @ upper bound rate	13.00%	-\$4.88m	Pay Back Period (Yrs)	12.01 Yrs	
NPV @ lower bound rate (WACC)	6.75%	\$1.49m	IRR%	7.59%	
Benefits					
Risk cost	As Is	To Be	Benefit	VCR Benefit	\$0.01m
Systems (reliability)	\$0.01m	\$0.00m	\$0.01m	ENS Penalty	\$0.00m
Financial	\$0.07m	\$0.01m	\$0.07m	All other risk benefits	\$1.75m
Operational/compliance	\$0.00m	\$0.00m	\$0.00m	Total Risk benefits	\$1.77m
People (safety)	\$1.10m	\$0.23m	\$0.87m	Benefits in the financial NPV*	\$1.75m
Environment	\$0.83m	\$0.02m	\$0.81m	*excludes VCR benefits	
Reputation	\$0.01m	\$0.00m	\$0.01m	Benefits in the economic NPV**	\$1.77m
Total Risk benefits	\$2.03m	\$0.26m	\$1.77m	**excludes ENS penalty	
Cost savings and other benefits			\$0.00m		
Total Benefits			\$1.77m		
Other Financial Drivers					
Incremental opex cost pa (no depreciation)			\$0.00m	Write-off cost	\$0.00m
Capital - initial \$m			-\$21.20m	Major Asset Life (Yrs)	50.00 Yrs
Residual Value - initial investment			\$10.18m	Re-investment capital	\$0.00m
Capitalisation period			4.00 Yrs	Start of the re-investment period	0.00 Yrs