

NEED/OPPORTUNITY STATEMENT (NOS)



Line 28 330kV Transmission Line Renewal

NOS- 000000001274 revision 3.0

Ellipse project description: 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
Approved	Lance Wee	Manager/Asset Strategy
Date submitted for approval	28 November 2016	

Change history

Revision	Date	Amendment
0	24 April 2016	Initial issue
1	2 August 2016	Update to 2016/17 dollars
2	28 November 2016	Revised to contain tower strength commentary and update to format

1. Background

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.

Condition assessment NACA-1274¹ performed in January 2016 has identified a number of issues with transmission line 28 which require rectification in the short – medium term to ensure that the asset remains operational in the long term. Corrosion of steel is the main contributing factor leading to a decline in the health of the asset.

This transmission line falls within a zone of medium² corrosion.

2. Need/opportunity

Condition assessment NACA-1274 has identified issues which require rectification, these are summarised in Table 1.

Table 1 – Transmission Line 28 Condition Issues

Issue	Extent (% line)	Cause	Impact
Ground line corrosion of steel at footing	2%	Buried steelwork at footing	Steel corrosion of critical member, can lead to structural failure of tower
Buried concrete foundations	5%	Erosion of soil building up around footings	Accelerated corrosion of critical member
Earth strap	18%	Corrosion as buried at footing	Earthing safety hazard
Corroded conductor attachment fittings	30%	Zinc galvanising end of life	Conductor drop
Corrosion of earth wire attachment fittings	50%	Zinc galvanising end of life	Conductor drop
Insulator pin corrosion	70%	Pollution build up and deterioration of galvanising	Conductor drop
Earth wire dampers	15%	Damaged/Weathered	Accelerated earth wire fatigue due to vibration

The risk cost associated with the issues identified in Table 1 is \$0.79m per annum (refer Attachment 1). The most significant element of concern is ground line corrosion of steel transmission tower legs at the footings.

¹ [NACA-1274](#) on PDGS Need Site

² Steel corrosion rate as defined in AS 4312 – *Atmospheric corrosivity zones in Australia*

Ground line corrosion of steel transmission tower legs at the footings is a significant item of concern as these are the critical load bearing members of the tower and cannot be easily remediated if the condition passes a stage where rectification work is not possible.

The single circuit transmission line structures used on Line 28 were designed to the standards at that time but were found to be a lower set of design criteria compared with newer structures. Following a number of structure failures in extreme wind events, investigations found that these single circuit suspension towers had design deficiencies in the governing load combinations when compared to more recent design philosophies and standards. Strengthening of structures with utilisation over 85% at road crossings and public areas has occurred. As not all structures have been strengthened, it is essential that condition issues on these towers be addressed so that they do not reduce the capacity of the towers and further reduce the security of supply.

Corrosion of fittings is as expected given the age and location of the asset. These items are original and the sacrificial zinc galvanising layer has reached end of life. These items generally had a significantly thinner layer of galvanising at the time of manufacturing compared with the steel tower members due to fabrication processes.

Corrosion of steel pins on ceramic insulators is also a significant issue as fitting or insulator failure may result in conductor drop, as many of these items are a single point of failure (e.g. insulator attachments). The pins on the underside of suspension insulator discs build up pollution and are not adequately washed by rain which leads to an increased rate of corrosion. Inspections have also identified rusting of insulator caps and associated rust stains on insulator sheds (5%). In addition, insulators of the original 1965-1974 vintage make up another 65% of Line 28. These require replacement to reduce the risk of conductor drop.

The corrosion issues associated with fittings and insulators is consistent with other transmission lines of the same vintage in the region.

The benefit of addressing the condition issues on Transmission Line 28 is to continue providing the service at a lower risk of failure.

3. Related needs/opportunities

No related needs/opportunities have been identified.

4. Recommendation

It is recommended that options be considered to address the identified need/opportunity by 2023.

Attachment 1 - Risk costs summary

Summary of results is attached below. Refer to supporting document in PDGS for full risk assessment.

Current Option Assessment - Risk Summary



Project Name: Line 28

Option Name: 1274 - Base Case

Option Assessment Name: 1274 - Base Case - Assessment 1

Rev Reset Period: Next (2018-23)

Major Component	No.	Minor Component	Sel. Hazardous Event	LoC x CoF (\$M)	Failure Mechanism	NoxLoC xCoF (\$M)	PoF (Yr 1)	Total Risk (\$M)	Risk (\$M) (Rel)	Risk (\$M) (Op)	Risk (\$M) (Fin)	Risk (\$M) (Peo)	Risk (\$M) (Env)	Risk (\$M) (Rep)
Conductor	240	Insulators	Conductor Drop (Conductor)	\$5.27	Insulator Failure	\$1,265.71	0.02%	\$0.24	\$0.04	\$0.00	\$0.00	\$0.05	\$0.18	\$0.00
Conductor	240	Insulators	Unplanned Outage - HV (Conductor)	\$0.96	Structural Failure	\$230.85	0.02%	\$0.04	\$0.04	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Conductor 2	240	Fittings	Conductor Drop (Conductor 2)	\$5.27	Fitting Failure	\$1,265.71	0.00%	\$0.01	\$0.01	\$0.00	\$0.00	\$0.00	\$0.01	\$0.00
Conductor 2	240	Fittings	Unplanned Outage - HV (Conductor 2)	\$0.96	Structural Failure	\$230.85	0.00%	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Earth Wire	160	Fittings (inc Attachment)	Earth Wire Drop (Earth Wire)	\$1.22	Fitting Failure	\$194.69	0.00%	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Earth Wire	160	Fittings (inc Attachment)	Unplanned Outage - HV (Earth Wire)	\$0.96	Structural Failure	\$153.90	0.00%	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Earth Wire 2	0	Earth Wire (inc Joints)	Earth Wire Drop (Earth Wire 2)	\$0.00	Break	\$0.00	0.00%	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Earth Wire 2	0	Earth Wire (inc Joints)	Unplanned Outage - HV (Earth Wire 2)	\$0.00	Break	\$0.00	0.00%	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Structure	4	Earthing	Uncontrolled Electrical Contact / Discharge (Structure)	\$0.05	Earthing Failure	\$0.21	1.74%	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Structure	51	Steel Structure	Unplanned Outage - HV (Structure)	\$6.73	Structural Failure	\$343.37	0.08%	\$0.27	\$0.27	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Structure	51	Steel Structure (inc Footings)	Conductor / Earth Wire / OPGW Drop (Structure)	\$5.54	Structural Failure	\$282.73	0.08%	\$0.22	\$0.22	\$0.01	\$0.01	\$0.05	\$0.16	\$0.00
								\$0.79	\$0.31	\$0.01	\$0.01	\$0.11	\$0.35	\$0.00
								Total VCR Risk: \$0.31						
								Total ENS Risk: \$0.00						

Number of Components

The number of components used in the Risk costs summary model has been derived as follows:

- > Steel Structures: The extent of the steel structures on the transmission line with advanced corrosion condition and footing issues identified in Table 1 (7%) multiplied by the total number of original structures (51).
- > Steel Structure Earthing: The number of steel structures on the line in areas readily accessible by members of the general public (5).
- > Conductor Fittings: The extent of the conductor fittings on the transmission line with advanced corrosion condition issues identified in Table 1 (30%) multiplied by the total number of fittings (3 per suspension structure and 6 per tension structure).
- > Insulators: The extent of insulators on the transmission line with advanced corrosion condition issues identified in Table 1 (70%) multiplied by the total number of suspension insulators on the line (3 per suspension structure).
- > Earth Wire Fittings: The extent of the earth wire fittings on the transmission line with advanced corrosion condition issues identified in Table 1 (50%) multiplied by the total number of fittings (2 per suspension structure and 4 per tension structure).

Probability of Failure

As per the Risk costs summary model.

Consequence of Failure

As per the Risk costs summary model.