NEED/OPPORTUNITY STATEMENT (NOS)

Line 17 330kV Transmission Line Renewal

NOS- 000000001352 revision 2.0

Ellipse project description: P0007971
TRIM file: [TRIM No]

Project reason: Reliability - To meet overall network reliability requirements
Project category: Prescribed - Asset Renewal Strategies

Approvals

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Date submitted for approval	28 November 2016	

Change history

Revision	Date	Amendment
0	12 April 2016	Initial issue
1	27 July 2016	Update to 2016/17 dollars
2	28 November 2016	Revised to contain tower strength commentary and update to format

1. Background

Line 17 is a single circuit steel tower 330kV transmission line between Avon and Macarthur 330kV substations, with a route length of 41 km. The transmission line is a key link between the Wollongong region and the Sydney metropolitan area. This transmission line was constructed in 1964 as the Dapto to Sydney West 330kV line and consists of 101 structures. The southern section of the transmission line mainly traverses through forested areas, with a significant section located in land belonging to the Sydney Catchment Authority. There are large numbers of residences and populated areas in the northern half of the line from Appin through to Macarthur. The Campbelltown area is rapidly expanding, with suburban developments likely to build up next to the line in the near future.

Condition assessment NACA-1352[1] performed in March 2016 has identified a number of issues with Transmission Line 17 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.

2. Need/opportunity

Condition assessment NACA-1352 has identified issues which require rectification, these are summarised in Table 1.

Table 1 – Transmission Line 17 Condition Issues

Issue	Extent (% line)	Cause	Impact
Ground line corrosion of steel at footing	15%	Buried steelwork at footing	Steel corrosion of critical member, can lead to structural failure of tower
Buried concrete foundations	20%	Erosion of soil building up around footings	Accelerated corrosion of critical member
Corroded fasteners	5%	Zinc galvanising end-of-life	Structural failure
Corroded insulators	90%	Corrosion of steel caps Zinc sleeve protection end-of-life	Conductor drop
Corroded conductor attachment fittings	7%	Zinc galvanising end-of-life	Conductor drop
Corrosion of earthwire attachment fittings	5%	Zinc galvanising end-of-life	Conductor drop
Corroded earthwire	60%	Zinc galvanising end-of-life	Conductor drop
Conductor dampers	10%	Damaged/Weathered	Accelerated conductor fatigue due to vibration

[1] NACA-1352 on PDGS Need Site

The risk cost associated with the issues identified in Table 1 is $1.22m per annum (refer Attachment 1). The most significant element of concern is conductor drop due to the corrosion of steel pins on ceramic insulators. 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. The majority of insulators on the line are the original 1962 NGK, plain profile insulators (89%), with insulators of the 1965-1974 vintage making up another 1% of Line 17. These are not in good condition with pin corrosion being widespread and in some cases well advanced.

Another significant area of concern is the corrosion of steel members on the structures, particularly ground line corrosion of steel tower legs at the footings. As these members are critical load bearing members of the tower, they cannot be easily remediated if the condition passes a stage where rectification work is not possible. The corrosion issues associated with the tower structures are consistent with other transmission lines of the same vintage in the region.

The single circuit transmission line structures used on Line 17 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 fasteners and fittings is as expected given the age of the asset as the sacrificial zinc galvanising layer on these items 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. Fasteners also have no galvanising on the nut thread which explains their poor condition relative to the main tower steelwork.

Significant corrosion of the earthwires from the coastal atmospheric conditions is as expected. The earthwires have lost galvanising and appear red/brown in colour, and require addressing to extend life.

Conductor dampers show various signs of drooping, and require replacement to prevent accelerated conductor fatigue.

The benefit of addressing the condition issues on Line 17 is to continue providing the service at a lower risk of failure.

Given the significant proportion of earthwire identified with corrosion related issues, replacement of an earthwire with OPGW will improve the communications system. Installation of OPGW on both Lines 10 and 17 would bring by bringing fibre to Avon and provide duplicated paths to Dapto, Macarthur and Marulan. The benefits of this opportunity come as a result of reduced OPEX through maintenance and licensing saving, with an expected quantified benefit of $0.035m per annum. Should OPGW be installed on Line 17 only, the expected benefit reduces to $0.0115m per annum. It is noted that organisational benefits such as efficiency savings have not been taken into account.

3. Related needs/opportunities

> Need 1481 – Lines 10 and 11 Steel Earthwire Renewal: There are increased benefits through the duplication of paths should OPGW be installed on both Lines 10 and 17.

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 17

Option Name: 1352 - Base Case

Option Assessment Name: 1352 - 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	372	Fittings	Conductor Drop (Conductor)	$3.39	Fitting Failure	$1,261.90	0.00%	$0.01			$0.00	$0.00	$0.01	$0.00
Conductor	372	Fittings	Unplanned Outage - HV (Conductor)	$0.36	Structural Failure	$134.24	0.00%	$0.00	$0.00		$0.00			$0.00
Conductor	372	Insulators	Conductor Drop (Conductor)	$3.39	Insulator Failure	$1,261.90	0.06%	$0.75			$0.01	$0.07	$0.67	$0.00
Conductor	372	Insulators	Unplanned Outage - HV (Conductor)	$0.36	Structural Failure	$134.24	0.06%	$0.08	$0.08		$0.00			$0.00
Earth Wire	12	Earth Wire (inc Joints)	Earth Wire Drop (Earth Wire)	$0.22	Break	$2.66	0.40%	$0.01	$0.00		$0.00	$0.01	$0.00	$0.00
Earth Wire	12	Earth Wire (inc Joints)	Unplanned Outage - HV (Earth Wire)	$0.36	Break	$4.33	0.40%	$0.02	$0.02		$0.00			$0.00
Earth Wire 2	248	Fittings (inc Attachment)	Earth Wire Drop (Earth Wire 2)	$0.35	Fitting Failure	$86.35	0.00%	$0.00	$0.00		$0.00	$0.00	$0.00	$0.00
Earth Wire 2	248	Fittings (inc Attachment)	Unplanned Outage - HV (Earth Wire 2)	$0.36	Structural Failure	$89.49	0.00%	$0.00	$0.00		$0.00			$0.00
Structure	99	Steel Structure	Unplanned Outage - HV (Structure)	$2.53	Structural Failure	$250.04	0.06%	$0.14	$0.14		$0.00			$0.00
Structure	99	Steel Structure (inc Footings)	Conductor / Earth Wire / OPGW Drop (Structure)	$3.66	Structural Failure	$361.92	0.06%	$0.21			$0.02	$0.02	$0.17	$0.00
Structure 2	0	Earthing	Uncontrolled Electrical Contact / Discharge (Structure 2)	$0.00	Earthing Failure	$0.00								
				$14.98		$3,587.06		$1.22	$0.24		$0.03	$0.10	$0.85	$0.00

Total VCR Risk: $0.24

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 issues identified in Table 1 (20%) multiplied by the total number of original structures (101).
- Insulators: The extent of insulators on the transmission line with advanced corrosion condition issues identified in Table 1 (90%) multiplied by the total number of suspension insulators on the line (3 per suspension structure
- Conductor Fittings: The extent of the conductor fittings on the transmission line with advanced corrosion condition issues identified in Table 1 (7%) multiplied by the total number of fittings (3 per suspension structure and 6 per tension structure).
- Earth Wire: Length of earth wire on the transmission line multiplied by the portion with advanced corrosion condition issues identified in Table 1 (60%).
- Earth Wire Fittings: The extent of the earth wire fittings on the transmission line with advanced corrosion condition issues identified in Table 1 (5%) 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.