NEED/OPPORTUNITY STATEMENT (NOS)

Line 25/26 330kV Transmission Line Renewal

NOS- 000000001350 revision 2.0

Ellipse project description: P0007967
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	29 November 2016	

Change history

Revision	Date	Amendment
0	11 April 2016	Initial issue
1	27 July 2016	Update to 2016/17 dollars
2	29 November 2016	Revised to contain tower strength commentary and update to format

1. Background

Line 25 is a 330kV transmission line between Eraring and Vineyard 330kV substations, with a total route length of 109 km. Line 26 is a 330kV transmission line between Munmorah and Sydney West 330kV substations, with a total route length of 123 km. The two lines run together as a double circuit for the majority of their routes. The transmission line is a key link between the Central Coast generators and the Sydney metropolitan area. This NOS covers the single circuit section of Line 26 and the double circuit section of Line 25/26 between Structure 11 and Vineyard only.

The single circuit section of Line 26 between Munmorah and Vales Point, a route length of 7 km, was constructed in 1962 and consists of 24 structures. The transmission line traverses land in close vicinity to the Pacific Ocean, lakes and power stations. The double circuit section between Structure 11 and Vineyard, a route length of 93 km, was constructed in 1965 and consists of 262 structures. It was constructed originally as the Vales Point to Sydney West 330kV Double Circuit Transmission Line before various re-arrangements with connections to Eraring, Munmorah and Vineyard. The transmission line traverses National Parks, heavily timbered ridgetops, rural areas and suburban areas as it enters the Sydney basin. There are several major road and rail crossings as well as numerous local road crossings.

Condition assessments NACA-40201 performed in February 2011 and NACA-13502 performed in March 2016 have identified a number of issues with the single circuit section of Line 26 and the double circuit section of Line 25/26 respectively 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 assessments NACA-4020 and NACA-1350 have identified issues which require rectification, these are summarised in Tables 1 and 2 respectively.

Table 1 – S/C Transmission Line 26 Condition Issues

Issue	Extent (% line)	Cause	Impact
Ground line corrosion of steel at footing	46%	Buried steelwork at footing	Steel corrosion of critical member, can lead to structural failure of tower
Buried concrete foundations	46%	Erosion of soil building up around footings	Accelerated corrosion of critical member
Corrosion of tower steel members	46%	Zinc galvanising end-of-life	Steel corrosion, particularly of critical members, can lead to structural failure of tower
Corroded fasteners	7%	Zinc galvanising end-of-life	Structural failure

[1] NACA-4020 on Network Asset Condition Assessment Site

[2] NACA-1350 on PDGS

Issue	Extent (% line)	Cause	Impact
Corroded suspension insulators	30%	Corrosion of steel caps and pins Zinc sleeve protection end-of-life	Conductor drop
Corroded tension insulators	100%	Corrosion of steel caps and pins Zinc sleeve protection end-of-life	Conductor drop

Table 2 – D/C Transmission Line 25/26 Condition Issues

Issue	Extent (% line)	Cause	Impact
Ground line corrosion of steel at footing	5%	Buried steelwork at footing	Steel corrosion of critical member, can lead to structural failure of tower
Buried concrete foundations	16%	Erosion of soil building up around footings	Accelerated corrosion of critical member
Earth strap	10%	Corrosion as buried at footing	Earthing safety hazard
Corroded fasteners	3%	Zinc galvanising end-of-life	Structural failure
Corroded insulators	7%	Corrosion of steel caps Zinc sleeve protection end-of-life	Conductor drop
Conductor dampers	5%	Damaged/Weathered	Accelerated conductor fatigue due to vibration
Earthwire dampers	5%	Damaged/Weathered	Accelerated earthwire fatigue due to vibration

The risk cost associated with the issues identified in Table 1 is $3.14m per annum (refer Attachment 1). The most significant element of concern is corrosion of steel pins on insulators.

Corrosion of steel pins on ceramic insulators is a significant issue as it may result in conductor drop due to insulator failure. 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 corrosion issues associated with insulators, particularly on the single circuit section of Line 26, is consistent with other transmission lines of the same vintage in the region.

Ground line corrosion of steel transmission tower legs at the footings is also a key issue. As these are the critical load bearing members of the tower, they cannot be easily remediated if the condition passes a stage where rectification work is not possible. Parts of the line pass through some low lying and coastal areas which promote buried steel corrosion. Erosion of soil has also led to issues with earth strap corrosion.

Due to the proximity of the single circuit section of Line 26 to the coast, Vales Point and the former Munmorah Power Stations, it is considered to have the higher level of corrosion than the remainder of the line. In a 2015 steelwork condition report by Dennis Richards, corrosion of tower steel members was identified as an issue, in

particular, around the waist diaphragm and arm support chord of the towers. Painting has been recommended on all tension towers (11 in total) in this section, with the whole tower to be painted due to the higher level of corrosion.

The transmission line structures used on the single circuit section of Line 26 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. Nuts and bolts of the entire structures are generally poor condition ranging from signs of rusting to severe corrosion and metal loss (including partially/completely blown nuts) in some circumstances.

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

Note that the single circuit section of Line 26 experiences constant and ongoing higher levels of corrosion due to the mixed environments that it passes through, including:

- Pacific Ocean;
- Lake Munmorah and Lake Macquarie; and
- Munmorah and Vales Point Power Stations.

There has been a long history of corrosion related defects on this section of the line, affecting tower members, nuts and bolts, insulators and conductor and earthwire fittings.

The benefit of addressing the condition issues on Line 25/26 is to continue providing the service at a lower risk of failure.

3. Related needs/opportunities

- Pre-requisite: There are no pre-requisite needs
- Related: The following projects involving Line 25/26 may have outage clashes and require coordination
  - Need ID 0528 – Relocation of Line 24 for Centennial Coal (Mandalong Mine)
    - As part of the mine extension works, 12 cruciform foundations have been proposed on Structures 35, 36, 37, 38, 39, 40, 41, 42, 44, 45, 46 and 47 of Line 25/26 to mitigate the effects of subsidence
- Dependent: There are no dependent needs

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 25/26

Option Name: 1350 - Base Case

Option Assessment Name: 1350 - 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	0	Conductor (inc Joints)	Conductor Drop (Conductor)	$6.47	Break	$0.00	0.00%	$0.00			$0.00	$0.00	$0.00	$0.00
Conductor	0	Conductor (inc Joints)	Unplanned Outage - HV (Conductor)	$0.48	Break	$0.00	0.00%	$0.00	$0.00		$0.00			$0.00
Conductor	2121	Fittings	Conductor Drop (Conductor)	$6.47	Fitting Failure	$13,719.90	0.00%	$0.07			$0.00	$0.01	$0.05	$0.00
Conductor	2121	Fittings	Unplanned Outage - HV (Conductor)	$0.48	Structural Failure	$1,015.24	0.00%	$0.01	$0.01		$0.00			$0.00
Conductor	2121	Insulators	Conductor Drop (Conductor)	$6.47	Insulator Failure	$13,719.90	0.01%	$1.33			$0.01	$0.28	$1.04	$0.00
Conductor	2121	Insulators	Unplanned Outage - HV (Conductor)	$0.48	Structural Failure	$1,015.24	0.01%	$0.10	$0.10		$0.00			$0.00
Earth Wire	0	Earth Wire (inc Joints)	Earth Wire Drop (Earth Wire)	$1.40	Break	$0.00	0.00%	$0.00	$0.00		$0.00	$0.00	$0.00	$0.00
Earth Wire	0	Earth Wire (inc Joints)	Unplanned Outage - HV (Earth Wire)	$0.48	Break	$0.00	0.00%	$0.00	$0.00		$0.00			$0.00
Earth Wire	742	Fittings (inc Attachment)	Earth Wire Drop (Earth Wire)	$1.40	Fitting Failure	$1,037.76	0.04%	$0.46	$0.00		$0.01	$0.45	$0.00	$0.00
Earth Wire	742	Fittings (inc Attachment)	Unplanned Outage - HV (Earth Wire)	$0.48	Structural Failure	$355.17	0.04%	$0.16	$0.16		$0.00			$0.00
Structure	19	Earthing	Uncontrolled Electrical Contact / Discharge (Structure)	$0.05	Earthing Failure	$0.96	7.71%	$0.07			$0.00	$0.07		$0.00
Structure	283	Steel Structure	Unplanned Outage - HV (Structure)	$3.35	Structural Failure	$948.14	0.03%	$0.32	$0.32		$0.00			$0.00
Structure	283	Steel Structure (inc Footings)	Conductor / Earth Wire / OPGW Drop (Structure)	$6.72	Structural Failure	$1,902.97	0.03%	$0.64			$0.03	$0.13	$0.48	$0.00
				$34.72		$33,715.28		$3.14	$0.58		$0.05	$0.94	$1.57	$0.01

Total VCR Risk: $0.58

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 (46%) multiplied by the total number of original structures (24) and in Table 2 (16%) multiplied by the total number of original structures (262).
- Steel Structure Earthing: The number of steel structures on Line 25/26 in areas readily accessible by members of the general public (19).
- Insulators: The extent of insulators on the transmission line with advanced corrosion condition issues identified in Table 1 (30%) and in Table 2 (7%) multiplied by the total number of suspension insulators on the line (3 per single circuit suspension structure and 6 per double circuit suspension circuit).

Probability of Failure

As per the Risk costs summary model.

Consequence of Failure

As per the Risk costs summary model.