NEED/OPPORTUNITY STATEMENT (NOS)

Line 2M 330kV Transmission Line Renewal

NOS- 000000001411 revision 2.0

Ellipse project description: P0008173
TRIM file: [TRIM No]

Project reason: Reliability - To meet overall network reliability requirements
Project category: Prescribed - Replacement

Approvals

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Approved	Lance Wee	Manager/Asset Strategy
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 2M is a single circuit steel tower 330kV transmission line between Munmorah and Tuggerah (Sterland) 330kV Substations, with a route length of 39.5 km. The transmission line is a key link between the Central Coast generators and Central Coast load area. This transmission line was originally constructed in 1959 as a double circuit 132kV line between Sydney North and Dora Creek. The section between Munmorah and Jilliby was built in 1965 and it was subsequently upgraded as Line 21 to single circuit 330kV. A tee section was added in 1986 to connect Tuggerah Substation to Line 21 at Sterland. Line 21 was divided into two circuits in 2004 – Line 21 now connects Sydney North and Tuggerah and Line 2M connects Munmorah with Tuggerah. The transmission line mainly traverses through national park, ridgetop, residential and industrial areas. This NOS covers the single circuit section of the line only, a length of 26.5 km totalling 64 structures.

Condition assessment NACA-1411[1] performed in January 2016 has identified a number of issues with Line 2M 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-1411 has identified issues which require rectification, these are summarised in Table 1.

Table 1 – Transmission Line 2M Condition Issues

Issue	Extent (% line)	Cause	Impact
Corrosion of tower steel members	25%	Zinc galvanising end of life	Steel corrosion, particularly of critical members, can lead to structural failure of tower
Corroded fasteners	10%	Zinc galvanising end of life	Structural failure
Corroded conductor attachment fittings	20%	Zinc galvanising end of life	Conductor drop
Corrosion of earthwire attachment fittings	5%	Zinc galvanising end of life	Conductor drop
Corroded suspension insulators	20%	Corrosion of steel caps and pins Zinc sleeve protection end of life	Conductor drop
Corroded tension insulators	72%	Corrosion of steel caps and pins Zinc sleeve protection end of life	Conductor drop
Corroded earthwire	40%	Zinc galvanising end of life	Conductor drop

[1] NACA-1411 on PDGS Need Site

Issue	Extent (% line)	Cause	Impact
Conductor dampers	10%	Damaged/Weathered	Accelerated conductor fatigue due to vibration
Earthwire dampers	20%	Damaged/Weathered	Accelerated earthwire fatigue due to vibration

The risk cost associated with the issues identified in Table 1 is $7.25m per annum (refer Attachment 1). The most significant element of concern is corrosion of conductor and earthwire fittings, which may result in conductor drop.

The single circuit transmission line structures used on Line 2M 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. 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/Bolts and pins are rusting with some nuts/bolts starting to explode losing their shape. Over the past 20 years, a maintenance program replacing corroded nuts and bolts on various towers has also been carried out.

Corrosion of steel pins on ceramic insulators is also a significant issue, as it may result in conductor drop failure. There have been a number of insulator failures leading to conductor drop that have occurred due to the pins corroding through. A number of fittings and insulators have been replaced during the 1990s and 2000s. Corrosion of steel pins on ceramic insulators is an issue. 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.

Corrosion of tower steel members is another area of concern due to the proximity of the line to the coast. As some 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 steelwork condition report from Dennis Richards particularly highlighted corrosion issues around the waist diaphragm and arm support chord of the towers, and accordingly, painting has been recommended on all tension towers (16 in total). NPV cost analysis has indicated that from a cost perspective, it will be more beneficial to paint the entire tower in the section of line near Munmorah due to the higher level of corrosion (4 in total). The corrosion issues associated with the tower structures are consistent with other transmission lines of the same vintage in the region.

Severe corrosion of the SC/GZ earthwire is evident having lost galvanising and appearing red/brown in colour. It requires addressing to extend life.

Earthwire dampers show signs of deterioration and issues with steel fatigue may be exacerbated by rusted stands and rigid suspension attachment points. Conductor dampers show various signs of drooping, and require replacement to prevent accelerated conductor fatigue.

The benefit of addressing the condition issues on Line 2M 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 2M

Option Name: 1411 - Base Case

Option Assessment Name: 1411 - 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	246	Insulators	Conductor Drop (Conductor)	$3.66	Insulator Failure	$899.45	0.04%	$0.40			$0.00	$0.01	$0.39	$0.00
Conductor	246	Insulators	Unplanned Outage - HV (Conductor)	$0.07	Structural Failure	$17.90	0.04%	$0.01	$0.01		$0.00			$0.00
Conductor 2	246	Fittings	Conductor Drop (Conductor 2)	$3.66	Fitting Failure	$899.45	0.71%	$6.37	$0.00		$0.06	$0.14	$6.16	$0.01
Conductor 2	246	Fittings	Unplanned Outage - HV (Conductor 2)	$0.07	Structural Failure	$17.90	0.71%	$0.13	$0.13		$0.00			$0.00
Earth Wire	4	Earth Wire (inc Joints)	Earth Wire Drop (Earth Wire)	$0.06	Break	$0.23	0.09%	$0.00	$0.00		$0.00	$0.00	$0.00	$0.00
Earth Wire	4	Earth Wire (inc Joints)	Unplanned Outage - HV (Earth Wire)	$0.07	Break	$0.29	0.09%	$0.00	$0.00		$0.00			$0.00
Earth Wire 2	164	Fittings (inc Attachment)	Earth Wire Drop (Earth Wire 2)	$0.11	Fitting Failure	$17.35	0.45%	$0.08	$0.00		$0.02	$0.06	$0.00	$0.00
Earth Wire 2	164	Fittings (inc Attachment)	Unplanned Outage - HV (Earth Wire 2)	$0.07	Structural Failure	$11.93	0.45%	$0.05	$0.05		$0.00			$0.00
Structure	61	Steel Structure	Unplanned Outage - HV (Structure)	$0.51	Structural Failure	$31.05	0.08%	$0.02	$0.02		$0.00			$0.00
Structure	61	Steel Structure (inc Footings)	Conductor / Earth Wire / OPGW Drop (Structure)	$3.92	Structural Failure	$239.27	0.08%	$0.19			$0.01	$0.00	$0.17	$0.00
Structure 2	0	Earthing	Uncontrolled Electrical Contact / Discharge (Structure 2)	$0.00	Earthing Failure	$0.00								
				$12.20		$2,134.83		$7.25	$0.21		$0.09	$0.21	$6.72	$0.01

Total VCR Risk: $0.21   Total ENS Risk: $0.00

Number of Components

The number of components used in the risk 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 (25%) multiplied by the total number of original structures (64).

> Conductor Fittings: The extent of the conductor fittings on the transmission line with advanced corrosion condition issues identified in Table 1 (20%) 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 (20%) multiplied by the total number of suspension insulators on the line (3 per suspension structure).

> Earth Wire: Length of earth wire on the transmission line multiplied portion with advanced corrosion condition issues identified in Table 1 (40%).

> 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 figure above.

Consequence of Failure

As per figure above.