NEED/OPPORTUNITY STATEMENT (NOS)

Line 22 330kV Transmission Line Renewal

NOS- 000000001349 revision 2.0

Ellipse project description: P0007963
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	5 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 22 is a single circuit steel tower 330kV transmission line between Vales Point and Sydney North 330kV substations, with a route length of 86 km. The transmission line is a key link between the Central Coast generators and the Sydney metropolitan area. It was constructed as the Vales Point to Sydney North No.1 Line in 1962 and consists of 190 structures. The transmission line mainly traverses small rural holdings, heavily timbered ridgetops and National Parks. It crosses the M1 Motorway, Pacific Highway and Main Northern Railway as well as numerous local roads.

Condition assessment NACA-1349[1] performed in March 2016 and Tower Inspection Report conducted by Dennis Richards (DMR 216) have identified a number of issues with Line 22 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-1349 has identified issues which require rectification, these are summarised in Table 1.

Table 1 – Transmission Line 22 Condition Issues

Issue	Extent (% line)	Cause	Impact
Ground line corrosion of steel at footing	35%	Buried steelwork at footing	Steel corrosion of critical member, can lead to structural failure of tower
Buried concrete foundations	45%	Erosion of soil building up around footings	Accelerated corrosion of critical member
Earth strap	5%	Corrosion as buried at footing	Earthing safety hazard
Corrosion of tower steel members	35%	Zinc galvanising end-of-life	Steel corrosion, particularly of critical members, can lead to structural failure of tower
Corroded fasteners	1%	Zinc galvanising end-of-life	Structural failure
Corroded suspension insulators	30%	Corrosion of steel caps and pins Zinc sleeve protection end-of-life	Conductor drop
Corroded tension insulators	11%	Corrosion of steel caps and pins Zinc sleeve protection end-of-life	Conductor drop
Corroded conductor attachment fittings	20%	Zinc galvanising end-of-life	Conductor drop
Corrosion of earthwire attachment fittings	15%	Zinc galvanising end-of-life	Conductor drop

[1] NACA-1349 on PDGS Need Site

Issue	Extent (% line)	Cause	Impact
Corroded earthwire	40%	Zinc galvanising end-of-life	Conductor drop
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 $2.89m per annum (refer Attachment 1). The most significant element of concern is ground line corrosion of steel transmission tower legs at the footings. 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.

The single circuit transmission line structures used on Line 22 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 tower steel members is also a key issue, particularly on the waist diaphragm and arm support chord of the towers as identified in the steelwork condition report from Dennis Richards. Painting has been recommended on all tension towers and five suspension towers which have been identified as unsuitable for replacement (66 in total), in particular, around the waist diaphragm and arm support chord of the towers. 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 Vales Point due to the higher level of corrosion (6 in total).

Corrosion of steel pins on ceramic insulators is also a significant issue, which 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 is consistent with other transmission lines of the same vintage in the region. Past condition issues have been handled through maintenance and there has been a significant program to replace the suspension and pilot insulators on the line over the last 20 years.

Significant corrosion of the SC/GZ 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.

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 in poor condition ranging from signs of rusting to severe corrosion and metal loss in some circumstances.

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

Due to the environment that Line 22 traverses through, there has been a long history of corrosion related defects on the line, affecting tower members, nuts and bolts, insulators and conductor and earthwire fittings. The line has a history of corrosion of steel members on the structures, particularly ground line corrosion of steel tower legs at the footings, which has resulted in tower legs being dug/cleaned/painted with various materials over the last 20 years.

Painting of rusted steel alone, without proper sandblasting and/or concrete encasement, has proven to be an ineffective method of halting corrosion.

The benefit of addressing the condition issues on Line 22 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 22 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, one cruciform foundation has been proposed on Structures 32 of Line 22 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 22

Option Name: 1349 - Base Case

Option Assessment Name: 1349 - 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	753	Fittings	Conductor Drop (Conductor)	$4.20	Fitting Failure	$3,165.01	0.00%	$0.03			$0.00	$0.00	$0.02	$0.00
Conductor	753	Fittings	Unplanned Outage - HV (Conductor)	$0.00	Structural Failure	$0.94	0.00%	$0.00	$0.00		$0.00			$0.00
Conductor	753	Insulators	Conductor Drop (Conductor)	$4.20	Insulator Failure	$3,165.01	0.03%	$0.87			$0.01	$0.02	$0.84	$0.00
Conductor	753	Insulators	Unplanned Outage - HV (Conductor)	$0.00	Structural Failure	$0.94	0.03%	$0.00	$0.00		$0.00			$0.00
Earth Wire	24	Earth Wire (inc Joints)	Earth Wire Drop (Earth Wire)	$0.10	Break	$2.33	0.56%	$0.01	$0.00		$0.00	$0.01	$0.00	$0.00
Earth Wire	24	Earth Wire (inc Joints)	Unplanned Outage - HV (Earth Wire)	$0.00	Break	$0.03	0.56%	$0.00	$0.00		$0.00			$0.00
Earth Wire 2	502	Fittings (inc Attachment)	Earth Wire Drop (Earth Wire 2)	$0.12	Fitting Failure	$57.88	0.03%	$0.02	$0.00		$0.00	$0.02	$0.00	$0.00
Earth Wire 2	502	Fittings (inc Attachment)	Unplanned Outage - HV (Earth Wire 2)	$0.00	Structural Failure	$0.63	0.03%	$0.00	$0.00		$0.00			$0.00
Structure	190	Steel Structure	Unplanned Outage - HV (Structure)	$0.01	Structural Failure	$1.60	0.23%	$0.00	$0.00		$0.00			$0.00
Structure	190	Steel Structure (inc Footings)	Conductor / Earth Wire / OPGW Drop (Structure)	$4.47	Structural Failure	$849.91	0.23%	$1.96			$0.13	$0.05	$1.77	$0.00
Structure 2	10	Earthing	Uncontrolled Electrical Contact / Discharge (Structure 2)	$0.00	Earthing Failure	$0.04	6.61%	$0.00			$0.00	$0.00		$0.00
				$13.11		$7,244.32		$2.89	$0.00		$0.15	$0.11	$2.63	$0.00

Total VCR Risk: $0.00

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 (45%) multiplied by the total number of original structures (190).
- 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).
- Earth Wire Fittings: The extent of the earth wire fittings on the transmission line with advanced corrosion condition issues identified in Table 1 (15%) 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.