NEED/OPPORTUNITY STATEMENT (NOS)

TL Silmalec Fitting Condition Phase 2

NOS- 000000001590 revision 2.0

Ellipse project description: P0009435
TRIM file: [TRIM No]

Project reason: Capability - Asset Replacement for end of life condition
Project category: Prescribed - Asset Renewal Strategies

Approvals

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1. Background

Large diameter Silmalec single all aluminium alloy conductor has been installed on 330kV lines in the high altitude areas of the transmission lines connected to the Snowy Hydro scheme, in particular around Upper Tumut Switching Station (UTSS) and Lower Tumut Switching Station (LTSS). These lines were constructed between about 1957 and 1964 and play a critical role in the NEM transferring energy from Victoria/Snowy to NSW and connecting major hydroelectric generation.

In recent years, a number of issues have arisen around lines with Silmalec conductor, particularly with midspan joints, conductor deadend fittings and vibration dampers.

In 2003, a midspan joint failed on 01 T/L in span 2-3 outside UTSS. Metallurgical examination of the failed fitting showed a fatigue failure, expected to have started from a compression of the joint tube adjacent to the end of one of the conductors, creating a shear crack that grew under tension to an eventual fatigue failure. In 2010, a midspan joint failed on 01 T/L in span 38-39. Metallurgical examination of the failed fitting showed cracking that grew to an eventual fatigue failure.

In 2015, a deadend failed on U7 T/L on Structure 1 in span 1-2. Metallurgical examination of the failed fitting showed points of stress and cracking which grew until there was an eventual fatigue failure. A further metallurgical examination of five other deadends removed from U7 following site dye penetrant testing showed that cracking they exhibited was due to stress corrosion cracking. The indication from these failures in this manner and the identification of some level of cracking on other deadends through dye penetrant is that these fittings may be reaching end of life. It is probable that bowing of the deadends (refer Attachment 1) during installation (due to difficulties associated with handling and terminating conductor of this larger size) has exacerbated the formation of cracks.

Lines with Silmalec conductor are fitted with “Elgra” vibration dampers from the original construction. Manufactured in Sweden, these dampers consist of a number of weights resting on elastomer pads around a central rod suspended vertically. They have been discarded from service in Sweden and elsewhere because of excessive wear at the connecting rod joint. In low winds, conductors on these lines have been seen vibrating, supporting the industry findings that these style of dampers are ineffective. These vibrations increase fatigue on the conductor and its associated fittings, shortening the expected life of the conductor and increasing its likelihood of failure and resultant conductor drop over time.

2. Need/opportunity

Transmission Line & Cables Asset Management has undertaken a review of all 330kV transmission lines installed with Silmalec conductors and identified a total of 451 original deadend fittings and 62 original midspan joints that are potentially at risk of failure by this mode (cracking of the conductor fitting). A number of these lines have been identified as being generally strung at a higher tension (> 48kN), and due to the potentially higher consequences associated a conductor failure of this type, have been addressed as a priority under Need 1290 (a total of 99 deadends and 57 midspan joints). All “Elgra” vibration dampers on the aforementioned spans were also addressed under Need 1290.

The remaining deadends and midspan joints for lines generally strung at lower tensions (< 48kN) still require remediation. A summary of these transmission lines along with their respective number of deadend fittings and midspan joints is listed in Table 1. In addition, all “Elgra” vibration dampers on these spans are to be replaced in conjunction with the conductor deadends and midspan joints.

Table 1 – Transmission Lines with Silmalec Conductor (Line Tension < 48kN)

Line	Deadends to be Replaced	Midspan Joints to be Replaced	Vibration Dampers to be Replaced	General Line Tension and Comments
64 (UTSS – LTSS)	36	1	All spans	34-46kN, mainly 34-36kN Deadends are different with transverse palms
1 (UTSS – CNB)	52	1	All spans	30-35kN
2 (UTSS – YAS)	144	3	All spans	25-45kN, mainly low 30kN
L1 (T3 – LTSS)	12	Nil	All spans	30kN
L3 (T3 – LTSS)	12	Nil	All spans	32kN
L5 (T3 – LTSS)	12	Nil	All spans	33kN
M1 (M1 – MSS)	6	Nil	All spans	Landing span
M3 (M1 – MSS)	6	Nil	All spans	Landing span
M5 (M1 – MSS)	6	Nil	All spans	Landing span
M7 (M1 – MSS)	6	Nil	All spans	Landing span
M9 (M1 – MSS)	6	Nil	All spans	Landing span
M11 (M2 – MSS)	36	Nil	All spans	29kN
M13 (M2 – MSS)	18	Nil	All spans	30kN
Total	**352**	**5**		

The risk cost associated with the Silmalec conductor deadends and midspan as identified in Table 1 is $1.09 million per annum, with the main risk being conductor drop failure. The consequences of this could include serious injury to persons, bushfire, regulatory non-compliance, and a failure of TransGrid to meet its obligations under the connection agreement with Snowy Hydro.

Lines with Silmalec conductor are often located in high altitude, generally in the Kosciuszko National Park or alpine areas which have high environmental sensitivity. The local conditions increases the level of consequence associated with a bushfire event generated from a conductor drop. Failure on these lines also has a high consequence in the electricity market due to the role these lines play in connecting major hydroelectric generation in the Snowy Region to NSW and Victoria. In addition, longer repair times are typical for infrastructure in this area due to accessibility issues, particularly during the snow season.

The majority of the deadends and midspan joints identified are in areas where access is poor and significant earth works would be required to carry out rectification works due to the steep terrain. Some midspan joints are also too high from the ground to be accessed. It is expected that reinforcement of the deadends and midspan joints via helicopter will be required.

The access issues and reinforcement options are detailed in the "Silmalec Deadends and Midspan Joints Position Paper".

3. Related needs/opportunities

Pre-requisite:

- Need 1290 – 330kV Silmalec Conductor Deadends and Midspan Joints Phase 1

Related:

- There are no related needs.

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 Example of bowed deadend

Attachment 2 Risk costs summary

Current Option Assessment - Risk Summary

Project Name: TL Silmalec Fitting Condition Phase 2

Option Name: TL Silmalec Fitting Condition Phase 2 - Base Case

Option Assessment Name: TL Silmalec Fitting Condition Phase 2 - 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 Drop	5	Conductor (inc Joints)	Conductor Drop (Conductor Drop)	$3.38	Break	$16.88	0.16%	$0.03	$0.00		$0.01	$0.00	$0.02	$0.00
Conductor Drop	5	Conductor (inc Joints)	Unplanned Outage - HV (Conductor Drop)	$0.73	Break	$3.66	0.16%	$0.01	$0.00		$0.01			$0.00
Conductor Drop	352	Fittings	Conductor Drop (Conductor Drop)	$3.38	Fitting Failure	$1,188.46	0.07%	$0.87	$0.00		$0.18	$0.03	$0.66	$0.00
Conductor Drop	352	Fittings	Unplanned Outage - HV (Conductor Drop)	$0.73	Structural Failure	$257.73	0.07%	$0.19	$0.01		$0.18			$0.00
				$8.22		$1,466.73		$1.09	$0.01		$0.37	$0.03	$0.68	$0.00

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

Number of Components

The number of components used in the risk model has been derived as follows:

- Conductor Fittings: The extent of the conductor deadend fittings on the transmission lines with condition issues identified in Table 1 (352).
- Conductor Mid-Span Joints: The extent of the conductor mid-span joints on the transmission lines with condition issues identified in Table 1 (5).

Probability of Failure

As per figure above.

Consequence of Failure

As per figure above.