NEED/OPPORTUNITY STATEMENT (NOS)

Improved Fault Location on Various 132 kV Lines

NOS- 000000001480 revision 2.0

Ellipse project no.: P0008612
TRIM file: [TRIM No]

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

Approvals

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Date submitted for approval	9 January 2017	

1. Background

There are a number of 132 kV lines on the HV system outside the coverage of the Travelling Wave Fault Locator (TWFL) Network that have experienced tripping events without discernible external events such as lightning storms or wind/rain events (unexplained trips). These types of line trips are very difficult to locate, so remedial works to minimise the likelihood of future trips is not currently possible.

A location of the fault allows for a review of the cause of the line trip, and the potential to identify remedial works to minimise the likelihood of a similar trip occurring in the future. The existing fault location capability on most lines is via the distance protection relays. The relays providing this protection can report either a protection zone (e.g. zone 1 – 80% of the line) or a distance to fault in km. The accuracy of these fault locations is hampered by:

- Protection zones from older relays – there are three options for fault location:
  - zone 1 from the close end and zone 2 from the far end places the fault in the first 20% of the line, leading to say 20km of a 100km line to patrol;
  - zone 2 from the close end zone 1 from the far end places the fault in the last 20% of the line; or
  - zone 1 from both ends places the fault in the middle 60% of the line, 60km of a 100km line to patrol.

  Any of these patrols are looking for a possible visible flashover on a porcelain insulator, or worse a small bead of metal where the flashover occurred from conductor to steel crossarm. These patrols have been determined to be of little value and are not performed unless it is a repeated tripping of a line and there's a possibility that the fault has weakened insulation enough that there could be equipment failure.
- Distance to fault measurements from modern protection relays are calculated from the measured impedance of the fault and known line impedance. This percentage of the line length gives a distance. Generally, where this is provided from both ends of a line, or from both protections at one end of a line, rarely do the distances match. From both ends of a line, it is likely that the sum of these distances could be 10km greater than the total length of the line, leaving an area of approximately 10km to patrol, which is better than the best available from protection zoning, but still very difficult to cost effectively target the finding of the small markings of flashover. The distances are compromised through the impedance of the fault itself. If the arc is long through smoke from a nearby fire, then the impedance is high and this could add a number of kilometres to the fault distance calculation. If the transmission line is solidly connected to earth, then the fault impedance is likely to be lower and distances more accurate.
- Fault location in these scenarios also requires staff to visit the substations and read either the zone flags or the distance to fault information from the relay screen. This can be a time consuming task, as well as requiring staff call out.

The requirements for an after fault patrol are determined based upon information about the fault location and the decision tree available in the Transmission Line Maintenance Plan. Existing fault location methods require a staff member to visit the substation at each end of the line to read the distance to fault information from the protection relays. Once the fault is located, in many cases for a successful auto reclose, an after fault patrol is not required unless there is public exposure likely should the line be compromised by the trip.

Without an accurate fault location, there is often the requirement to patrol road crossings and other areas where the public may come in proximity to a damaged transmission line to check for damage that may compromise the safety of the transmission line. This does not identify a cause and does not provide information on how to minimise the likelihood of future trips.

2. Need/opportunity

An opportunity exists to improve the fault location on 132kV lines that experience a number of unexplained trips, such that location of the fault can be reliably determined.

132kV lines with up to seven trips in 2009 – 2016 that are not covered by the existing TWFL Network are:

Line (Length in km)	Number of unexplained trips	Number of storm trips	Total trips 2009 - 2016
990 Yass – Wagga (150.4km)	5	11	16
963 Tomago – Taree tee Hawks Nest (143km)	4	7	13
97K Cooma – Munyang tee Snowy Adit (76.8km)	4	7	11
966 Armidale – Koolkhan (177.2km)	4	6	11
999 Yass – Cowra (114.7km)	6	4	10
998 Forbes – Cowra (88.6km)	3	4	8
99L Deniliquin – Coleambally (152.9km)	5	2	7
96T Armidale – Glen Innes (96.1km)	4	2	7
99K Darlington Pt – Griffith (59.4km)	4	1	7
944 Wallerawang – Orange North (98.0km)	3	2	7
96R Glen Innes – Tenterfield (80.2km)	2	5	7

The ability to locate faults for unknown trips will improve the ability to identify the cause of the external source and determine if there is an opportunity to apply some maintenance practice, hardware change or some other control to minimise the likelihood of a trip in the future. The choice to patrol becomes a far more calculated and targeted activity, minimising unnecessary costs in looking for signs of a fault that are inherently difficult to find, and one that leads to further understanding of line trips out of the blue.

On a line lockout trip, the patrol can potentially be directly targeted without the need to look at multiple road crossings first, and can generally be carried out with a crew ready to repair rather than a second call out to a location many hours later. The cost savings on restoration times can be significant in these cases.

Of these lines identified, 963 and 97K each have tee sections feeding customer loads. Fast fault location during unsuccessful reclose attempts can enable faster line restoration for the customer.

3. Related needs/opportunities

Need 1402 – Fault Data Interrogation System

4. Recommendation

It is recommended that options be considered to address the identified need/opportunity.

Attachment 1 Risk costs summary

Current Option Assessment - Risk Summary

Project Name: Making the Grid More Resilient - Improved Fault Location on Various 132kV Lines

Option Name: 1480 - Base Case

Option Assessment Name: 1480 - 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)
Faults on TWFL Lines	12	Conductor	Unplanned Outage - HV (Faults on TWFL Lines)	$0.26	Low Span	$3.14	132.14%	$4.14			$4.14			
				$0.26		$3.14		$4.14			$4.14			

Total VCR Risk:

Total ENS Risk:

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