OPTIONS EVALUATION REPORT (OER)

Improved Fault Location on Various 132 kV Lines

OER 000000001480 revision 3.0

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

Approvals

Author	Ronny Schnapp	Network & Connection Analysis Engineer
Reviewed	Lulu Shao	Network & Connection Analysis Senior Engineer
Endorsed	Vincent Ong	Network & Connection Analysis Manager
Approved	Andrew Kingsmill	Manager/Network Planning
Date submitted for approval	9 January 2017	

1. NEED/OPPORTUNITY

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. 132kV lines with up to seven trips in 2009 – 2016 that are not covered by the existing TWFL Network are listed in NOS 1480.

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.

As described in NOS-1480, there is an opportunity for TransGrid 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.

2. RELATED NEEDS/OPPORTUNITIES

- Need 1402 – Fault Data Interrogation System

3. OPTIONS

Base case

The base case is to continue with the current fault location methods and inspection practices.

Base case Risk Cost

The base case risk cost is calculated assuming the requirement of climbing and inspecting a large number of lines to detect a fault following a line fault. For most faults, patrolling of about 10 km of the line is required if the protection relay distance to fault information is available. However, depending on the accuracy of the protection information available, in certain instances, up to 60% of the line is required to be patrolled to explain the reasons for a fault. Refer to NOS 1480 for more details. Based on TransGrid historical statistics and labour costing information, the following assumptions can be used in calculating the risk costs[1].

- Cost of line trip when protection relay distance to fault successful: $71,000 / line trip for 60%[2] of the lines where detection of reason for fault is successful based on protection relay distance to fault information
- Cost of line trip when protection relay distance to fault not successful (unexplained trips): $542,666 / line trip for patrolling 60% of the line in zone 1 for 40%[2] of the lines
- No. of lines[3] = 12

[1] Refer to NOS 1480 Rev 0 section 2.1 for details and justification

[2] Based on the historical fault events and number of historical unexplained faults (refer NOS 1480) of 45 out of 111 in the period 2009 to 2016

- No. of explained trips per year across 12 lines[2] = No. of explained trips in 7 years/7 = 66/7 = 9.4 trips/year
- No. of unexplained trips per year across 12 lines[2] = No. of unexplained trips in 7 years/7 = 45/7 = 6.4 trips/year

Risk Cost per year = Cost of explained trips/year + Cost of unexplained trips/year

= [No. of lines * No. of explained trips / year/line * Cost/trip] + [No. of lines * No. of unexplained trips / year/line * Cost/trip]

= [12 * (9.4/12) * 71,000] + [12 * (6.4/12) * 542,666]

= $4.14 million/ year

Option A — Install TWFL on 132 kV Lines

This option is to expand the TWFL network to monitor 132 kV lines to better identify the location of faults, enabling faster customer restoration times as well as remediation works to minimise the likelihood of future trips.

The following lines have been identified for TWFL:

- 990 Yass – Wagga
- 963 Tomago – Taree tee Hawks Nest
- 97K Cooma – Munyang tee Snowy Adit
- 966 Armidale – Koolkhan
- 999 Yass – Cowra
- 998 Forbes – Cowra
- 99L Deniliquin – Coleambally
- 96T Armidale – Glen Innes
- 99K Darlington Pt – Griffith
- 944 Wallerawang – Orange North
- 96R Glen Innes – Tenterfield

This option has been assessed for feasibility in OFS-1480A. The estimated un-escalated capital cost of the option is $2.31m in $2016-17.

Option Risk Cost

The option risk cost is calculated on the premise that the implementation of TWFL would reduce the cost of identification of a fault location (tower) in order arrange remedial measures. With the ability of TWFL systems to estimate the location of a fault to an accuracy of 1km, the number of towers/spans to be patrolled will be significantly reduced. The likelihood of a line trip occurring is unchanged from base case.

The following is assumed based on TransGrid historical statistics and labour costing for lines with TWFL systems:

Cost of line trip when TWFL systems available[4]: $13,101 / line trip for all lines

No. of trips per year across 12 lines = No. of trips in 7 years/7 = 111/7 = 15.9 trips/year

Risk Cost = [No. of lines * (No. of trips / year/line) * (Cost/trip)]

= $12 * (15.9/12) * 13,101

[3] There are 12 lines listed in NOS 1480 that do not have TWFL facility

[4] Refer to NOS 1480 Rev 0 Section 2.1

= $0.21 million / year

Option B – Targeted replacement of line protection relays on 132 kV lines

Install electronic line protection relays that provide a distance to fault indication.

This option would involve a capital cost greater than the cost of Option A, and will have a larger post option risk, i.e. Risk cost = $12 * (15.9/12) * 71,000. Therefore this option was not considered.

Option C – Expand the Tarigma GEM data interrogation system

This option is to expand the Tarigma GEM data interrogation system at appropriate sites to allow the protection system flagging and data output to be read from the Asset Monitoring Centre. This will allow distance to fault to be determined without sending field staff to site to read the protection relay distance to fault measurements.

It is not anticipated that existing relays would have the required functionality to allow this. This would therefore require similar investment to Option B, with additional equipment installed to allow connection to the Tarigma GEM data interrogation system and therefore larger cost than Option A. The fault location functionality will not be as accurate as the TWFL, and as such, would require a larger section of line to be inspected. Therefore the post investment risk cost will also be larger than the risk cost in Option A. As such, this option was also not considered further.

Option D – Installation of time-domain line protection relays

Time-domain protection relays, although offering faster protection operation with two-ended fault location, are not tested and proven for use in TransGrid's network. For this reason, this is not considered to be a technically feasible solution and has not been considered.

Non-network option

No feasible non-network solutions have been identified to address this Need.

4. EVALUATION

A single option was identified to be analysed further and is evaluated below against the base case.

The economic evaluation of the technically feasible options is set out in Table 1.

Table 1 – Options Comparison

Option	Description	Capex ($m)^#	Opex ($m)	Yearly post project risk cost ($m)	NPV ($m)	Rank
Base case	'Do nothing'	Nil	-	4.14		2
A	Install TWFL on 132 kV Lines	2.31*	0.05	0.21	22.35	1

^ In 2016-17 dollars
 # Expenditure in 2018-19 period
** Non-Escalated cost*

The commercial evaluation is based on:

- a 10% discount, with sensitivities based on TransGrid's current AER-determined pre-tax real regulatory WACC of 6.75% for the lower bound and 13% for the upper bound provided in Appendix A.
- the applied sensitivities on the discount rate give the following economic NPVs:

Discount Rate (%)	Economic NPV (2018/19$m)
6.75	29.35
13.00	17.69

Capital and operating expenditure

The expected annual operating cost for option A is $0.0496 million, which is 2% of the Capital Cost, escalated at an annual rate of 2.9%.

Regulatory Investment Test

No RIT-T is required for this project as the total cost is less than $6 million.

Risk Cost Benefits

Option A would realise a risk cost benefit of $3.93 million per annum.

Net Present Value

The NPV of this option is $22.35 million based on a standard discount rate of 10%.

The pay-back period is 0.63 years (less than 1 year).

5. RECOMMENDATION

Based on the economic evaluation above, Option A is the preferred option to address the Need as it significantly reduces TransGrid's risk exposure and reduces the risk from $4.14m to $0.21m.

It is recommended that an RPS be issued for the expansion of the TWFL Network to cover the identified 132 kV lines within the regulatory period 2018–2023.

Appendix A Financial and Economic Evaluation Report

Project_Option Name	Install TWFL on 132 kV Lines to reduce costs

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	$22.35m	*NPV / Capital (Ratio)*	*9.67*
NPV @ upper bound rate	13.00%	$17.69m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	$29.35m	*IRR%*	*113.38%*

2. Economic Evaluation (includes VCR benefits but excludes tax benefits from non-cash transactions, ENS penalty and overall tax cost)

NPV @ standard discount rate	10.00%	$22.35m	*NPV / Capital (Ratio)*	*9.67*
NPV @ upper bound rate	13.00%	$17.69m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	$29.35m	*IRR%*	*113.38%*

Benefits

Risk cost	As Is	To Be	Benefit
Systems (reliability)	*$0.00m*	*$0.00m*	*$0.00m*
Financial	*$0.00m*	*$0.00m*	*$0.00m*
Operational/compliance	*$4.14m*	*$0.21m*	*$3.93m*
People (safety)	*$0.00m*	*$0.00m*	*$0.00m*
Environment	*$0.00m*	*$0.00m*	*$0.00m*
Reputation	*$0.00m*	*$0.00m*	*$0.00m*
Total Risk benefits	$4.14m	$0.21m	$3.93m
Cost savings and other benefits			$0.00m
Total Benefits			$3.93m

VCR Benefit	*$0.00m*
ENS Penalty	*$0.00m*
All other risk benefits	*$3.93m*
Total Risk benefits	$3.93m
Benefits in the financial NPV*	$3.93m
**excludes VCR benefits*	
Benefits in the economic NPV**	$3.93m
***excludes ENS penalty*	

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-$0.05m	Write-off cost	$0.00m
Capital - initial $m	-$2.31m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	$0.00m	Re-investment capital	$0.00m
Capitalisation period	2.00 Yrs	Start of the re-investment period	2024-25