

OPTIONS EVALUATION REPORT (OER)

Protection - Feeder OC Condition

OER 000000001368 revision 1.0



Ellipse project description:

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. Need/opportunity

Feeder Overcurrent Protection relays are used through the network to protect transmission lines and some capacitor banks. These types of protection installations are a remnant of design standards from the 1960s to 80s. All relays will have reached the end of their technical life by 2023. Manufacturer support for these has ceased meaning no firmware or hardware upgrades are available and spares currently held by TransGrid for these models are projected to be exhausted.

The use of duplicated protection schemes across all transmission lines and transformers are a continuing requirement of the Australian Energy Regulator (AER) as outlined in the National electricity Rules (NER). These protection schemes are required into the foreseeable future.

2. Related needs/opportunities

The following Needs address parts of the omitted relays covered by this Need:

- > Need ID 1180 - Wagga 330kV Secondary Systems Renewal
- > Need ID 1186 - Murrumburrah Secondary Systems Renewal
- > Need ID 1191 - Deniliquin Secondary Systems Renewal
- > Need ID 1192 - Lower Tumut Secondary Systems Renewal
- > Need ID 1193 - Broken Hill Secondary Systems Renewal
- > Need ID 1194 - Tenterfield Secondary Systems Renewal
- > Need ID 1196 - Coleambally Secondary Systems Renewal
- > Need ID 1243 - Tamworth 330kV Secondary Systems Renewal
- > Need ID 1244 - Wallerawang 330kV Secondary Systems Renewal
- > Need ID 1246 - Panorama Secondary Systems Renewal
- > Need ID 1247 - Muswellbrook Secondary Systems Renewal
- > Need ID 1252 - Cowra Secondary Systems Renewal
- > Need ID 1253 - Darlington Point Secondary Systems Renewal
- > Need ID 1255 - Ingleburn Secondary Systems Renewal
- > Need ID 1258 - Regentville Secondary Systems Renewal
- > Need ID 1263 - Tuggerah Secondary Systems Renewal
- > Need ID 1266 - Marulan Secondary Systems Renewal
- > Need ID 1267 - Molong Secondary Systems Renewal
- > Need ID 1599 - Liverpool Secondary Systems Renewal

3. Options

Base case

The Base Case for this Need is to run these assets to failure. This approach does not address the deteriorating condition of the assets or the risk cost associated with the Need. At \$0.777m per annum, the risks are foreseen to increase as the probability of failure of the assets will also likely increase. Key drivers for this risk cost are:

- > Increasing probability of failure rates
- > Consequence assumes loss of site for assets protecting primary plant at 132kV and below with “N-1” redundancy. The restoration time has been set as 8 hours with an assumed average 42MW of load interrupted to mixed customers (residential, commercial, and agricultural) as an average based on this consequence.
- > Inability to acquire spares

Increasing the maintenance for the assets cannot reduce the probability of failure in order to reduce the risk cost.

Option A — Replacement of individual Assets <OFR 000000001368A, OFS 000000001368A>

This option covers the replacement of assets in a “like for like” manner. This involves removing the panel and replacing it with a new relay panel utilising the same features currently in use. This option doesn’t include any upgrade of systems to maximise the utilisation of available technology.

Operating costs have been estimated at \$3.25k per annum for this option based on current maintenance plan settings.

Due to the “like for like” nature of this option, no benefit has been calculated in accordance with TransGrid’s Renewal and Maintenance Strategy for Secondary Systems Site Installations¹.

The expected total capital cost to replace all 38 assets identified under this need is \$4.98m (in un-escalated 2016/17 dollars). This costing is estimated using TransGrid’s “Success” estimating system. For this OER, the quantity of asset replacements has been reduced to 26 and cost has been adjusted to \$3.41m to account for 12 assets that will be replaced under Secondary Systems Renewal needs. This adjustment has been carried out using the unit costs provided in the OFS.

The residual risk associated with this option upon completion of the project amounts to \$0.068m per annum (base case risk cost = \$0.777m). The risk reduction is realised through the reduction in the probability of failure for all assets.

The assets under investigation have been categorised into two broad categories:

Assets protecting primary assets <330kV and <150MW

This configuration covers only replacing the assets protecting primary assets where the peak load at risk is less than 150MW and service voltage is less than 330kV.

The expected capital cost to replace this category of assets is \$3.28m (in un-escalated 2016/17 dollars). This costing was estimated using the unit costs provided under OFS-000000001368A and applying them to those assets that would be replaced. These costs are broken down in the table below:

Item	Unit Cost, Including Labour (\$k)	Quantity	Total Cost (\$m)
Overcurrent <=220kV	131	25	3.28
Total estimated cost			3.28

The residual risk associated with this portion of assets upon completion of the project amounts to \$0.059m per annum (base case risk cost component = \$0.761m). The risk reduction is realised through the reduction in the probability of failure for the affected assets.

Assets protecting primary assets <330kV and >150MW

This configuration covers only replacing the assets protecting primary assets where the peak load at risk is greater than 150MW and service voltage is less than 330kV.

The expected capital cost to replace this category of assets is \$0.13m (in un-escalated 2016/17 dollars). This costing was estimated using the unit costs provided under OFS-000000001368A and applying them to those assets that would be replaced. These costs are broken down in the table below:

¹ Refer TRIM: D2015/15386 - SSA Strategy - Renewal and Maintenance -Secondary Systems Site Installations

Item	Unit Cost, Including Labour (\$k)	Quantity	Total Cost (\$m)
Overcurrent <=220kV	131	1	0.131
Total estimated cost			0.131

The residual risk associated with this portion of assets upon completion of the project amounts to \$0.010m per annum (base case risk cost component = \$0.015m). The risk reduction is realised through the reduction in the probability of failure for the affected assets.

4. Evaluation

Evaluation of the proposed options has been completed using economic considerations. The results of this evaluation are outlined below.

Commercial Evaluation

The commercial evaluation of the technically feasible options is set out in the table below.

Option	Description	Capex (16/17 \$m)	Opex (\$m pa)	Post project risk cost (\$m pa)	Economic NPV (\$m) @10%	Financial NPV (\$m) @10%	Rank
Base case	Run to fail	NA	0.007	0.777	NA	NA	2
A	Replace individual Assets	3.41	0.003	0.068	0.74	(2.42)	1 ²
i)	Replace <150MW Assets	3.28	0.003	0.059	0.82	(2.32)	-
ii)	Replace >150MW Assets	0.131	0.000	0.009	(0.05)	(0.08)	-

Table 1: Commercial Evaluation

The commercial evaluation is based on:

- > Economic life of the assets is assumed 15 years, hence this assessment period has been applied
- > Write-offs have not been estimated
- > Capital cost is not escalated and it does not include capitalised interest

Sensitivities on with changing discount rate are shown in the table below:

² Preferred Option for subset of assets with positive NPV

Option	Description	Economic NPV with Discount Rate of 13% (16/17 \$m)	Economic NPV with Discount Rate of 6.75% (16/17 \$m)
A	Replace All Assets	0.07	1.89
i)	Replace Assets <150MW	0.15	1.96
ii)	Replace Assets >150MW	(0.05)	(0.05)

Table 2: Option Sensitivity

SFAIRP/ALARP Evaluation

Options to reduce the network safety risk as per the risk treatment hierarchy have been considered in other lifecycle stages of the asset, and it has been determined that no reasonably practicable options exist to reduce the risk further than those capital investment options listed in Table 3.

Evaluation of the proposed options has been completed against the SFAIRP (So Far As Is Reasonably Practicable)/ALARP (As Low As Reasonably Practical) obligation, as required by the Electricity Supply (Safety and Network Management) Regulation 2014 and the Work Health and Safety Act 2011. The Key Hazardous Events and the disproportionality multipliers considered in the evaluation are as follows:

- > Catastrophic failure of asset/uncontrolled discharge or contact with electricity/ unauthorised access to site - 3 times the safety risk and 10% of the reliability risk (applicable to safety)
- > Conductor drop/structure failure - 6 times the bushfire risk , 6 times the safety risk and 10% of the reliability risk (applicable to safety)
- > Unplanned outage of HV equipment - 10% of the reliability risk (applicable to safety).

The results of this evaluation are summarised in the tables below.

Option	Description	CAPEX	Expected Life	Annualised CAPEX
Base	Do nothing	N/A	N/A	N/A
A	Replace all assets	\$3.41m	15 years	\$230k

Table 3: Feasible Options

Options	Annual Residual Risk			Annual Risk Savings		
	Safety Risk	Reliability Risk	Bushfire Risk	Safety Risk	Reliability Risk	Bushfire Risk
Base	\$1k	\$699k	\$12k	N/A	N/A	N/A
A	\$0	\$30k	\$2k	\$1k	\$669k	\$10k

Table 4: Annual Risk Calculations

Option	Network Safety Risk Reduction ³	Annualised CAPEX	Reasonably practicable ⁴ ?
A	\$130k	\$230k	No

Table 5: Reasonably Practicable Test

Option A is not reasonably practicable.

Preferred Option

The outcome of the SFAIRP/ALARP evaluation is that none of the options presented in **Error! Reference source not found.** are reasonably practicable, and are therefore not required to satisfy the organisation's SFAIRP/ALARP obligations.

The option to address the condition of the identified assets, *Option A (i)* – Replace <150MW Assets is the preferred option for all assets identified.

This option has been selected due to its technical viability and reduction in reliability risk. This option provides significant technical benefits and provides the greatest positive NPV. This option removes all obsolete and unsupported assets under this Need from the network.

Capital and operating expenditure

There is negligible difference in predicted ongoing operational expenditure between the option and base case. Implementing Option A will reduce callouts to address defects and this benefit has been captured in the risk assessment. These have been captured as benefits for delivering the project.

Regulatory Investment Test

An RIT-T is not required as this is an asset replacement project with no augmentation component.

5. Recommendation

It is recommended to proceed with the replacement of all 25 identified assets in the categories above.

³ The Network Safety Risk Reduction is calculated as 6 x Bushfire Risk Reduction + 3 x Safety Risk Reduction + 0.1 x Reliability Risk Reduction

⁴ Reasonably practicable is defined as whether the annualised CAPEX is less than the Network Safety Risk Reduction

Appendix A

A.1 Assets protecting loads <150MW

EQUIP_NO	EQUIP_CLASS	PLANT_NO	ITEM_NAME_1	EQUIP_LOCATION
000000011425	PT	COPBERCR35B4N2	851 MUDGEE TEE 66KV FDR NO2 PROTECTION	BER
000000048779	PT	NTPCOFCRA4B4T2	705 STH COFFS HARBOUR 66KV FDR NO2 PROT	COF
000000048782	PT	NTPCOFCRA5B4R2	706 SOUTH COFFS HBR 66KV FDR NO2 PROT	COF
000000011278	PT	COPFB2CRB404N2	895 PARKES 66 - 66KV FDR NO2 PROTECTION	FB2
000000011275	PT	COPFB2CRB444M2	NO2 66KV CAPACITOR NO2 PROTECTION	FB2
000000011293	PT	COPFB2CRB424V2	NO1 66KV CAPACITOR NO2 PROTECTION	FB2
000000062883	PT	SWPFNYCRE042C2	NO1 66KV CAPACITOR NO2 PROTECTION	FNY
000000049819	PT	NTPKS2CRB196L2	NO2 33KV CAPACITOR NO2 PROTECTION	KS2
000000057469	PT	SYPMNYCRC066A1	NO1 PERISHER FEEDER NO1 PROTECTION	MNY
000000057470	PT	SYPMNYCRC056A2	NO1 PERISHER FEEDER NO2 PROTECTION	MNY
000000057472	PT	SYPMNYCRC086B1	NO2 PERISHER FEEDER NO1 PROTECTION	MNY
000000057473	PT	SYPMNYCRC076B2	NO2 PERISHER FEEDER NO2 PROTECTION	MNY
000000049573	PT	NTPMRECRA8B4D2	NO1 66KV CAPACITOR NO2 PROTECTION	MRE
000000049576	PT	NTPMRECRA104P2	NO2 66KV CAPACITOR NO2 PROTECTION	MRE
000000082663	PT	SYPMURCRRPD8E	NO3 KHANCOBAN TOWN 11KV FEEDER PROTN	MUR
000000082664	PT	SYPMURCRRPD8D	NO1 MURRAY 1 PS 11KV FEEDER PROTECTION	MUR
000000082665	PT	SYPMURCRRPE8J	NO2 MURRAY 2 PS 11KV FEEDER PROTECTION	MUR
000000020485	PT	NNPNEWCR91B2FE2	NO2 132KV CAPACITOR NO2 PROTECTION	NEW
000000057940	PT	COPPKSCRE012M2	898 TRUNDLE 66KV FDR NO2 PROTECTION	PKS
000000071466	PT	COPPKSCRD032L3	89L PARKES 66 - 66KV FDR BYPASS PROT	PKS

000000086795	PT	COPPKSCRE032N2	NO2 66KV CAPACITOR NO2 PROTECTION	PKS
000000020593	PT	NNPPMQCRF6B6S2	710 OWEN ST NO1 33KV FDR NO2 PROTECTION	PMQ
000000020587	PT	NNPPMQCRF7B6N2	707 BORONIA ST 33KV FDR NO2 PROTECTION	PMQ
000000062832	PT	SWPYA2CRB244F2	841 NARRANDERA 66KV FDR NO2 PROTECTION	YA2