OPTIONS EVALUATION REPORT (OER)

Protection - Reyrolle OHx Condition

OER 000000001356 revision 4.0

Ellipse project no.: P0007980
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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Date submitted for approval	16 December 2016	

Change history

Revision	Date	Amendment
0	24 June 2016	Initial issue
1	24 June 2016	Minor amendment
2	25 October 2016	Update to 2016/17 dollars and SFAIRP/ALARP data
3	13 December 2016	Update to format
4	14 December 2016	Minor amendment
5	16 December 2016	Minor amendment – replace NPV image (correct labelling)

1. Need/opportunity

The assets raised within this Need are primarily used in line/feeder protection schemes across all voltage levels. The asset population has not demonstrated any significant defects to date, however have been identified for replacement to address their end of life condition and management of the remaining asset fleet.

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

All dollar values in this document are expressed in un-escalated 2016/17 dollars.

Base Case

The Base Case for this Need is to run these assets to failure. This approach does not address the increasing failure rates or the risk cost associated with the Need. At $891k per annum, the risks are significant and foreseen to increase as the probability of failure of the assets will also likely increase. The key driver for this risk cost is the age of the relays as they near and exceed their end of life condition. The population of this asset group is 85 units across all voltage levels and sites within the network.

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 1356A, OFS 1356A]

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 $5.40k per annum for this option based on current maintenance plan settings.

Due to the "like for like" nature of this option, no OPEX benefit has been calculated in accordance with TransGrid's Renewal and Maintenance Strategy for Secondary Systems Site Installations[1].

The expected total capital cost to replace every asset identified under this Need is $8.70m. This costing is estimated using TransGrid's "Success" estimating system. This cost has been adjusted to $4.30m for analysis in this OER to account for the reduction of 42 assets that will be replaced under Secondary Systems Renewal Needs or are utilised on negotiated services. This adjustment has been carried out using the unit costs provided in the Option Feasibility Study (OFS).

The residual risk associated with this option upon completion of the project amounts to $265k per annum (base case risk cost = $891k). The risk reduction is realised through the reduction in the probability of failure for all assets.

The assets under investigation have been categorised into three 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 $3.20m. This costing was estimated using the unit costs provided under OFS 1356A and applying them to those assets that would be replaced. These costs are broken down in Table 1.

Table 1 – Expected costs for assets protecting primary assets <330kV and <150MW ($ thousand)

Item	Unit Cost, Including Labour	Quantity	Total Cost
OH1-311 ≤132kV Transmission Lines	100	21	2,100
OH-305 ≤132kV Transmission Lines	100	11	1,100
Total estimated cost			**3,200**

[1] Refer SSA Strategy - Renewal and Maintenance - Secondary Systems Site Installations

The residual risk associated with this portion of assets upon completion of the project amounts to $94k per annum (base case risk cost component = $317k). 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 classified as protecting where the peak load is greater than 150MW and service voltage is less than 330kV.

The expected capital cost to replace this category of assets is $1.10m. This costing was estimated using the unit costs provided under Option Feasibility Study (OFS) OFS 1356A and applying them to those assets that would be replaced. These costs are broken down in Table 2.

Table 2 – Expected costs for assets protecting primary assets <330kV and >150MW ($ thousand)

Item	Unit Cost, Including Labour	Quantity	Total Cost
OH1-311 ≤132kV Transmission Lines	100	8	800
OH-305 ≤132kV Transmission Lines	100	3	300
Total estimated cost			**1,100**

The residual risk associated with this portion of assets upon completion of the project amounts to $171k per annum (base case risk cost component = $574k). The risk reduction is realised through the reduction in the probability of failure for the affected assets.

Assets protecting primary assets >=330kV

This configuration covers only replacing the assets classified as protecting primary assets operating at 330kV and above.

There are no assets identified with this configuration.

4. Evaluation

Evaluation of the proposed options has been completed using the ALARP (As Low as Reasonably Practicable) regulatory requirements and economic considerations. The results of this evaluation are outlined below.

4.1 Commercial evaluation

The result of commercial evaluation for each of the technically feasible options is summarised in Table 3.

Table 3 – Commercial evaluation ($ million)

Option	Description	Total capex	Annual opex	Annual post project risk cost	Economic NPV @10%	Financial NPV @10%	Rank
Base Case	Run-to-fail	N/A	0.01	0.97	N/A	N/A	2
A	Replace individual Assets	4.30	0.01	0.27	(1.04)	(3.45)	1[2]

[2] This option is ranked 1 only for those categories of assets that provide a positive Net Present Value (NPV).

Option	Description	Total capex	Annual opex	Annual post project risk cost	Economic NPV @10%	Financial NPV @10%	Rank
i)	Replace <150MW Assets	3.20	0	0.09	(1.34)	(2.00)	-
ii)	Replace >150MW Assets	1.10	0	0.17	1.14	(0.65)	-
iii)	Replace >=330kV Assets	-	-	-	-	-	-

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 economic Net Present Value (NPV) for the options with changing discount rates are shown in Table 4.

Table 4 – Discount rate sensitivities ($ million)

Option	Description	Economic NPV @13%	Economic NPV @6.75%
A	Replace individual Assets	(1,37)	(0.42)
i)	Replace <150MW Assets	(1.44)	(1.12)
ii)	Replace >150MW Assets	0.69	1.88
iii)	Replace >=330kV Assets	-	-

4.2 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 5.

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 High Voltage (HV) equipment - 10% of the reliability risk (applicable to safety).

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

Table 5 – Feasible options ($ thousand)

Option	Description	CAPEX	Expected Life	Annualised CAPEX
Base	Run-to-fail	N/A	N/A	N/A
A	Replace individual Assets	4,300	15 years	290

Table 6 – Annual risk calculations ($ thousand)

Option	Annual Residual Risk			Annual Risk Savings		
	Safety Risk	Reliability Risk	Bushfire Risk	Safety Risk	Reliability Risk	Bushfire Risk
Base	3	728	30	N/A	N/A	N/A
A	1	217	5	2	511	25

Table 7 – Reasonably practicable test ($ thousand)

Option	Network Safety Risk Reduction[3]	Annualised CAPEX	Reasonably practicable[4]?
A	207	290	No

Option A is not reasonably practicable.

4.3 Preferred option

The outcome of the SFAIRP/ALARP evaluation is that Option A is beyond reasonably practicable to provide the greatest network safety risk reduction, and is therefore not required to satisfy the organisation's SFAIRP/ALARP obligations.

The option to address the condition of the identified assets is Option A (ii) – Replacement of Assets >150MW. This option has been selected due to its technical viability and positive economic NPV.

Refer to Attachment 1 for details of the assets to be replaced under this Need.

Capital and operating expenditure

There is negligible difference in predicted ongoing operational expenditure between the option and Base Case. Implementing Option A (ii) 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

A Regulatory Investment Test for Transmission (RIT-T) is not required as this is an asset replacement project with no augmentation component.

[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

5. Recommendation

It is recommended to proceed with the replacement of 11 identified assets with capex estimate of $1.10m.

Attachment 1 – Assets for replacement

A.1 Assets protecting <330kV, >150MW

EQUIP_NO	EQUIP_CLASS	PLANT_NO	ITEM_NAME_1	EQUIP_LOCATION
000000010156	PT	CMPDPTCR2292X1	98F MT TERRY 132KV FEEDER NO1 PROTECTION	DPT
000000010177	PT	CMPDPTCR3252K1	981 BELLAMBI CREEK 132KV FEEDER NO1 PROT	DPT
000000010182	PT	CMPDPTCR2292J11	980 BELLAMBI CREEK 132KV FEEDER NO1 PROT	DPT
000000009971	PT	CMPSYSCR2042J2	284 MENAI 132KV FEEDER NO2 PROTECTION	SYS
000000009986	PT	CMPSYSCR2062K22	912 PORT HACKING 132KV NO2 PROTECTION	SYS
000000020481	PT	NNPNEWCR61B2F1	96U KURRI ZS 132KV FEEDER NO1 PROTECTION	NEW
000000020487	PT	NNPNEWCR63B2G1	96W CAPRAL 132KV FEEDER NO1 PROTECTION	NEW
000000020526	PT	NNPNEWCR77B2T1	EX 95N WARATAH WEST 132KV FDR NO1 PROT	NEW
000000020532	PT	NNPNEWCR79B2V1	96B CAPRAL 132KV FEEDER NO1 PROTECTION	NEW
000000020535	PT	NNPNEWCR81B2X1	96A KURRI 132KV FEEDER NO1 PROTECTION	NEW
000000089385	PT	CMPVYDCRJ032E1	938 ROUSE HILL 132KV FDR NO1 PROTECTION	VYD

Option A NPV calculation

Project_Option Name	Option A - Individual Asset Replacements - All Assets

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-$3.45m	*NPV / Capital (Ratio)*	*-0.81*
NPV @ upper bound rate	13.00%	-$3.16m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	-$3.83m	*IRR%*	*Not measurable*

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%	-$1.04m	*NPV / Capital (Ratio)*	*-0.24*
NPV @ upper bound rate	13.00%	-$1.37m	*Pay Back Period (Yrs)*	*9.18 Yrs*
NPV @ lower bound rate (WACC)	6.75%	-$0.42m	*IRR%*	*5.24%*

Benefits

Risk cost	As Is	To Be	Benefit
Systems (reliability)	*$0.73m*	*$0.22m*	*$0.51m*
Financial	*$0.14m*	*$0.04m*	*$0.10m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*
People (safety)	*$0.00m*	*$0.00m*	*$0.00m*
Environment	*$0.03m*	*$0.00m*	*$0.03m*
Reputation	*$0.00m*	*$0.00m*	*$0.00m*
Total Risk benefits	$0.90m	$0.26m	$0.64m
Cost savings and other benefits			-$0.17m
Total Benefits			$0.47m

VCR Benefit	*$0.51m*
ENS Penalty	*$0.00m*
All other risk benefits	*-$0.04m*
Total Risk benefits	$0.47m
Benefits in the financial NPV* *excludes VCR benefits	-$0.04m
Benefits in the economic NPV** **excludes ENS penalty	$0.47m

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-$0.01m	Write-off cost	$0.00m
Capital - initial $m	-$4.26m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	$0.00m	Re-investment capital	$0.00m
Capitalisation period	5.00 Yrs	Start of the re-investment period	0.00 Yrs

Option A(i) NPV calculation

Project_Option Name	Option A - Individual Asset Replacements - Only assets <=150

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-$2.00m	*NPV / Capital (Ratio)*	*-0.63*
NPV @ upper bound rate	13.00%	-$1.93m	*Pay Back Period (Yrs)*	*-0.08 Yrs*
NPV @ lower bound rate (WACC)	6.75%	-$2.05m	*IRR%*	*-8.27%*

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%	-$1.34m	*NPV / Capital (Ratio)*	*-0.42*
NPV @ upper bound rate	13.00%	-$1.44m	*Pay Back Period (Yrs)*	*14.13 Yrs*
NPV @ lower bound rate (WACC)	6.75%	-$1.12m	*IRR%*	*0.60%*

Benefits

Risk cost	As Is	To Be	Benefit		
Systems (reliability)	*$0.20m*	*$0.06m*	*$0.14m*	*VCR Benefit*	*$0.14m*
Financial	*$0.10m*	*$0.03m*	*$0.07m*	*ENS Penalty*	*$0.00m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	*All other risk benefits*	*$0.09m*
People (safety)	*$0.00m*	*$0.00m*	*-$0.00m*	Total Risk benefits	$0.23m
Environment	*$0.02m*	*$0.00m*	*$0.02m*	Benefits in the financial NPV*	$0.09m
Reputation	*$0.00m*	*$0.00m*	*$0.00m*	**excludes VCR benefits*	
Total Risk benefits	$0.32m	$0.09m	$0.23m		
Cost savings and other benefits			$0.00m	Benefits in the economic NPV**	$0.23m
Total Benefits			$0.23m	***excludes ENS penalty*	

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-$0.00m	Write-off cost	$0.00m
Capital - initial $m	-$3.17m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	$0.00m	Re-investment capital	$0.00m
Capitalisation period	5.00 Yrs	Start of the re-investment period	0.00 Yrs

Option A(ii) NPV calculation

Project_Option Name	Option A - Individual Asset Replacements - Assets protecting >1

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	-$0.65m	*NPV / Capital (Ratio)*	*-0.59*
NPV @ upper bound rate	13.00%	-$0.64m	*Pay Back Period (Yrs)*	*-0.06 Yrs*
NPV @ lower bound rate (WACC)	6.75%	-$0.65m	*IRR%*	*-6.08%*

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%	$1.14m	*NPV / Capital (Ratio)*	*1.04*
NPV @ upper bound rate	13.00%	$0.69m	*Pay Back Period (Yrs)*	*2.63 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$1.88m	*IRR%*	*23.01%*

Benefits

Risk cost	As Is	To Be	Benefit
Systems (reliability)	*$0.54m*	*$0.16m*	*$0.38m*
Financial	*$0.04m*	*$0.01m*	*$0.03m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*
People (safety)	*$0.00m*	*$0.00m*	*$0.00m*
Environment	*$0.01m*	*$0.00m*	*$0.01m*
Reputation	*$0.00m*	*$0.00m*	*$0.00m*
Total Risk benefits	$0.59m	$0.17m	$0.42m
Cost savings and other benefits			$0.00m
Total Benefits			$0.42m

VCR Benefit	*$0.38m*
ENS Penalty	*$0.00m*
All other risk benefits	*$0.04m*
Total Risk benefits	$0.42m
Benefits in the financial NPV*	$0.04m
**excludes VCR benefits*	
Benefits in the economic NPV**	$0.42m
***excludes ENS penalty*	

Other Financial Drivers

Incremental opex cost pa (no depreciation)	-$0.00m	Write-off cost	$0.00m
Capital - initial $m	-$1.10m	Major Asset Life (Yrs)	15.00 Yrs
Residual Value - initial investment	$0.00m	Re-investment capital	$0.00m
Capitalisation period	5.00 Yrs	Start of the re-investment period	0.00 Yrs