OPTIONS EVALUATION REPORT (OER)

50V and 110V Battery Charger Condition

OER 000000001362 revision 3.0

Ellipse project no.: P0007992
TRIM file: [TRIM No]

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

Approvals

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Date submitted for approval	14 December 2016	

Change history

Revision	Date	Amendment
0	23 June 2016	Initial issue
1	31 October 2016	Update to 2016/17 dollars and SFAIRP/ALARP data
2	13 December 2016	Update to format
3	14 December 2016	Minor amendment

1. Need/opportunity

Nickel Cadmium batteries are used throughout the NSW network to provide a continuous supply of power to site equipment during a loss of primary supply across all voltage levels. The availability of an uninterruptible power supply is crucial particularly during a black event. The assets investigated under this Need are aged battery chargers that have reached the end of their technical life resulting in reduced capabilities to meet backup supply performance requirements.

The use of battery chargers for batteries providing backup power supplies during an outage event are a continuing requirement of the Australian Energy Regulator (AER) as outlined in the National Electricity Rules (NER). Backup power supply systems are required into the foreseeable future.

2. Related Needs/opportunities

The following Need would benefit from coordination with these works:

- Need ID 1360 - 50V and 110V NiCd Battery Condition

3. Options

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

Base Case

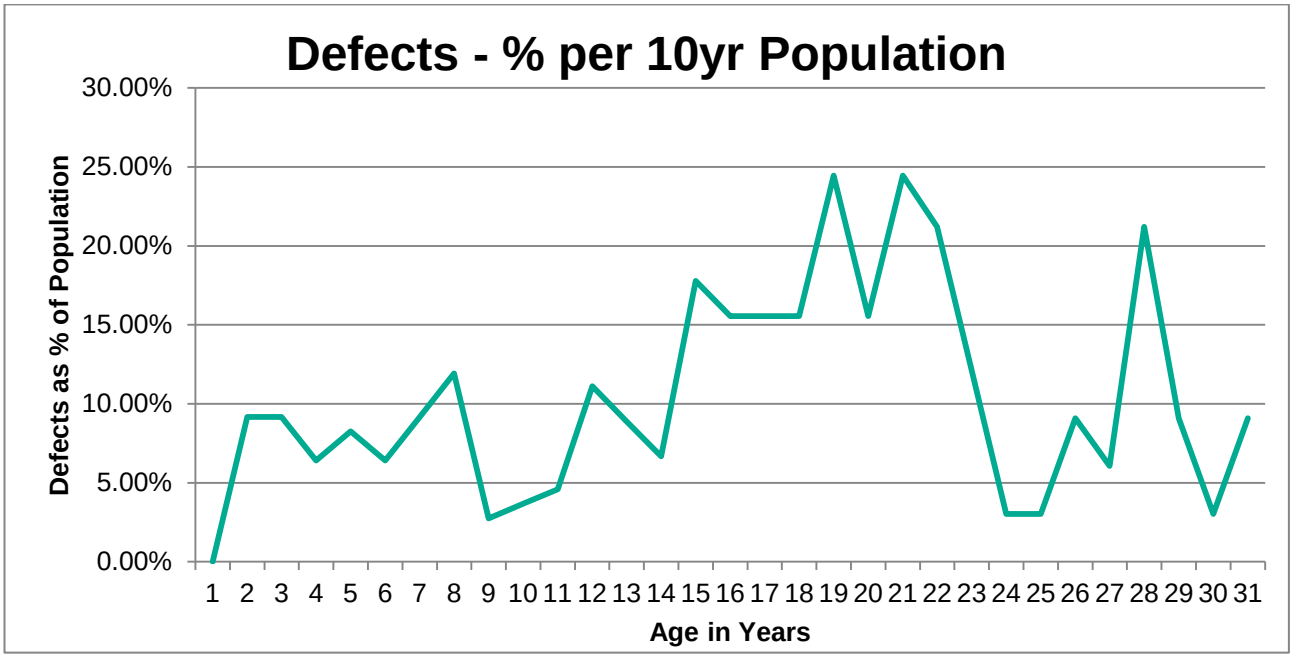
The Base Case for this Need is to run these assets to failure. This approach does not address the increasing failure rates or the risk cost associated with the Need. At $27.60m per annum, the risks are significant and foreseen to increase as the probability of failure of the assets will also likely increase. Key drivers for this risk cost are:

- Probability of asset failure
- Consequence assumes loss of load for a site with “N-1” redundancy. The restoration time has been set as 8 hours with an assumed 150MW of load interrupted to mixed customers (residential, commercial, and agricultural) to model a number of potential network scenarios based on this consequence.
- The total population of this asset group at 210 chargers 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.

A summary of defect rates based on age at defect has been provided below. The percentages are calculated as defects per population per age bracket. This has taken the assumption that the age spread of assets has remained similar historically:

Figure 1 – Defect rates based on age



Option A — Replace Chargers at Various Locations [OFR 1362A, OFS 1362A]

This option covers the replacement of 52 assets in a “like for like” manner for 110V and 50V NiCd chargers. This involves removing the existing charger and replacing it in the same position.

No maintenance is carried out specifically for the chargers.

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 Installations[1].

The expected total capital cost to replace every asset identified under this Need is $2.08m. This costing is estimated using TransGrid’s “Success” estimating system.

The residual risk associated with this option upon completion of the project amounts to $16.70m per annum (base case risk cost = $27.60m). The risk reduction is realised through the reduction in the probability of failure for the assets.

Option A has been identified as the only technically viable option as refurbishment of the chargers is not possible.

The assets under investigation have been categorised into four age brackets for the purpose of risk assessment:

Assets with an age <10

There are 110 assets within this grouping and all have been determined as meeting their requirements and have not been assessed further.

Assets with an age >10 and <=20 years

There are 45 assets within this grouping and all have been determined as meeting their requirements and have not been assessed further.

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

Assets with an age >20 and <=30 years

This configuration covers replacing all assets with a current age between 21 and 30 years.

The expected capital cost to replace this category of assets is $1.28m. This costing was estimated using the unit costs provided under Option Feasibility Study (OFS) OFS 1360A and applying them to those assets that would be replaced. These costs are broken down in Table 1.

Table 1 – Expected costs for replacing assets with an age >20 and <=30 years ($ thousand)

Item	Unit Cost, Including Labour	Quantity	Total Cost
110V Battery Charger	42	17	706
50V Battery Charger	39	15	578
Total estimated cost			**1,280**

The residual risk associated with this portion of assets upon completion of the project amounts to $0.80m per annum (base case risk cost component = $3.34m). The risk reduction is realised through the reduction in the probability of failure for the affected assets.

Assets with an age >30 years

This configuration covers replacing all assets with a current age greater than 30 years.

The expected capital cost to replace this category of assets is $0.79m. This costing was estimated using the unit costs provided under OFS 1360A and applying them to those assets that would be replaced. These costs are broken down in Table 2.

Table 2 – Expected costs for replacing assets with an age >30 years ($ thousand)

Battery Voltage	Unit Cost, Including Labour	Quantity	Total Cost
110V Battery Charger	42	8	332
50V Battery Charger	39	12	462
Total estimated cost			**794**

The residual risk associated with this portion of assets upon completion of the project amounts to $0.51m per annum (base case risk cost component = $9.00m). 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 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	27.6	N/A	N/A	2
A	Replace Chargers at Various Locations	2.14	0	16.7	56.2	4.19	1
i)	Age 0-10 years	N/A	0	8.10	N/A	N/A	-
ii)	Age 11-20 years	N/A	0	7.18	N/A	N/A	-
iii)	Age 21-30 years	1. 28	0	0.80	12.4	0.41	-
iv)	Age 31-40 years	0.79	0	0.51	44.3	3.91	-

The commercial evaluation is based on:

- Economic life of the NiCd assets is assumed as 20 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 Chargers at Various Locations	40.20	83.50
iii)	Age 21-30 years	8.75	18.70
iv)	Age 31-40 years	31.83	65.60

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 below.

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 Chargers at Various Locations	2,140	20 years	110

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	110	24,860	0	N/A	N/A	N/A
A	70	15,020	0	40	9,840	0

Table 7 – Reasonably practicable test ($ thousand)

Option	Network Safety Risk Reduction[2]	Annualised CAPEX	Reasonably practicable[3]?
A	1,104	110	Yes

Option A is reasonably practicable.

4.3 Preferred option

The outcome of the SFAIRP/ALARP evaluation is that Option A is the preferred option as it is reasonably practicable and provides the greatest network safety risk reduction, and is therefore required to satisfy the organisation's SFAIRP/ALARP obligations.

The option to address the condition of the identified assets, Option A – Replacement of Selected Assets is the preferred option for each of the three categories of assets identified.

This option has been selected due to its technical viability, positive economic Net Present Value (NPV) and reduction in reliability risk.

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

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

[3] Reasonably practicable is defined as whether the annualised CAPEX is less than the Network Safety Risk Reduction

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

A Regulatory Investment Test for Transmission (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 52 identified assets with replacement chargers.

Attachment 1 – Assets for replacement

A.1 110V

EQUIP_NO	EQUIP_CLASS	PLANT_NO	ITEM_NAME_1	EQUIP_LOCATION
000000053162	SS	SWSANMBAT11	ANM NO1 110V BATTERY AND CHARGER	ANM
000000053163	SS	SWSANMBAT12	ANM NO2 110V BATTERY AND CHARGER	ANM
000000059887	SS	NNSBAYBAT1A	NO1 110V STATION BATTERY AND CHARGER	BAY
000000059889	SS	NNSBAYBAT1B	NO2 110V STATION BATTERY AND CHARGER	BAY
000000052958	SS	CMSBFWBAT12	BEACONSFIELD #2 110V STATION BATTERY	BFW
000000053243	SS	SWSBRGBAT11	BURONGA NO1 110V BATTERY AND CHARGER	BRG
000000065779	SS	COSCW2BAT01	COWRA #1 110V BATTERY AND CHARGER	CW2
000000053388	SS	SWSFNYBAT11	FINLEY NO1 110V BATTERY AND CHARGER	FNY
000000053389	SS	SWSFNYBAT12	FINLEY NO2 110V BATTERY AND CHARGER	FNY
000000048600	SS	NTSGN2BAT1A	NO1 120V BATTERY AND CHARGER	GN2
000000048601	SS	NTSGN2BAT1B	NO2 120V BATTERY AND CHARGER	GN2
000000052961	SS	CMSKCRBAT11	KEMPS CREEK #1 110V STATION BATTERY	KCR
000000048090	SS	NNSKS2BAT1A	NO1 120V BATTERY AND CHARGER	KS2
000000060645	SS	NNSNEWBAT1A	NO1 110V STATION BATTERY AND CHARGER	NEW
000000060646	SS	NNSNEWBAT1B	NO2 110V STATION BATTERY AND CHARGER	NEW
000000065798	SS	COSPKSBAT01	PARKES #1 110V BATTERY AND CHARGER	PKS
000000065799	SS	COSPKSBAT02	PARKES #2 110V BATTERY AND CHARGER	PKS
000000060650	SS	NNSPMQBAT1A	NO1 110V STATION BATTERY AND CHARGER	PMQ
000000060651	SS	NNSPMQBAT1B	NO2 110V STATION BATTERY AND CHARGER	PMQ
000000052939	SS	CMSSYSBAT11	SYDNEY SOUTH #1 110V STATION BATTERY	SYS

EQUIP_NO	EQUIP_CLASS	PLANT_NO	ITEM_NAME_1	EQUIP_LOCATION
000000052940	SS	CMSSYSBAT12	SYDNEY SOUTH #2 110V STATION BATTERY	SYS
000000060658	SS	NNSTOMBATA11	TOMAGO 330 MAIN NO1 110V BATTERY & CHAR	TOM
000000060659	SS	NNSTOMBATA12	TOMAGO 330 MAIN NO2 110V BATTERY & CHAR	TOM
000000060666	SS	NNSVP1BAT1A	N01 110V STATION BATTERY AND CHARGER	VP1
000000060667	SS	NNSVP1BAT1B	N02 110V STATION BATTERY AND CHARGER	VP1

A.2 50V

EQUIP_NO	EQUIP_CLASS	PLANT_NO	ITEM_NAME_1	EQUIP_LOCATION
000000053164	SS	SWSANMBAT21	ANM NO1 50V BATTERY AND CHARGER	ANM
000000059893	SS	NNSBAYBAT2A	NO1 50V COMMS BATTERY AND CHARGER	BAY
000000059895	SS	NNSBAYBAT2B	NO2 50V COMMS BATTERY AND CHARGER	BAY
000000052959	SS	CMSBFWBAT21	BEACONSFIELD #1 50V COMM BATTERY	BFW
000000052960	SS	CMSBFWBAT22	BEACONSFIELD #2 50V COMM BATTERY	BFW
000000053245	SS	SWSBRGBAT21	BURONGA NO1 50V BATTERY AND CHARGER	BRG
000000060619	SS	NNSER0BAT2B	NO2 50V COMMS BATTERY AND CHARGER	ER0
000000053428	SS	SWSGRFBAT21	GRIFFITH NO1 50V COMMS BATTERY & CHARGER	GRF
000000053518	SS	SWSJDABAT21	JINDERA NO1 50V BATTERY & CHARGER	JDA
000000053519	SS	SWSJDABAT22	JINDERA NO2 50V BATTERY & CHARGER	JDA
000000052964	SS	CMSKCRBAT22	KEMPS CREEK #2 50V COMM BATTERY	KCR
000000048035	SS	NTSKLKBAT2A	NO1 50V BATTERY AND CHARGER	KLK
000000048035	SS	NTSKLKBAT2A	NO1 50V BATTERY AND CHARGER	KLK
000000048092	SS	NNSKS2BAT2A	NO1 50V BATTERY AND CHARGER	KS2
000000048092	SS	NNSKS2BAT2A	NO1 50V BATTERY AND CHARGER	KS2
000000119046	SS	NNSMN1BAT2A	NO1 50V COMMS BATTERY AND CHARGER	MN1

EQUIP_NO	EQUIP_CLASS	PLANT_NO	ITEM_NAME_1	EQUIP_LOCATION
000000119047	SS	NNSMN1BAT2B	NO2 50V COMMS BATTERY AND CHARGER	MN1
000000071316	SS	COSMPPBAT03	MT PIPER 132KV #1 50V BATT & CHARGERS	MPP
000000060647	SS	NNSNEWBAT2A	NO1 50V COMMS BATTERY AND CHARGER	NEW
000000060648	SS	NNSNEWBAT2B	NO2 50V COMMS BATTERY AND CHARGER	NEW
000000052946	SS	CMSSE1BAT22	SYDNEY EAST #2 50V COMM BATTERY	SE1
000000052941	SS	CMSSYSBAT21	SYDNEY SOUTH #1 50V COMM BATTERY	SYS
000000052942	SS	CMSSYSBAT22	SYDNEY SOUTH #2 50V COMM BATTERY	SYS
000000048298	SS	NTSTA1BAT2A	NO1 50V BATTERY AND CHARGER	TA1
000000048299	SS	NTSTA1BAT2B	NO2 50V BATTERY AND CHARGER	TA1
000000060660	SS	NNSTOMBATA21	TOMAGO 330 COMM NO1 50V BATTERY AND CHAR	TOM
000000060662	SS	NNSTOMBATA22	TOMAGO 330 COMM NO2 50V BATTERY AND CHAR	TOM

Attachment 2 – Commercial evaluation report

Option A NPV calculation

Project_Option Name	Need ID 1362 - 50V and 100V NiCd Charger Condition - Option A

1. Financial Evaluation (excludes VCR benefits)				
NPV @ standard discount rate	10.00%	$4.19m	*NPV / Capital (Ratio)*	*2.01*
NPV @ upper bound rate	13.00%	$2.69m	*Pay Back Period (Yrs)*	*0.29 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$6.78m	*IRR%*	*29.25%*

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%	$56.20m	*NPV / Capital (Ratio)*	*27.05*
NPV @ upper bound rate	13.00%	$40.21m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	$83.46m	*IRR%*	*93.76%*

Benefits					
Risk cost	As Is	To Be	Benefit	*VCR Benefit*	*$9.84m*
Systems (reliability)	*$24.86m*	*$15.02m*	*$9.84m*	*ENS Penalty*	*$0.00m*
Financial	*$2.65m*	*$1.60m*	*$1.05m*	*All other risk benefits*	*$1.09m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	Total Risk benefits	$10.93m
People (safety)	*$0.11m*	*$0.07m*	*$0.04m*		
Environment	*$0.00m*	*$0.00m*	*$0.00m*	Benefits in the financial NPV*	$1.09m
Reputation	*$0.00m*	*$0.00m*	*$0.00m*	**excludes VCR benefits*	
Total Risk benefits	$27.62m	$16.69m	$10.93m		
Cost savings and other benefits			$0.00m	Benefits in the economic NPV**	$10.93m
Total Benefits			$10.93m	***excludes ENS penalty*	

Other Financial Drivers			
Incremental opex cost pa (no depreciation)	$0.00m	Write-off cost	$0.00m
Capital - initial $m	-$2.08m	Major Asset Life (Yrs)	20.00 Yrs
Residual Value - initial investment	$0.00m	Re-investment capital	$0.00m
Capitalisation period	5.00 Yrs	Start of the re-investment period	2028-29

Option A(iii) NPV calculation

Project_Option Name	Need ID 1362 - 50V and 100V NiCd Charger Condition - Option A

1. Financial Evaluation (excludes VCR benefits)

NPV @ standard discount rate	10.00%	$0.41m	*NPV / Capital (Ratio)*	*0.32*
NPV @ upper bound rate	13.00%	$0.09m	*Pay Back Period (Yrs)*	*0.14 Yrs*
NPV @ lower bound rate (WACC)	6.75%	$0.98m	*IRR%*	*14.26%*

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%	$12.41m	*NPV / Capital (Ratio)*	*9.70*
NPV @ upper bound rate	13.00%	$8.75m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	$18.67m	*IRR%*	*61.19%*

Benefits

Risk cost	As Is	To Be	Benefit		
Systems (reliability)	*$3.00m*	*$0.73m*	*$2.27m*	*VCR Benefit*	*$2.27m*
Financial	*$0.32m*	*$0.07m*	*$0.25m*	*ENS Penalty*	*$0.00m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	*All other risk benefits*	*$0.26m*
People (safety)	*$0.01m*	*$0.00m*	*$0.01m*	Total Risk benefits	$2.53m
Environment	*$0.00m*	*$0.00m*	*$0.00m*	Benefits in the financial NPV*	$0.26m
Reputation	*$0.00m*	*$0.00m*	*$0.00m*	**excludes VCR benefits*	
Total Risk benefits	$3.33m	$0.80m	$2.53m		
Cost savings and other benefits			$0.00m	Benefits in the economic NPV**	$2.53m
Total Benefits			$2.53m	***excludes ENS penalty*	

Other Financial Drivers

Incremental opex cost pa (no depreciation)	$0.00m	Write-off cost	$0.00m
Capital - initial $m	-$1.28m	Major Asset Life (Yrs)	20.00 Yrs
Residual Value - initial investment	$0.06m	Re-investment capital	$0.00m
Capitalisation period	5.00 Yrs	Start of the re-investment period	2028-29

Option A(iv) NPV calculation

Project_Option Name	Need ID 1362 - 50V and 100V NiCd Charger Condition - Option A

1. Financial Evaluation (excludes VCR benefits)				
NPV @ standard discount rate	10.00%	$3.91m	*NPV / Capital (Ratio)*	*4.95*
NPV @ upper bound rate	13.00%	$2.70m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	$6.00m	*IRR%*	*44.94%*

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%	$44.31m	*NPV / Capital (Ratio)*	*56.09*
NPV @ upper bound rate	13.00%	$31.83m	*Pay Back Period (Yrs)*	*Not measurable*
NPV @ lower bound rate (WACC)	6.75%	$65.55m	*IRR%*	*122.69%*

Benefits					
Risk cost	As Is	To Be	Benefit	*VCR Benefit*	*$7.64m*
Systems (reliability)	*$8.10m*	*$0.46m*	*$7.64m*	*ENS Penalty*	*$0.00m*
Financial	*$0.86m*	*$0.05m*	*$0.81m*	*All other risk benefits*	*$0.85m*
Operational/compliance	*$0.00m*	*$0.00m*	*$0.00m*	Total Risk benefits	$8.50m
People (safety)	*$0.04m*	*$0.00m*	*$0.04m*		
Environment	*$0.00m*	*$0.00m*	*$0.00m*	Benefits in the financial NPV*	$0.85m
Reputation	*$0.00m*	*$0.00m*	*$0.00m*	**excludes VCR benefits*	
Total Risk benefits	$9.00m	$0.51m	$8.50m		
Cost savings and other benefits			$0.00m	Benefits in the economic NPV**	$8.50m
Total Benefits			$8.50m	***excludes ENS penalty*	

Other Financial Drivers			
Incremental opex cost pa (no depreciation)	$0.00m	Write-off cost	$0.00m
Capital - initial $m	-$0.79m	Major Asset Life (Yrs)	20.00 Yrs
Residual Value - initial investment	$0.00m	Re-investment capital	$0.00m
Capitalisation period	5.00 Yrs	Start of the re-investment period	2028-29