Revised Proposal

Attachment 5.13.M.14

Sub-transmission Isolator and Earth Switches program CBA summary

January 2019

Attachment 5.13.M.14

Sub-transmission Isolator and Earth Switches program CBA summary

Introduction

Ausgrid has reviewed the risks associated with Sub-transmission Isolator and Earth Switches (sub-transmission isolators) by undertaking a quantitative risk assessment. This document covers the outcomes of cost benefit analysis, and should be reviewed in conjunction with the cost benefit analysis (CBA) modelling methodology report[1].

Scope

This model covers a portion of the forecast mapped to the following RIN categories:

- Switchgear - > 22 KV & < = 33 KV ; Switch
- Switchgear - > 33 KV & < = 66 KV ; Switch
- Switchgear - > 66 KV & < = 132 KV ; Switch

Analysis Outcome

The analysis was completed using historical data up to and including FY18. The CBA models forecast risk from FY19 onwards. The quantities included in FY19 are reflective of Ausgrid's committed program in this year.

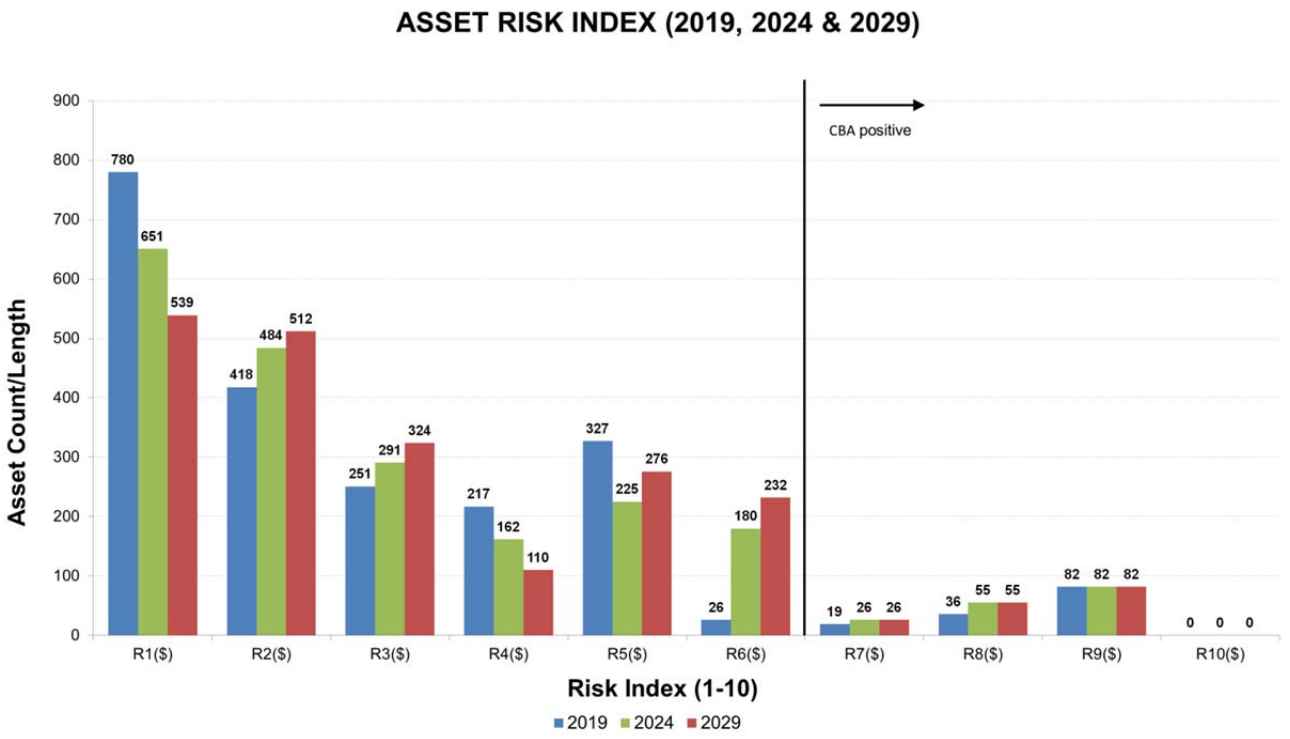
Based on the analysis completed, the model output is supporting the replacement of 163 sub-transmission isolators by the end of FY24. This includes a total of 29 sub-transmission isolators which have been committed in FY19 and a total of 134 sub-transmission isolators which are cost benefit positive between FY20 to FY24.

In forming this decision Ausgrid considered three options and performed sensitivity analysis as described in this document. Ausgrid is recommending Option 3 – levelled replacement of all assets cost benefit positive by the end of FY24 for this asset category.

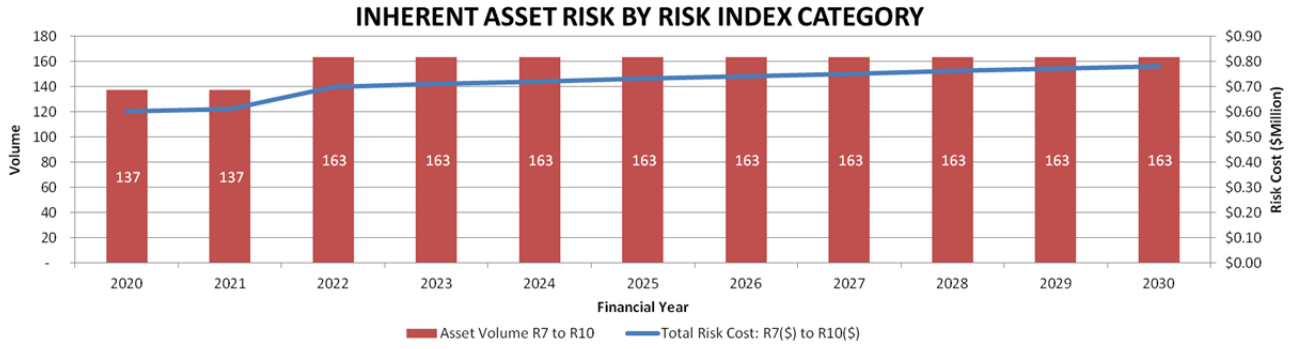
Risk Index

The normalised risk index below considers the probability of failure, consequence of failure and the annualised replacement cost.

[1] Attachment 5.13.M.0 – Repex program CBA modelling methodology



The inherent risk of sub-transmission isolators that are cost benefit positive is shown in the figure below.

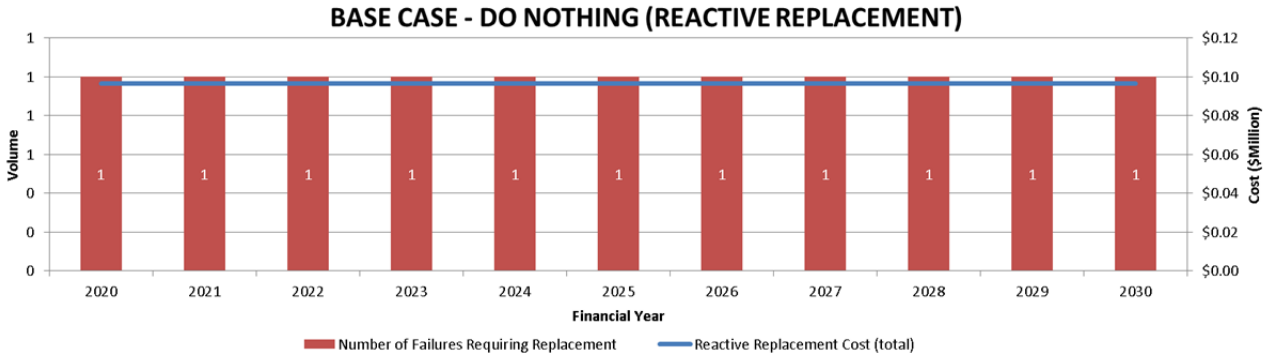


Option One – Base Case (Reactive Replacement)

Under a base case scenario, if Ausgrid were to adopt a reactive replacement strategy, the minimum replacement quantity during FY20 to FY24 is 5 sub-transmission isolators. The table below shows the quantity of assets which will require reactive replacement in the year that they are forecast to fail.

Financial Year	FY20	FY21	FY22	FY23	FY24
Quantity for replacement	1	1	1	1	1

This quantity represents the minimum required replacement volume with no proactive strategy is adopted.



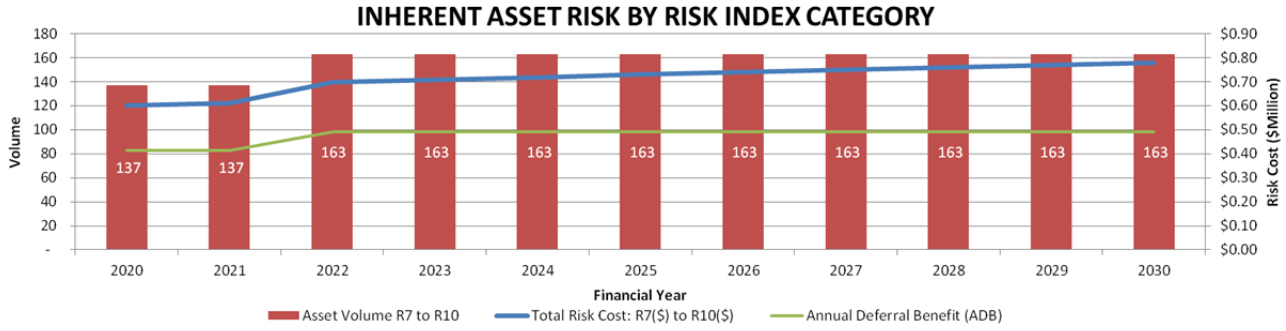
Option Two – Replace where cost benefit positive

Given Ausgrid plans to replace 29 sub-transmission isolators in FY19, the recommended replacement quantity from the model is 134 sub-transmission isolators. The table below shows the year in which these assets should be replaced based on when the benefit to customers exceeds the annualised deferral benefit:

Financial Year	FY20	FY21	FY22	FY23	FY24
Quantity for replacement	108	0	26	0	0

The large quantity in FY20 is due to a backlog of sub-transmission isolators which are cost benefit positive and using this option would all be replaced in the first year.

Based on this replacement quantity, the annual deferral benefit against the inherent risk for all assets above Risk Index 7 is shown in the figure below. The annual deferral benefit remains lower than the total risk as Ausgrid is not targeting any assets that are not cost benefit positive.



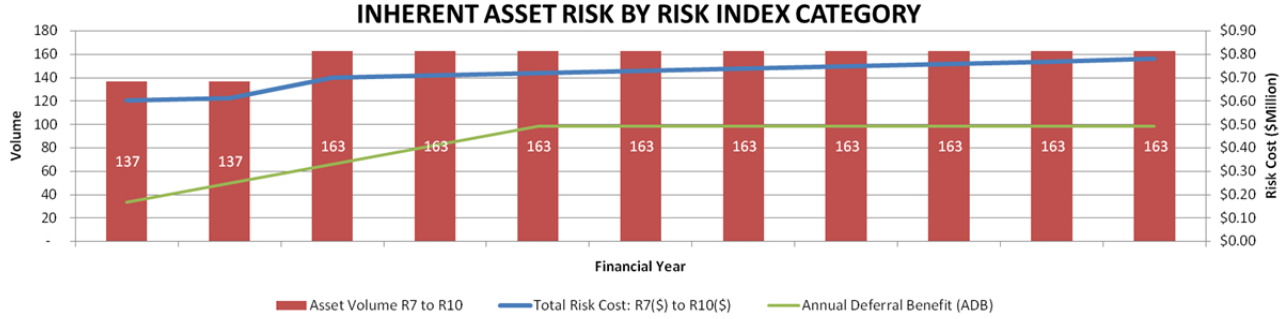
This option provides the maximum benefit to customers as it leads to the avoidance of risk at the point at which the benefits exceed the costs. However, the large delivery requirement in FY20 will not be reasonably achievable due to the constraints on network access, physical access and staff resourcing.

Option Three – Replace all cost benefit positive by the end of the period

Given the delivery constraints, under this option Ausgrid have considered the replacement of all sub-transmission isolators that are cost benefit positive by the end of FY24. This results in 26 subtransmission isolators being replaced in the first year and 27 in the remaining four years.

Financial Year	FY20	FY21	FY22	FY23	FY24
Quantity for replacement	26	27	27	27	27

Based on this replacement quantity, the annual deferral benefit against the inherent risk for all assets above Risk Index 7 is shown in the figure below.



This option balances achieving value for customers by the end of FY24 with consideration of the delivery constraints.

Data input

		Data Source
Population	2,156	SAP – Asset Register
Object Types	SW_HV_ISOL – HV Isolator	SAP – Asset Register
Conditional & Functional Failures / Time Period	458 failures 6 years	SAP – Defect Records
Asset standard life	46.84 years	RAB life
WACC	3.90%	Regulated Rate

Planned Replacement Cost

A weighted average for the period per asset was used in this model.

Cost	Data Source
$80,329	2020-24 Revised Regulatory Proposal (FY19 real direct costs +25% of indirect costs)

Weibull parameters

Developed by applying asset age to failure correlation using Ausgrid historical failure and asset data.

β_{good}	1.7135	$\beta_{average}$	1.7933	β_{poor}	1.8732
η_{good}	59.7114	$\eta_{average}$	49.7700	η_{poor}	42.1329

b (intercept)	-7.0072

Adjustments factors

Probability of Failure (PoF)	• Actual Failure Data • Age • Equipment Manufacturer Model
Probability of Consequence (PoC)	• Configuration (bus section isolators)

Model calculated failures

	2020	2021	2022	2023	2024
Failures	60	61	62	64	65

Sensitivity

Ausgrid tested the sensitivity of the applied grossly disproportionate factor by applying a factor of 3 to safety and fire consequences, based on the worker safety risk. The impact of these changes is a 16% reduction to the overall recommended replacement quantities.

Modelled inherent incident consequences

In determining the probability of severity, Ausgrid has utilised available information to determine the rate of occurrence of an event by each severity. These values were then tested for sensitivity.

Safety (specifically worker safety for this asset type)
Worker Safety ICR – 0.45% (Ausgrid's recorded ICR)

Severity	Cost of Consequence	Probability of Consequence	Grossly DF	Probability of Severity	Years until event
Severe	$ 4,469,292	0.00018	10	0.040	96
Major	$ 446,929	0.00027	8	0.060	64
Moderate	$ 44,693	0.00054	6	0.120	32
Minor	$ 4,469	0.00108	4	0.240	16
Insignificant	$ 447	0.00243	2	0.540	7.1

Average **safety** consequence per asset: $9,176 per event.

Ausgrid has experienced a number of near misses while operating isolators and therefore conservatively, Ausgrid have proposed that inherently a fatality would occur due to a failure of an isolator every 96 years (~100 years). Changing the probability of severity to 0.08 (or 1 fatality every 48 years), increases the average safety consequence by 88% and does not change the replacements during FY20 to FY24. Changing this to 0.02 (or 1 fatality every 191 years), reduces the average safety consequence by 44% and reduces the planned replacement quanitity by 26.

Fire
ICR – 0.10% (No events recorded, therefore estimated due to the potential for a fire)

Severity	Cost of Consequence	Probability of Consequence	Grossly DF	Probability of Severity	Years until event
Severe	$ 66,000,000	0	10	n/a	n/a
Major	$ 6,600,000	0	8	n/a	n/a
Moderate	$ 660,000	0.00015	6	0.150	115
Minor	$ 66,000	0.00030	4	0.300	57
Insignificant	$ 6,600	0.00055	2	0.550	31

Average **fire** consequence per asset: $680 per event.

Due to the location of these assets being within a substation, the risk of severe and major fire incident was low enough that the probability of consequence considered negligible and was set to zero for these severities. To consider the sensitivity, the ICR was set to 0.00% resulting in no change to the model outcome.

Environment
ICR – 0%

Severity	Cost of Consequence	Probability of Consequence	Grossly DF	Probability of Severity	Years until event
Severe	$ 10,193,119	n/a	1	n/a	n/a
Major	$ 4,558,501	n/a	1	n/a	n/a
Moderate	$ 1,019,312	n/a	1	n/a	n/a
Minor	$ 101,931	n/a	1	n/a	n/a
Insignificant	$ 10,193	n/a	1	n/a	n/a

Average **environment** consequence per asset: $ n/a.

There are negligible environmental consequences relating to subtransmission isolators.

Loss of supply
Ausgrid's failure data has been reviewed to determine the proportion of failures resulting in unserved energy, with consideration of the number of outages recorded using data from Ausgrid's outage management system (OMS).

Outage Type	Feeder/Tx	Data Source
Proportion of failures resulting in unserved energy	6%	OMS - 3 year average
VCR	$40.73/kWh	AEMO / AER
Average interruption duration	0.4 hrs	OMS - 3 year average
Time without supply	0.02 hrs	Calculated

Average **loss of supply** consequence per asset: $29,879 per event.

Finance

		Data Source
Annual deferral benefit of reactive	$3,618	20% increase on planned replacement cost applied at the WACC
Repair cost	$2,263	FY13-FY18 actuals (Direct '19)
Proportion replaced	1%	SAP – Asset Register
Weighted replacement/repair cost	**$2,277**	Calculated
Maintenance original asset per annum	$0	Based on historical maintenance
Maintenance replacement asset per annum	$0	Based on historical maintenance
Maintenance benefit per asset per annum	**$0**	Calculated

Average **financial** consequence/benefit per asset: $2,277 per event.

AVERAGE TOTAL CONSEQUENCE per asset: $42,012 (including POC x C($))