Program of Works

2017 – 2022

Circuit Breaker Replacement (PUBLIC VERSION)

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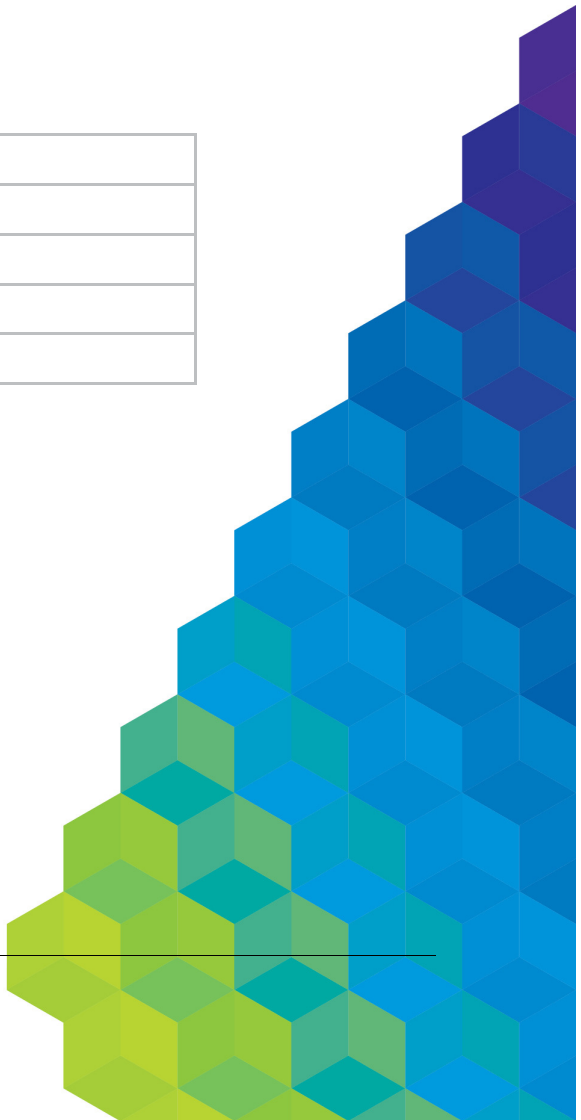

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1 Summary

PROGRAM	CB Replacements
SERVICE DATE	On-going throughout period 2017/18 – 2021/22.
LOCATION	Various Terminal Stations across Victoria.
VALUE	$29.6 M.

Table 1 – Program Overview

1.1 Program Scope

Table 2 identifies the types and quantities of Circuit Breakers (CBs) identified for replacement.

Voltage (kV)	Interrupting Type	Replacement Cost ($ '000s)	Condition Score	Quantity	Total CAPEX Costs ($'000s)
500	SF6 Live Tank	C-I-C	4	1	C-I-C
			5	6	C-I-C
220	Minimum Oil	C-I-C	4	8	C-I-C
			5	0	0
	SF6 Live Tank	C-I-C	4	3	C-I-C
			5	5	C-I-C
66	Bulk Oil	C-I-C	4	8	C-I-C
			5	3	C-I-C
	Minimum Oil	C-I-C	4	17	C-I-C
			5	4	C-I-C
	SF6 Live Tank	C-I-C	4	9	C-I-C
			5	5	C-I-C
22	Minimum Oil	C-I-C	4	0	0
			5	3	C-I-C

Table 2 – Types and quantities of CBs identified for replacement

1.2 Program Expenditure Forecast

2017/18 ($k)	2018/19 ($k)	2019/20 ($k)	2020/21 ($k)	2021/22 ($k)	Total ($k)
5,922	5,922	5,922	5,922	5,922	29,610

Table 3 – Program timing and forecast expenditure

Forecast costs shown in Table 3 are $2014/15 P50 direct costs. These costs exclude overheads, finance charges and cost escalation. Unit costs are described in Appendix 4D: Unit Rates.

2 Program Drivers

- Network reliability, quality and security of supply:
    - The failure of these CBs will result in unplanned extended outages of the failed CB and may cause adjacent circuit outages due to collateral damage caused by the failure;
- Safety and Environment:
    - Failure of bulk oil CBs can result in explosions and fires. The large volume of oil within the CB tank may spill oil and spread oil fires. Further, failure of porcelain bushings on these CBs can result in projectiles. All of these will present a safety risk to people working in the switch yard. Spillage of oil also poses environmental hazards as bulk oil CBs are not positioned within a bunded area.
- Financial Impacts:
    - Failure of the CBs may result in market impact costs;[1]
    - The financial penalties from incentive schemes;[2]
    - Increased costs associated with emergency replacements following major failures;
    - Costs associated with collateral damage to the adjacent plant caused as a result of oil fires and projectiles;
    - Costs associated with injuries / fatalities arisen to staff and contractors working on site as a result of fires and projectiles.
- Regulatory Compliance:
    - To comply with all applicable obligations or requirements associated with the provision of transmission services including capital expenditure objectives as described in National Electricity Rule 6A.6.7a and obligations set out in the Electricity safety Act. Rule 6A.6.7a requires the Transmission Network Service Provider (TNSP) to propose capital expenditure forecasts which meet the expected demand, comply with applicable regulatory requirements, and maintain the quality, reliability and security of supply of both prescribed transmission services and the transmission network. Under the Electricity Safety Act the TNSP must design, construct, operate, maintain and decommission its supply network to minimise as far as practicable the hazards and risks to the safety of any persons or damage to any person's property arising from the supply network.
- Corporate Image:
    - To maintain good corporate image as a prudent asset manager by managing risk as low as practicable

[1] Market Impact Parameter Scheme (MIPS).

[2] AER Service Target Performance Incentive Scheme.

3 Obligations

The National Electricity Rules (clauses 6A.6.6 and 6A.6.7) require AusNet Services to forecast operating and capital expenditures to, amongst other objectives, *comply with all applicable regulatory obligations or requirements associated with the provision of prescribed transmission services;*

The Electricity Safety Act (clause 98) requires a major electricity company, such as AusNet Services to design, construct, operate, maintain and decommission its supply network to minimise as far as practicable:

(a) the hazards and risks to the safety of any person arising from the supply network; and

(b) the hazards and risks of damage to the property of any person arising from the supply network; and

(c) the bushfire danger arising from the supply network.

In the definitions of this Act, the term 'practicable', means having regard to:

(a) the severity of the hazard or risk in question; and

(b) the state of knowledge about the hazard or risk and any ways of removing or mitigating the hazard or risk; and

(c) the availability and suitability of ways to remove or mitigate the hazard or risk; and

(d) the cost of removing or mitigating the hazard or risk.

This means "as far as practicable" which has been interpreted as until the safety related costs are (grossly) disproportionate to the safety related benefit.

The Occupational Health and Safety Act requires AusNet Services to provide and maintain so far as is reasonably practicable for employees, a working environment that is safe and without risks to health.

4 Overview

The transmission asset health report (AHR 20-54 – CBs) was updated in May 2015 as a snap shot of the network at 31 July 2014. The report assigns a condition score C1 to C5 based primarily on recorded equipment failure rate.

Analysis of the risks associated with CB failure is described in AMS 10-54 Circuit Breakers. This analysis indicates that the replacement of 172 CBs over a 5 year period is economic. Approximately 53 CBs are expected to be replaced as part of terminal station rebuild projects suggesting that a program of replacement consisting of 119 CBs could be economically justified.

Further examination of the individual CBs in condition C4 and C5 that aren't listed for replacement as part of an existing project or a proposed station rebuild and for which refurbishment is not considered worthwhile has been completed. This has identified 72 CBs for replacement[3].

The program of works document proposes CBs that can be economically replaced. They will be integrated with replacement of other asset types when projects are developed.

[3] Less CBs are planned for replacement than can be economically justified as there are a number of CBs that can be refurbished or other maintenance activities can reduce the risk of failure

5 Risk Matrix

Replacement of CBs in poor condition reduces the risk of complete failure and explosive failure reducing the risk of:

- injury to personnel;
- adverse environmental egress;
- network unavailability;
- unplanned replacement.

Replacement of the CBs which have an elevated probability of failure (CBs in condition C4 and C5) is expected to reduce the likelihood of an unplanned failure moving the Likelihood from C to B as shown on the AusNet Services risk matrix shown in Figure 1.

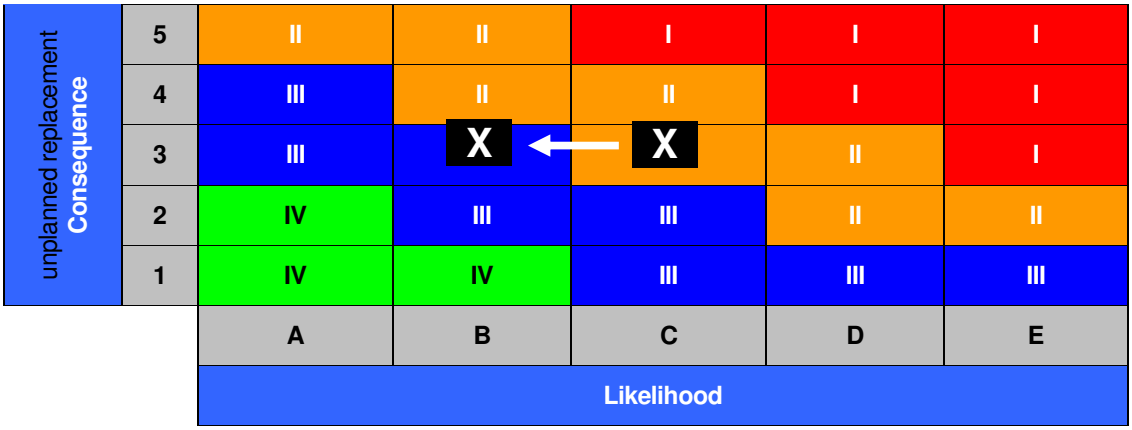

Figure 1 – Risk Matrix

6 Option

The following four options consider the benefits and consequences of complete CB replacements. The options either replace CBs or keep them in service subject to normal maintenance. Replacement reduces potential failure costs but requires capital investment, retaining CBs requires no capital investment but runs the risk of a major failure.

Condition based failure rates, standardised replacement costs and standardised internal consequential costs models are used as inputs to the NPV analysis of each option. The standardised replacement costs are shown in section 1.1.

6.1 Option 1 – Do nothing

The Do Nothing option involves continuing the standard inspection and maintenance program for these CBs. In this option, no refurbishment is undertaken and the CBs are not replaced after they fail.

This option assesses the residual costs of not replacing 72 CBs with a condition score of C4 and C5. The residual costs include:

- Inventory cost of a new CB;
- labour (including overtime);
- network outage penalties (AIS, MIPS, connection agreements);
- occupational health and safety;

- environment (oil spills, SF6 leaks).

Apart from the financial implications, this option is inconsistent with AusNet Services' obligations under the National Electricity Rules. It is not consistent with the obligations of the Electricity Safety Act and with AusNet Services' approved Electricity Safety Management Scheme and asset management strategy for CBs.

This option forms the baseline for comparison. The total present value (PV) cost over a 20-year period (2017 – 2037) is $60,056,000 and the net present value is negative. There is no direct capital expenditure.

6.2 Option 2 – Replacement of all specified CBs

Option 2 assesses the economic rationale behind replacing all 72 CBs that weren't replaced in option 1, consisting of 26 CBs with a C5 condition and 46 CBs with a condition score of C4.

This option proactively replaces all CBs over the 2017-22 period and completely removes the risk costs associated with the failure of the 72 CBs in question.

This option has the lowest PV cost of the four options with $36,246,000 and the most positive NPV of $3,551,000.

Due to the recent reduction in the value of customer reliability (VCR) fewer station rebuilds are proposed. Over the longer term, this will have the effect of more assets being replaced in targeted replacement programs. However, Option 2 will result in the average annual replacement of 14 CBs which is consistent with recent annual replacement rates.

Removing the failure risk of the 72 CBs is the most prudent course of action and is the preferred option of the four.

6.3 Option 3 – Replacement of all C5 CBs

Option 3 considers the replacement of all CBs, out of the list of 72 that have a condition of C5. This results on the replacement of 26 CBs. The remaining 46 CBs will remain untouched to be replaced in the event of a failure as per option 1.

The benefit of this option is less CAPEX, however replacement of only C5 CBs does not reduce risk to an economic level as the PV costs are only marginally less than the do nothing option, at $52,331,000.

6.4 Option 4 – Replacement of all C5 AND selected C4 CBs

Option 4 exists as an attempt to minimise the PV costs while undertaking the maximum number of replacements. The resultant option was to replace all 26 CBs with a condition score of C5 and 34 66kV CBs with a condition score of C4. This option has a lower PV cost compared to option 3 with $45,467,000, however the residual risk of failure of the C4 CBs above 66kV means that this option is still less preferred than option 2.

7 Financial Analysis

The table below shows the results of the economic evaluation. Option 2, the preferred option, has the most positive NPV, presents the highest community benefits and is therefore preferred.

Economic Analysis of Options ($'000s)	PV Capital Cost	PV Opex Costs	PV Community Benefits	PV Proceeds From Sales	Total PV Cost	NPV including Reg Return
Do Nothing	-	(22,794)	(37,263)	-	(60,056)	**(8,894)**
Replacement of all specified CBs	(27,437)	(2,599)	(6,209)	-	(36,246)	**3,551**
Replacement of all C5	(12,452)	(13,017)	(26,862)	-	(52,331)	**1,668**
Replacement of all C5 CBs and selected C4 CBs	(20,611)	(18,340)	(6,515)	-	(45,467)	**1,002**
	-	-	-	-	-	**-**

All figures are in $000's unless otherwise stated.
(nominal and discounted)

Table 4 – NPV analysis

8 Recommended Action

Replace CBs in line with option 2. Create projects that integrate the replacement works with the program of works for other adjacent asset types grouping works by station.

9 Reference Documents

AHR 10-54 Victorian Electricity Transmission Network Asset Health Report – CBs.