Program of Works

2017 – 2022

Reactive Plant Replacements (PUBLIC VERSION)

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Table of Contents

1 SUMMARY

PROGRAM	Reactive Plant Replacements
SERVICE DATE	On-going throughout period 2017/18 – 2021/22.
LOCATION	Various Terminal Stations across Victoria.
VALUE	$820,000

Table 1 – Program overview

1.1 Program Scope

The scope for replacement of components on the network reactive plant covers the following:

Static VAR Compensators (SVC)

- Replacement of 12, 10.5kV thyristor switched reactor / capacitor wall bushings on the ROTS 2 SVC;
- Replacement of 3 air core reactors in C5 condition on the ROTS 2 SVC.

Neutral Reactors

- Replacement of 3 poor condition neutral air core reactors.

Capacitor Banks

- No replacements of capacitor bank components are being proposed in this program of works.

1.2 Program Expenditure Forecast

2017/18 ($k)	2018/19 ($k)	2019/20 ($k)	2020/21 ($k)	2021/22 ($k)	Total ($k)
164	164	164	164	164	820,000

Table 2 – Program Timing & Forecast Expenditure

2 Program Drivers

- **Network reliability, quality and security of supply**
  - The failure of reactive plant within a terminal station results in a reduction or complete loss of ability to provide dynamic voltage support to the transmission network. This gives rise to increased system losses and restricted ratings on transmission lines and transformers as well as an overall reduction in effective station loading capability and may result in electricity market constraints.

- **Safety and Environment**
  - Typical failure modes of air core reactors or capacitor bank cans can result in fire or explosions of capacitor cans. The modular design of these reactive systems lead to risks of collateral damage to nearby equipment as a result of a failure of one or more components.

    All of these will present a safety risk to people working in the switch yard. Additionally there are risks of environmental contamination due to the spillage of oil from capacitor cans if not adequately bunded.

- **Financial Impacts**
  - Failure of reactive devices on the network 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 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 (STPIS).

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 low as reasonably 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 work place that is safe and without risks to health.

4 Overview

The transmission asset health reports for reactive plant/s (AHR 10-53 – Capacitor Banks, AHR 10-71 – Static VAR Compensators & AHR 10-70 – Air Core Reactors) have been updated in June 2015 as a snap shot of the network at 31 July 2014. The report assigns a condition score C1 to C5 for each asset based primarily on recorded equipment failure rates and recorded work order history.

Reactive plant is modular in design, but operates as an integrated system. This program of work considers the risk of failure of individual components within the integrated system which are in condition C4 and C5 that aren't already listed for replacement on existing projects or proposed station rebuilds.

The likelihood of failure is based on the condition score whilst the consequence considers the health and safety, environment, network availability and emergency replacement.

This program of works document proposes equipment that technically (condition based) should be replaced. All replacements will be integrated with replacement of other asset types when projects are developed to factor for efficiencies in outage costs as well as labour utilisation.

5 Risk Matrix

Replacement of reactive plant components in poor condition reduces the risk of complete failure of the integrated system leading to catastrophic failure. This reduces the risk of:

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

Consequence					
5	II	II	I	I	I
4	III	II	II	I	I
3	III	III	II	II	I
2	IV	X ←	X	II	II
1	IV	IV	III	III	III
	A	B	C	D	E
	Likelihood				

Figure 1 – Risk Matrix

6 Detailed Scope of Proposed Replacement Works

The following options detail the proposed replacement options of the various deteriorated condition assets over the next five year period to ensure that the risks of failure and network availability are maintained.

The options either replace components or keep them in service subject to normal maintenance. Replacement reduces potential failure costs but requires capital investment, retaining these assets requires no capital investment but runs the risk of a major failure in the short to medium term.

The replacement costs are shown in section 1.1.

6.1 SVC component replacements

The SVC serves to regulate system voltages by using the Thyristor Controlled Reactor (TCR) to consume VARs from the network under capacitive loading conditions. Conversely, under inductive loading conditions the SVC uses the Thyristor Switched Capacitor (TSC) to add VARs to the network. The use of the SVC facilitates continuous voltage stability enabling the network to withstand unplanned outage events such as the loss of a line following lightning strike.

When a SVC fails, the dynamic VAR support provided at the terminal station is lost, and this gives rise to increased system losses and restricted ratings on mainly lines and terminal station transformers. It lowers the effective station loading capability.

SVCs are modular in design, but operate as an integrated system. Without adequate spares available, sourcing replacement components such as capacitors, thyristors, reactors, etc, can take over six months leaving the SVC unavailable for service for an extended period. This is an unacceptable risk.

The general condition of the 4 SVC's on the network is considered to be good. The ROTS 2 SVC is showing signs of serious deterioration of a number of its components which will pose a significant risk of unplanned outages in the future if left unaddressed.

To minimise the risk of extended unplanned outages it is proposed to replace the following C5 condition components on the ROTS2 SVC over the period:

- Replacement of 12, 10.5kV thyristor switched reactor/capacitor wall bushings on the ROTS 2 SVC;
- Replacement of 3 air core reactors in C5 condition on the ROTS 2 SVC.

6.2 Air Core reactor replacements (neutral reactors only)

AusNet Services has many air core reactors on the network that are not part of Capacitor Banks or Static VAR Compensators. These reactors are Line Traps, Series Reactors or Neutral Reactors.

Line Traps

The condition of the in service Line Traps used for communications are generally deemed to be good. These have been identified under separately funded projects for removal.

Series Reactors

Series reactors are all deemed to be in good condition and as such no replacement works are necessary over the next five years.

Neutral Reactors

Neutral reactors are used on the neutrals of transformers to limit the phase to earth fault currents. Each transformer only requires one natural reactor on a single phase

Most of the 69 Neutral Reactors installed on the transmission network are deemed to be in good condition, except reactors with concrete housings manufactured in the 1960's. Nine of these are deemed to be in bad condition and require replacement. This program of works only proposes expenditure for the replacement of three neutral reactors at two terminal stations.

- 2 x C-I-C Neutral Reactors;
- 1 x C-I-C Type Natural Reactor.

The remaining six will be replaced under existing planned projects and do not form part of this program of works.

6.3 Capacitor bank component replacements

AusNet Services has 71 capacitor banks in service at 29 terminal stations. Banks range in size from 5.4 MVAr to 220 MVAr and are connected at voltages ranging from 22 kV up to and including 330 kV. All of the capacitor banks are fenced or caged outdoor installations.

59% of the capacitor banks installed in terminal stations are between 11 and 20 years old. 99% are in a "very good", "good" or "average" condition and the remaining 1 % are classified as in a "poor" condition.

None of the banks were considered to be in a "very poor" condition requiring immediate action at the time of compiling this report.

As such no expenditure is proposed for major replacement works on the capacitor banks on the network.

7 Reference Documents

AHR 10-53	Victorian Electricity Transmission Network Asset Health Report – Capacitor Banks.
AHR 10-70	Victorian Electricity Transmission Network Asset Health Report – Air Core Reactors.
AHR 10-71	Victorian Electricity Transmission Network Asset Health Report – SVC's.