Program of Works

2017 – 2022

Transformer Improved Safe Maintenance Access

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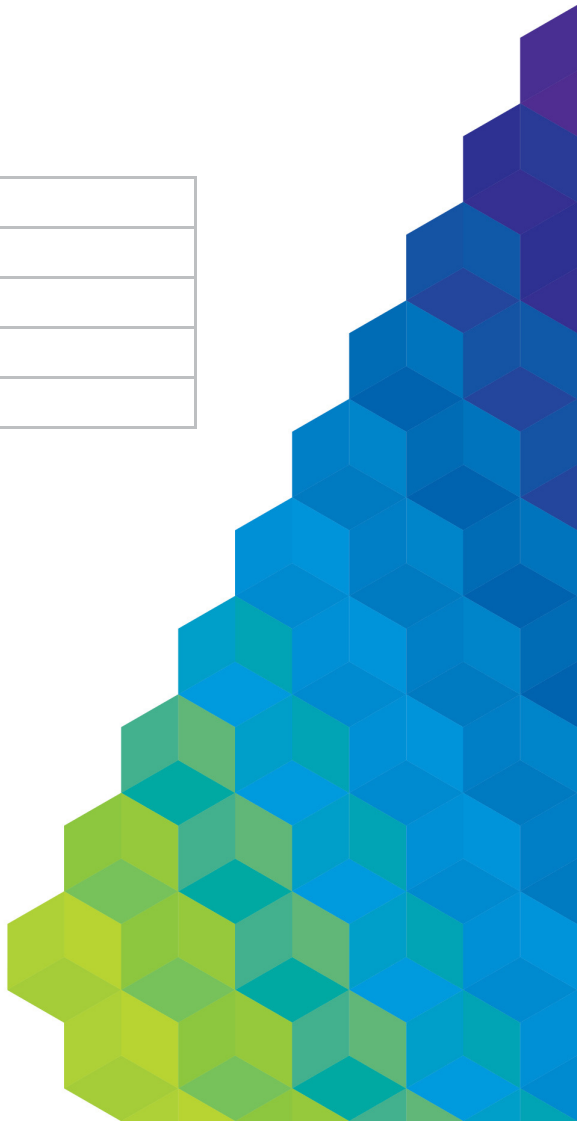

ISSUE/AMENDMENT STATUS

Issue Number	Date	Description	Author	Approved by
0.1	04/03/15	Initial document	C. Odendaal P. Seneviratne	S. Owen
0.2	24/06/15	Convert to AusNet Services' template Modified options to suit actual project scope. Updated NPV and costing.	C. Odendaal	S. Owen
1.0	24/06/15	Initial Issue	C. Odendaal	S. Owen

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1 Summary

This works program summarises the activities necessary to provide safe access to power transformers in the Victorian electricity transmission network for inspection and maintenance purposes. This document should be read in conjunction with AMS 10-67 Power Transformers Oil and Filled Reactors.

PROGRAM	Transformer - Improved safe maintenance access
SERVICE DATE	On-going throughout period 2017 – 2022
LOCATION	Multiple Terminal Stations in the Victorian electricity transmission network
VALUE	$ 2.5M

Table 1 – Program overview

1.1 Program Scope

The scope of works involves:

Engagement of transformer manufacturers or other suppliers to design, manufacture and install safe maintenance access systems for 50 transformers on the AusNet Services transmission network. The use of a modular / adjustable system may provide suitable flexibility for similar designed transformers as well as accommodating transformers installed in a sound enclosure.

The system would comprise of:

- galvanised fence / handrail system with kick rail for each transformer tank lid;
- two ladder access points to the lid;
- a working platform and ladder access point to the Buchholz relay;
- harness turnbuckle attachments to each bushing turret.

Before commencement, design verification and evaluation against safety and access requirements will need to be performed. The handrail system will include the installation brackets and/or fixing mechanism. Where there is a requirement for welding onto the existing tank or lid, this would be included as well as the repair of the corrosion protection system.

The identified transformers are 50 units manufactured since late 1990s and before handrails became part of the standard requirements.

1.2 Program Expenditure Forecast

2017/18 ($k)	2018/19 ($k)	2019/20 ($k)	2020/21 ($k)	2021/22 ($k)	Total ($k)
500	500	500	500	500	2,500

Table 2 – Program timing and forecast expenditure

Forecast costs shown in Table 2 are $2014/15 P50 direct costs. These costs exclude overheads, finance charges and cost escalation.

2 Program Drivers

In line with AusNet Services' Mission Zero safety program, the addition of safety handrails on transformer tank lids will provide an engineering solution to working on the transformer lid or accessing the gas relay at heights in excess of 4 metres above ground level.

Implementation of this program of work will assist AusNet Services in addressing the following business drivers:

- Safety of employees and contractors working at heights on transformers:
  - Minimise OH&S risk to employees and contractors.
- Financial risk:
  - Reduce operating costs through improved mobility / access restrictions.
  - Reduce legal actions resulting from personal injury / compromised health.
- Regulatory compliance:
  - Compliance with Electricity Safety Act.
  - Compliance with Electricity Safety (Management) Regulations.
  - Compliance with Occupational Health & Safety Act (provide safe work environment).
  - Compliance code for Prevention of Falls in General Construction.
- Corporate image maintained as prudent asset managers:
  - Manage safety risks "as far as is practicable".

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;

The Occupational Health and Safety Act requires AusNet Services to:

> *"so far as is reasonably practicable, provide and maintain for employees of the employer a working environment that is safe and without risks to health".*1

When determining what is (or what was, at a particular time), reasonably practicable in ensuring health and safety, the OHSA requires that regard be had to the following matters:

a) the likelihood of the hazard or risk concerned eventuating;
b) the degree of harm that would result if the hazard or risk eventuated;
c) what the person concerned knows, or ought reasonably to know, about the hazard or risk and any ways of eliminating or reducing the hazard or risk;
d) the availability and suitability of ways to eliminate or reduce the hazard or risk;
e) the cost of eliminating or reducing the hazard or risk.2

In economic terms, "reasonably practicable" requires AusNet Services to address safety hazards up until the point that the costs of remediation become grossly disproportionate to the benefits.

4 Overview

The on-going transformer maintenance activities require periodic access to the top of transformers and gas relays which are located at heights in excess of 4 metres above ground level.

The activities involve maintaining the on-load tap changer (OLTC), taking an oil sample, core and frame earthing inspection or condition based tests requiring access to the transformer bushings. Access to the gas relay for operational checks for both wiring and alarms or inspection of the gas accumulation, all requires working at or above the height of the transformer lid. Some power transformers leak insulating oils from seals located on the top of the transformer. This creates a safety hazard for workers.

Generally, ladders are used as the means of access to the transformer and its accessories. Ladder placement and suitable tie-off points are currently not defined. For some transformers tie-off points for the ladder securing rope are limited. When traversing from the ladder to the transformer lid and vice versa, it is essential the ladder does not move or slip as this exposes the person to a fall hazard.

Gas relays are usually located between the radiator elements and the bottom of the conservator or at some height above the transformer tank lid. As access to this device can be difficult via elevated work platform, much of the work is traditionally performed from a ladder. Tie-off points for the ladder and location of a suitable harness anchor point requires some effort.

The provision of a barrier, to define the work area and prevent an inadvertent slip and fall, will reduce the risk of injury to personnel and liabilities to AusNet Services. This program of work aims to reduce the risks associated with working on a transformer and accessing its components including the gas relay.

[1] *Occupational Health and Safety Act 2004* (Vic), Section 21(1).

[2] *Occupational Health and Safety Act 2004* (Vic), Section 20(2).

5 Risk Matrix

Risk reduction will primarily be obtained by reducing the likelihood of a fall that could cause serious injury and secondarily reducing the severity of consequences associated with a fall. The installation of safe maintenance access systems will prevent a worker from falling, and therefore reduce the likelihood of a serious injury or fatality. The system will also limit the potential for a worker to fall into the safe approach distance near live equipment.

Formal risk assessments performed by AusNet Services as part of development of the ESMS indicates the "falling while working at heights" on transmission lines assets register a risk rating of III. A similar risk applies to working on transformers.

The risks associated with a fall will decrease from a score of II to IV on the AusNet Services corporate risk matrix. Figure 1 displays the expected improvement in risks achieved through the implementation of the safe maintenance access systems. Likelihood is expected to reduce from "years to decades" to "a 100-year event" and consequences are expected to reduce from "Severe irreversible disability" to "Medium term largely reversible disability to one or more persons.

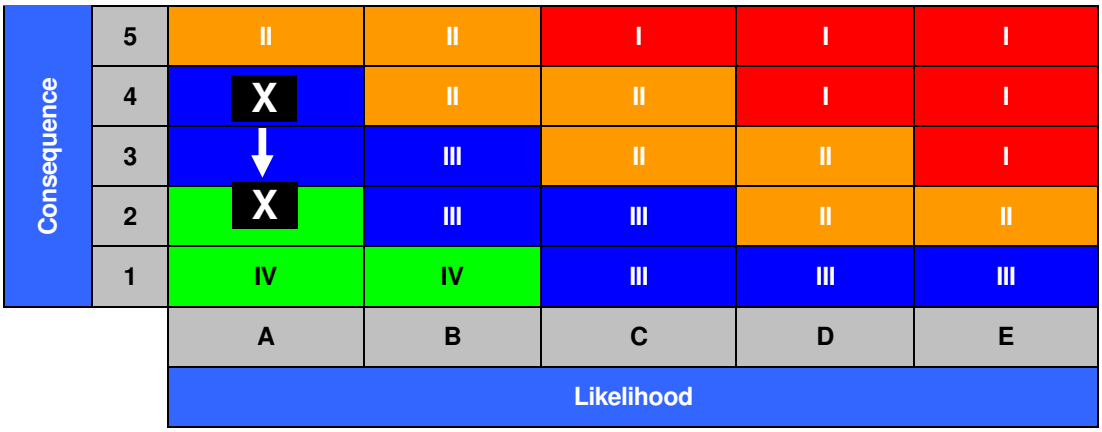

Figure 1 – Risk matrix

6 Options

Three options have been evaluated to reduce the risk of fall from a transformer.

Option 1 Do Nothing.

Option 2 Use Maypole and Personal Protective Equipment (PPE) Solution.

Option 3 Ladder landings, handrails, kick rails, harness turnbuckles on turrets and Buchholz platform with ladder landing (preferred option).

Table 3 outlines the risks which will be addressed through implementation of each option.

	Risks addressed		
	Ladder Attachment	**Access Transformer Lid**	**Access Gas Relay**
Option 1	**No**	**No**	**No**
Option 2	**No**	**Partially**	**No**
Option 3	**Yes**	**Yes**	**Yes**

Table 3 – Option analysis

Only Option 3 addresses all the risks. The other options do not provide sufficient control over the identified risk.

6.1 Option 1 – Do nothing

The Business as Usual option involves:

- Continuing to use harness and lanyard to prevent falls.
- Access the transformer lids using knuckle boom vehicles or makeshift ladder attachments.
- No reduction in safety risks while working aloft.
- Relies on PPE, the lowest option in the hierarchy of controls for risk management.

This option fails to address any of the key business drivers listed in the Program Drivers section.

The 'Business as Usual' approach exposes workers to safety risks which may result in single fatality or a severe irreversible disability to one or more persons. This option exposes AusNet Services to financial risk by failing to demonstrate an appropriate level of risk mitigation.

This option is inconsistent with AusNet Services' obligations under the Electricity Safety Act and those of the Occupational Health and Safety Act. This option is inconsistent with AusNet Services' accepted Electricity Safety Management Scheme and AusNet Services' mission Zero safety program.

This option is included to aid the quantification of risks for economic modelling purposes.

6.2 Option 2 – Maypole and PPE

Implementing a Maypole PPE solution involves:

- Providing sufficient Maypoles to each terminal station to cater for the maximum number required for concurrent use.
- PPE still required to be used.
- Hierarchy of controls lists PPE as the least favourable / least effective option.

This option fails to address some of the key business drivers listed in the Program Drivers section.

This option is similar to the 'Do Nothing' option with the exception that a suitably rated Maypole is used for attaching PPE. It does not remove the need to use PPE just providing a point of connection for the harness/lanyard. There is also concern of the weight of this device which needs to be installed on the top of the transformer each time it is required.

Option 2 does not address the need for suitably located ladder access points with an integrated tie-off system to prevent ladder slip. Similarly, access to transformer components such as the gas relay is not addressed. This option may reduce potentially significant health and safety and financial liabilities but still uses PPE as the basis of fall prevention.

Choosing option 2 would involve accepting the risks associated with working at height. It will not significantly reduce the height safety risks into the future.

Whilst going some way to addressing the requirements of the Electricity Safety Act and those of the Occupational Health and Safety Act, this option does not demonstrate management of safety risks "as far as is practicable".

This option is inconsistent with practices within the electricity supply industry[3]. It is also inconsistent with the accepted Electricity Safety Management Scheme and mission Zero safety program.

6.3 Option 3 – Retrofit Handrails, Access platforms and ladder access points

Implementing a retrofit of handrails, access platforms and ladder access points involves:

- Proactively providing a safer work area for transformer access;
- Reducing the risks associated with working at height;
- Reducing the potential injury to AusNet Services employees and contractors;
- Reducing the injuries from incorrectly worn PPE (harness, lanyard, etc.);
- Providing an engineering solution to the current practices.

This option addresses all of the key business drivers listed in the Program Drivers section. This option is a proactive approach to further reduce the risk presented to personnel working at height on transformers. This option reduces potentially significant health and safety and financial liabilities by providing a handrail to enclose the work area, platforms for access to gas relays and defined ladder attachment points.

Choosing option 3 ensures that risks associated with working at height on transformers are reduced below current levels. Option 3 will ensure that risks associated with ladder placement and securing are reduced which are essential given the possible health and safety consequences. Implementation of a ladder access point, platform and handrail retrofit program will improve levels of safe access to transformers and their associated equipment.

This option addresses the requirements of the Electricity Safety Act and those of the Occupational Health and Safety Act by managing safety risks "as far as is practicable".

This option is consistent with practices within the electricity supply industry[4]. It is also consistent with the accepted Electricity Safety Management Scheme and missionZero safety program.

[3] National Fall Protection Guidelines for the Electricity Industry (ENA NENS 05-2006).

[4] National Fall Protection Guidelines for the Electricity Industry (ENA NENS 05-2006).

7 Financial Analysis

Table 4 shows the results of the economic evaluation. Option 3, the preferred option, has a similar but slightly more positive NPV than Option 2. However, Option 2 accepts a level of Health & Safety risk that could be managed lower and is therefore not consistent with the obligation to reduce safety risks 'so far as is practicable'.

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	-	(187)	(3,367)	-	(3,554)	**-**
Maypole PPE Solution	-	(253)	(2,693)	-	(2,946)	**20**
Retrofit Handrails, Access Platforms & Ladder Access Points	(2,316)	-	-	-	(2,316)	**76**
	-	-	-	-	-	**-**
	-	-	-	-	-	**-**

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

Table 4 – NPV Analysis

8 Recommended Action

The retrofit of handrails, access platforms and ladder access points, Option 3, is recommended to improve safety and meet statutory obligations.

9 Reference Documents

- National Electricity Rules.
- Electricity Safety Act.
- Electricity Safety (Management) Regulations.
- Occupational Health & Safety Act.
- AMS 10-01 – Victorian Electricity Transmission Network.
- AMS 10-67 Power Transformers Oil Filled Reactors.
- National Fall Protection Guidelines for the Electricity Industry (ENA NENS 05-2006).
- Compliance Code – Prevention of Falls in General Construction – WorkSafe Victoria.
- Safe Work Australia: National Code of Practice for the Prevention of Falls in Housing Construction (2009).