Asset Management Plan

Ground Mounted Substations – Distribution

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Authorisations

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Responsibilities

This document is the responsibility of the Substation Asset Strategy Team, Tasmanian Networks Pty Ltd, ABN 24 167 357 299 (hereafter referred to as "TasNetworks").

The approval of this document is the responsibility of the Asset Strategy Team Leader.

Please contact the Substation Asset Strategy Team Leader with any queries or suggestions.

- Implementation All TasNetworks staff and contractors.
- Compliance All group managers.

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Reference documents

TasNetworks Asset Management Policy – R40766

TasNetworks Strategic Asset Management Plan – R954721

TasNetworks Risk Management Framework – R909655

Record of revisions

Revision	Details	Date
1.0	Original issue	16/10/2015
2.0	Amended for R19 submission. Financials removed	26/05/2017
6.0	Document revised to new AMP format.	07/10/2022

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1 Purpose

The purpose of this document is to describe, for the ground mounted distribution substations assets:

- TasNetworks' approach to their asset management, as reflected through its legislative and regulatory obligations and strategic plans.
- The key projects and programs underpinning its activities.
- Forecast capital (**capex**) and operational (**opex**) funding, including the basis upon which these forecasts are derived.

2 Scope

This management plan covers the following assets:

- Ground mounted substations (including high voltage switching stations);
- High Voltage (**HV**) switchgear;
- Low Voltage (**LV**) switchboards; and
- Ground mounted transformers.

3 Management strategy and objectives

This asset management plan has been developed to align with TasNetworks' Asset Management Policy, Strategic Asset Management Plan and Strategic Objectives.

4 Description of the asset portfolio

Ground mounted distribution substations are installed on the network where there is a requirement to supply a large load, a large number of customers or provide a single customer with supply from the high voltage underground reticulation network. The substations are used to reduce the voltage of the high voltage distribution network down to the customer supply voltage.

4.1 Substations

The ground mounted substations consist of a variety of construction types, sizes and configurations. The majority of substations comprise an enclosure, high voltage switchgear, transformer(s) and a low voltage switchboard. These substations range in size from 300 kVA to 4500 kVA, are supplied at either 22 kV or 11 kV and have a secondary voltage of 400/230 volts. Switching stations comprise only an enclosure and high voltage switchgear. There are currently 2,081 ground mounted substations on the distribution network.

The assets have a typical service life of 40 to 50 years before major refurbishment or replacement is required.

Ground mounted substations can be divided into the following construction types:

- Building
- Fence
- Kiosk (Padmount)
- Vault

4.1.1 Building substations

Building type substations are often of a larger capacity and used to supply commercial customers. They may comprise either a stand alone building, or be incorporated into a larger a privately owned building.

These substations are designed to suit the site specific network and customer requirements. They are made up from individual components, consisting of high voltage switchgear, transformer(s), a low voltage switchboard and anciliary systems. These substations may also include include a fire detection and supression system. They range in size from 300 kVA to 3750 kVA.

Building type substations have been installed on the network since the early 1960s.

4.1.2 Kiosk substations (Padmount)

Kiosk substations are a complete stand alone assembly and comprise a variety of standard configuations, construction and equipment types. The equipment is installed in a weatherproof enclosure. The enclosures have historically been made from fibreglass panelling, brick, steel and precast concrete. New kiosks have a steel enclosure. They range in size from 300 kVA to 2000 kVA.

Kiosk type substations have been installed on the network since the late 1960s.

Figure 1 Block wall kiosk (1977)

Figure 2 Modern steel kiosk (2012)

4.1.3 Fence type substations

Fence type substations are stand alone outdoor installations. These substations have an external perimeter fence and usually consist of high voltage switchgear, transformer(s) and a low voltage switchboard. The equipment may be either designed to be outdoors, or indoor equipment installed in individual weatherproof cabinets. They range in size from 100 kVA to 4500 kVA. Figure 3 represents a typical fence type installation.

These substations have been installed on the network since the late 1950s.

Figure 3 Fence type substation (1967)

4.1.4 Vault type substations

Vault type substations are building type substations that are installed below ground level. There is only one vault type substation on the network and it is incorporated into a large privately owned building.

The substation contains a high voltage switchboard, transformer, a low voltage switchboard and anciliary systems. A fire detection system is installed in the substation. It was installed in 1979.

The various ground mounted substations mentioned above have an external enclosure to provide a secure location for the equipment and to prevent unauthorised access and ensure public safety is maintained.

Within the Hobart CBD, some substations have additional ancillary systems installed. These may include protection systems, batteries, ventilations systems and fire management systems. Communications cables may also be installed to provide a link to adjacent substations.

All ground mounted substations have an underground earthing system. These systems are essential for maintaining personnel and public safety and for correct operation of protection equipment under fault conditions. The fault level, protection clearing time and local soil resistivity dictate the design and performance of the earthing system. The earthing system is typically a copper earth grid, possibly with associated earth pins. All metallic components of the installation, including the enclosure, are connected to the earthing system. This grid is usually interconnected with the surrounding Multiple Earthed Network (**MEN**).

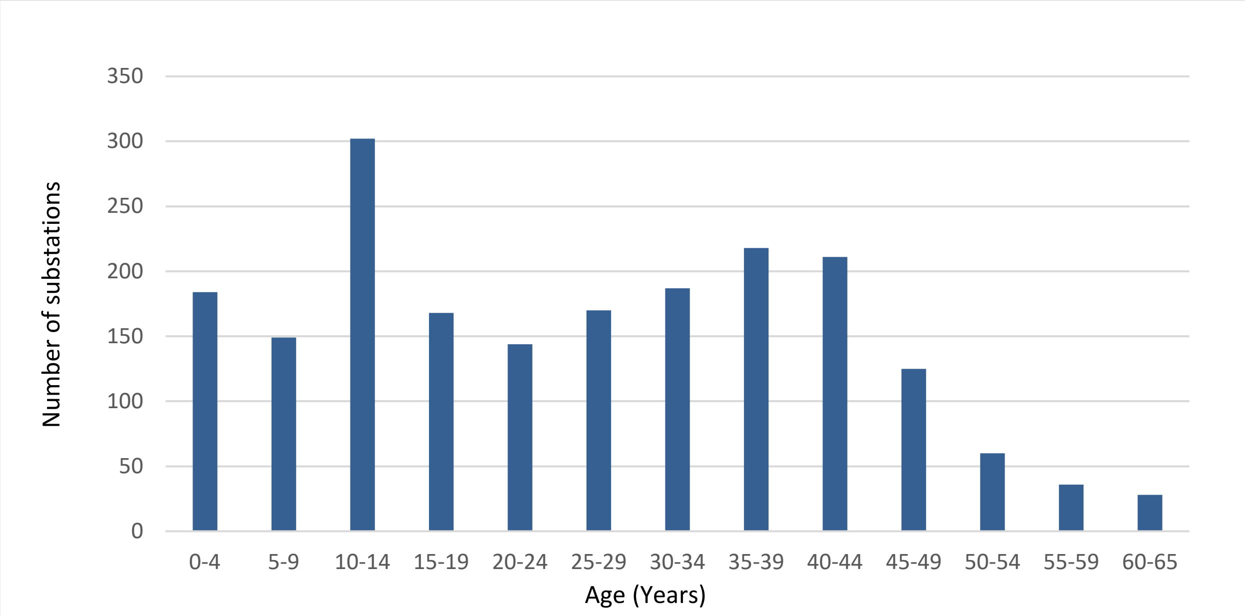
The number of each substation type installed on the network is provided in Table 1.

Table 1 Ground mounted substations (as at September 2022)

Description	Number Installed
Building	348
Fence	73
Fence with brick switchboard enclosure	12
Kiosk	1647
Block wall	388
Fibreglass	200
Pre-cast concrete	7
Steel	1036
Mini-kiosk	16
Vault	1
Total	2081

The age profile for the substations is provided in Figure 4 (following). Although the age profile is quite evenly spread, in the next 10 years, approximately 25 per cent of the substations, or the equipment within them, will reach or pass the end of their expected service life.

Figure 4 Age profile of ground mounted substations (as at September 2022)



* There are an additional substation 104 substations whose original date of installation is unknown.

4.2 High voltage switchgear

The switchgear installed in ground mounted substations primarily provides for the disconnection, connection and isolation of high voltage installations on the network.

There is a variety of high voltage switchgear types installed in the substations, with the installations dating back to the late 1950s. The switchgear on the network comprises both standalone switchgear e.g. Reyrolle JKSS and Statter and switchgear installed in a larger switchboard e.g. Alstom Fluokit and Schneider SM6. It operates at 11 kV or 22 kV, uses air, gas or oil as the insulating medium and may be installed indoors or outdoors. The switchgear types installed in the substations and their volumes are listed in Table 2.

Older high voltage switchgear usually uses oil as the insulating medium, and although very effective in arc suppression, the medium does result in an increased safety risk under fault. The significant quantity of oil in the switchgear amplifies the intensity of a fire if an explosive failure occurs. Due to the operator safety risk associated with this type of switchgear, oil is no longer used as an insulating medium. Modern switchgear uses either air or gas as an insulating medium.

Under fault conditions older switchgear is limited in its ability to contain internal arc faults. This deficiency can result in an increased risk to operational staff and the public. The modern switchgear installed on the network has an improved capability for containing internal arc-faults, which greatly reduces the safety risk if a fault occurs.

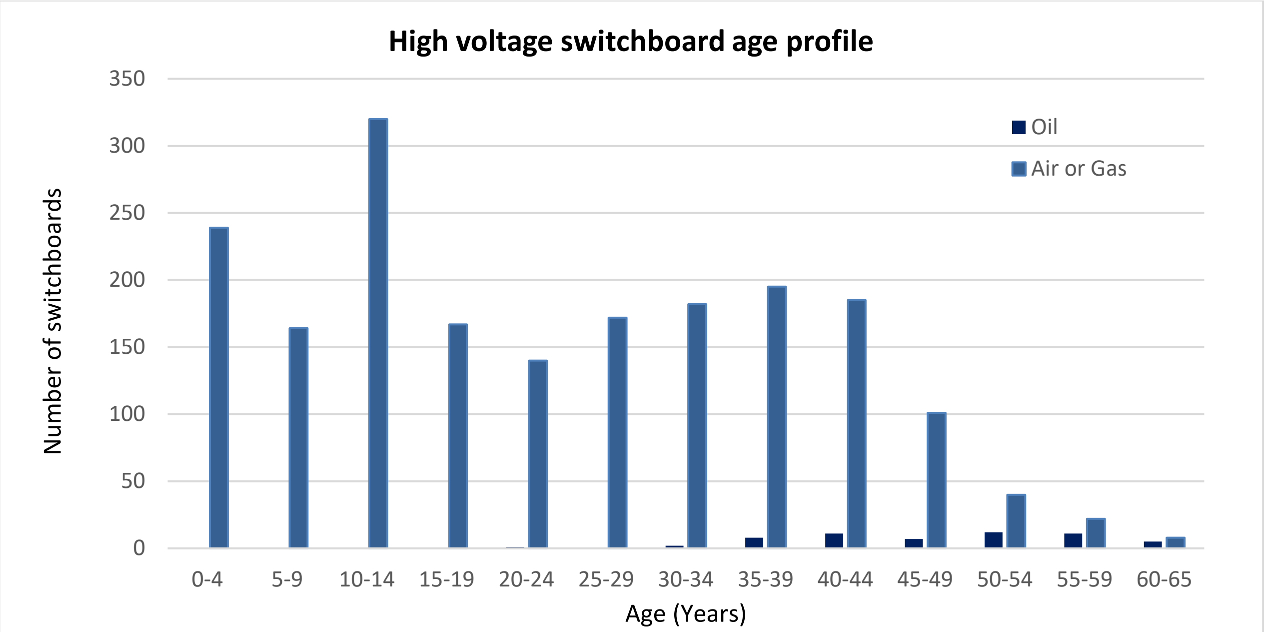
Table 2 High voltage switchgear installed in ground mounted substations (as at September 2022)

Manufacturer	Type	Voltage (kV)	Insulating medium	Volume	Years installed	Arc fault containment capability
ABB	CTC12	11	Gas	2	1999	No
ABB	CTC24	22	Gas	76	1975-1999	No
ABB	RGB12	11	Air	491	1972-2003	No
ABB	RGB24	22	Air	13	1977-2000	No
Brush	HF 11	11	Oil	1	1960-1979	No
English Electric	OLX/OLX2	11	Oil	3	1960-1984	No

Manufacturer	Type	Voltage (kV)	Insulating medium	Volume	Years installed	Arc fault containment capability
Fluokit	M24	11 & 22	Air	136	1973-2001	No
Hazemeyer	MD4	11	Air	64	1969-2003	No
Merlin Gerin	M6	11 & 22	Gas	82	1982-2006	No
Merlin Gerin / Schneider	RM6	11 & 22	Gas	903	1999-2022	Partial (Front and lateral)
Merlin Gerin / Schneider	SM6	11 & 22	Gas	93	1999-2022	Partial (Front and lateral)
Mini-kiosk	Fuse	11 & 22	-	16	2005-2020	No
Reyrolle	JK	11	Oil	2	1961-2004	No
Reyrolle	JKSS	11	Oil	26	1959-1999	No
Reyrolle	LMT	11	Oil	11	1962-1993	No
Reyrolle	LMVP	11	Air	87	2010-2015	Partial (Front and lateral)
Siemens	8CK	22	Air	2	1983	No
Statter	ODSA	11	Oil	18	1964-2003	No
Yorkshire	YSF6	11	Gas	2	1986	No

With a shift in the 1970s to undergrounding of urban distribution networks, there was a notable increase in the number of ground mounted substations being installed in the 1970s and 1980s. The impact of this change can be seen with the switchgear age profile shown in Figure 5.

Figure 5: High voltage switchgear age profile (as at September 2022)



4.3 Transformers

Ground mounted substations contain one or more transformers. They are used to transform the high voltage of distribution feeders down to a lower secondary voltage (400/230 V) suitable for customer supply.

The transformers range in size from 100 – 2000 kVA, are supplied at either 11 kV or 22 kV and can be installed either outside in an enclosed yard, or within an enclosure or building.

The transformers tank containing the transformer core and winding is usually filled with oil. The oil acts as an insulating medium and also assists with cooling the transformer winding. While alternative construction type are available e.g. air insulated transformers, oil filled transformers are usually preferred due because of their superior performance characteristics and simplicity.

The standard transformer sizes used on the network are:

- 500 kVA
- 750 kVA
- 1000 kVA
- 1500 kVA
- 2000 kVA.

There are a small number of older transformers in the system of non-standard sizes. Where transformer replacement is required, they will be replaced with a standard size transformer.

The number of transformers and size of them is dependent on the connected load or customer requirements at the network location.

Table 3 and Table 4 provide details of the transformers installed on the distribution network by type, size and quantity installed.

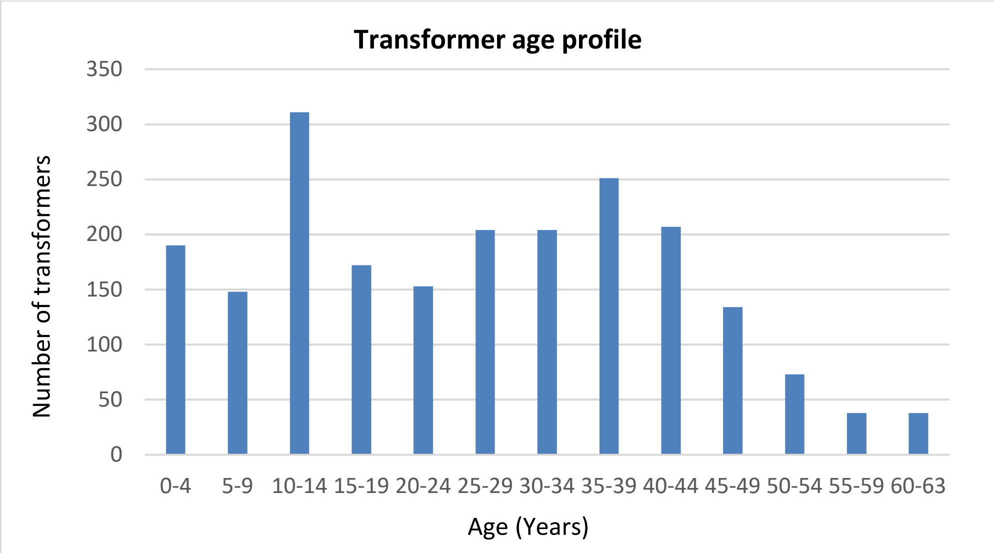
Table 3 Ground mounted oil insulated distribution transformers (as at September 2022)

Size (kVA)	Voltage (kV)	Number installed
Less than 500	11	140
	22	34
	44	2
500	11	561
	22	284
750	11	705
	22	385
1000	11	66
	22	60
1500	11	55
	22	75
Greater than 1500	11	9
	22	14
	Total:	2200

Table 4 Ground mounted air insulated transformers (as at September 2022)

Size (kVA)	Voltage (kV)	Number installed
800	11	4
1100	11	2
1750	11	3

Figure 5 Transformer age profile (as at Sep. 2022)



* There are an additional 61 transformers with unknown ages.

4.4 Low voltage switchboards and associated switchgear

All ground mounted substations, with the exception of high voltage switching stations, have a low voltage switchboard. These switchboards allow for the disconnection, connection and isolation of the low voltage distribution network and customer loads connected to it. The switching is done by the switchgear installed within the switchboard. The switchgear includes circuit breakers, busbars, links, fuses and isolators. These switchboards operate at 400 volts.

There are a variety of types of switchboard types and configurations. Switchboards installed on the network prior to the 1980s were often of an open front design (Live front) where the live equipment is not fully encapsulated. Due to the risk associated with this type of arrangement this design is no longer used. The switchboards in newer substations have all the live equipment enclosed within the switchboard (Dead front), with no exposed live equipment being present. Table 5 provides a summary of the different low voltage switchboard types installed in the substations.

Table 5 Low voltage switchboard types installed in distribution substations (as at September 2022)

Building type substation	**Number installed**
Shielded	104
Partially shielded	31
Live Front – Covered[1]	174
Unknown	10
Kiosk and Fence type substations	
Shielded	826
Live Front – Covered[2]	685
Unknown	112

Notes: 1 - Exposed live components covered up with by addition of insulated barriers.
2 - Switchboard covered up by kiosk/cabinet doors, but switchboard may have uncovered components.

5 Associated risk

5.1 Risk management framework

TasNetworks has developed a Risk Management Framework for the purposes of assessing and managing its business risks, and for ensuring a consistent and structured approach is applied to the management of risk. An assessment of the risks associated with the distribution ground mounted substations has been undertaken in accordance with the Risk Management Framework.

TasNetworks has introduced a Health Based Risk Management (**HBRM**) framework for the quantification of asset risks. Due to the level of risk identified with these assets, active management plans are necessary to manage the risk.

5.2 Asset risks

The substations and the assets within them present a number of specific issues and risks. These risks are detailed in the following sections.

5.2.1 Safety/security issues

Substations contain energised electrical equipment that can be hazardous to both operational staff and the public. To manage this risk, substations are secured using fences and/or secure doors to prevent unauthorised access. Signage is also installed at each substation to inform people of the risks of entering the substation.

Although rare, unauthorised access to substations does sometimes occur. This creates a risk of unauthorised operation of the equipment, with resultant network or customer impacts and also people being exposed to equipment containing live parts, with the potential for electrocution.

The doors to older fibreglass and block wall substations have been found to be less secure than steel enclosures. To address this risk an improvement program was initiated to reinforce these doors and replace their locking mechanisms.

5.2.2 Emergency and exit lighting

Building substations do not usually contain any natural lighting, which makes evacuation of them more hazardous under blackout conditions. To mitigate against this risk, emergency and exit lighting is installed in all new building substations.

The installation of emergency and exit lighting within substations is a requirement of the *National Construction Code*. The inspection and maintenance requirements for the lighting systems are defined in AS/NZS 2293.2 Emergency evacuation lighting for buildings – Inspection and maintenance.

5.2.3 Arc-flash

Under fault conditions older electrical equipment is often limited in its ability to contain internal arc faults. This deficiency can result in an increased risk to operational staff and the public. Modern switchgear has a greater capability to contain internal arc faults, which reduces the safety risk if an internal fault occurs.

To determine the arc-flash risks present on the network a state-wide study of all the substations was undertaken, with a focus on the switchboards. The outcome of the study was a quantification of the risk for each substation when working in close proximity to the equipment.

The study identified many instances where existing operational and administrative practices were deficient in safely managing the risks, especially while work was being undertaken on the assets. As a result, changes were made to operational practices to reduce the risks down to a manageable level. These changes included additional administrative controls and operational restrictions, such as exclusion zones, increased levels of PPE and, in some instances, operational bans being applied to the equipment.

5.2.4 Low voltage switchboards

The low voltage switchboards risks include possible electrocution and also injury from exposure to arc-flashes during fault conditions.

5.2.4.1 Live electrical equipment

Many older substations on the network contain live exposed electrical equipment because the low voltage switchboards are of a 'live front' construction, i.e. the live components of the switchboards were not originally covered. Whilst these distribution boards met the standard of the day when they were installed, they do not reflect the current level of safety expected in modern installations and do not comply with current standards.

The 'live front', low voltage switchboards are present in approximately 859 of the substations on the distribution network. The construction of these boards means that live equipment is easily accessible and poses an elevated risk to personnel safety.

The 'live front' switchboards in the building type substations are sometimes located in restrictive sites, near doorways and, in some instances, near lights switches, with little access for escape in the event of contact with live parts. To manage this risk, a cost effective solution has been to cover the front of the switchboards. This solution prevents inadvertent contact with live components for the switchboard, but it does not reduce the risk to operational personnel when they need to access the switchboard, during operations such as fuse replacement.

5.2.4.2 Arc-flash

Arc flash risks were determined to be greatest in substations with multiple transformers supplying unshielded low voltage switchboards. While barriers have been installed on these switchboards to prevent electrocution, these barriers do not have the mechanical strength necessary to block an arc-flash event. To reduce the risk to a manageable level, further operational restrictions were applied, with increased levels of PPE also being required.

However, in some instances, even with these controls, it was still not possible for operational activities to be done safely due to the high arc-flash energy level under fault conditions. TasNetworks' highest level of PPE that can be used in these environments only provides adequate protection when the arc-flash energy level under fault conditions does not exceed 40 cal/cm^2. However, there are 273 substations where the energy under fault exceeds 40 cal/cm^2 safety risk for switching activities. As a result these switchboards have been deemed to be a 'High' risk, resulting in an operational ban being applied to these switchboards. To undertake operational activities, such as low voltage fuse replacement, the entire switchboard needs to be de-energised first. This can have a significant network impact, with all customers supplied from the substation losing supply until the work is completed.

5.2.5 High voltage switchgear

Switchgear failures in high voltage switchboards usually result in notable customer supply disruption, with full or partial loss of a high voltage feeders often resulting. Explosive failures can also present an elevated safety risk to operational personnel and the public.

5.2.5.1 Oil-filled switchgear

Oil was a common insulating medium used in high voltage switchgear up until the 1980s. There are 61 substations on the network containing this type of switchgear.

Although the equipment has historically been very reliable, and the oil is very effective for arc suppression, it results in an increased safety risk if an internal fault occurs within the switchgear. The consequences of a significant failure with oil-filled switchgear are much greater than other types of switchgear due to the flammability of the oil. The significant quantity of oil in the switchgear amplifies the intensity of a fire if an explosive failure occurs.

Due to the operator safety risk associated with this type of switchgear, it has not been installed on the network since the early 1990s. The switchgear installed since this time uses either air or gas as the insulating medium.

There have been several instances on the network where failures have occurred with this type of equipment.[1] There have also been three deaths in Australia in the last ten years as a result of failures of this type of switchgear.

TasNetworks has made the replacement of this equipment an area of focus.

5.2.5.2 Siemens switchgear

Siemens 8CK switchgear was installed on the distribution network from the early 1970s. Due to a higher than expected rate of failure and deteriorating condition of the switchgear, an operating ban was placed on this equipment in 2008. There are currently only two substations remaining on the network containing this equipment, with a replacement plan in place for both of them.

5.2.5.3 Brown Boveri RGB switchgear

Brown Boveri RGB12 and RGB24 switchgear was installed on the network from the late 1970s to the early 1980s. There had historically been an increased rate of failure of the RGB24 switchgear due to the design of the epoxy spouts at the rear of the switchgear, which allowed for the collection of dirt and moisture over time. This has caused flash-overs and complete failures, resulting in an outage of the entire site. Usually, complete switchgear replacement has been required when this occurs.

Through routine maintenance of the RGB12 switchgear, cracking of the epoxy interrupter housings has been detected in both the line and fuse-switches. This defect has required the units to be replaced because if the cracks became more extensive they would result in increased partial discharge in the switchgear, leading to a flash-over and complete failure. The defects are being monitored through routine maintenance and replaced where the cracking presents a notable risk of a failure occurring.

5.2.5.4 Hazemeyer MD4 switchgear

The majority of Hazemeyer MD4 switchgear was installed on the network from the 1970s to the late 1980s. This type of switchgear is contained within both building and kiosk type substations, with the switchgear installed in 64 substations.

Due to safety concerns with operating this switchgear stemming from its inability to contain an arc-fault when a fault occurs, an operating ban has been placed on it. This restriction can result in extended network switching and fault restoration times in network locations where this switchgear is installed.

5.2.6 Transformers

The failure of a substation transformer usually results in notable customer supply disruption, with all customers supplied by the substation losing supply until an alternative means of supply is provided.

Although rare, there is the potential for a catastrophic failure occurring which can result in a fire and complete loss of the substation. Section 5.2.8 provide further detail on this risk and how it is managed.

The failure of a transformer can also result in oil spillage, which presents both environmental and safety risks where the oil containment system within the substation is deficient. Section 5.2.9 provides further detail on this risk and how it is managed.

5.2.7 Earthing systems

Earthing systems in ground mounted substations are designed to ensure that all step and touch potentials that are generated under fault conditions pose a negligible level of risk to TasNetworks' staff and the

[1] Failure of cast iron cable termination enclosures on JK switchgear in substations at Caltex depot, Selfs Point Rd and T252989 Lindisfarne Primary School.

public. Distribution substation earthing systems usually include a large interconnected multiple earthed network which significantly lowers the overall Earth Potential Rise (**EPR**) and shock hazard during high voltage fault conditions.

For safety compliance, TasNetworks uses the probabilistic approach outlined in *ENA DOC 025 EG-0 Power system earthing guide - Part 1: management principles* to assess the risks at each site. Generally, the standard earthing designs that have been historically used for TasNetworks' ground mounted substations pose negligible risk when they are highly interconnected to the network. However, in network areas with little interconnection and higher frequency contact scenarios, safety risks may be present under fault conditions that present a risk to people in close proximity to the substation.

TasNetworks undertakes routine auditing of distribution substation earthing systems to ensure the risks are maintained at a manageable level.

Table 6 Summary of asset risks

Risk Identification		Risk Analysis (Inherent)				
Asset	**Risk Description**	**Category**	**Likelihood**	**Consequence**	**Risk Rank**	**Treatment Plan Yes / No**
Substations buildings and enclosures.	Unauthorised entry resulting in injury or unauthorised operation of equipment. Fire resulting in loss of substation, with possibility of third party property damage. Water ingress from rainfall or flooding resulting in damage to equipment within substation. Partial collapse of structure resulting in third party injury or property damage.	Safety and People	Possible	Major	High	Yes
		Financial	Rare	Minor	Low	
		Customer	Unlikely	Minor	Low	
		Regulatory Compliance	Unlikely	Minor	Low	
		Network Performance	Possible	Minor	Low	
		Reputation	Unlikely	Minor	Low	
		Environment and Community	Rare	Minor	Low	
Substation equipment Switchgear Transformers	Flashover within switchboard or failure of circuit breaker resulting in: • loss of supply to one or more HV feeders supplied from the substation. • loss of supply to one or more LV supplies from the substation. • injury to operational personnel. Failure of a transformer resulting in: • loss of customer supply. • an oil leak and environmental incident.	Safety and People	Unlikely	Major	Medium	Yes
		Financial	Unlikely	Negligible	Low	
		Customer	Unlikely	Negligible	Low	
		Regulatory Compliance	Rare	Negligible	Low	
		Network Performance	Possible	Minor	Low	
		Reputation	Possible	Negligible	Low	
		Environment and Community	Rare	Negligible	Low	

5.2.8 Fire

Fires within substations and their consequences present a significant risk. Fires can result in loss of customer supply, significant financial cost and have the potential to result in harm or death to operational staff and members of the public. Where substations are located within buildings or close to neighbouring buildings, there is also the potential for damage to occur to these buildings.

The consequences of fire are a consideration in the location and design of new substations and can also influence the removal or relocation of existing substations.

These risks are managed by ensuring substations are built in compliance with relevant standards, the use of fire containment systems and active suppression systems. The on-going risk is managed through routine inspection and maintenance of these systems.

5.2.8.1 Compliance with fire standards

TasNetworks ensures that its design and management practices are compliant with legislative requirements and relevant standards. All new substations are compliant with the requirements of *AS 2067: Substations and high voltage installations exceeding 1 kV a.c*. All new building substations are also compliant with the *National Construction Code of Australia (NCC).*

Risk assessments are undertaken at existing substations and improvements undertaken where necessary.

5.2.8.2 Inspection and maintenance

Fire detection and suppression systems in substations are routinely inspected and tested, in compliance with Australian standard *AS1851: Maintenance of fire protection systems and equipment*. Inspections are also routinely undertaken on all external access ways, ventilation and building penetrations.

5.2.8.3 Containment

Fire containment measures are incorporated into the design of substations to minimise the risk of a substation fire to surrounding property.

For kiosk substations, careful consideration is given to the location of new installations and ensuring that the fire separation zones defined in AS 2067 are adhered to.

For building type substations, the design of the substation is required to provide containment of a fire within the confines of the substation for a minimum period of two hours. This time period is designed to provide sufficient time for a fire authority to respond and contain a fire before it can spread outside of the substation.

Containment is achieved through the use of fire resistant materials in the external walls, floors and ceilings of substations, the installation of fire rated doors and fire barriers across all other external openings.

5.2.8.4 Fire suppression

Integrated building and vault type substations present a greater risk from fire than other substations due to them being incorporated into larger buildings. This arrangement results in an elevated risk of a fire to spreading to an adjacent property and increases the risk of more extensive damage occurring and an increased risk to public safety. These substations can also sometimes be less accessible, which can impact on the fire authority’s ability to extinguish a fire should it occur.

To manage this risk, in addition to the installation of containment measures used for building type substations, fire detection and suppression systems are also installed where the risk is high enough to warrant their installation.

5.2.9 Oil containment

Distribution transformers contain mineral insulating oil for electrically insulating the internal components and cooling. Older switchgear may also use oil as the insulating medium. Mineral oil can be harmful to the environment.

Unlike newer substations, older substations often have limited capability to contain spillages and, consequently, present a higher risk to the environment if a transformer oil leak occurs.

The Australian standard covering high voltage installations, *AS 2067: HV substations exceeding 1 kV ac (Clause 6.7.11*), requires that every high voltage installation containing equipment with more than 1000 litres of a liquid dielectric, must have provision for containing the total volume of any possible leakage. The containment system is required to meet the overall objectives of *AS 1940: Storage and handling of flammable and combustible liquids*.

Approximately forty per cent of the substations on the network contain an oil containment system that is compliant with this Australian standard.

TasNetworks has experienced several oil spill incidents in recent years where the oil has not been contained on site due to an oil containment system not being present.

5.2.10 Environmental impact

In harsher environments, such as those located in close proximity to the coast and industrial areas (e.g. mine sites), higher levels of corrosion of assets can occur. Corrosion resistant kiosk enclosures are available when substations need to be installed in these environments.

In certain locations increased levels of condensation within kiosk substation enclosures can result in a faster rate of deterioration of the equipment inside the substation, with flashovers even occurring on high voltage equipment if the air quality is not controlled.

5.2.11 Asbestos

Asbestos is a material that has historically been used in the electrical industry. Asbestos has been identified as a hazardous material that can cause harm to health. Substations installed prior to 1980 may contain asbestos.

TasNetworks has management practices in place for the management of asbestos and for working in proximity to equipment containing asbestos. TasNetworks is required to comply with *the Work Health and Safety Act and Regulations 2012* and *Work-Safe Tasmania – How to Manage and Control Asbestos in the Workplace Code of Practice 2012*.

The equipment that may contain Asbestos Containing Material (**ACM**) within substations includes switchboards, metering panels, roof linings, conduits and doors. To manage the risk, TasNetworks conducted an asbestos audit of substations in 2009 and created a register of these sites, as well as set up on-site registers.

5.2.11.1 Asbestos arc chutes in low voltage circuit breakers

Nilsen circuit breakers were installed in building type substations from the 1960s, primarily in the Hobart urban area. The circuit breakers use arc-chutes to controlling arcing when they operate. These arc-chutes contain asbestos, which has the potential to expose personnel to the hazards associated with ACM. Where the condition of these circuit breakers presents an elevated risk they are replaced.

Where asbestos has been identified in substations, in addition to the on-site registers, labelling is installed to provide notification of the presence of the material and warn of the hazard. These asbestos containing materials are also routinely inspected.

5.2.12 Confined spaces

There are three ground mounted substations that are classified as confined spaces due to their below ground location and limited access and egress. To reduce the risks to operational personal, access to these substation can only be done in accordance with TasNetworks' procedure for working in confined spaces.

All of these substations contain fire suppression systems which TasNetworks routinely inspects and maintains, to ensure that they will operate as designed in the event of a fire.

6 Whole of life management plan

6.1 Preventive and corrective maintenance (opex)

6.1.1 Condition monitoring and load checks (AIDSM)

Substation inspection programs exist to monitor the condition of assets and ensure they are in sound condition and secure. Where deficiencies are identified they are rectified at that time or a defect is registered for rectification at a later time. As part of the inspection, partial discharge testing is undertaken on the high voltage equipment.

The timing of these inspections has been chosen to coincide with Tasmania's peak load (i.e. winter), because this is the time substations have the highest loading. Inspection frequencies by substation type are listed in Table 7.

Table 7 Inspection frequency for ground mounted substations

Classification	Frequency
Substations less than 20 years of age	Once every two years (Winter)
Substations equal to or greater than 20 years of age	Once per year (Winter)

6.1.2 Fire system inspections (AIDSM)

Routine inspections and maintenance activities are undertaken on fire protection systems and associated equipment. This work is done in accordance with Australian standard *AS1851: Maintenance of fire protection systems and equipment*.

The work is undertaken by an external service provider accredited to work on fire protections systems. The work is done in accordance with the requirements of AS1851.

Fire system inspections comprise the following programs:

- Fire suppression systems;
- Fire and exit doors; and
- Emergency and exit lighting.

Each of these programs are described in the following sections.

6.1.2.1 Fire suppression inspections

Where fire suppression systems are installed, the fire panels and smoke alarms are inspected monthly.

6.1.2.2 Fire and exit doors inspections

The fire and exit doors at substations that contain fire suppression systems are inspected on a six monthly basis, with the timing of the work aligned with fire suppression system maintenance. The fire and exit doors at all other substations are inspected as part of the routine substation inspections.

6.1.2.3 Emergency and exit lighting inspections

Substation buildings may be classified as a Class 8 building as part of the *National Construction Code (NCC).* Where they are, the installation of emergency lighting, exit lights and warning systems is governed by the requirements of the *NCC Volume 1* (Part E4 Emergency lighting, Exit signs and warning systems).

The maintenance requirements for emergency lighting in ground mounted substation buildings are specified in *AS/NZS 2293.2: Emergency evacuation lighting for buildings – Inspection and maintenance*.

The testing of the emergency and exit lighting at substations that contain a fire suppression system is done in accordance with *AS 2293.2* on a six monthly basis. The timing of the work is aligned with fire suppression system maintenance.

The emergency exit lighting at all other substations is completed as part of the routine substation inspections.

Table 8 Inspection frequency for fire systems

Classification	Frequency
Fire suppression system inspection and testing.	Monthly
Fire and exit door inspections.	Six monthly
Emergency and exit lighting Inspections.	Six monthly

6.1.3 Earthing audits (Injection testing) (AIDSM)

Routine testing is undertaken on substation earthing systems. This work aims to manage and reduce the risk of electrical shocks to people under fault conditions. The assessment of risk is in accordance with AS 2067 and *ENA DOC 025 EG-0 Power system earthing guide - Part 1: Management principles.*

The testing focusses on substations that may present a higher risk. The following criteria are used in the prioritisation:

- Substations with little earthing system interconnection via cable screens or MEN networks.
- Areas with high fault levels or high soil resistivity.
- Sites with above average contact scenarios (schools, swimming pools, shopping centres, etc.).

Testing is undertaken on five substation per fiscal year.

6.1.4 Special audits (AIDSM)

Where special audits are required on ground mounted substations due to emerging risks or issues they are undertaken under this program. Special audits are also undertaken where deficiencies in asset information is identified and additional information is required.

6.1.5 Transformer oil testing (RMDSR)

Testing of transformer oil is used to assist in determining the condition of transformers. Where the PCB status of the oil in a transformer is unknown a sample of oil is taken from the transformer for testing. The testing is predominantly undertaken on older transformers where an in service failure would have a notable impact on customer supply, for example, in network areas classified as ‘Critical infrastructure’ or ‘High density commercial’.

6.1.6 Switchgear maintenance (RMDSR)

Routine maintenance is undertaken on all the high voltage switchgear in the substations. This maintenance ensures the reliable operation of it until the next maintenance cycle. The maintenance also includes the removal of vegetation build-up within the substation enclosures, thermal and partial discharge inspections and other general maintenance activities. Protection systems are also checked at this time.

This maintenance program is also used to identify assets where their condition has deteriorated to a level where renewal has become necessary and to monitor risks associated with specific programs identified within the asset category.

The switchgear maintenance frequency ranges from three to eight years and is dependent on the switchgear type. The maintenance frequencies are listed in Table 9 (below).

Table 9 Switchgear maintenance frequencies

Switchgear type	Frequency
Siemens 8CK	Once every 3 years
Asea Brown Boveri RGB12/24, CTC12/24 English Electric OLX Brush COQ Fluokit M24 GEC DDFC GEC Oil RMU Hazemeyer MD4 Reyrolle JK/JKSS Reyrolle LMT Statter Yorkshire YSF6	Once every 4 years
Reyrolle LMVP Merlin Gerin Vercors M6	Once every 6 years
Schneider RM6 and SM6	Once every 8 years

6.1.7 Civil maintenance (RMDSR)

Civil maintenance is routinely undertaken on the fence type substations. The work primarily involves the removal of vegetation and is undertaken every four months.

6.1.8 Minor and major asset repairs (ARDSR)

Defects identified during asset inspections, routine maintenance, ad-hoc site visits or customer reporting, are prioritised and rectified through the general asset defects management process and maintenance programs. The remedial work required is undertaken under this program.

6.1.9 Summary of opex expenditure

Table 10 Summary of opex programs and expenditure

Project/Program	Func. Area	Expenditure ($)									
		FY20 ($)	FY21 ($)	FY22 ($)	FY23 ($)	FY24 ($)	FY25 ($)	FY26 ($)	FY27 ($)	FY28 ($)	FY29 ($)
Ground mounted substation inspections:	AIDSM										
• Condition monitoring		207 842	207 842	207 842	207 842	207 842	260 000	260 000	260 000	260 000	260 000
• PD testing		93 970	98 846	103 611	108 376	113 141	118 017	122782	127547	84 440	89 205
• Transformer oil testing		19 972	19 972	19 972	19 972	19 972	49 500	49 500	49 500	49 500	49 500
• Fire system inspections		56 850	56 850	56 850	56 850	56 850	75 190	78 858	82 526	86 193	89 861
• Earth-grid audits and testing		52 000	52 000	52 000	52 000	52 000	100 000	100 000	100 000	100 000	100 000
• Special Audits		12 226	12 226	12 226	12 226	12 226	25 000	25 000	25 000	25 000	25 000
Ground mounted substation routine maintenance:	RMDSR										
• Switchgear maintenance		569 636	569 636	569 636	569 636	569 636	645 580	645 580	645 580	645 580	645 580
• Transformer oil testing							40 000	40 000	40 000	40 000	40 000
• Civil maintenance		43 086	43 086	43 086	43 086	43 086	49 500	49 500	49 500	49 500	49 500
Asset repairs:	ARDSR										
• Minor		200 655	200 655	200 655	200 655	200 655	200 655	200 655	200 655	200 655	200 655
• Major		100 629	100 629	100 629	100 629	100 629	100 629	100 629	100 629	100 629	100 629
• Graffiti removal		14 684	14 684	14 684	14 684	14 684	14 684	14 684	14 684	14 684	14 684
• Disposal of SF6		36 710	36 710	36 710	36 710	36 710	36 710	36 710	36 710	36 710	36 710

6.2 Reliability and quality maintained (capex)

Where routine maintenance is no longer able to ensure the performance or safety of the assets, they are prioritised for replacement prior to an in-service failure occurring. Asset replacement prior to failure is usually preferred, due to the criticality of the assets and consequences of an in-service failures e.g. network impact and risk to public safety.

The drivers for asset replacement are usually either from a deterioration in their condition, or other specific issues that presents a risk that cannot be addressed through other means. These risks are defined in Section 5. The deficiencies are usually detected though routine inspections and maintenance practices. Asset failures can also result in a need for early asset replacement.

Although, due to a business decision to significantly reduce the expenditure for the substation asset replacement programs from the fiscal year ending 2021, the quantity of planned asset replacement work has reduced. As result, the historical strategies that were to replace equipment prior to failure or when elevated risks were present, were only able to remain as preference, not something that was always achievable. Where elevated risks would normally have resulted in their replacement, due to the funding constraints, some assets were required to continue to remain in service with operational restrictions or bans being applied to them until they could be replaced at a later time.

A business decision has also been made to further reduce the expenditure for the substation asset replacement programs for the 2024-2029 regulatory control period. As a result the replacement volumes for these programs will be required to further reduce, with a resultant increase in asset failures and operational restrictions/bans being foreseen. Following asset failures, the funding for the replacement of the failed asset would come from the deferring of other planned work, or the equipment would need to remain out of service for an extended period.

The current and future constraints are primarily affecting the asset replacement programs for the following assets:

- Kiosk substations;
- High voltage switchboards;
- Low voltage switchboards;
- Transformers; and
- Substation earthing systems.

6.2.1 Upgrade ground mounted earthing systems (REGEA)

Where testing of earthing systems has identified hazards that may present a safety risk, they are rectified under this program. The remedial work usually incorporates modifications or additions to the current earthing system to reduce the risk to a manageable level and achieve compliance with current standards.

6.2.2 Replacement of ground mounted substations (REGMS)

A replacement program exists for the ground mounted kiosk substations. Replacements are prioritised based on risk, with the assessment done in accordance with TasNetworks Risk Framework.

Due to the increased rate of failure of the equipment within the substations exceeded 50 years of age, typically the switchgear, the strategy consisted of a targeted replacement of kiosk substations at approximately 50 years. Although the actual replacement of equipment was based on condition and risk, which resulted in some substations being able to remain in service for more than 50 years, and some needing to be replaced sooner.

However, due to the business decision to significantly reduce the forward expenditure for this asset replacement program, this strategy is no longer achievable. The strategy has been revised to just replacement of the highest risk assets, with the number of replacements determined from the funding available. This reduction in expenditure and replacement volumes has resulted in a number of instances where when equipment has been determined to be too unsafe to operate it, yet it has had to remain in service with an operation ban, rather than being replaced. As a September 2022 there were approximately

70 kiosk substations that were in-service with an operational ban applied to them, and an additional number with operation restrictions.

Where equipment is replaced the driver usually results from increased probability of an asset failure occurring, particularly the high voltage switchgear and the consequences if the failure occurred e.g. safety risk to operational personnel and the public, network disruption and environmental impact.

Each substation identified for potential replacement is prioritised based on an assessment against the following criteria:

- Risk to public safety i.e. level of exposure e.g. enclosure type, location;
- Criticality of the installation and consequences if a failure occurred;
- Condition and resultant likelihood of failure occurring; and
- Non-compliance with current standards and resultant risk.

The assessment of condition for the substation condition considers the substation enclosure, high voltage switchgear, transformer, low voltage switchboard. Due to the risks associated with a switchgear failure, in the majority of cases the replacement of the switchgear is the driver for the replacement of the substation.

The following substation types are an area of focus.

6.2.2.1 Fence type substations

The fence type substations are an older design of substation that comprised separate high voltage switchgear, transformer and low voltage switchboard, all of which was enclosed in a fence enclosure. Due to the substations having had lengthy service, containing higher risk equipment and providing little protection to the public when failures occur, these substations are usually given a higher priority for replacement.

The most cost effective solution, is complete replacement of the substations with a kiosk substation.

6.2.2.2 Kiosks containing Hazemeyer MD4 switchgear

There are operational restrictions in place for Hazemeyer MD4 switchgear due to the exposed design creating an elevated risk to operators undertaking operational work on this type of switchgear. Where the operational restriction notably impacts upon network operations or other issues are identified, asset replacement is undertaken. In these instances the only viable option is the replacement of the kiosk substation.

6.2.2.3 Substations containing Reyrolle JK/JKSS and Statter switchgear

Due to the risks associated with oil-filled switchgear, fence type substations containing Reyrolle JK or JKSS, or Statter ODSA switchgear are often prioritised for replacement.

6.2.2.4 Kiosks containing ABB RGB24 switchgear

Due to the increased probability of failure with this type of switchgear[2], kiosks containing it are given a higher priority for replacement. Depending on the condition of the substation and other equipment installed within the substation, the replacement may consist of just replacement of the switchgear, or complete substation replacement. If it is only the switchgear being replaced, the work would be done under the REHSW program.

6.2.3 Refurbishment of substation buildings (REGMS)

As part of routine substation inspections, the condition of substation buildings (e.g. walls, roofs, drainage) is assessed. Where the condition is such that there is the potential for something to occur that may impact on the security of the installation or the equipment is no longer adequately protected from the

[2] For description of asset risks, Section 5.2.4.

environment, planned refurbishment work is undertaken on the building prior to there being a need to undertake reactive asset repairs. The planned work is undertaken under this program.

6.2.4 Replace ground mounted transformer (REGTF)

This replacement program covers the replacement of the transformers in the substations. Replacements are prioritised based on risk, with the assessment done in accordance with TasNetworks' Risk Framework.

Replacement is initiated where the condition is such that there is a high likelihood of a failure occurring that would result in unacceptable consequences. Transformers in poor condition that are likely to be considered for replacement are those supplying critical or commercial loads, or where a failure could present a safety or environmental risk.

The transformer condition is determined through asset inspections and oil analysis.

Transformers with exposed live bushings or polychlorinated biphenyls (**PCB**) contamination are given a higher priority for replacement.

While the historical strategy was to replace the transformers prior to failure occurring, due to the business decision to significantly reduce the future expenditure for this program, transformers that would have normally been replaced due to their condition and risk are having to remain in service for extended periods. This results in an increased risk of an in-service failure occurring. When transformers do fail they will be replaced under fault conditions.

6.2.5 Replace high voltage switchgear (REHSW)

This replacement program covers the replacement of high voltage switchgear in building substations and block wall kiosks. Where higher risk switchgear exists in a kiosk substation, the condition of the other equipment often results in complete replacement of the kiosk. Where this occurs the work is undertaken under the REGMS program.

Replacements are prioritised based on risk, with the assessment done in accordance with TasNetworks' Risk Framework.

Due to the increased rate of failure when the equipment nears 50 years of age, the historical strategy was the targeted replacement of switchgear at approximately 50 years. Although the actual replacement was based on condition and risk, which resulted in some switchgear being able to remain in service for more than 50 years, some needed to be replaced sooner.

The replacement program has historically focused on the oil-filled switchgear due to its lengthy service life, exposure to the public in some situations and higher risks should a failure occur. The removal of oil filled switchgear from the network results in a reduction in operational costs, as modern switchgear requires less frequent and less intrusive maintenance.

The replacement of switchgear is prioritised based on:

- Risk to safety i.e. level of exposure under fault;
- Criticality of the installation and consequences of failure; and
- Condition and resultant likelihood of failure occurring.

The historical objective of this program was to replace the switchgear prior to failure, because its failure presented an elevated safe risk or because it was no longer deemed safe to operate. However, due to a significant reduction in the expenditure for this program from the fiscal year ending 2021, it is no longer possible to achieve this objective. Switchgear that would have normally been replaced is now required to remain in service, with operational controls put in place, where possible, to reduce the risk if failure occurs.

6.2.6 Replacement of low voltage switchboards (RELSW)

This replacement program covers the replacement of low voltage switchboards in building substations and block wall kiosks. Where higher risk switchgear exists in a kiosk substation, the condition of the other equipment often results in complete replacement of the kiosk. Where this occurs the work is undertaken under the REGMS program.

The replacements are prioritised based on risk, with the assessment done in accordance with TasNetworks' Risk Framework.

The arc-flash risk to operational personnel under fault conditions is usually the dominant risk. While operational restrictions can reduce the safety risk, they can impact upon network performance and increase the duration of customer supply disruptions following faults. As a result, the factors that have the greatest influence in prioritising switchboards for replacement and those with high arc-fault energy levels, operational restrictions or are in poor condition.

As a result of the risks identified through the state-wide 'arc flash study', an initiative was begun in 2020 which focused on reducing the safety risk to operational personnel when working on these assets. This initiative resulted in an increase in the rate at which the older higher risk low voltage switchboards were to be replaced. However, due to a business decision to reduce the funding for this program, this did not occur. As a result, where there safety risks were deemed to be too high to safely operate the switchboard, rather than replace the switchboard, in the majority of instances the switchboards are remaining in service, with operational restrictions and bans applied to them to reduce the risk until their replacement occurs.

6.2.7 Safety and environment in ground mounted substations (SIGMS)

Programs undertaken under the SIGMS category are those that are driven by safety, environment or compliance factors.

There are five sub-programs under this program, with these being:

- Replacement/refurbishment of building substation fire doors;
- Improvements to deficient oil containment systems;
- Upgrading of substation locks and locking mechanisms;
- The management of asbestos; and
- Installations of fire management systems.

Each of these components is described in the following sections.

6.2.7.1 Replacement/refurbishment of building substation doors

Where the doors on substations are deemed to be in poor condition, they are replaced prior to their being a risk to the security of the substation and an increased risk of unauthorised entry occurring.

To minimise the risk associated with fire in building substations, the substations are designed to contain an internal fire for a minimum of two hours. To achieve this all external substation doors are required to be fire rated. Where doors are identified at building types substations that are not fire rated they are replaced under this program. Fire rated doors in poor condition are also repaired or replaced.

An audit was undertaken on all the building substations to determine the condition of external substation doors and identify any areas where work was necessary to achieve compliance. Of the 368 building substations on the network, the doors for approximately one third required either remedial work to be undertaken or complete door replacement to achieve compliance with the standard.

6.2.7.2 Management of deficient oil containment systems

Historically, most building type substation where not built with an oil containment system installed. The risks from an oil spill from a transformer were managed through routine inspections, but with the equipment ageing and planned transformer replacements being deferred, the risk of an oil spill occurring increases the risk of an environmental incident occurring.

Where an oil leak in a substation has the potential to impact the environment, the risk is assessed against TasNetworks' Risk Framework. Where the level of risk is above a manageable level, options are considered to reduce the risk.

Where possible, the existing cable trenches within a substation are used for the containment system. Although some improvements are often required, the use of cable trenches is an economical means of providing an oil containment system.

Dry-type transformers are also considered where an oil containment system cannot be easily or economically constructed. Although due to their performance limitations and cooling needs, the use of oil filled transformers is usually the preferred solution when an oil containment system is available.

6.2.7.3 Replacement of locks and locking mechanisms on substations

Where locks and locking mechanisms on substation doors are defective they are replaced to maintain the security of the site and minimise the risk of exposing the public to energised electrical equipment.

The program is predominantly focused on the locking mechanism used on block wall and fibreglass kiosks because the design of their doors has deficiencies that can mean they are not as securely retained, with some instances of doors coming open. The replacement locking mechanism uses a dead latch arrangement that is more secure.

6.2.7.4 Management of asbestos

Historically, asbestos containing materials (**ACM**) were used in some of the equipment installed in substations (e.g. light and power boards and meter boards). The safety risks associated with exposure to ACMs are managed through a routine inspection program and work practices.

Where the material has deteriorated to a state where there is an elevated safety risk (e.g. the material approaches a 'friable' condition) it is replaced.

6.2.7.5 Fire detection and suppression systems

Where the failure of equipment within a substation presents an elevated fire risk (e.g. injury to the public or third party property damage) consideration is given to the installation of a fire detection and suppression system. The greatest risk is usually with building type substations that are integrated into larger buildings with restricted access. Fire detection and suppression are installed in new building type substations.

Where a fire suppression system is required, the Stat-X suppression system is used.

6.2.8 Asset replacement following failure

In addition to the planned replacement programs, TasNetworks experiences a number of asset failures. These failures can be as a result of external influences, such as lightning strikes, vehicles hitting substations, vermin or the asset being in a deficient condition that results in an inability to function or failure.

Due to the reduced rate of asset replacement in future years, an increased number of asset failures is expected. Where an asset failure occurs and asset replacement is required, planned replacement work will be deferred to fund the replacement of the failed asset.

6.3 Spares management

Strategic spares for distribution substations are managed in accordance with the Spares Management Policy.[3]

6.4 End of life management

Materials that pose a risk to human health as well as being a possible environmental hazard (e.g. asbestos and transformer oils) are disposed of in accordance with the *Environmental Management Pollution Control Act 1994*, TasNetworks' internal safety and environmental management plan and ANZECC.

6.4.1 Recovery and disposal of redundant SF6 switchgear

The disposal of redundant equipment containing SF_6 is undertaken in accordance with TasNetworks' Environmental Management Procedure and compliant with legislative requirements.

[3] Distribution Substations – Spares Management Policy – R1792713

Equipment containing SF_6 that is removed from service is stored at the nearest depot until the storage container is full. It is then transported by an accredited transportation corporation interstate for SF_6 recovery and disposal of units at an accredited end of life facility.

TasNetworks is required to report the loss and disposal of SF_6 in accordance with the *National Greenhouse and Energy Reporting Act 2008*. This process is managed by TasNetworks' Environmental Management team.

6.4.2 Polychlorinated biphenyls

Polychlorinated biphenyls (**PCBs**) were used in insulating oils and other products from the 1930s to the 1970s. It has been shown to be toxic material and carcinogenic and its use has been banned in Australia since the 1970s.

TasNetworks manages PCBs in accordance with its Environmental Management Procedure EM-M09 Management of PCBs. This management process meets the requirements of the Australian and New Zealand Environment and Conservation Council (ANZECC) Polychlorinated Biphenyls Management Plan and the *Environmental Management Pollution Control Act 1994*.

Whilst records indicate that no distribution transformers were purchased with PCB insulating material, cross contamination has occurred over time where oil management was undertaken using equipment also used for oil management of PCB-contaminated assets. This has led to a number of transformers with PCB contamination.

As part of routine switchgear maintenance, if asset records indicate that the status of the oil in a transformer is 'unknown' then a sample of oil is taken from the transformer for PCB testing. If the PCB test results indicate PCB levels equal to or greater than 50 ppm, the transformer is prioritised for replacement.

6.4.3 Details of capex programs

Further details of the capex programs are provided in Table 11.

Table 11 Program/project details

Project/Program description	Functional area	Link to HBRM initiative
Kiosks substation replacement	REGMS	PRJ000609
Building substation refurbishments	REGMS	PRJ000607
Remedial work to substation earthing systems	REGEA	PRJ000605
HV switchboard replacement	REHSW	PRJ000614
LV switchboard replacement	RELSW	PRJ000618
Transformer replacement	REGTF	PRJ000610
Fire door replacement program	SIGMS	PRJ000697
Upgrades to oil containment systems	SIGMS	PRJ000698
Substation door lock replacements	SIGMS	PGM000883

7 Related standards and documentation

The following documents have been used to either in the development of this management plan, or provide supporting information to it:

- AS 2067 Substations and high voltage installations exceeding 1 kV AC.
- AS 1851 Maintenance of fire protection systems and equipment.
- AS/NZS 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules).
- AS/NZS 2293.2 Emergency evacuation lighting for buildings – Inspection and maintenance.
- ENA EG-0 Power system earthing guide – Part 1: management principles – Doc 025-2022.

- ENA EG-1 Substation earthing guide – Doc 045-2022.
- National Construction Code of Australia.
- Work Health and Act and Regulations 2012.
- Workplace Standards Tasmania – Confined Spaces Code of Practice 2012.
- Work-Safe Tasmania – How to Manage and Control Asbestos in the Workplace 2012.
- Australian and New Zealand Environment and Conservation Council (ANZECC) Polychlorinated Biphenyls Management Plan (Revised Edition April 2003).