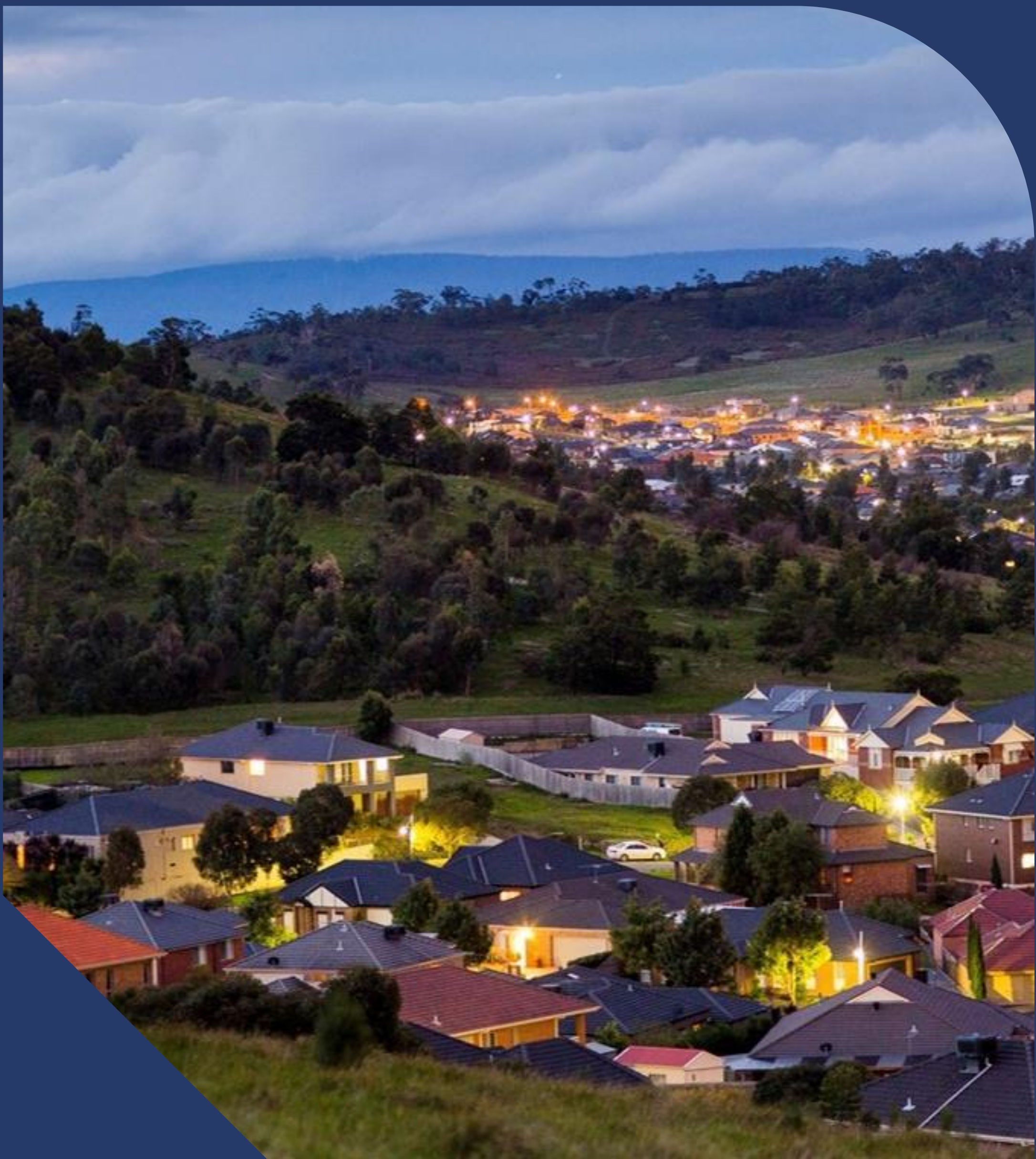
AusNet

HV Switches, Disconnectors and Earth Switches

AMS – Electricity Distribution Network



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AusNet

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1. Executive Summary

This document is part of the suite of Asset Management Strategies relating to AusNet electricity distribution network. The purpose of this strategy is to outline the inspection, maintenance, replacement and monitoring activities identified for economic life cycle management of zone substation HV switches, Disconnectors and earth switches.

This strategy covers the 2392 switches installed within AusNet Zone substations. The majority are the hook stick operated underslung type (45.2 % of the total population), and remainder 3 phase gang operated switches and disconnectors (13.6% of total population) and earth switches (41.2% of the entire population).

Proactive management of HV switches, disconnectors and earth switches including condition-based maintenance and replacement practice is required to ensure that stakeholder expectations of cost, safety, reliability and environmental performance are met. The summary of proposed asset strategies is listed below.

1.1. Asset Strategies

1.1.1. New Assets

- Continue to purchase fully type tested isolators and earth switches to the latest specification
- Procure high quality hook stick operated isolators, consider alternative designs to replace them with rotary double break switches

1.1.2. Maintenance

- Continue maintaining isolators and switches in accordance with PGI 02-01-04. Review maintenance regime for under slung isolators
- Continue with annual thermo-vision scans of all disconnecting switches (as part of station scan and as per SMI 67-20-01)

1.1.3. Spares

- Maintain strategic spares holding of HV switches, disconnectors and earth switches as per spare holding policies
- Salvage good condition component parts from switches removed from station rebuild projects to generate spare parts for older switch types

1.1.4. Replacement

- Replace poor condition HV switches, disconnectors and earth switches under proposed major station rebuild projects under EDPR 2026-31
- Replace associated poor condition HV switches, disconnectors and earth switches under proposed circuit breaker, instrument transformer, power transformer asset replacement programs under EDPR 2026-2031

2. Introduction

2.1. Purpose

The purpose of this document is to outline the inspection, maintenance, replacement and monitoring activities identified for economic life cycle management of High Voltage (HV) switches, disconnectors and earth switches installed in zone substations in AusNet Victorian electricity distribution network. This document is intended to be used to inform asset management decisions and communicate the basis for activities.

In addition, this document forms part of our Asset Management System for compliance with relevant standards and regulatory requirements. It is intended to demonstrate responsible asset management practices by outlining economically justified outcomes.

2.2. Scope

Included in this strategy is all HV switches, disconnectors and earth switches associated with the AusNet electricity distribution network that operate at 66 kV, 22 kV, 11 kV and 6.6 kV in zone substations and power station switchyards.

Excluded from this strategy is MV fuse switch disconnectors (AMS 20-61), and MV switches and ACRs (AMS 20-60).

2.3. Asset Management Objectives

The high-level asset management objectives are outlined in *AMS 01-01 Asset Management System Overview*.

The electricity distribution network objectives are stated in *AMS 20-01 Electricity Distribution Network Asset Management Strategy*.

3. Abbreviations and definitions

TERM	DEFINITION
HV	High Voltage
Pof	Probability of failure
Cof	Consequence of failure
Zk	Work order Notifications associated with failures (unplanned power interruptions)
ZA	Work order Notifications associated with corrective actions from planned inspections

4. Asset Description

4.1. Function

HV switches are used at 66 kV, 22 kV, 11 kV and 6.6 kV in zone substations to manually energise and de-energise transformers and bus-tie circuits when carrying load current and also used for plant isolation.

Disconnectors are used for isolating major primary plant such as transformers, circuit breakers, reactors, instrument transformers, capacitors and lines for maintenance access, and for isolating faulty equipment from energised circuits. They have continuous current ratings and through fault current ratings but do not have the load breaking ratings or fault interruption ratings of HV switches.

Some HV switches/disconnectors are fitted with earthing switches and separate earth switches in capacitor banks to connect de-energised equipment to the general mass of earth and permit safe access for maintenance work.

4.2. Population

Population Considerations

The population profile for HV Switches is crucial for effective lifecycle management. This profile includes detailed data on the quantity, types, locations, and specifications of these assets within the electrical distribution network.

A comprehensive understanding of the population profile allows asset managers to:

- **Identify critical assets:** Determine which HV switches are essential for maintaining the integrity and reliability of the network. For example, a particular HV switch serving a critical industrial area, or a single Transformer station might be deemed essential and require more frequent inspections to ensure uninterrupted service.
- **Allocate resources efficiently:** Plan and allocate maintenance resources effectively by knowing the exact number and location of assets. For instance, knowing that a certain region has a high concentration of specific types of HV switches can help in scheduling maintenance activities more efficiently.
- **Risk management:** Assess and manage risks associated with different assets. For example, if the population profile indicates that certain HV switches are in areas prone to extreme weather, additional protective measures can be implemented in those areas.
- **Optimise maintenance schedules:** Develop optimised maintenance schedules based on the distribution and condition of assets. For instance, HV switches that are critical for feeder circuits from a zone substation might be scheduled for more frequent inspections and maintenance to prevent any potential failures.
- **Enhance reliability and safety:** Ensure that all components, including different types of HV switches, meet the required standards for reliability and safety. For example, if the profile reveals that certain switches have outdated components that no longer meet safety standards, these can be prioritised for replacement.
- **Support strategic planning:** Inform long-term strategic planning and investment decisions. For instance, the population profile might show that a significant portion of HV switches in a rapidly developing suburban area need upgrading to support increased demand, guiding future investment in that region.

Geographic Impact Areas

The AusNet electrical distribution network covers a significant portion of Victoria, including Melbourne's northern and eastern suburbs, and extends across eastern and north-eastern Victoria. This region encompasses a diverse range of geographic locations, each with specific environmental impacts on HV switches. Understanding these impacts is essential for effective asset management within the AusNet electrical distribution network.

Notable examples include:

- **High Wind Areas:** High wind areas, particularly in elevated regions and open plains, subject HV switches to significant stress and fatigue. Example: The structural integrity of HV switches in the elevated regions of the Dandenong Ranges must be robust enough to withstand high wind speeds, ensuring they remain securely in place and do not fail under stress.
- **Corrosive Areas:** Coastal areas and industrial regions where salt and pollutants are prevalent can cause corrosion of metallic components in HV switches. Example: Regular maintenance and the use of corrosion-resistant materials are crucial to prolong the lifespan of these switches. HV switches in coastal towns like Wonthaggi require regular inspections and maintenance to mitigate the effects of salt-induced corrosion.
- **Bushfire Areas:** Bushfire-prone areas, common in many parts of Victoria, pose a risk of fire damage to HV switch infrastructure. Example: Fire-resistant materials and strategic vegetation management around switch installations are essential for reducing this risk. In the bushfire-prone regions of the Yarra Valley, HV switches must be designed to withstand high temperatures, and installations must be cleared of nearby vegetation to prevent fire spread.
- **Flood-Prone Areas:** Areas prone to flooding can impact the performance and integrity of HV switches. Example: Proper waterproofing and drainage systems are essential to protect these assets. In regions like Gippsland, where flooding is more frequent, HV switches must be installed on elevated structures to minimise water damage and subsequent failures.
- **Seismic Zones:** Though less common, areas with potential seismic activity may require HV switches to be constructed with flexibility and resilience to absorb and dissipate seismic forces, reducing the risk of structural failure. Example: In areas near fault lines, HV switches may need to incorporate seismic-resistant features to ensure stability during earth tremors.

Population by Asset Type

Air Break Switch

- **Summary Explanation of Form and Function:** An air break switch is a type of HV switch that operates in air and is used to manually open or close electrical circuits. It typically consists of a set of moving and stationary contacts that are separated or joined to control the flow of electricity via arc chutes to quench the arc during opening.
- **Purpose within the Asset Class:** Air break switches are used to isolate and de-energise sections of the network for maintenance or fault management.
- **Purpose within the Network Design:** In the network design, these switches are strategically placed to allow for the safe isolation of equipment and ensure continuity of supply by sectionalising the network.
- **Process Function:** The switch operates manually, using an insulated rod to engage or disengage the contacts, thereby breaking or making the circuit.
- **Historical Application:** Historically, air break switches have been used extensively due to their simplicity and reliability, particularly in outdoor settings where other types of insulation might be less effective.

Outdoor Earth Switches

- **Summary Explanation of Form and Function:** Outdoor earth switches are used to connect de-energised equipment to the ground, ensuring that there is no residual voltage that could pose a safety risk.
- **Purpose within the Asset Class:** They provide a safe path to earth, enabling maintenance personnel to work on de-energised equipment without the risk of electrical shock.
- **Purpose within the Network Design:** These switches are essential for the safe operation and maintenance of outdoor electrical equipment, particularly in zone substations.
- **Process Function:** The switch connects the equipment to the earth, either manually or automatically, ensuring that any residual charge is safely dissipated.
- **Historical Application:** Outdoor earth switches have been a critical safety component in electrical networks, particularly in areas with extensive outdoor infrastructure.

Indoor Earth Switches

- **Summary Explanation of Form and Function:** Similar to outdoor earth switches, indoor earth switches are used within indoor environments such as switchgear rooms to safely discharge residual electrical energy from de-energised equipment.
- **Purpose within the Asset Class:** They ensure the safety of maintenance personnel working on indoor electrical equipment by providing a reliable path to earth.
- **Purpose within the Network Design:** Indoor earth switches are integrated into indoor switchgear systems to enhance safety during maintenance operations.
- **Process Function:** These switches operate to connect equipment to earth, typically through a manual mechanism that ensures the equipment is fully discharged before maintenance begins.
- **Historical Application:** Indoor earth switches have been used in switchgear systems for many years to enhance safety and ensure compliance with electrical safety standards.

Vertical Break Switch

- **Summary Explanation of Form and Function:** A vertical break switch operates by moving a blade in a vertical direction to open or close the circuit. It is typically used for isolating equipment in substations.
- **Purpose within the Asset Class:** Vertical break switches are used to isolate sections of the network for maintenance and operational flexibility.
- **Purpose within the Network Design:** These switches are installed in substations to provide clear isolation points, ensuring the safety and reliability of the network.
- **Process Function:** The vertical movement of the blade either engages or disengages the circuit, providing a visual confirmation of the switch's status.
- **Historical Application:** Vertical break switches have been widely used in substations due to their reliable operation and clear visual indication of their status.

Underslung Switch

- **Summary Explanation of Form and Function:** An underslung switch is mounted below the conductor it controls, providing an accessible point for manual operation to open or close the circuit.
- **Purpose within the Asset Class:** These switches are used for isolating circuits, particularly in areas where space constraints require the switch to be mounted below the conductors.
- **Purpose within the Network Design:** Underslung switches are utilised in areas with limited space to ensure that circuits can be safely isolated for maintenance or fault resolution.
- **Process Function:** The switch operates manually, typically using a pull rod or lever to engage or disengage the contacts.
- **Historical Application:** Historically, underslung switches have been used in urban areas or other constrained environments where traditional switch mounting options are impractical.

Rotary Double Break Switch

- **Summary Explanation of Form and Function:** A rotary double break switch uses a rotary mechanism to break the circuit at two points simultaneously, enhancing the isolation and safety of the operation.
- **Purpose within the Asset Class:** These switches provide enhanced isolation capabilities, making them suitable for critical applications where reliable disconnection is essential.
- **Purpose within the Network Design:** Rotary double break switches are used in substations and other critical locations to ensure that sections of the network can be safely isolated for maintenance or fault handling.
- **Process Function:** The rotary mechanism engages or disengages the contacts at two points, providing a robust and reliable means of circuit isolation.
- **Historical Application:** These switches have been preferred in high-reliability applications due to their enhanced isolation capabilities and mechanical robustness.

Gas Switch

- **Summary Explanation of Form and Function:** A gas switch uses gas, typically SF_6, as an insulating medium to interrupt the flow of electricity, providing high efficiency switching capabilities.
- **Purpose within the Asset Class:** Gas switches are used for their superior insulation properties and are often employed load break switching in medium voltage applications.

- **Purpose within the Network Design:** These switches are installed in few substations to ensure remote operation
- **Process Function:** The gas acts as an insulator, allowing the switch to safely break and make load currents under high voltage without arcing.
- **Historical Application:** Gas switches have become cost effective solution for switching smaller power transformers due to their high reliability and efficiency in medium-voltage environments. They are being gradually phased out during station upgrades.

Fused Isolator

- **Summary Explanation of Form and Function:** A fused isolator combines the functions of a fuse and an isolator, providing both overcurrent protection and isolation capabilities in a single device.
- **Purpose within the Asset Class:** These devices protect equipment from overcurrent conditions while allowing circuits to be safely isolated for maintenance.
- **Purpose within the Network Design:** Fused isolators are used in various parts of the network to provide both protection and isolation, enhancing safety and reliability.
- **Process Function:** The fuse provides overcurrent protection by breaking the circuit if a fault occurs, while the isolator allows the circuit to be manually opened for maintenance.
- **Historical Application:** Fused isolators have been used for many years to provide dual functionality, combining protection and isolation in a single, compact device.

Population Profile

AusNet has a total of 1406 Disconnectors, HV switches and 986 earth switches installed in AusNet zone substations. Earth switches are typically gang operated and an integral part of a disconnector / earth switch in outdoor type earth switches. The majority of disconnectors are installed outdoor, and most are manually operated.

There are also earth switches installed in third and fourth generation type indoor switchboards on the bus side and feeder side to provide earthing for the feeder exit cable and enable safe access for bus maintenance work.

Figure 1 below illustrates switches, disconnectors and earth switches in service in zone substations in AusNet network by key object types. It is noted that single phase operated under slung isolators (45.2 %) are the key type of disconnecting device used in zone substations. Gang operated disconnecting devices and rotary double break switches contribute to about 13.6%.

Indoor and outdoor type earth switches contribute to about 41.2% of the total population of switches.

Figure 1: Disconnector and earth switch population by Object type

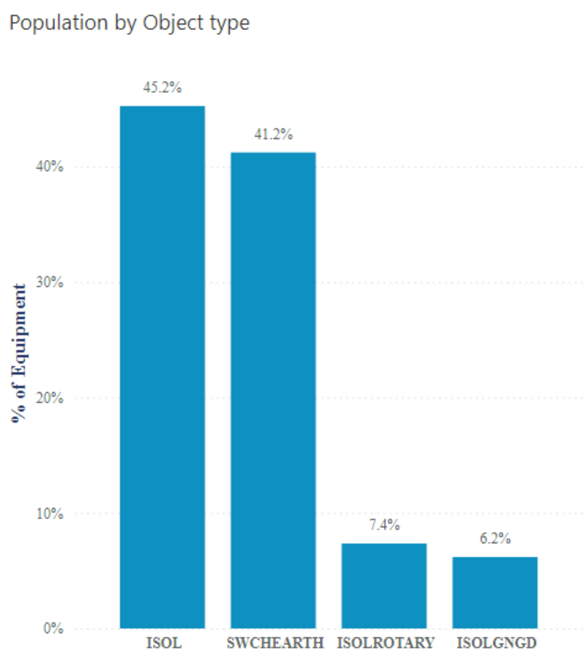
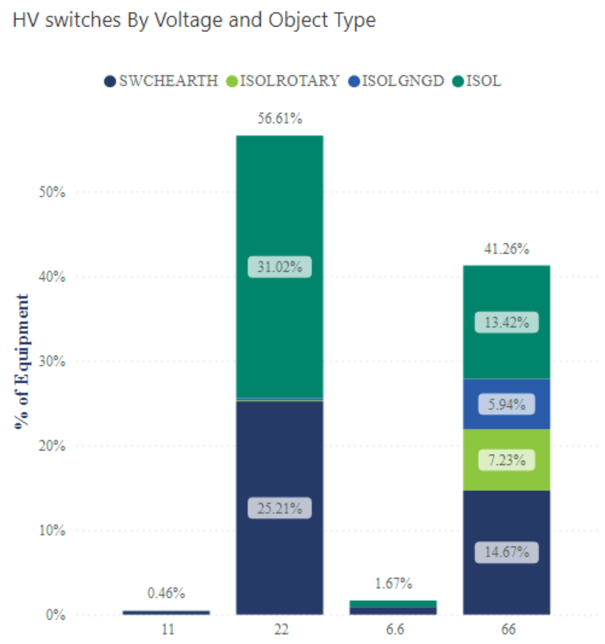


Figure 2 below illustrates various types of switches, disconnectors and earth switches by service voltage in zone substations in AusNet network. Larger population of under slung isolators are found in 22kV outdoor distribution network (31%) compared to 66kV voltage level (13.4%).

Figure 2: Disconnector and earth switch population by service voltage



4.3. Age

Age Considerations

Understanding the age profile of HV switches is critical for effective asset management and lifecycle planning. Knowing the age distribution of these assets helps in predicting their remaining useful life and planning maintenance, upgrades, or replacements accordingly.

Age Profile

The service age profile of zone substation isolators and earth switches by service voltage and type is shown in figure 3 & 4.

About 24.3% of the total population of switches are older than 50 years old. Approximately 13.9% of those operate at 22kV and 10.1% operate at 66kV switches as a percentage of total population.

Figure 3: Disconnector Age Group by Voltage

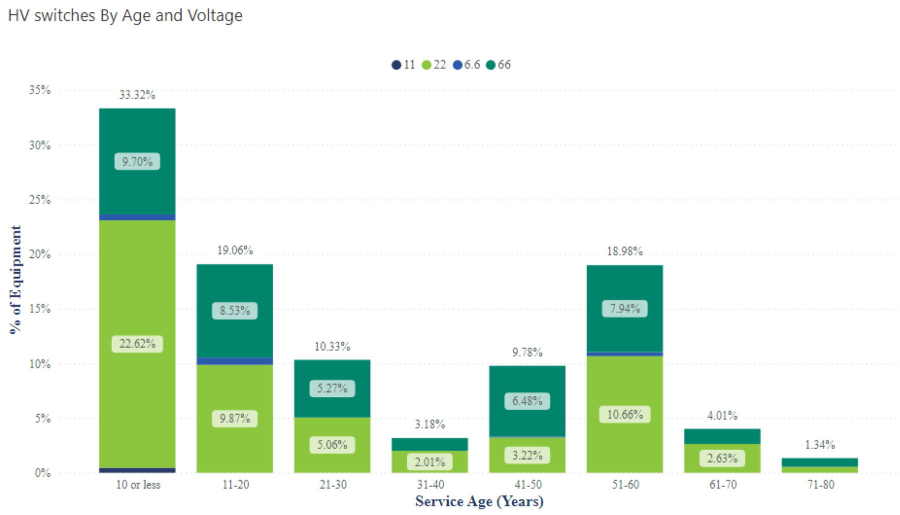
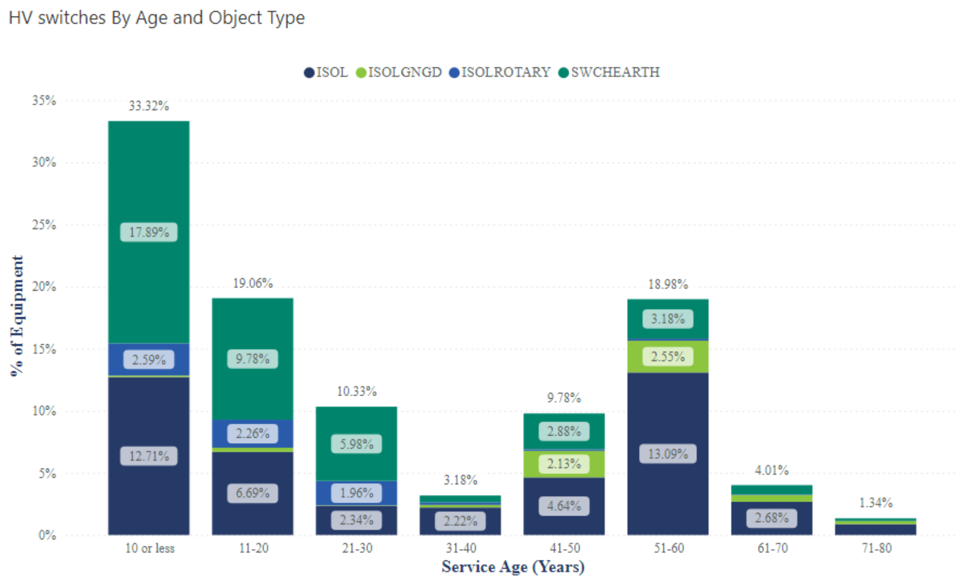


Figure 4: Disconnector Age Group by Type



5. Risk

AusNet maintains a risk management system designed in accordance with AS ISO 31000 Risk Management – Guidelines to ensure risks are effectively managed to provide greater certainty for the owners, employees, customers, suppliers, and the communities in which we operate.

The risk of each asset is calculated as the multiplication of probably of failure (PoF) of the asset and the consequence of failure (CoF). The risk is then extrapolated into the future accounting for forecast changes in PoF and CoF.

In the distribution network, AusNet aims to maintain risk. Risk treatments required to achieve this over time include replacement, refurbishment, and maintenance activities, and are developed based on current risk and extrapolated risk.

The overall approach to quantified asset risk management is detailed in AMS -01-09. Section 5.1, 5.2 and 5.3 of this document describe the considerations and methodologies to determine PoF, Cof, and risk treatments that are unique to HV Switches, Disconnectors and Earth Switches.

5.1. Probability of failure

An asset is deemed to have failed when it does not meet the functional requirements for which it was acquired. Both quantitative and qualitative analysis is used to assess the condition of the asset to determine the probability of failure and to estimate the remaining useful life. AMS 01-09 describes the detail methodologies used in calculating and deriving the probability of a failure considering the four key factors: asset life, asset utilization, location and physical condition.

5.1.1. Failure Modes

Station switches and earth switches are required to be manually operated when the need arises to for isolation and earthing of major primary plant such as transformers, circuit breakers, reactors, instrument transformers, capacitors and lines for maintenance access, and for isolating faulty equipment from energised circuits break load current or fault current. They rarely fail in service without a physical operation.

They are required to physically open or close a circuit physically fully opening of main contacts and auxiliary contacts (if applicable to the type) so that electrical live clearance is maintained with no excessive operating force.

The keyways station switch fail to meet functional requirements are:

•Failure to open or contacts not fully open. This can be caused by wear, mechanism that fail to fully travel ,seizure, stiffness

•Failure to close or contacts not fully close: This can be caused by a breakage in the mechanism drive, seizure, stiffness

- Current path issues due to contact welding, mis alignment, high resistance contacts
- Support insulator failures due to cracks as result of fatigue, insulation flashover due to pollution contamination

Most of the above defects are only noticed during a switching operation and sometimes detected during thermos vision camera inspections during annual station surveys.

Failure Modes by Asset Type

Air Break Switch

- **Insulation Degradation:** The insulation material can degrade over time due to thermal aging and environmental exposure, leading to reduced arc-extinguishing effectiveness and potential electrical faults. Example: High temperatures can accelerate the degradation of insulation materials, compromising their ability to extinguish electrical arcs effectively.

- **Mechanical Wear:** Components such as contact points and hinge mechanisms can suffer from wear and fatigue, affecting the switch's ability to operate correctly. Example: Frequent operations may wear down the mechanical components, leading to slower or incomplete disconnection during faults.
- **Environmental Degradation:** Exposure to harsh environments, such as coastal areas or high pollution zones, can lead to corrosion of metal components and degradation of insulation. Example: Salt spray in coastal regions can accelerate the corrosion of metal parts, leading to premature failure.
- **Moisture Ingress:** Water or moisture can penetrate the switch unit, leading to corrosion of internal components and reduced insulation effectiveness. Example: In high humidity areas, moisture ingress can corrode the internal components, compromising reliability.
- **Thermal Overload:** Excessive current flow can cause the switch to overheat, leading to thermal degradation and potential failure. Example: Sustained high current can cause overheating, leading to melting of internal components and failure to clear the fault.

Outdoor Earth Switches

- **Insulation Breakdown:** Insulation materials can degrade due to exposure to UV radiation and environmental conditions, reducing their effectiveness. Example: UV exposure can cause the insulation to become brittle and crack, leading to failures.
- **Mechanical Wear:** Moving parts such as contacts and hinges can wear out over time, reducing the switch's reliability. Example: Frequent operation of the switch can wear down mechanical components, causing operational failures.
- **Corrosion:** Metal components can corrode due to environmental exposure, especially in coastal areas with high salt content. Example: Salt corrosion can weaken the structural integrity of metal parts, leading to failures.
- **Environmental Impact:** Exposure to harsh weather conditions, including extreme temperatures and moisture, can affect the switch's performance. Example: Extreme cold can cause metal components to become brittle and break.

Indoor Earth Switches

- **Insulation Degradation:** Indoor environments with high humidity or dust can cause insulation materials to degrade. Example: Dust accumulation can lead to insulation breakdown and failures.
- **Mechanical Wear:** Components such as springs and contact points can wear out with frequent use. Example: Regular operation can cause wear and tear, leading to failures.
- **Corrosion:** Indoor environments with high humidity can lead to corrosion of metal components. Example: Corroded parts can fail, compromising the switch's reliability.

Vertical Break Switch

- **Mechanical Wear:** Moving parts such as the blade and hinges can suffer from wear and fatigue, reducing the switch's effectiveness. Example: Frequent use can cause mechanical components to wear out, leading to failures.
- **Insulation Degradation:** Insulation materials can degrade over time due to environmental exposure and thermal aging. Example: Degraded insulation can lead to arc faults and failures.
- **Corrosion:** Metal parts can corrode due to environmental exposure, especially in high humidity areas. Example: Corrosion can weaken the structural integrity of the switch, leading to failures.

Underslung Switch

- **Mechanical Wear:** Components such as levers and hinges can wear out with frequent use, reducing the switch's reliability. Example: Regular operation can cause mechanical wear, leading to failures.
- **Insulation Degradation:** Insulation materials can degrade due to environmental exposure and aging. Example: Degraded insulation can lead to arc faults and failures.
- **Corrosion:** Metal parts can corrode due to environmental exposure, especially in areas with high moisture content. Example: Corrosion can weaken the structural integrity of the switch, leading to failures.

Rotary Double Break Switch

- **Mechanical Wear:** The rotary mechanism and contact points can wear out with frequent use, reducing the switch's effectiveness. Example: Frequent operation can cause mechanical components to wear out, leading to failures.
- **Insulation Degradation:** Insulation materials can degrade over time due to thermal aging and environmental exposure. Example: Degraded insulation can lead to arc faults and failures.
- **Corrosion:** Metal components can corrode due to environmental exposure, especially in areas with high salt content. Example: Corrosion can weaken the structural integrity of the switch, leading to failures.

Gas Switch

- **Insulation Degradation:** Gas insulation can degrade over time due to leakage or contamination, reducing the switch's effectiveness. Example: Gas leakage can reduce the insulating properties, leading to failures.
- **Mechanical Wear:** Components such as seals and moving parts can wear out over time, reducing the switch's reliability. Example: Frequent operation can cause wear and tear, leading to failures.
- **Corrosion:** Metal parts can corrode due to environmental exposure, especially in high humidity areas. Example: Corrosion can weaken the structural integrity of the switch, leading to failures.

Fused Isolator

- **Insulation Breakdown:** The insulation materials can degrade over time due to thermal aging and environmental exposure, reducing their effectiveness. Example: High temperatures can accelerate insulation degradation, leading to failures.
- **Mechanical Wear:** Moving parts such as contacts and fuses can wear out with frequent use, reducing the isolator's reliability. Example: Frequent operation can cause wear and tear, leading to failures.
- **Corrosion:** Metal components can corrode due to environmental exposure, especially in high moisture areas. Example: Corrosion can weaken the structural integrity of the isolator, leading to failures.

5.1.2. Probability of Failure Assessments

As per the methods of calculation described in section 3 of AMS 01-09, the conditional PoF for Station switch is derived from health index based on asset life, asset utilisation, location and asset physical condition based on observed condition.

5.2. Consequence

Failure of a Switch has the potential of resulting in failing to supply customers with energy when a time-consuming unplanned works need to be performed to make the switch operational and fit for purpose. There is also a possibility the failed asset injures an employee during the operation or maintenance switching operation. There is operator safety risks associated with older hook stick operated fused isolators and underslung isolators and older rotary double break switches with brown cap and pin type insulators. During operation, the insulator may break away causing live connections to separate which can cause insulators and conductors to fall to the ground and pose safety risk to operators.

Following key consequences of Switch failure effects have been considered viewed through two lenses.

1. Safety impact,
2. Community impact due to outages (unserved energy)

The detail methodology of the consequence assessment is described in AMS 01-09.

5.3. Risk Treatment

Risk treatments are required to maintain risk by targeting reduction of PoF or CoF depending on the nature of the risk. Treatment measures include asset replacement, asset refurbishment, inspections, testing or system redesign, and are achieved through capital projects or operational expenditure. Risk treatment options are described in the section on 'Risk Treatment' in AMS 01-09.

Capital replacement is a major component of asset risk management. The prerequisites for replacing assets:

- replacement of an asset will result in a material risk reduction
- risks can't be feasibly managed through maintenance or refurbishment
- monetised risk exceeds the replacement cost – ie replacement is economic.

6. Performance

6.1.1. Performance Analysis

In the context of asset management for HV switches, assessing asset performance is a vital tool for effective lifecycle management. Performance information provides a comprehensive understanding of how these assets behave under various conditions, enabling asset managers to make informed decisions that enhance the reliability, safety, and efficiency of the electrical distribution network.

Performance data helps identify trends and patterns in asset behaviour, which are crucial for making strategic decisions regarding maintenance, upgrades, and replacements. Understanding how assets perform over time allows for proactive management, reducing the risk of unexpected failures. The assessment employed by AusNet involves analysing failure trends and any significant impacts resulting from failure, which provides valuable insights into the health and reliability of the assets.

6.1.2. Performance Profile

Figure 5 below shows the ZA & Zk notifications during the period 2020 – 2024.

Figure 6 & 7 below shows the Zk notifications during the period 2020 - 2024 against the object type & voltage.

Figure 5: ZA & Zk notifications during the period 2020 – 2024

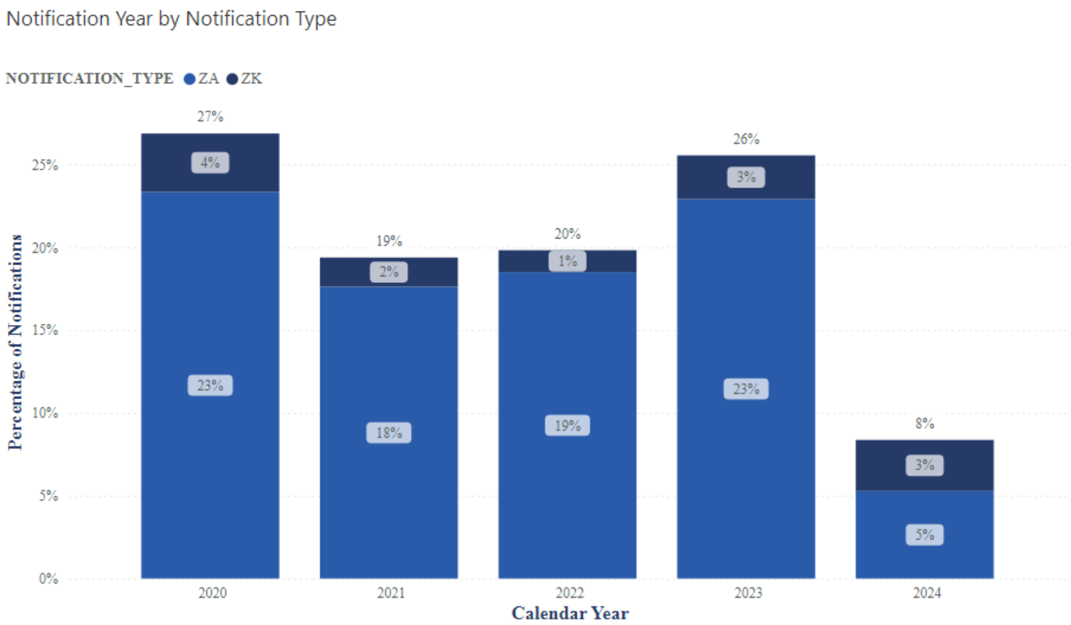


Figure 6: Zk notifications during the period 2020 – 2024 by object type

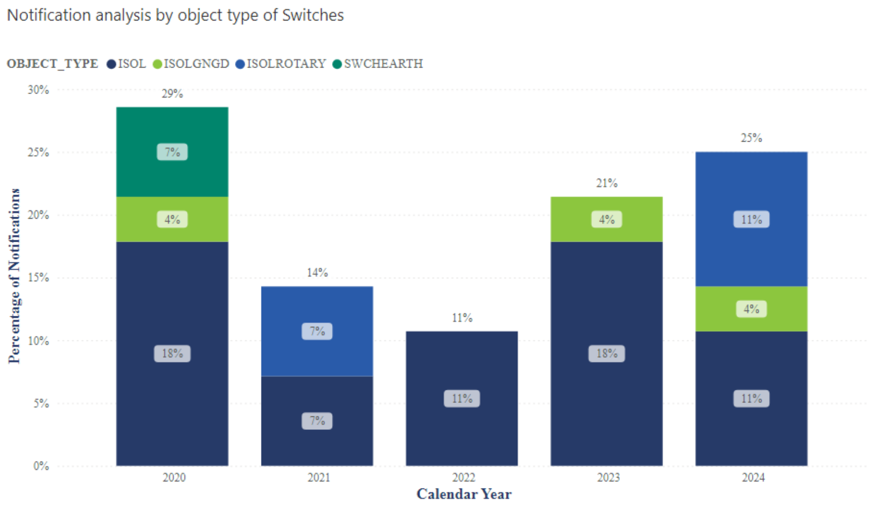


Figure 7: Zk notifications during the period 2020 – 2024 by service Voltage

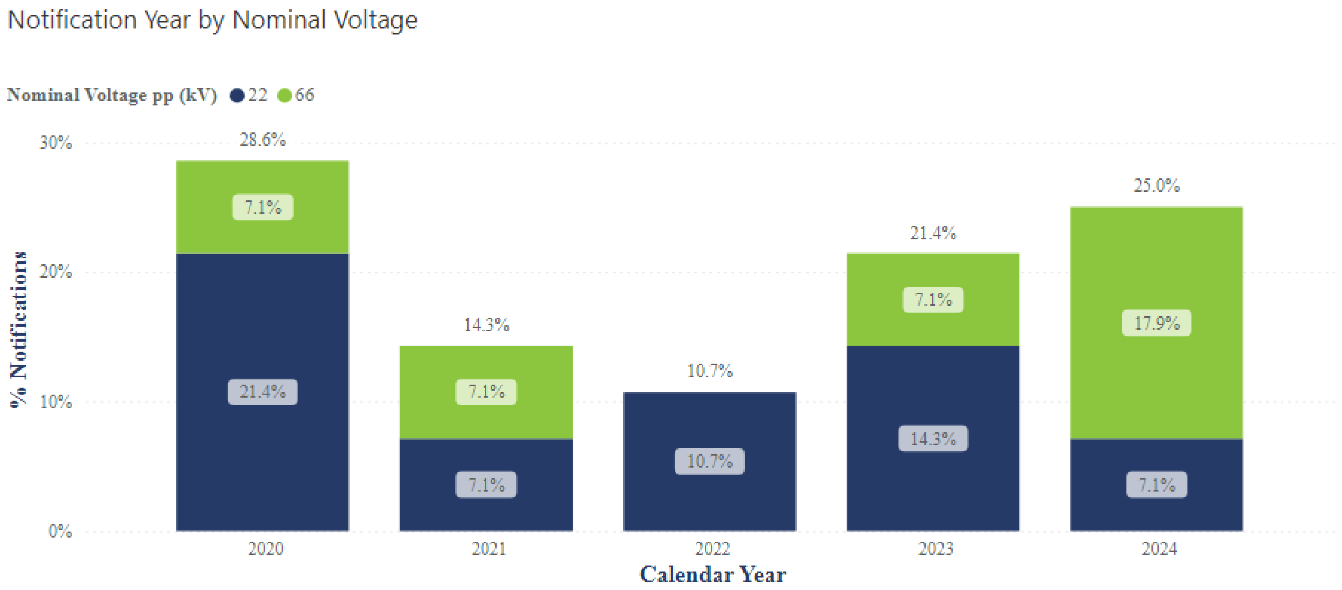


Figure 8 & 9 below shows the ZA & Zk notifications during the period 2020 - 2024 against the object part affected.

Figure 8: ZA notifications during the period 2020 - 2024 against the object part affected

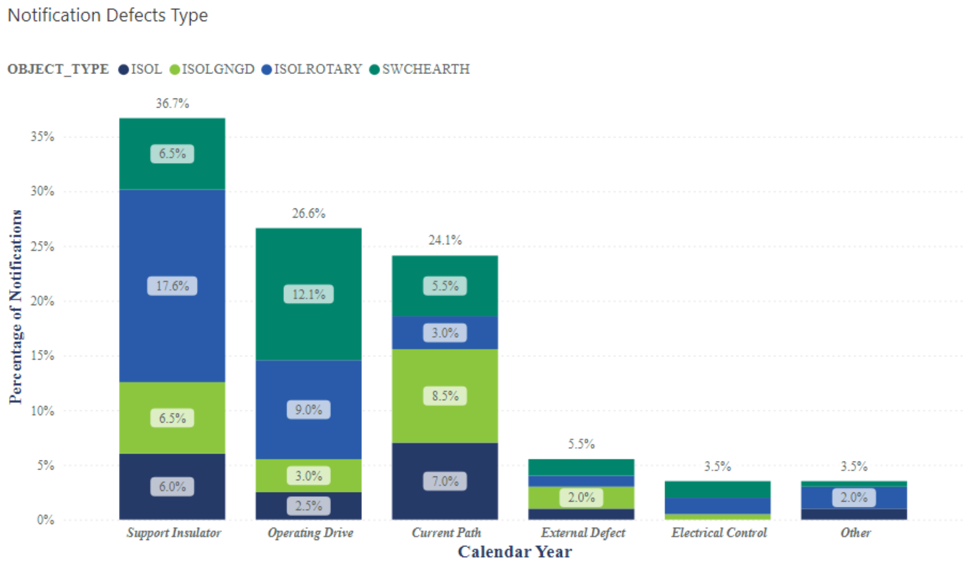


Figure 9: Zk notifications during the period 2020 - 2024 against the object part affected

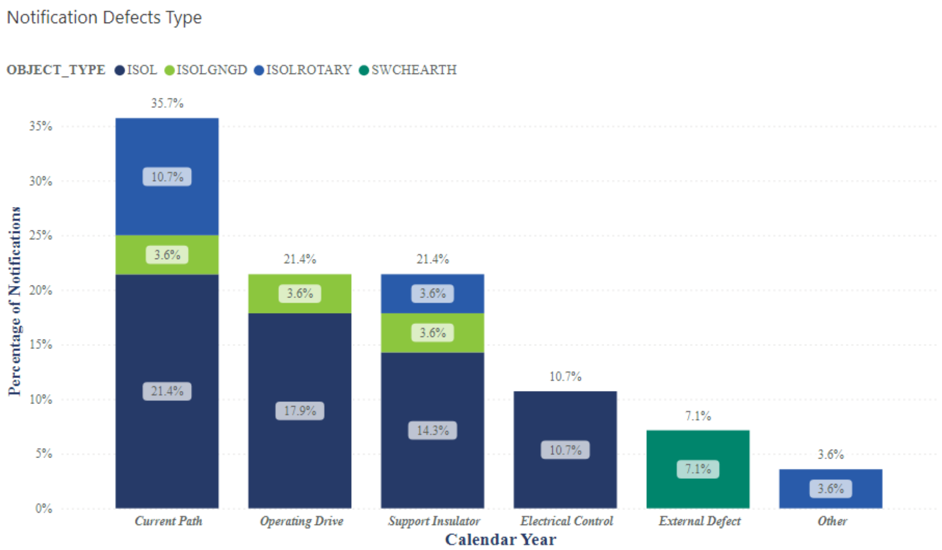


Figure 10 below shows Zk notifications against age group during the period 2020-2024.

Figure 10: Zk notification based on aged group during the period 2020 - 2024

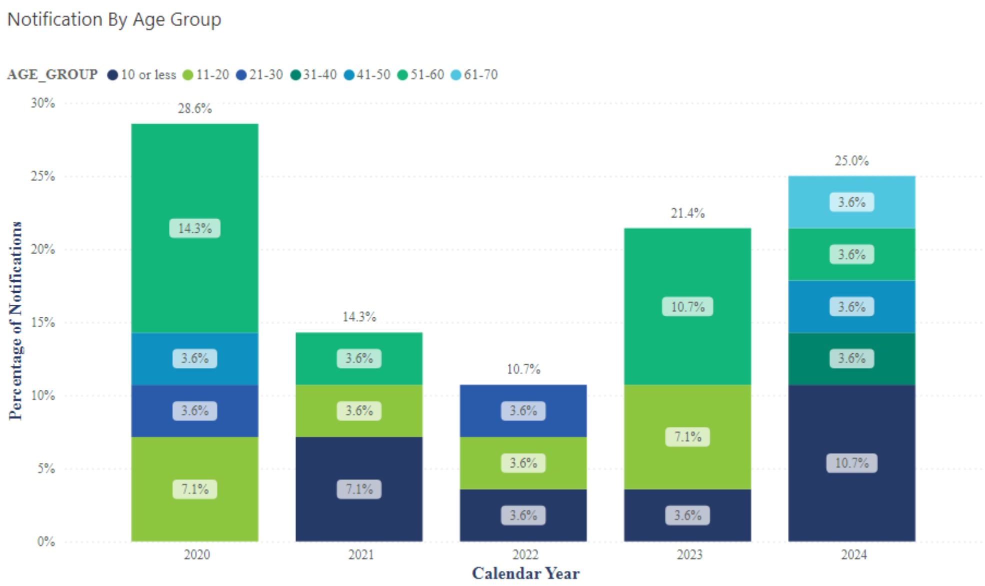


Figure 11 and 12 shows the ZA and Zk notification rate per year/Total population during the period 2020 -2024.

Figure 11: Zk notification rate during the period 2020 -2024 by object type

ZK Notifications

OBJECT_TYPE	Count of NOTIFICATION_ID	Population	Notitifcations / year/Total population
ISOL	18	1082	0.15%
ISOLGNGD	3	148	0.03%
ISOLROTARY	5	176	0.05%
SWCHEARTH	2	986	0.08%

Figure 12: ZA notification rate during the period 2020 -2024 by object type

ZA Notifications

OBJECT_TYPE	Count of NOTIFICATION_ID	Population	Notitifcations / year/Total population
ISOL	35	1082	0.29%
ISOLGNGD	41	148	0.34%
ISOLROTARY	68	176	0.57%
SWCHEARTH	55	986	0.46%

Disconnector and earth switch Notification analysis revealed following issues.

1. It is observed the Zk failure notifications contributed to only approximately 12.3% against ZA notifications (87.7%) over the period 2020 -24. Key reason being defects are rarely found in disconnectors and earth switches in service, and they mostly remain hidden and found during switching operations or planned maintenance. (refer Figure 5)

2. Approximately 64.3% of Zk notifications reported from Underslung isolators, Earth switches (7.1%), ganged isolators (10.7%) and rotary isolators (10.7%) (Figure 6) It was noted 60.7% of Zk notifications reported from 22kV switches. (refer Figure 7)

3. ZA notification analysis revealed Key object parts defects support insulator failures (36.7%) operating drive (26.6%) and current path issues (24.1) which contributed to 87.4% of notifications reported during the period 2020-2024. (refer figure 8)

4. It is also noted that most Zk failure notifications reported in the same period 2020-2024 were associated with object parts current path (35.7%), operating drive (21.4%), support insulator failures (21.4%) and mostly reported from underslung isolators. (refer Figure 9)

5. Zk notifications were reported from all age groups of disconnectors /earth switches, but more defects reported from less than 20-year age group (46.4%) and over 50yrs (35.5%) which contributed to approximately 82%, mostly reported from underslung isolators. (refer figure 6 & 10). Further analysis of the manufacturer model revealed that they are [CIC] and older models such as [CIC], [CIC], [CIC], [CIC] make.

6. Figure 11 & 12 tables reveal the notification rate of ZA and ZK notifications are highest for under slung isolators compared to other types in service ,0.29% and 0.15% respectively during the period 2020-2024.

Above observations indicate the necessity of reviewing the planned maintenance regime of underslung isolators and consider replacing the poor condition isolators during planned maintenance inspections or replace during station augmentation projects. Also consider other options such as; review design to replace underslung isolators with rotary double break switches , procure isolators of improved design and quality. Refer sections 8.1, 8.3 and 8.4.

6.1.3. Major failures resulting in Safety incidents

There had been three significant incidents reported during the period 2013 - 2018 of isolator and switches in Zone Substations and Terminal Stations. These incidents resulted in near misses of serious injury to operators while operating them.

In 2016, ASEA P type rotary type old ganged 3 phase isolator failed at Mansfield ZSS (MSD) when performing switching duties. The fixed jaw assembly of one phase separated from the rotary switch insulator and fell onto the adjacent bus below, ending up suspended 1 meter from the ground resulting in a near miss. (IMS reference 225511). Safety gram SG 2016040 was issued.

The details of the two significant incidents reported at Terminal stations are as follows:

In 2013, a 22kV Stanger type fused isolator at Rowville Terminal station (ROTS) failed when attempting to open the isolator. This caused the top fuse bracket insulator breaking resulting in the conductor falling and swinging towards the Operator resulting in an electric shock. Energy Safe Victoria (ESV) attended to conduct an independent assessment. A Significant Incident Investigation was launched under reference IMS 210811. Safety gram SG 2013039 was issued.

In 2015, a 22kV Stanger type fused isolator at Richmond terminal station (RTS) failed when attempting to open the isolator during decommissioning of retired plant. The top of the failed insulator failed and broke away and remained suspended above ground. The ceramic fuse was retained on the operating stick and fortunately there were no injuries. (IMS reference 215324)

Mechanical failures in old, fused isolator support insulators are a result of combination of mechanical operating loads imposed on an insulator that weakened due to cement growth of grouting compound, used on the cap and pin style insulator. Cement growth is a known failure mode of cap and pin insulators and usually starts to appear after 30 to 40 years in service.

7. Related Matters

7.1. Regulatory Framework

7.1.1. Compliance Factors

Regulatory and Legislative Reference

Effectively managing compliance obligations specific to legislation and policies is a core element of Asset Class Planning and supports the sustainable operation and management of Network Assets. Ensuring adherence to relevant laws, policies and codes helps prevent legal and regulatory breaches, which can lead to significant penalties, operational disruptions, and reputational damage.

Refer to Section 9 and 10 for detailed guidance notes and references, supplied to support the assessment of this factor and the ways it impacts and influences the management of this Asset Class.

Technical Standards and Procedures

Effectively managing compliance with technical standards and operational procedures is an important element of Asset Class Planning. Adhering to these standards ensures that the assets are designed, constructed, maintained, and operated in a manner that meets industry best practices, enhances safety, and ensures reliability. Compliance with technical standards helps prevent asset failures, reduces risks, and ensures interoperability within the electrical distribution network. For example, ensuring that all components of various asset types are installed and maintained according to Australian Standards can prevent unplanned failure and operational faults, enhancing network reliability.

Refer to Station Design Manual for detailed guidance notes and references, supplied to support the assessment of this factor and the ways it impacts and influences the management of this Asset Class.

External Factors

Technical Factors

Understanding and managing the technical factors that can directly impact the lifecycle planning for Network Assets across all the AusNet Asset Classes is a core element of effective asset management. These factors encompass various design, engineering, and technical performance considerations that directly impact the ability to manage and maintain these assets efficiently. Ensuring that Network Assets meet specific technical performance standards is vital for maintaining the reliability and safety of the electrical distribution network. For example, selecting construction materials with appropriate durability and weather resistance is essential to prevent faults and ensure consistent performance under varying environmental conditions.

Targeted Activities (Technical Factors)

REF	DETAILS OF MATERIAL CONSIDERATIONS
01	**Cap and Pin support insulator failures** Cap and pin type insulator types used in HV switches, Disconnectors are also used as bus bar support insulators in older zone substations. Although they are used as stand-off support insulators, they tend to electrically fail due in pin corrosion similar to HV switches and Disconnectors, with insulator cracking of porcelain and insulation failure causing bus outages. Many of have them have reached end of life. There were three incidents of 22kV bus outages caused due to cap and pin type insulator failures during the period 2015-2018 affecting number of customers. (MYT ZSS -2016, BWR -2018, TGN -2018). Consider replacing under planned inspection.

02	**Very low operation of switches** It is often found that switches that operate very rarely are often found with the difficulty to open or too hard or stiff to operate during network switching operations. This causes delays and extended outage time due to unforeseen unplanned work to be carried out in them. Exercising the switches by operating at regular time periods and consider replacing under planned inspection.

Environmental Factors

Environmental Management

Not applicable.

Stakeholder/ Social Factors

Social Factors

Not applicable.

Stakeholder Factors

Not applicable.

Internal Factors

Training and Competency Factors

Effective training and competency development is a core element of asset class. Ensuring that asset managers, engineers, operational staff, and field personnel possess the necessary skills and knowledge is crucial for maintaining the reliability, safety, and efficiency of the asset network. Competent staff can effectively perform inspections, maintenance, and repairs / replace, preventing asset failures and minimising downtime. Continuous training helps in keeping up with technological advancements, regulatory changes, and best practices, thereby enhancing overall asset management performance.

Resource Management Factors

Resource Management is a core element of asset class planning for Network Assets. Proper oversight ensures that the management of AusNet's resource bases meets stringent quality and performance standards, which is essential for preventing asset failures, managing risks, and maintaining compliance with regulatory requirements. Effective resource management contributes to cost efficiency via activities such as leveraging the expertise of specialised in-house skills and contractors while avoiding hidden costs associated with inefficiencies and non-compliance.

There are three critical sub-categories of consideration for this factor. These sub-categories are:

- Resourcing strategies
- Outsourcing
- Supply Chain Management[i]

Economic Factors

Economic factors significantly influence the lifecycle management of network assets, impacting financial stability, investment decisions, and overall network performance. Major contracts being tendered, such as those for infrastructure development, maintenance, and technology upgrades, can materially affect asset management. These contracts involve substantial investments, requiring rigorous management to align with long-term asset goals, mitigate risks, and control costs. Effective contract management ensures that service providers deliver value, supporting the network's reliability and performance while maintaining financial health.

Material developments and significant commercial agreements also play pivotal roles in the economic landscape of asset management. Developments like new regulatory requirements or technological advancements can alter network needs, necessitating strategic adjustments in asset management. Commercial agreements, including customer service agreements, dictate service levels, performance metrics, and penalties, impacting operational priorities. Regular reviews of these agreements ensure adaptability to changing economic conditions, customer expectations, and regulatory landscapes. Additionally, planned renewal programmes and changes to asset types and purchasing strategies must be evaluated for their financial impact to ensure efficient resource allocation. By addressing these economic factors, AusNet can manage financial risks, optimise investments, and support robust lifecycle models, aligning financial planning with operational goals and regulatory requirements.

Safety Factors

Safety is a paramount concern in the management of electricity distribution network assets, as outlined in **ESMS 20-01**. Effective asset management planning and activities are crucial for protecting employees, contractors, the public, and the environment from potential hazards associated with electrical infrastructure. Ensuring adherence to safety regulations and standards through diligent asset management helps prevent accidents, minimise risks, and maintain the integrity of the network.

Targeted asset management activities include conducting regular safety audits and risk assessments, maintaining a robust Bushfire Mitigation Plan, continuously improving asset inspection and maintenance programmes, providing ongoing safety training and competency assessments, regularly reviewing and updating emergency response plans, engaging with the community to raise awareness about electrical safety, and adopting new technologies and practices to enhance network safety. By integrating these safety-focused activities into asset management planning, AusNet can effectively minimise safety risks "as far as practicable," as outlined in the Electricity Safety Act 1998 and reflected in ESMS 20-01.

7.2. Future Developments

Technology and Innovation Factors

Effectively managing the process of tracking future technology developments and innovations is a core element of asset class planning. Staying informed about technological advancements ensures that asset management practices remain up-to-date, efficient, and competitive. Innovations can lead to improved materials, better monitoring systems, and enhanced maintenance techniques that increase the reliability, safety, and longevity of critical infrastructure. For example, advancements in diagnostic tools for detecting early signs of wear and the development of advanced materials for asset components can significantly enhance their performance and maintenance. For technology and innovation, this is a process that looks to existing technologies, processes, or practices that have been proven in the market and have already been taken to market.

Research and Development Factors

Effectively managing the process of investing in research and development (R&D) and seeking funds for R&D activities is a core element of asset class planning. R&D investment ensures that the organisation stays at the forefront of technological advancements, develops innovative solutions to emerging challenges, and enhances the reliability, safety, and efficiency of its assets. For example, developing new materials with improved structural properties for buildings or advanced monitoring systems for environmental systems can significantly extend their lifespan and reduce maintenance costs. Research and development is the process of researching and investing in an idea, process, practice, or technology that has not been realised in the market yet; it is a step before tracking innovation and technology because the investment to build and take the item to market still needs to be proven and undertaken.

Continuous Improvement

Continuous Improvement (CIP) is a critical lynchpin process in the overall application of asset management, particularly for managing Distribution Assets. CIP ensures that asset management practices remain effective, efficient, and adaptive to changing conditions and emerging challenges. By consistently seeking ways to enhance processes, technologies, and strategies, organisations can maintain high levels of performance, reliability, and safety. For example, regularly updating maintenance protocols for buildings, environmental systems, and security fences based on feedback and new insights can prevent issues before they become major problems, thereby extending the lifespan of critical infrastructure.

Best practice asset management promotes a culture of continuous improvement, encouraging organisations to regularly evaluate their asset management systems, identify areas for enhancement, and implement changes. This iterative process involves monitoring performance, analysing data, and applying lessons learned to refine practices. By focusing on CIP, organisations can ensure that their asset management activities remain dynamic, resilient, and aligned with best practices and strategic objectives. This approach not only enhances the overall efficiency and effectiveness of asset management but also supports long-term sustainability and success. CIP differs from technology and innovation as well as R&D because it involves the ongoing enhancement of existing processes and practices based on real-world feedback and performance data, rather than the development and introduction of new technologies or the exploration of unproven ideas.

8. Asset Strategies

8.1. New Assets

New Asset Considerations

A strategic asset strategy for the introduction of new assets provides high-level guiding principles and overarching goals for asset management, focusing on long-term planning and sustainability. This strategy outlines the aspects of asset upgrades or changes, detailing the conditions under which new assets may be introduced into the network. This is not a like-for-like replacement but rather a strategic change or upgrade to a different type of asset to enhance reliability, improve efficiency, and incorporate advanced technologies. It serves as a roadmap that is ideal to follow if possible, guiding the decision-making process for integrating new assets into the AusNet network.

Targeted Activities (New Asset Strategies)

REF	DETAILS OF MATERIAL CONSIDERATIONS
01	Continue to purchase fully type tested isolators and earth switches to the latest specification.
02	Procure high quality hook stick operated isolators, consider alternative designs to replace them with rotary double break switches

8.2. Inspections and Monitoring

A strategic plan for inspections and monitoring provides high-level guiding principles and overarching goals for asset management, focusing on long-term planning and sustainability. This strategy outlines the ideal framework and objectives for conducting inspections and monitoring activities, such as enhancing reliability, improving efficiency, and incorporating advanced technologies. It serves as a roadmap that is ideal to follow if possible, guiding the decision-making process for establishing comprehensive inspection and monitoring protocols within the AusNet network.

8.3. Maintenance Planning

A strategic plan for maintenance provides high-level guiding principles and overarching goals for asset management, focusing on long-term planning and sustainability. This strategy outlines the ideal framework and objectives for conducting maintenance activities, such as enhancing reliability, improving efficiency, and incorporating advanced technologies. It serves as a roadmap that guides the decision-making process for establishing comprehensive maintenance protocols within the AusNet network. This involves creating a structured approach to regular maintenance activities to ensure optimal performance and longevity.

Targeted Activities (Inspection and Monitoring Strategies)

REF	DETAILS OF MATERIAL CONSIDERATIONS
01	Continue maintaining isolators and switches in accordance with PGI 02-01-04. Review maintenance regime for under slung isolators
02	Continue with annual thermo-vision scans of all disconnecting switches (as part of station scan and as per SMI 67-20-01).

8.4. Renewals Planning

A strategic asset strategy for renewals and replacements provides high-level guiding principles and overarching goals for asset management, focusing on long-term planning and sustainability. This strategy outlines the aspects of asset refurbishments or like-for-like replacements, detailing the conditions under which existing assets may be renewed or replaced within the network. This process ensures continued reliability and efficiency, manages obsolescence, and maintains adequate spares. It serves as a roadmap that is ideal to follow if possible, guiding the decision-making process for renewing or replacing assets within the AusNet network.

Targeted Activities (Renewal Strategies)

REF	DETAILS OF MATERIAL CONSIDERATIONS
01	Replace poor condition HV switches, disconnectors and earth switches under proposed major station rebuild projects under EDPR 2026-31.
02	Replace associated poor condition HV switches, disconnectors and earth switches under proposed circuit breaker, instrument transformer, power transformer asset replacement programs under EDPR 2026-2031.
03	**Technical obsolescence and spares management** Manufacturers generally cease to formally support when switchgear are older and could not normally obtain OEM spares parts beyond 30 years. Although serviceability can be improved midway through asset operational life, by increasing the level of spares held in stores just before the OEM ceases manufacture stores holding will deplete to the point that salvaging components and reverse engineering become the only means of supporting a fleet. Also reused components cannot economically extend asset lives further and at this point it will become technically obsolete. [CIC], [CIC], [CIC], [CIC], [CIC] make are typical under slung isolators and Vertical Break switches and Taplin Air Break Switches that are technically obsolete and the availability of new spares is very limited to maintain the fleets. Maintain strategic spares holding of HV switches, disconnectors and earth switches as per spare holding policies Salvage good condition component parts from switches removed from station rebuild projects to generate spare parts for older switch types

8.5. Decommissioning

A strategic asset strategy for decommissioning provides high-level guiding principles and overarching goals for asset management, focusing on long-term planning and sustainability. This strategy outlines the aspects of safely and efficiently removing assets from service, detailing the conditions under which decommissioning may occur. It ensures that the process is conducted in a way that minimises disruption, manages environmental impacts, and complies with regulatory requirements. It serves as a roadmap that is ideal to follow if possible, guiding the decision-making process for decommissioning assets from within the AusNet network.

9. Legislative References

STATE	REGULATOR	REFERENCE
VIC	WorkSafe Victoria	Occupational Health and Safety Act 2004

10. Resource References

NO.	TITLE	DOCUMENT TITLE
1	QMS 20-04	Documented information Control
2	AMS 01-09	Asset Risk Assessment Overview
3	AS ISO 31000	Risk Management – Guidelines
4	AMS 01-01	Asset Management System Overview
5	AMS 20-01	Electricity Distribution Network Asset Management Strategy
6	PGI 02-01-04	Summary of Maintenance Intervals – Distribution Plant Guidance and Information
7	SDM	Station Design Manual
8	SMI 67-20-01	Non-Invasive Inspection for Electrical Asset Condition Assessment

11. Schedule of revisions

ISSUE	DATE	AUTHOR	DETAILS OF CHANGE	APPROVED BY
1	02/07/08	NB	Initial draft	
2	18/07/08	NB	Updated with comments from SD, GL and DP.	
3	08/09/08	NB	Included HV switches and RCM analysis	G Towns
4	27/03/09	SD, GL	Updated strategies	G Towns
5	06/07/09	NB, GL	Added reference to ABS replacement program	G Towns
6	24/11/09	Nilima Bapat	Minor Editorial and other changes	G Towns
7	05/02/15	P Seneviratne D Meade P Yeung	Review and update	J Bridge
8	18/06/19	N Boteju	Review and update	P Ascione
9	22/01/25	N Boteju	Review and update	

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