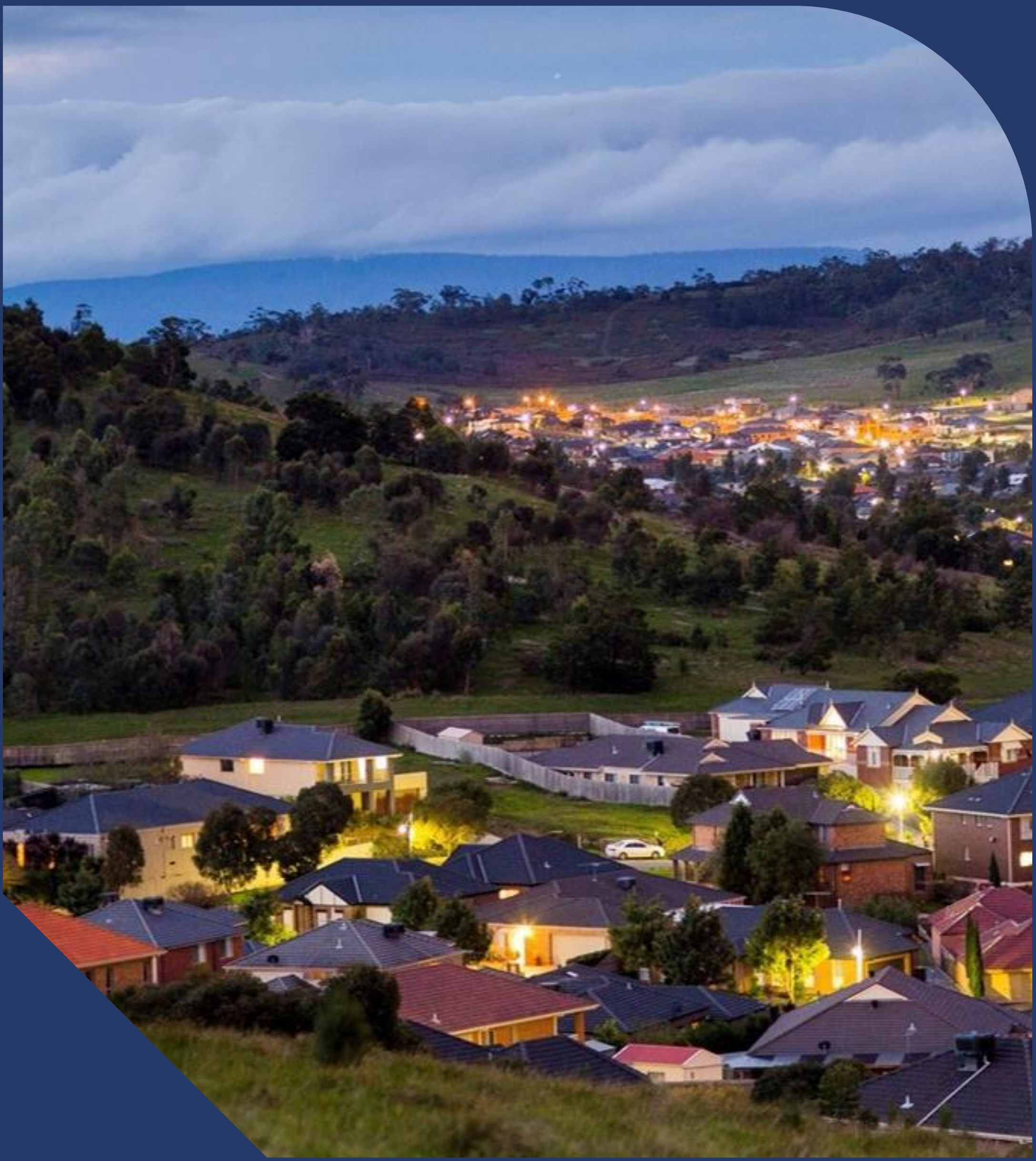
AusNet

Disconnectors and Earth Switches

Asset Management Strategy



AusNet

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Abbreviations and definitions

TERM	DEFINITION
AMS	Asset Management Strategy
CAPEX	Capital Expenditure (used for asset replacements or works associated with life extensions)
COF	Consequence of Failure
OPEX	Operational Expenditure (used for maintenance activities)
PGI	Plant Guidance and Information
POF	Probability of Failure
RDB	Rotary Double Break Isolator (typically installed at 66kV)
ROI	Remote Operated Isolator (typically installed at 220kV and above)
SAP	Brand name for enterprise-oriented database software
SMI	Standard Maintenance Instructions
ZK	Work order Notifications associated with failures (unplanned power interruptions)
ZA	Work order Notifications associated with corrective actions from planned inspections

1. Executive Summary

This document outlines AusNet's Asset Management Strategy for disconnectors and earth switches within the regulated electricity transmission network. It outlines the approach to inspection, maintenance, replacement and monitoring activities to support effective and economic life cycle management.

AusNet manages a fleet of over 4,100 disconnectors and earth switches, spanning voltage levels from 4.5kV to 500kV. Disconnecting switches represent 59.4% of the fleet, including single-phase underslung models at 66kV and below (33.6%) and three-phase ganged type switches (25.7%), while earth switches account for the remaining 40.6%. These assets are essential for the safe isolation and earthing of primary plant at terminal stations.

A significant portion of the fleet is ageing, with approximately 13.8% of units exceeding 50 years of service, and many showing signs of technical obsolescence, mechanical wear, and increased safety risks. AusNet's management strategy centres on a risk-based replacement approach, ensuring that replacement decisions are economically justified and aligned with broader station and circuit breaker upgrade programs. This integrated approach aims to optimise installation costs and minimise operational disruptions during outages.

Between 2027 and 2032, AusNet's major station replacement programs will focus on replacing the majority of disconnectors and earth switches identified as being in poor or very poor condition. Additionally, disconnectors requiring replacement outside these major programs will be synchronised with the 22kV and 66kV circuit breaker asset replacement initiatives, ensuring efficient and coordinated asset renewal across the network.

1.1. Asset Strategy Summary

AusNet's asset strategy for disconnectors and earth switches focuses on proactively managing risk, ensuring safety, and maintaining reliability through a targeted program of replacement, refurbishment, spares management and maintenance activities. The approach implements a targeted replacement schedule for critical asset models, including:

- [C.I.C] (500kV) - (Major Projects)
- [C.I.C] (330kV and 220kV) (Major Projects)
- [C.I.C] (66kV) (Asset replacement and Major Projects)

These models are increasingly maintenance-intensive and lack OEM support, making refurbishment impractical and spare parts scarce. Typical performance failures are characterised by high resistance contacts, insulator failures and for motor driven models, driveline seizures or electrical control malfunctions. Recent years have seen major failures in [C.I.C] and [C.I.C] models, causing unplanned outages and affecting customers and markets. Manually operated mechanisms also present safety risks due to stiff operation and mechanical failures.

For new assets, only fully type-tested disconnectors and earth switches are procured, applying lessons learned to optimise specifications and meet current standards. Maintenance follows internal procedures, (PGI 02-01-02), with annual thermo-vision scans (as per SMI 67-20-01) used for early detection of deterioration.

The spares strategy involves maintaining a strategic inventory aligned with spare holding policies and continue utilising major station replacement projects, as a source of salvaging assemblies from asset types that lack manufacturer support or all available spares are used up.

The refurbishment element involves ongoing collaboration with manufacturers to address mechanical issues, such as stiffness in the 220kV [C.I.C] STA switches. These efforts are part of a broader strategy designed to maintain the performance and reliability of AusNet's transmission network. Refurbishment opportunities are limited due to the declining quality of unsupported or remanufactured components and challenges meeting current safety standards; however, intermediate repair programs will continue until higher risk models can be replaced.

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 disconnectors and earth switches installed in terminal stations in AusNet Victorian regulated electricity transmission 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

This asset management strategy applies to all disconnectors and earth switches associated with the AusNet regulated asset base electricity transmission network that operate at 500kV, 330kV, 275kV, 220kV, 66kV, 22 kV, 11 kV and 4.5 kV in terminal stations.

The following related assets are excluded from this report:

- Disconnectors and Earth switches installed in GIS/Metalclad Switchgear (covered by AMS 10-62).
- Unregulated Disconnectors and Earth switches

2.3. Asset Management Objectives

As stated in AMS 01-05 Strategic Asset Management Plan, asset management objectives are:

<table>
<tr><th colspan="8">Trusted to bring the energy today and build a cleaner tomorrow</th></tr>
<tr><th colspan="6">Strategic Pillars</th><th colspan="2">Ambition</th></tr>
<tr><th colspan="4">Safely deliver our customer's energy needs today</th><th>Create the energy network of tomorrow</th><th>Enable the transition to a net zero future</th><th colspan="2">Be a leader in asset management practice</th></tr>
<tr><th colspan="6">Asset Management Objectives</th><th colspan="2">Enabling AMOs</th></tr>
<tr><td>Safety: Minimise risk to our people, contractors, customers and communities AFAP across our networks</td><td>Reliability: Meet the reliability expectations of our customers and communities, and meet our reliability targets</td><td>Resilience: Improve the resilience of our network to adapt to a changing climate and energy system environment</td><td>Compliance: Comply with all legislation, regulations, relevant standards and industry codes</td><td>Planning and decision-making: Deliver valued planning and network outcomes through optimising asset lifecycle management</td><td>Sustainability: Build stakeholder trust and deliver social value. Reduce our environmental impact. Operate efficiently to sustain financial value creation.</td><td>Competency and capability: Develop asset management capability and competency in the organisation</td><td>Continuous improvement: Continually improve asset management maturity for effective delivery of services</td></tr>
</table>

3. Asset Description

3.1. Function

Disconnectors and Earth Switches are used at 500kV, 330kV, 275kV, 220kV, 66 kV, 22 kV,11 kV and 4.5 kV in terminal stations. Disconnectors are mainly 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.

Most ganged disconnectors are fitted with earthing switches and separate standalone earth switches are also provided for earthing of certain equipment as required by the design to connect de-energised equipment to the general mass of earth and permit safe access for maintenance work.

3.2. Population

AusNet has a total of 4104 switches comprised of 2438 disconnectors and 1666 earth switches installed in AusNet terminal stations as of 22 Sep 2025. Most disconnectors are installed outdoors and are either manually or automatically operated. Earth switches are typically gang operated and an integral part of a disconnector / earth switch or as a separate standalone earth switch outdoor type earth switches.

Figure 1 below illustrates various types of disconnectors and earth switches in service in terminal stations in AusNet regulated network. It is noted that single phase operated under slung disconnectors (ISOL) contribute to 36.45% of the disconnector population. Three phase gang operated disconnectors (ISOLGNGD & ISOLROTARY) contribute to about 22.95% of the total population of switches. Outdoor type earth switches contribute to about 40.59% of the total population of switches.

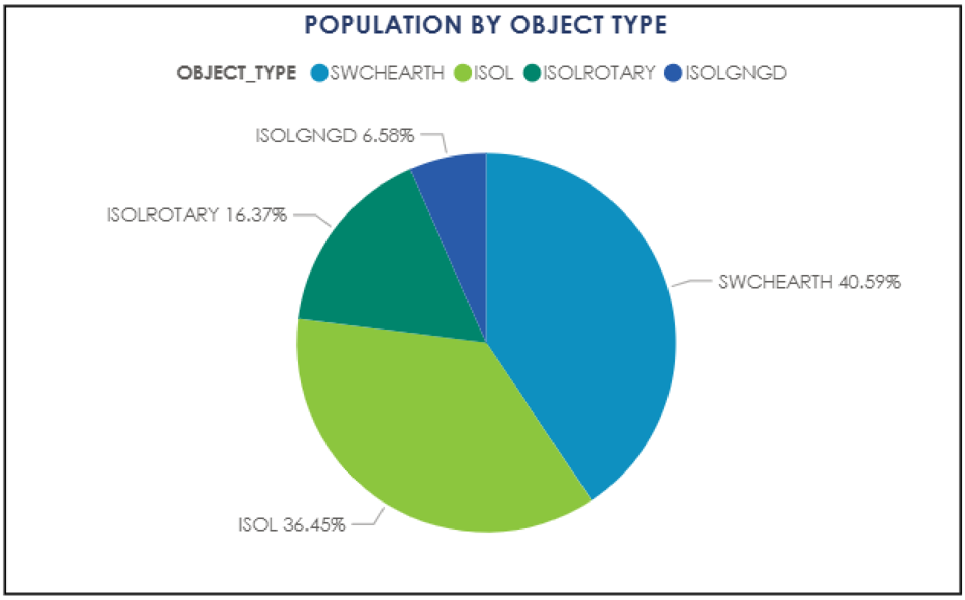

Figure 1: Population of disconnectors and earth switches by Objective Type

Figure 2 below shows various types of disconnectors and earth switches by service voltage in terminal substations in AusNet network. The larger population of Switches are found in the 220kV Transmission network, approx. 48.12%. Followed by 66kV transmission network approx. 28.6% together constitute 76.72% of the total population of disconnectors and earth switches.

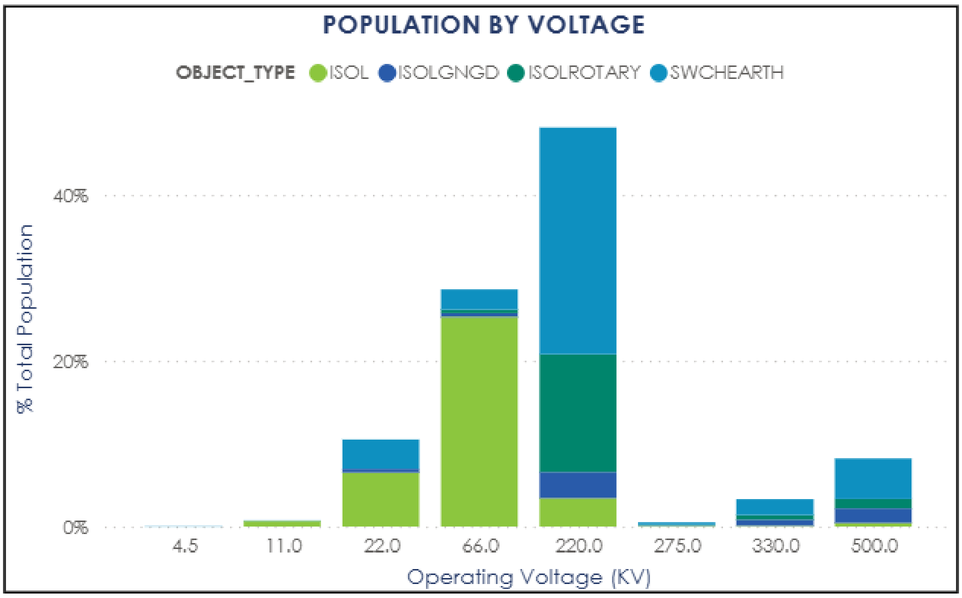

Figure 2: Population of Disconnectors and earth switches by service voltage and type

3.3. Age

The service age profile of terminal station disconnectors and earth switches by service voltage is shown in figure 3. About 10% of the total population of switches are older than 50 years old. Approximately 5.5% operate at 66kV & below while 3% operate at and above 220kV.

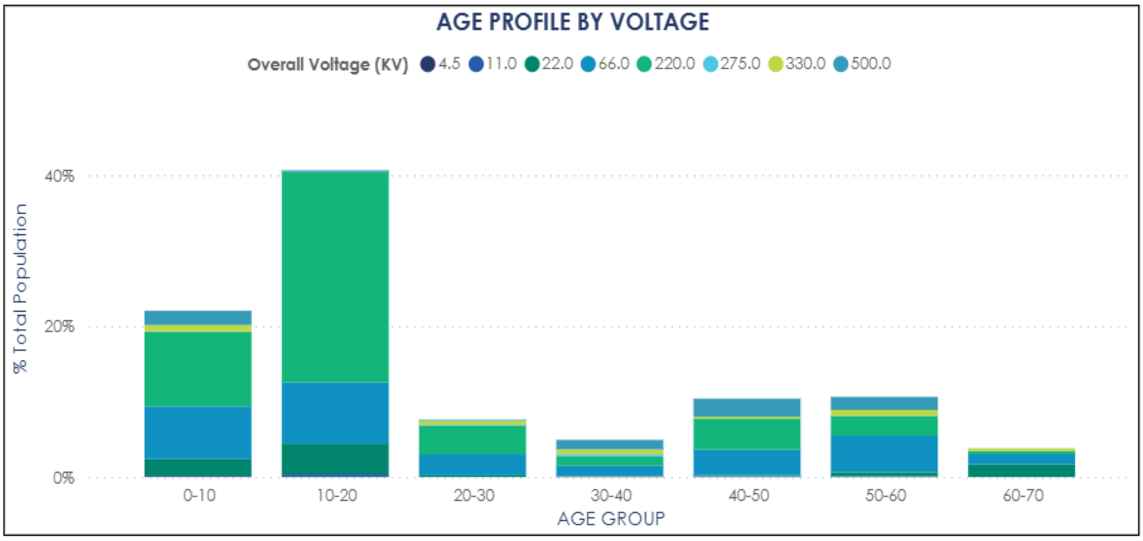

Figure 3: Age Profile of Disconnectors and Earth switches

Figure 4 provides the service age profile of disconnectors and earth switches by objective type.

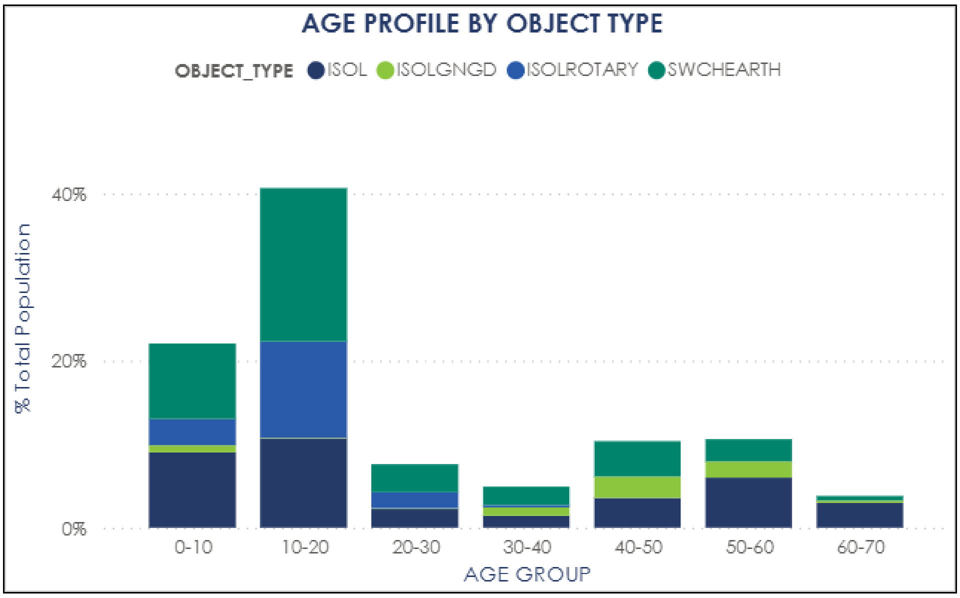

Figure 4: Age Profile of disconnectors and earth switches by Type

Approximately 13.8% of the total population are older than 50 years old. From a type of perspective, approximately 8% of total population in this age bracket are the single-phase underslung type. These are mainly [C.I.C], [C.I.C], C729 and [C.I.C], and [C.I.C], make where the support insulators are mainly cap and pin type. Cap and pin type have a historical failure of insulators breaking away from the metal pin and posed operator safety risk during operation and maintenance activities.

Approximately 1.8% of the total population in the older than 50 years age bracket are ganged horizontal and vertical break type switches. These are mainly [C.I.C], and [C.I.C], types. The remainder are their associated earth switches.

4. Asset Performance

AusNet routinely analyses the root cause of unplanned work undertaken on disconnectors and earth switches and investigates all major failures and tracks their effects on reliability and power quality to the customers.

Assessing the performance of instrument transformers is an important part of managing their lifecycle. It helps asset managers understand how these assets behave in different conditions, which supports better decisions around maintenance, upgrades, and replacements. At AusNet, this involves looking at failure trends and the impact of those failures to get a clearer picture of asset health and reliability. This kind of insight allows for more proactive planning and helps improve the safety and efficiency of the transmission network

4.1. Defect Analysis

4.1.1. Notification Data

All terminal station disconnectors and earth switches are routinely maintained in accordance with PGI 02-01-02 and relevant standard maintenance instructions (SMI).

Analysis of corrective maintenance work (ZA - condition based and ZK – urgent work orders) carried out during 2020- to mid-year 2025 period is shown in Figure 5,6,7,8 &9.

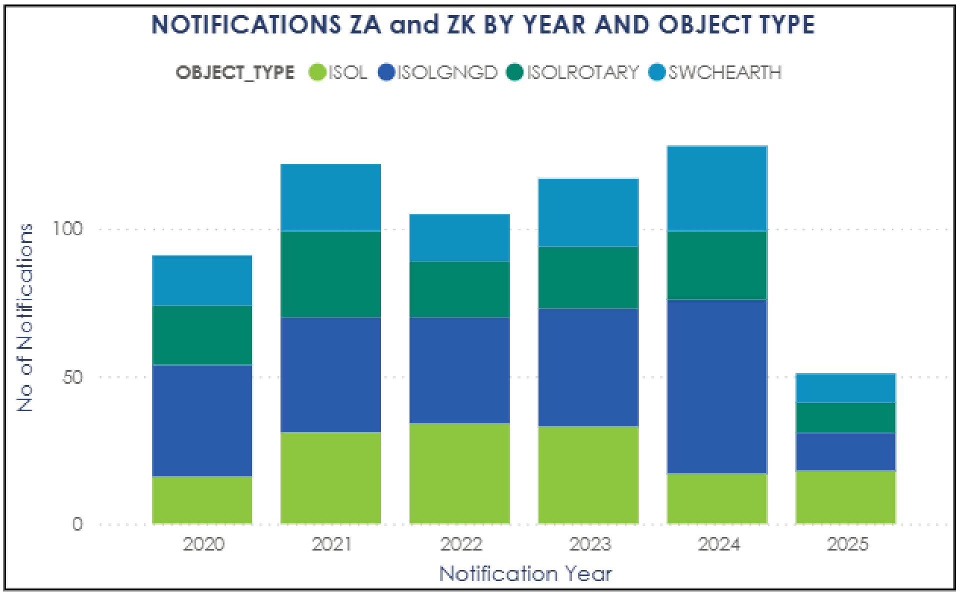

Figure 5: ZA and ZK Notification by object type of Switches - 2020-mid 2025

Figure 5 above shows notification trends for four object types of Disconnectors (ISOL, ISOLNGND, ISOLROTARY) and Earth Switch (SWCHEARTH) from 2020 to mid-2025. Notification volumes were relatively lower during 2020 to 2022, likely influenced by the COVID-19 pandemic, which may have affected inspection schedules, reporting practices, and asset access. From 2023 onward, there's a clear upward trend, with 2024 showing the highest number of notifications across all object types particularly ISOL and ISOLNGND suggesting increased asset stress or improved detection. ISOLROTARY and SWCHEARTH also saw noticeable rises in 2024, indicating emerging reliability concerns. While 2025 shows a decline, the data only covers the first half of the year, so full-year trends remain uncertain.

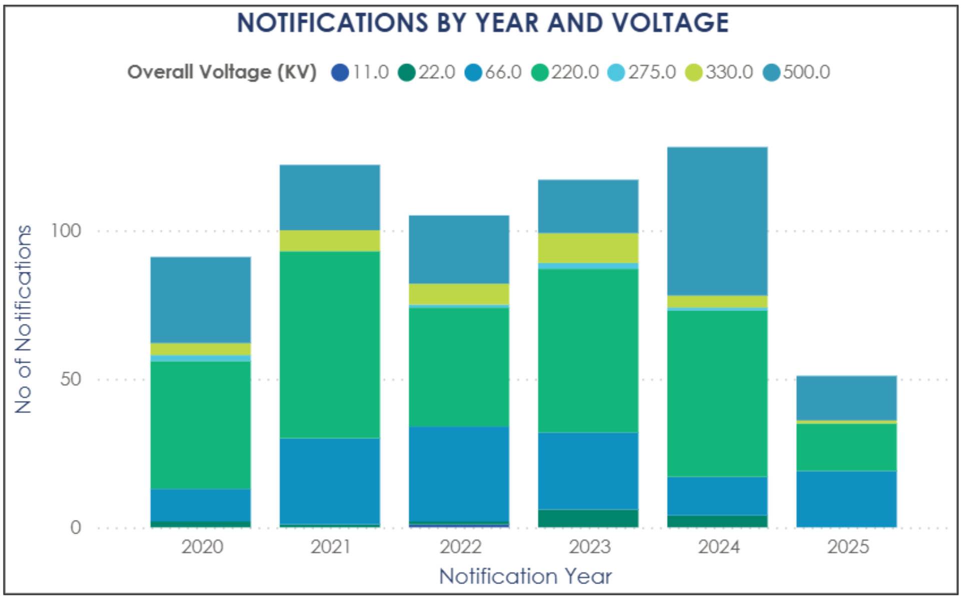

Figure 6: ZA and ZK Notification by year and operating voltage - 2020-mid 2025

Figure 6 highlights from 2020 to mid-2025, notifications at 66 kV and above show a clear upward trend post-COVID, with 2024 marking the peak across most voltage levels, especially 220 kV and 500 kV. The lower counts during 2020-2022 likely reflect pandemic-related inspection delays. 66 kV shows steady growth, while 275 kV and 330 kV rise sharply in 2024, indicating emerging reliability concerns. Notifications drop in 2025, though only half-year data is available, so the full-year trend remains uncertain.

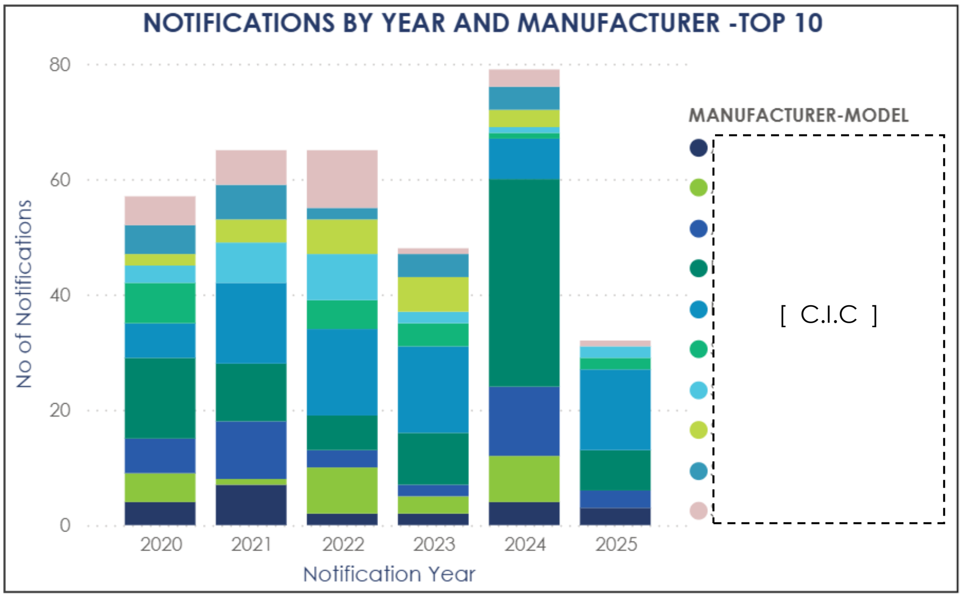

Figure 7: ZA and ZK Notification by Manufacturer - 2020-mid 2025 (top 10 by noti counts)

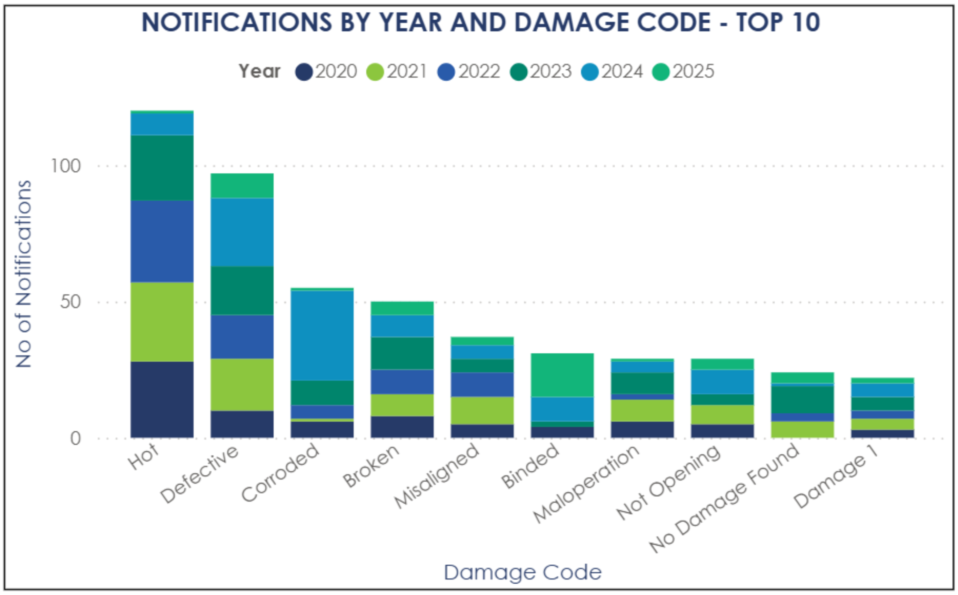

Figure 8: ZA and ZK Notification by Defect - 2020 -mid 2025 (top 10 by noti counts)

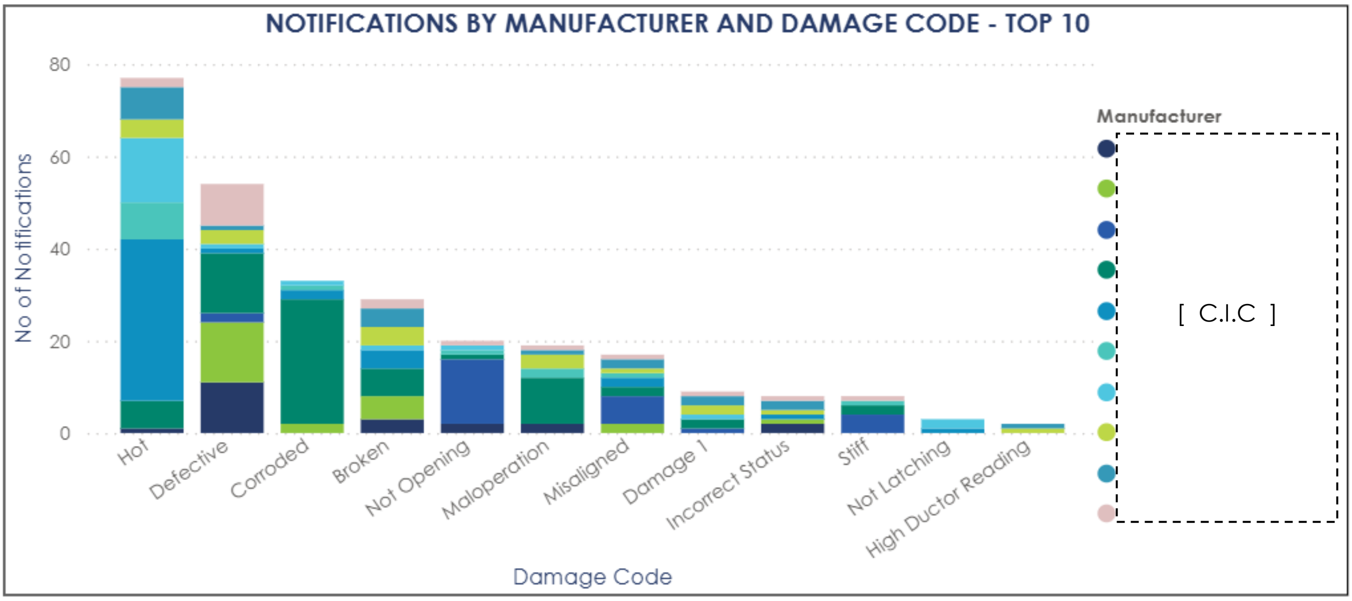

Figure 9: ZA and ZK Notification by Defect - 2020- mid 2025

(top 10 manufacturer by noti counts)

The following observations were derived from Figures 5, 6, 7, 8, and 9:

- Between 2020 and mid-2025, 500kV [C.I.C] switches recorded the highest number of ZA notifications, with a notable spike in 2024. This increase was primarily driven by stalling mechanisms, which led to motor burnout and wiring earth faults caused by moisture/dust ingress and corrosion. As an intermediate measure to improve reliability, motors across the fleet have been re-wound and replaced and that program of works is almost complete. The root cause of the problem, however, is stiff joints and linkages due to sticky grease and dust ingress. Resolution of this problem requires a mid-life full refurbishment, which is not considered normal maintenance would require a step-change in OPEX.

  The same [C.I.C] ROI's incorporate Earth Switches, which are also prone to moisture ingress at the mechanism boxes with subsequent auxiliary contact corrosion that leads to incorrect SCADA signalling. This is considered an operational safety risk.

  The average age of these [C.I.C] switches is about 44 yrs and they are currently maintenance intensive requiring frequent intervention. The cost of a full 'reverse engineered' refurbishment is expected to represent a significant portion of the capital investment. The [C.I.C] fleet are obsolete and unsupported by the OEM. This unavailability of key components such as, gear boxes, insulators and motors from suppliers. The issue is particularly critical for complex linkage arrangements that depend on OEM parts and support. A growing number have been tagged an inoperable and a targeted refurbishment program has been undertaken to keep them operational until replacement. The replacement of [C.I.C] fleet has begun in the current regulatory period 2022-27 at MLTS.

- 66kV (& 22kV) [C.I.C] and [C.I.C] type under slung isolators recorded the next highest ZA notifications during the period 2020 - mid 2025, mainly due to high resistance contacts and latching problems. The average age of these isolators is about 39 and 31 years respectively. They are manually operated by hook sticks for equipment isolation during network operation & maintenance activities more frequently than typical 220kV and above ganged disconnectors and earth switches is the main cause for developing issues in midlife.
- 220kV [C.I.C] recorded the third highest ZA notifications during the period 2020- mid 2025, mainly due to corrosion, high resistance contacts, misalignment and latching problems. The average age of these switches is about 48.8 yrs, and they are becoming maintenance intensive, requiring frequent intervention.

4.1.2. Detailed Analysis of Notification

Table 2 below presents the notification rate per switch, categorised by manufacturer and model, for the period spanning from 2020 to mid-2025. The three selected voltage classes account for over 86% of the total switch population. In general, higher voltage classes tend to exhibit a greater number of notifications per switch. Key observation and analysis are listed below:

Voltage	Make	Model	Number of Notifications	Number of Switch with Notifications	Total Switch Population	Percentage of Switch with Notifications	Average Notification per Switch
500kV	OVERALL		135	79	296	27%	0.46
	[C.I.C]	[C.I.C]	85	45	114	39%	0.75
	[C.I.C]	[C.I.C]	24	16	66	24%	0.36
220 kV	OVERALL		248	162	1966	8%	0.13
	[C.I.C]	[C.I.C]	23	11	58	19%	0.40
	[C.I.C]	[C.I.C]	41	21	176	12%	0.23
	[C.I.C]	[C.I.C]	16	9	53	17%	0.30
66kV	OVERALL		124	91	1131	8%	0.11
	[C.I.C]	[C.I.C]	21	14	148	9%	0.14
	[C.I.C]	[C.I.C]	4	3	21	14%	0.19
	[C.I.C]	[C.I.C]	6	5	116	4%	0.05

Table 2: ZA and ZK Notifications per switch by Manufacturer and model 2020-mid 2025

- [C.I.C], operating at the 500 kV level, has a notably high notification rate of 0.75 per switch. This is well above the fleet average of 0.45. Meanwhile, [C.I.C], despite a lower notification rate, has an average in-service age exceeding 55 years and has shown signs of mechanical degradation, such as operating drive latching failures and stiffness in the mechanism. Both [C.I.C] and [C.I.C] are included in the proposed rebuild projects at HWTS and LYPS, alongside the high-risk Siemens 3AT5 circuit breakers, as part of a strategy to achieve long-term economic and operational efficiency.
- At the 220 kV level, [C.I.C] type exhibits an average notification rate of 0.4 per switch. This is more than three times higher than the overall average of 0.13 for this voltage class. This is followed by [C.I.C] with a rate of 0.3, and [C.I.C], at 0.23. These elevated rates suggest that certain models within the 220 kV fleet may require closer monitoring or prioritisation for maintenance or replacement planning.
- The [C.I.C], switch type, typically paired with high-risk [C.I.C], bulk oil circuit breakers, shows a notably lower notification rate compared to the overall 66 kV fleet. This reduced rate may be influenced by the fact that approximately 60% of the 116 switches are currently being replaced under Major station projects such as at BLTS, SHTS, and TSTS. Some defects are also fixed at time of manual operation and during maintenance,

such as latching issues, and there may be under-reporting of the extent of issues. As a result, the true average notification rate per switch for this type is likely closer to 0.1, reflecting the impact of ongoing asset renewal efforts and the gradual removal of technically obsolete equipment.

4.2. Major Failures

There had been four significant incidents reported during the period 2020 - 2025 of disconnector and switches in Terminal Stations. These incidents resulted in near misses of serious injury to operators while operating them.

In 2020, a hot spot was detected from a routine thermal investigation on a [C.I.C], disconnector at HYTS, necessitating an unplanned outage. High resistance readings were recorded across the affected phase, and the primary cause was determined to be incomplete operation of the double action 'roll-over' contacts during their last use. Additionally, the contact fingers were noted to be worn. Contacts on the moving contact arm and fingers on one of the fixed jaws were replaced, resolving the issue. This was an isolated and repairable problem at a mid-life return on investment, and it did not have a significant effect on asset lifespan. The fleet continues to be monitored for similar incidents to identify any potential trends or fleet related issues.

In Jun 2024, a 500kV [C.I.C], ROI was in mid-operation at MLTS when a mal operation occurred on a single phase of the associated CB. The mal-operation tripped the 500kV bus and a sustained low-voltage condition resulted across the 500kV network. Investigations found this major incident was initiated from failing windings on the ROI motor, which was faulting to earth under load. The local earth fault de-stabilised the earth reference at the CB and caused the CB trip coil to operate without a protection signal.

In Sep 2024, the No.4 500kV bus at LYPS tripped. A similar [C.I.C], was found to have two faulty 250V DC motors on the isolator during operation. Subsequent investigation confirmed intermittent DC earth faults that only occurred during the switching process. Improvements were made to isolate the CB earth from the ROI, but the failing motor issue is a known problem (described in Section 5) and these incidents were significant enough to trigger a testing, refurbish program on [C.I.C], ROIs across the network.

In 2024 a 220kV [C.I.C], ROI failed to properly close, the cause was attributed to be wear on the linkages that produce rollover action at the contacts. Local repairs were made, and the ROI returned to service, but the wear issue has triggered concerns for other [C.I.C], ROIs. An investigation is planned to be conducted across the fleet in 2026.

Mechanical failures in old, fused disconnector 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 usually starts to appear after 30 to 40 years in service. Between 2023 and 2024, two incidents occurred involving very old underslung isolators that failed while in service. In both cases, the isolators dropped out, resulting in supply imbalance and subsequent asset failures - surge arrester failure at HOTS and a neutral reactor fire at MWTS.

The 220kV [C.I.C] manually operated earth switches, installed in the 2000's across the transmission network, had the fixed and moving contacts binding together resulting in need for excessive force to open presenting an OH & S risk to the operators. Safety gram 2010-012 was issued regarding operation of [C.I.C] 245 earth switches. [C.I.C] subsequently proposed a modified blade with fixed and moving contacts to overcome this issue and it is being implemented at all sites.

The 220kV [C.I.C], manually operated earth switches, installed between 2008 to 2013, have had stiff operation issues that can result in excessive force having to be applied, frequently causing earth switches to jam closed. Once this occurs, access equipment is required to manually force blade out of the jaws. This issue has been under investigation with supplier for 10 years and cannot be attributed to any operator group, or region, it appears to be an inherent deficiency in the design. Multiple proposals for resolution have been proposed by the OEM and attempted, although the matter remains unresolved. To avoid re-occurrence, all EHV 220kV earth switches (and higher voltages) installed since 2013, have been fully motorised. To further mitigate the problem, AusNet have required the same voltage range of Earth Switches to utilise a form of contacts which require low physical energy to operate.

4.3. Type Issues

The table below lists key issues with older disconnector and earth switch types that require special intervention.

DESCRIPTION	KEY ISSUES
500 kV [C.I.C], make Disconnectors and Earth switches	• Major issues with operating drive, gearbox seizures. • Wiring and motor DC earth faults contribute ROI not operating electrically or remotely. • Moisture ingress into mechanism box. • Heavy corrosion on rotating stack insulator.
220 kV,330 kV & 500 kV [C.I.C], make Disconnectors and Earth switches	• Stiffness, Mechanism seizures, corrosion, drive rod failures, mechanism failures, alignment issues. • Frequent contact resistance issues due to corrosion. • Control circuit failures and switches not operating electrically. • No support from manufacturer
220 kV [C.I.C], and [C.I.C], Disconnectors and Earth switches	• Problems due to electrical control system issues such as auxiliary switch defects, incorrect status indication, alignment issues. • Damages to support insulators and one case of mechanism seizure reported. • Contact system failures and high resistance contacts, defective blades, and burnt contacts. • Drive rod failures, alignment issues and defective mechanisms. • Electrical control failures, failure to operate electrically or remotely. • No support from manufacturer
66 kV [C.I.C], [C.I.C], and [C.I.C], make switches (with Cap and Pin type insulators)	• Locking pin misalignment. • Wear and tear. • High resistance contacts. • Latching problems. • Brown cap and pin type support insulator failures due to grout expansion and pin corrosion. • No support from manufacturer

Table 3: Disconnector and Earth switch Type Issues

5. Asset Health

The asset health condition is illustrated by the likelihood of failure profile derived from the data and insights presented in Section 4 Asset Performance of this document, specifically within the performance analysis. The following graphs illustrate the likelihood of failure profiles from multiple perspectives, including object type, voltage level, and asset age, and the likelihood score reflects the probability of failure, with 1 being the least likely and 5 being the most (Refer to the table below and AMS 01-09 for detail). By examining these dimensions, we can obtain a comprehensive view of the asset health condition and the associated program of work proposed.

LIKELIHOOD BUCKET	LIKELIHOOD SCALE
5	Very Likely
4	Likely
3	Possible
2	Unlikely
1	Very Unlikely

Table 4: Likelihood Scale

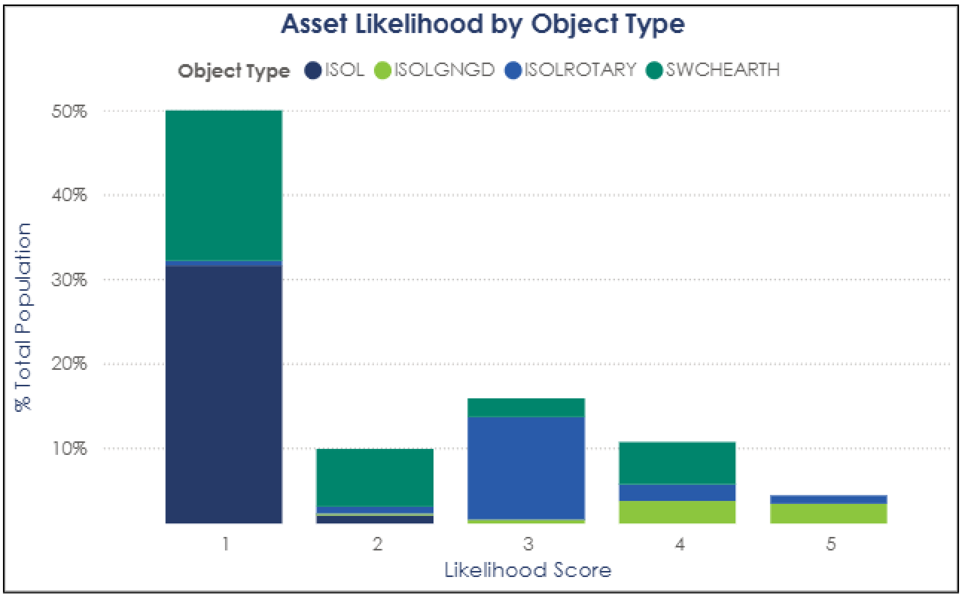

Figure 10: Disconnectors and Earth Switches Likelihood Score by Objective Type

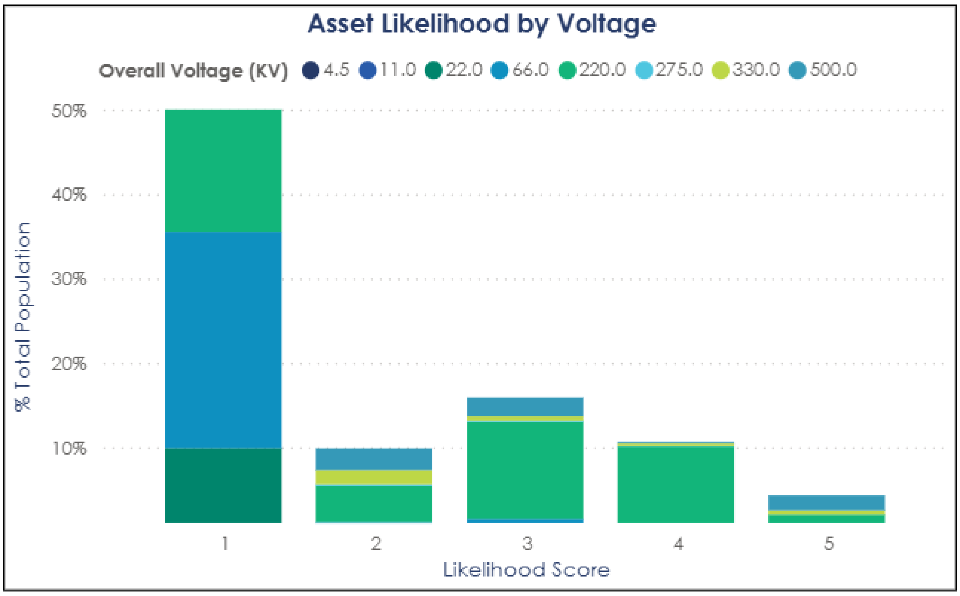

Figure 11: Disconnectors and Earth Switches Likelihood Score by Voltage Class

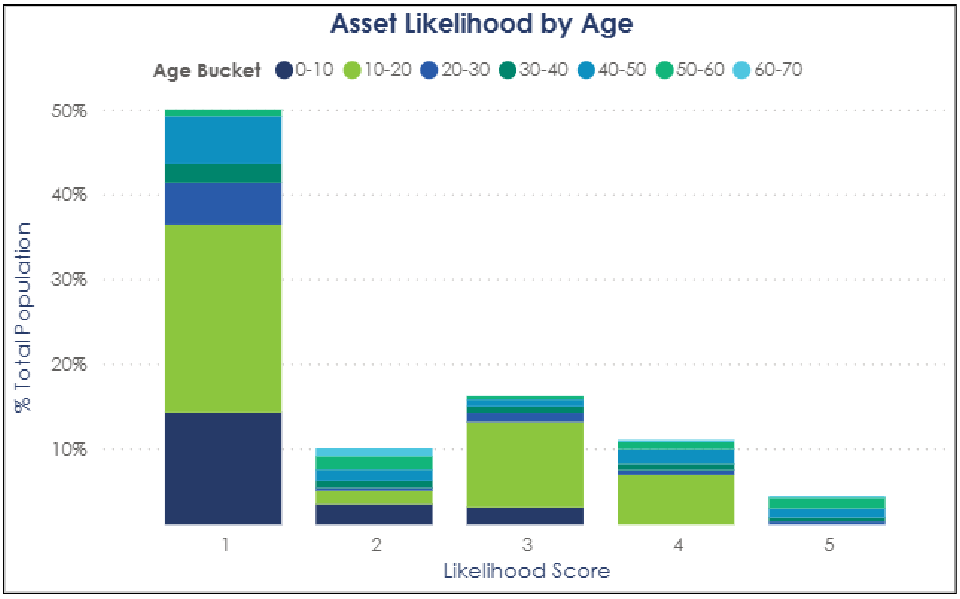

Figure 12: Disconnectors and Earth Switches Likelihood Score by Age Profile

Key Findings on Asset Health Conditions Derived from the Figures above:

- All 500kV [C.I.C] disconnectors, which had two failures in 2024, one of which was a motor DC earth fault resulting in a bus trip at LYPS, have been given a likelihood score of 4 or 5, indicating an elevated risk classification for the fleet. Key contributing factors include heavy corrosion on the stack insulator and moisture ingress into the mechanism box. Similarly, the [C.I.C] units, with an average age of 56 years, have a likelihood score of 4 or 5, indicating an elevated risk of failure. These [C.I.C] disconnectors are approaching end-of-life, with an obsolete technical design and the manufacturer no longer provides support. A major rebuild project is proposed under TRR 27–32 to replace the above-mentioned high-risk disconnectors, ensuring the continued safe operation of Victoria's 500kV network backbone.
- The over 45-year-old 66kV [C.I.C], type underslung disconnectors also carry a likelihood score of 4 or 5, indicating an elevated high risk of failure. These manually operated units are included in a separate proposed rebuild project, alongside the replacement of their associated [C.I.C], minimum oil circuit breakers. The replacement of these disconnectors aims to address issues such as high-resistance contacts and latching problems that have been observed in service.

- The 66kV [C.I.C] type and [C.I.C], type disconnectors, installed at certain terminal stations alongside LG4C bulk oil circuit breakers, have an average in-service age exceeding 55 years. These assets are no longer supported by OEM and have been assigned a likelihood score of 4 or 5. Given their age, technical obsolescence, and lack of OEM support, replacement is considered more economical than refurbishment.

All the likelihood 5 and portion of 4 assets are proposed to be replaced as part of major station and asset replacement projects in the 2027-32 period. The remaining younger likelihood 4 category are under investigation and will be addressed through a refurbishment program with OEM support.

6. Related Matters

6.1. Cap and Pin support insulator failures

Cap and pin style insulator types used in older disconnectors and are also used as bus bar support insulators in older terminal stations. Cap and pin style insulator types eventually fail through cement growth causing insulator cracking or pin drop out, in turn causing insulation electrical failure or more insidious a lack of mechanical strength. This is a specific safety concern where operation is manually performed underneath the switch. This applies to many of the 66 kV Underslung Stanger and Taplin make switches included in the proposed replacement.

6.2. Very low operation of switches

Switches that operate very rarely are often found to be difficult to open 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 or consider reduced maintenance frequency are the alternatives available to overcome this issue.

6.3. Technical obsolescence and spares management

Manufacturers generally completely cease support 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. The nature of reverse engineering components typically means results in reduced quality and or durability compared to original OEM parts. Additionally, reused components cannot economically extend asset lives further and at this point it will become technically obsolete.

The 500kV [C.I.C], make, 220kV [C.I.C], and [C.I.C], types, 220kV to 500kV [C.I.C], make, the 220kV [C.I.C], and 66kV [C.I.C], and [C.I.C], types, the 66kV [C.I.C], and [C.I.C], and [C.I.C], Air Brake Switches are all technically obsolete and the availability of new spares is particularly difficult to maintain these fleets.

6.4. Increasing Station Rating Requirements

The energy transition towards renewable generation, plus projected new loads (typified by Data Centres) are driving a net increase in alternative power flows with requirements for supplementary transformers that are envisaged to both increase nominal power and (potentially) fault current at key terminal stations. In most cases, older assets have lower ratings and these will require regulatory replacement to meet the demand of forthcoming developments.

6.5. Refurbishment

Refurbishment/part replacement of older existing disconnectors and earth switches is not cost effective as in most instances parts are required to be re-engineered due to technical obsolescence. Type tested performance cannot be guaranteed with modified components in disconnectors without testing or proven as safe. Nor can these easily be brought up to more modern safety standards, such as 220kV and above are now fully motorised operation (no manual handling and less direct exposure during operation) and greater clearances for safer operational access. Therefore, replacement is considered as the economically feasible option for older types.

7. Proposed Program of Work

7.1. Approach

7.1.1. Risk

AusNet's asset management decisions within the transmission network are guided by a risk-based approach, ensuring alignment with our organisational risk appetite. For disconnectors and earth switches, risk treatment required to achieve this over time involves replacement & maintenance activities. Justification for these projects are developed based on current risk and extrapolated risk.

The risk of each asset is calculated as the product of Probably of Failure (PoF) of the asset and the Consequence of Failure (CoF). This risk is then extrapolated into the future accounting for forecast changes in PoF and CoF.

AusNet's approach to asset risk management is detailed in REF: AMS 01-09 Asset Risk Assessment Overview.

Asset Risk Quantification Methods

The conditional Probability of Failure (PoF) for Disconnectors and Earth Switches is derived from all recorded corrective maintenance activities, including all ZA and ZK notifications.

A trained machine learning system, using all ZA/ZK notifications and a Random Forest advanced statistical model is used to correlate asset characteristics and measurements with the likelihood of defects and failures. The model output is calibrated against historical annual averages of ZA/ZK notifications and validated by subject matter experts. It delivers results consistent with previous assessment methods, eliminating the need for manual analysis.

The system generates a one-year-ahead forecast, calibrated against recent actual volumes of ZK and ZA notifications, ensuring alignment with observed intervention rates. Future-year PoF forecasts are extrapolated from the base-year forecast using Weibull parameters established by AusNet. For a detailed explanation of the methodology, refer to AMS 01-09.

Failure modes used for condition assessment to accurately target PoF, include the following:

1. Current path - the following key issues are associated with the current path, listed in order of decreasing significance:

- High resistance contacts
- High resistance connections
- Defective blade/contacts/Pivot joints
- Broken Braids
- Broken Rollover Mechanism

2. Electrical control - the following key issues are associated with the electrical control system, listed in order of decreasing significance:

- Auxiliary Switch Defect
- Limit Switches/Micro Switches
- Incorrect status /Alarms/COMMS
- Wiring Fault
- Does not operate remotely

3. Insulators - the following key issues are associated with the insulator, listed in order of decreasing significance:

- Physical damage/Cracked mortar

- Corona ring defect
- Bird nests
- Arcing damage

4. Operating drive - the following key issues are associated with the operating drive, listed in order of decreasing significance:

- Stiff
- Defective collars/Castings/Housing
- Out of alignment
- Defective motor
- Gearbox defective/Bushes

Consequence of Failure

AusNet assigns a monetised value to CoF which provides an economic basis of calculating potential consequence.

The cost of failure is assessed through key lenses: Safety, Customer/Market Impact and Financial consequences. These lenses provide a structured view of the potential impacts resulting loss of energy supply, injury to employees or members of the public, or environmental hazards. Table 4 summarises the focus of each lens.

CONSEQUENCE LENSES	DESCRIPTION
Safety	Threat to health and safety of people
Customer / Market	Loss of Supply to Customers Impact on energy market
Financial	Asset/Component replacement costs Collateral damage Emergency response

Table 5: Consequence lens description

7.2. Economic Viability

7.2.1. Economic Model

AusNet use the calculated risk based on PoF and CoF outputs to identify optimal intervention years, balancing technical feasibility with economic efficiency. These outputs are incorporated into an economic model combined with the circuit breaker model. The economic model demonstrates the year when the calculated annualised risk is higher than the annualised replacement cost, and as such when the asset becomes economically viable to replace. The concept is shown visually in figure 10 below.

The economic model is producing a structured approach for each asset in the fleet. The economic model for disconnectors and earth switches is included with their respective circuit breakers replacement program as a combined replacement asset class economic model REF: ANT - TRR 2027-32 Asset Replacement Economic Model – Circuit breakers, Disconnector & Earth switch combine – Final

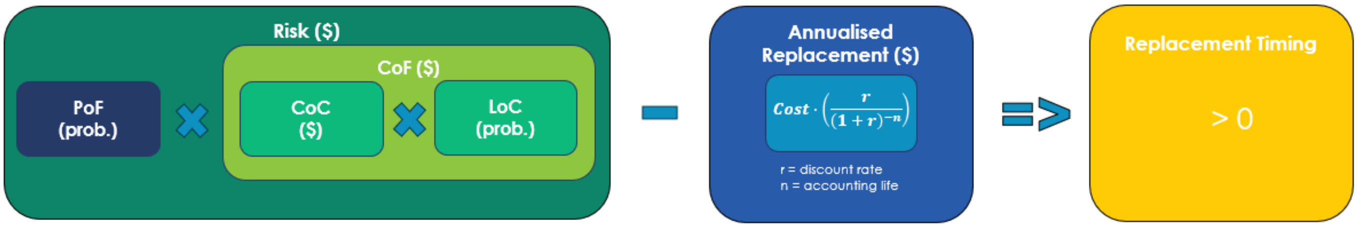

Figure 13: Viability Calculation

7.3. Output Validation

Following the advanced statistical model calculations and Weibull forecasts, a structured validation process is undertaken by SME. This step is intended to support the interpretation of model outputs in the context of engineering interventions, operational insights, and current asset condition.

SMEs assess whether the model's recommendations such as, asset replacement, refurbishment or no action are reasonably practicable. This involves verifying condition data, evaluating operational priorities, and considering strategic timing of interventions. Where appropriate, SMEs may recommend alternative actions based on their professional assessment.

This validation process complements the use of economic model forecasts by integrating predictive outputs with expert knowledge. It supports a balanced and accountable approach to asset management, one that upholds technical integrity while remaining responsive to operational realities.

7.4. Proposed Program

The proposed replacement program for disconnectors and earth switches is driven by a combined risk and economic assessment, and alignment with adjacent circuit breaker replacement. This assessment considers the condition of both circuit breakers and their associated disconnectors and earth switches.

The proposed asset replacement program list of assets is provided in Appendix 1. The [C.I.C] and [C.I.C] 66kV underslung disconnectors listed are all linked to the 66kV [C.I.C] Bulk Oil Circuit Breaker replacement program and single 22kV Email 345GC bulk oil circuit breaker replacement, which is being proposed across several terminal stations for TRR 2027-32. The drivers of this program are supply reliability and operator health and safety risk where operator health and safety are the dominant driver.

The proposed Major station replacement programs address the majority of the other deteriorating types 500kV [C.I.C], 330kV [C.I.C], 220kV [C.I.C]and [C.I.C], 220kV [C.I.C]and as well 66kV [C.I.C] and [C.I.C] types. This is the case as many of the other poor/very poor condition disconnectors are associated with poor/ very poor condition circuit breakers. Proactive replacement of poor condition Disconnectors and earth switches is done most efficiently when replacements are coordinated with the planned asset replacement of associated switchgear.

Some lower risk but deteriorating asset types remain without strategic spares. Strategic spares for these other types including the 500kV & 330kV [C.I.C] type are being proactively salvaged from Major Station Projects during the current and next period TRR period to support ongoing maintenance and reliability objectives.

In parallel, AusNet is also actively implementing OPEX based refurbishment programs for disconnector and earth switch assets where OEM support still remains available. This includes Disconnectors and Earth Switches manufactured by [C.I.C]and [C.I.C] (specifically [C.I.C] and [C.I.C] types). These refurbishment initiatives go well beyond basic component replacement; they involve comprehensive condition assessments, selective upgrades, and strategic life-extension activities. By leveraging OEM expertise and technical support, AusNet aims to enhance system reliability, maintain regulatory compliance and optimise asset performance without resorting to full scale replacements.

8. Asset Strategies

The following section summarises the strategies. The itemised program of work for disconnectors and earth switches is presented in Appendix 1.

8.1. New Assets

- Continue to purchase fully type tested disconnectors and earth switches to the latest specification. Specifications have been audited and improved to incorporate lessons learned from the procurement of earlier models. A typical example of these improvements are transitions to motorised drives at 220kV and above, which provide higher torques than manual operation.
- Continue maximise use of factory pre-assembled assemblies to minimise on site builds

8.2. Maintenance

- Maintenance of disconnectors and switches will continue in accordance with PGI 02-01-02.
- Continue with annual thermo-vision scans of all disconnecting switches (as part of station scan and as per SMI 67-20-01).

8.3. Spares

- Maintain strategic spares holding of disconnectors and earth switches as per spare policies
- Continue to salvage major assemblies, of selected types during replacement projects where no strategic spares exist and have no manufacturer support.
- Continue to reverse engineer where possible

8.4. Refurbishment

- Continue investigating stiffness issue and solution with manufacturer of the 220kV [C.I.C] manually operated earth switch
- Investigate [C.I.C] emerging fleet issues and perform refurbishment to extend the life span

8.5. Replacement

- Wherever reasonably practicable, replace poor and very poor condition disconnectors / earth switches in co-ordination with their associated CB.
- Refer to Appendix 1 for details of the disconnectors and earth switches replacement list under the asset replacement program.

9. Resource References

No.	TITLE
1	AMS 01-05 Strategic Asset Management Plan
2	AMS 01-09 Asset Risk Assessment Overview
3	PGI 02-01-02
4	SMI 67-20-01
5	HSP-05-05-1 guideline
6	HSEQ guidelines (HSP 05-32 PCB Management)
7	ANT – TRR 2027-32 Asset Replacement Economic Model – Circuit breakers, Disconnector & Earth switch combine – Final

10. Schedule of Revisions

ISSUE NUMBER	DATE	DESCRIPTION	AUTHOR	APPROVED BY
5	22/11/06	Editorial review.	[C.I.C]	[C.I.C]
6	06/03/07	Review and update.	[C.I.C]	[C.I.C]
7	16/03/07	Editorial review.	[C.I.C]	[C.I.C]
8	18/01/13	Editorial review.	[C.I.C]	[C.I.C]
9	27/07/15	Review and update	[C.I.C]	[C.I.C]
10	01/09/20	Review and update	[C.I.C]	[C.I.C]
11	30/08/2025	Review and update	[C.I.C]	[C.I.C]

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Appendices

Appendix 1 – Program of Works

Floc Description	Start-up Date	Voltage	Manufacturer	Model	Station
2-3 22KV B/T CB 2 B/S ISOL	21/03/1965	22	[C.I.C]	[C.I.C]	BLTS
2-3 22KV B/T CB 3 B/S ISOL	30/06/1965	22	[C.I.C]	[C.I.C]	BLTS
1-2 66KV B/T CB 1 B/S ISOL	30/06/1968	66	[C.I.C]	[C.I.C]	FTS
1-2 66KV B/T CB 2 B/S ISOL	30/06/1965	66	[C.I.C]	[C.I.C]	FTS
CBTS 1 66KV L CB B/S ISOL	30/06/1968	66	[C.I.C]	[C.I.C]	FTS
CBTS 1 66KV L CB L/S ISOL	30/06/1965	66	[C.I.C]	[C.I.C]	FTS
CBTS 2 66KV L CB B/S ISOL	30/06/1968	66	[C.I.C]	[C.I.C]	FTS
CBTS 2 66KV L CB L/S ISOL	30/06/1965	66	[C.I.C]	[C.I.C]	FTS
FSH 66KV FDR CB B/S ISOL	30/06/1968	66	[C.I.C]	[C.I.C]	FTS
FSH 66KV FDR CB FDR/S ISOL	30/06/1965	66	[C.I.C]	[C.I.C]	FTS
FTN 66KV FDR CB B/S ISOL	30/06/1968	66	[C.I.C]	[C.I.C]	FTS
FTN 66KV FDR CB FDR/S ISOL	30/06/1965	66	[C.I.C]	[C.I.C]	FTS
LWN 66KV FDR CB B/S ISOL	30/06/1968	66	[C.I.C]	[C.I.C]	FTS
LWN 66KV FDR CB FDR/S ISOL	30/06/1965	66	[C.I.C]	[C.I.C]	FTS
TBTS 66KV L CB B/S ISOL	30/06/1968	66	[C.I.C]	[C.I.C]	FTS
TBTS 66KV L CB L/S ISOL	30/06/1965	66	[C.I.C]	[C.I.C]	FTS
WN 2 66KV FDR CB FDR/S ISOL	01/01/1970	66	[C.I.C]	[C.I.C]	GNTS
WN 2 66KV FDR CB B/S ISOL	01/01/1970	66	[C.I.C]	[C.I.C]	GNTS
BN 1 66KV FDR CB B/S ISOL	01/01/1970	66	[C.I.C]	[C.I.C]	GNTS
BN 1 66KV FDR CB FDR/S ISOL	01/01/1970	66	[C.I.C]	[C.I.C]	GNTS
BN 2 66KV FDR CB B/S ISOL	01/01/1970	66	[C.I.C]	[C.I.C]	GNTS
BN 2 66KV FDR CB FDR/S ISOL	01/01/1970	66	[C.I.C]	[C.I.C]	GNTS
CHM/IKA 66KV FDR CB B/S ISOL	30/06/1970	66	[C.I.C]	[C.I.C]	HOTS
CHM/IKA 66KV FDR CB FDR/S ISOL	30/06/1970	66	[C.I.C]	[C.I.C]	HOTS
HSM 1 66KV FDR CB B/S ISOL	30/06/1970	66	[C.I.C]	[C.I.C]	HOTS
HSM 1 66KV FDR CB FDR/S ISOL	30/06/1970	66	[C.I.C]	[C.I.C]	HOTS
HSM 2 66KV FDR CB B/S ISOL	30/06/1970	66	[C.I.C]	[C.I.C]	HOTS
HSM 2 66KV FDR CB FDR/S ISOL	30/06/1970	66	[C.I.C]	[C.I.C]	HOTS
KWF 66KV FDR CB B/S ISOL	30/06/1970	66	[C.I.C]	[C.I.C]	HOTS
KWF 66KV FDR CB FDR/S ISOL	30/06/1970	66	[C.I.C]	[C.I.C]	HOTS
STL 2 66KV FDR CB B/S ISOL	30/06/1981	66	[C.I.C]	[C.I.C]	HOTS
STL 2 66KV FDR CB FDR/S ISOL	30/06/1981	66	[C.I.C]	[C.I.C]	HOTS

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