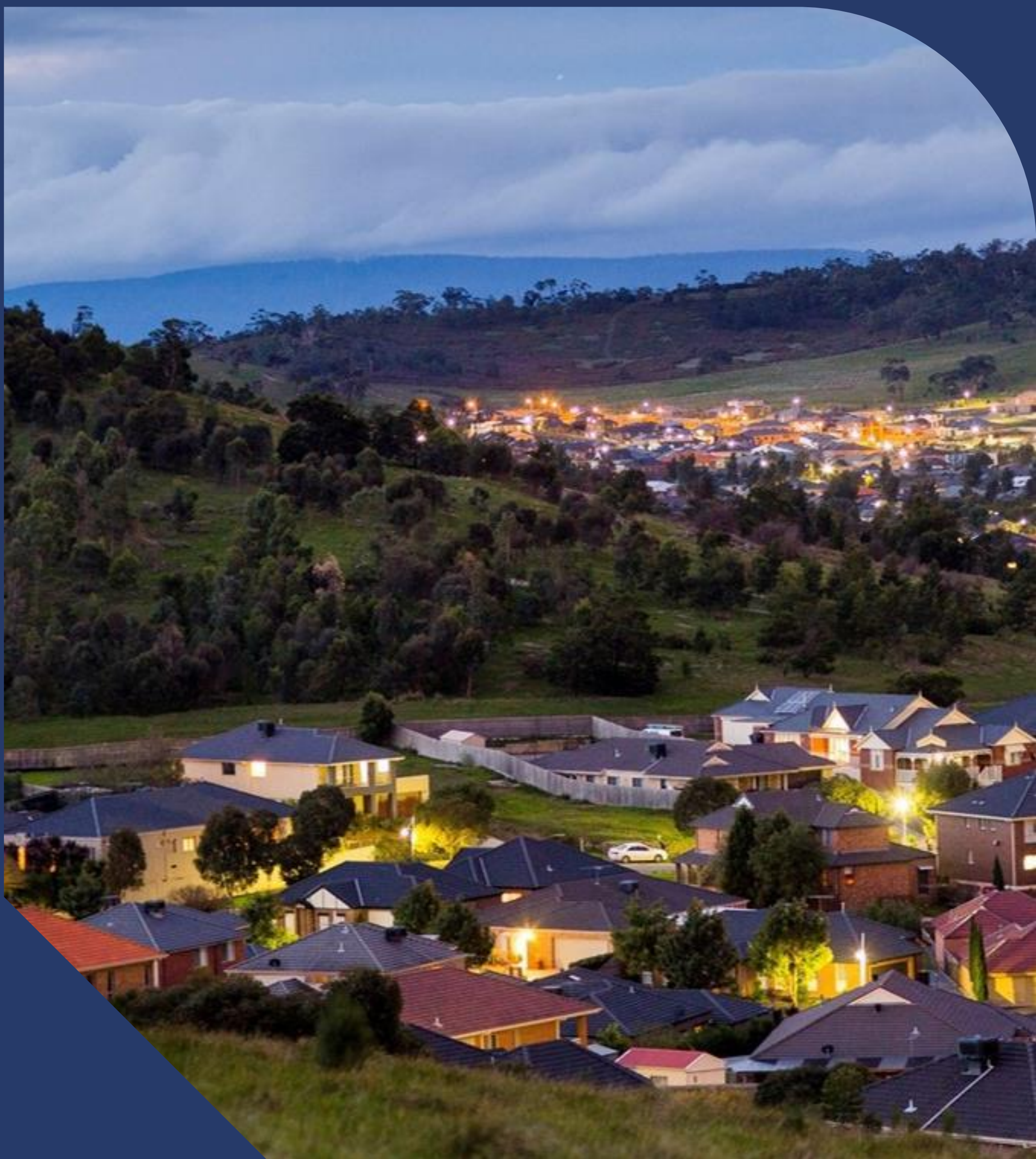
AusNet

# Pole Top Capacitors

## AMS – Electricity Distribution Network



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| **Document number:** | AMS 20-69 |
| **Issue number:** | 3 |
| **Status:** | Draft |
| **Approver:** | Denis McCrohan |
| **Date of approval:** | <insert date published on ECM> |

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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 all Pole Top Capacitors.

This strategy applies to the 69 MV Line pole top capacitors and 462 REFCL LV capacitive balancing units (CBU) installed on medium voltage (MV) distribution feeders. Each Pole Top Capacitor consist of capacitors, a switch with integral sensors and controller and a step-down distribution transformer (if REFCL LV CBU).

Failure risk cost is low compared to cost of replacement of a MV pole top capacitor and does not warrant a proactive risk-based replacement program at this time. However certain MV pole top capacitors can become important under N-1 feeder operating conditions and the present MV pole top capacitors are not able to be connected to SCADA or remotely monitored in real time. Investigation and development of SCADA connected MV pole top capacitor controller is a strategic development.

REFCL LV LBU units are relatively new, and they are all connected to SCADA are being closely monitored for their satisfactory performance for REFCL application.

The summary of proposed asset strategies is listed below.

## 1.1. Asset Strategies

### 1.1.1. New Assets

- Continue to procure pole-top capacitors in accordance with DES 10-03;
- Update and document the inspection criteria in the Asset Inspection Manual (4111-1) for MV and REFCL LV LBU pole top capacitors.
- Consider update of controller specification to include SCADA facility for remote monitoring
- Investigate root cause for battery associated failures in REFCL LV LBU pole top capacitor controllers and suggest design improvements in replacements and equipment specification improvements for future use

### 1.1.2. Inspection

- Continue with routine visual inspection program and conduct thermo-vision scans where required
- All pole mounted capacitors in HBRA and LBRA areas are subjected to regular condition inspections in conjunction with line asset inspections in accordance with the Asset Inspection Manual (4111-1).

### 1.1.3. Maintenance

- Review the capacitor control method (permanently ON, current or voltage controlled) periodically with distribution network changes/ modifications

### 1.1.4. Spares

- Maintain strategic spares holding of one complete unit of each MV Line and REFCL LV LBU pole top capacitor assembly with associated major components; controller, vacuum switches and associated instrument transformers, step down distribution transformer per region

### 1.1.5. Replacement

- Carry out condition based proactive replacement of pole mounted capacitors and controllers (MV line & REFCL LV LBUs) on planned inspection results or replace on failure and monitor controller failure rates
- Investigate economics of providing SCADA indication and control for summer critical pole top capacitor units, when available

# 2. Abbreviations and definitions

| TERM | DEFINITION |
|---|---|
| **HBRA** | Hazardous Bushfire Risk Areas |
| **MV** | Medium Voltage (ex: 22kV,12.7kV) |
| **LV** | Low Voltage (415V) |
| **REFCL** | Rapid Earth Fault Current Limiter |
| **CBU** | Capacitive Balancing Units |
| **Zk** | Work order Notifications associated with failures (unplanned power interruptions) |
| **ZA** | Work order Notifications associated with corrective actions from planned inspections |

# 3. Introduction

## 3.1. Purpose

The purpose of this document is to outline the inspection, maintenance, replacement and monitoring activities identified for economic life cycle management of pole top capacitors 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.

## 3.2. Scope

Included in this strategy is all pole-top capacitors associated with the AusNet electricity distribution network.

Excluded from this strategy are Medium Voltage Capacitor Banks installed in zone substations, which are covered under AMS 20 -53.

## 3.3. 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*.

# 4. Asset Description

## 4.1. Function

There are two types of pole top capacitors in service in AusNet Electricity distribution network.

**MV line Pole Top Capacitors:**

MV line Pole–top capacitors are used to provide reactive power at selected locations in medium voltage feeders to improve the energy transfer efficiency of the immediate and upstream network. In the long radial sections of the medium voltage network, the pole-top capacitors produce a "leading" current that offsets or reduces the "lagging" load current. Compensating the lagging current reduces the network's electrical losses. Pole-top capacitors are strategically positioned closer to the loads causing the "lagging" current to achieve this performance.

These pole-top capacitors are operated by controllers and are either permanently on, voltage controlled or current controlled depending on the requirement at the location.

**REFCL LV Capacitive Balancing Units (LBU):**

With the deployment of REFCL systems in designated parts of AusNet distribution network, new type of pole top capacitors have been established called LV Capacitive Balancing Units (CBU) to maintain balance of network capacitance to earth required for satisfactory REFCL operation.

MV line pole-top capacitor installation typically consists of three MV capacitor cans, a voltage transformer, three single phase switches, current sensors, surge arresters and three single phase MV fuse switches to protect and as required isolate each phase. Additionally, a REFCL LV LBU unit will contain a 25 KVA step down distribution transformer to connect with LV capacitors along with its associated REFCL controllers.

## 4.2. Population

### 4.2.1. Population Considerations

The population profile for pole-top capacitors 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 pole-top capacitors are essential for maintaining the integrity and reliability of the network. For example, a pole-top capacitor installed in a critical industrial area might be deemed essential and require more frequent inspections to ensure uninterrupted service and power quality.
- **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 pole-top capacitors 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 sections of the network have pole-top capacitors prone to environmental stress, 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, pole-top capacitors that form the backbone of 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 pole-top capacitors, meet the required standards for reliability and safety. For example, if the profile reveals that certain components 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 pole-top capacitors in a rapidly developing suburban area need upgrading to support increased demand, guiding future investment in that region.

### 4.2.2. 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 pole-top capacitors. 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 pole-top capacitors to significant stress and fatigue. Example: The structural integrity of pole-top capacitors 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 pole-top capacitors. Example: Regular maintenance and the use of corrosion-resistant materials are crucial to prolong the lifespan of these assets. Pole-top capacitors 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 pole-top capacitor infrastructure. Example: Fire-resistant materials and strategic vegetation management around installations are essential for reducing this risk. In the bushfire-prone regions of the Yarra Valley, pole-top capacitors 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 pole-top capacitors. Example: Proper waterproofing and drainage systems are essential to protect these assets. In regions like Gippsland, where flooding is more frequent, pole-top capacitors must be installed in elevated areas with robust waterproofing measures to prevent water ingress and subsequent failures.
- **Seismic Zones:** Though less common, areas with potential seismic activity may require pole-top capacitors 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, pole-top capacitors may need to incorporate seismic-resistant features to ensure stability during earth tremors.

### 4.2.3. Population by Type

AusNet has two key primary components of pole-top capacitor installations (MV Line or REFCL LV LBU type) on the distribution network:

1. Pole-top capacitors with three capacitor cans
2. Capacitor controllers

#### Pole-top Capacitor:

- **Summary Explanation of Form and Function:** A pole-top capacitor installation consists of three capacitor cans, a voltage transformer, three single-phase switches, current sensors, surge arresters, and three single-phase MV fuse switches, a step-down transformer in the case of REFCL LV LBU capacitors. These components are assembled on a pole to form a complete capacitor bank.
- **Purpose within the Asset Class:** The pole-top capacitor serves the primary function of providing reactive power at selected locations in medium voltage feeders or provide capacitance balancing in REFCL networks. It improves the energy transfer efficiency of the immediate and upstream network, particularly in long radial sections or latter case, it provides satisfactory REFCL Application and public safety.
- **Purpose within the Network Design:** Within the electrical distribution network, pole-top capacitors are strategically positioned closer to the loads causing the "lagging" current to achieve performance improvements. By producing a "leading" current, these capacitors offset or reduce the "lagging" load current, thus compensating for the lagging current and reducing electrical losses across the network for MV pole top capacitors or latter case, it provides improved REFCL performance.

- **Process Function:** Most pole-top capacitor installations are designed to operate automatically, controlled by voltage or current sensors depending on the requirement at the specific location. They can be set to be permanently on or controlled dynamically based on real-time conditions to maintain optimal power quality and efficiency.
- **Historical Application:** Historically, pole-top capacitors have been used to manage reactive power in distribution networks, enhancing voltage stability and reducing power losses. Their application has evolved with advances in capacitor technology and control systems, enabling more efficient and reliable operation. REFCL LV LBUs is new technology introduced recently to improve public safety against bushfire risk via REFCL operation.

### Capacitor Controller:

- **Summary Explanation of Form and Function:** A capacitor controller is an electronic device used to manage the operation of pole-top capacitors. It ensures that the capacitors switch on or off based on pre-determined voltage or current levels. It provides health and status indication in the case of REFCL LBU units via SCADA.
- **Purpose within the Asset Class:** The capacitor controller is crucial for the dynamic operation of pole-top capacitors, allowing them to respond to changing network conditions and maintain the desired power quality and efficiency or provide satisfactory REFCL performance in the case of REFCL LV LBUs.
- **Purpose within the Network Design:** In the network design, capacitor controllers enable the integration of pole-top capacitors into the broader network management system. They help in optimising the reactive power compensation, ensuring that the capacitors are active only when needed to support the network.
- **Process Function:** The controllers monitor the voltage and current levels in the network and control the switching of the capacitors accordingly. This automated control helps in maintaining a stable and efficient power distribution system. In the case of REFCL LV LBUs, it provides health and status of LBU for REFCL remote operation.
- **Historical Application:** Capacitor controllers have been used in electrical distribution networks to automate the operation of MV pole-top capacitors, replacing manual switching and improving the responsiveness and efficiency of the network. REFCL LV LBU is a new technology adopted in AusNet since recently for capacitive balancing of unbalanced distribution networks for REFCL remote operation.

## 4.2.4. Population Profile

AusNet has a total of 69 pole top capacitors in service in MV distribution network on 22kV distribution feeders. There are also 462 REFCL LV LBU pole top capacitors. Total population of pole top capacitors and the capacitor controller by manufacturer are shown in figure 1 & 2.

**Figure 1: Pole Top Capacitors by Manufacturer**

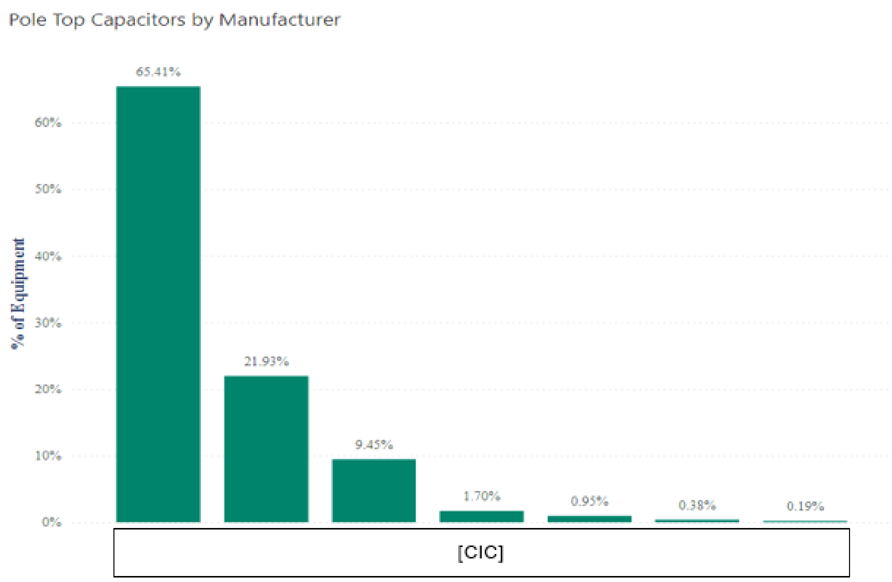
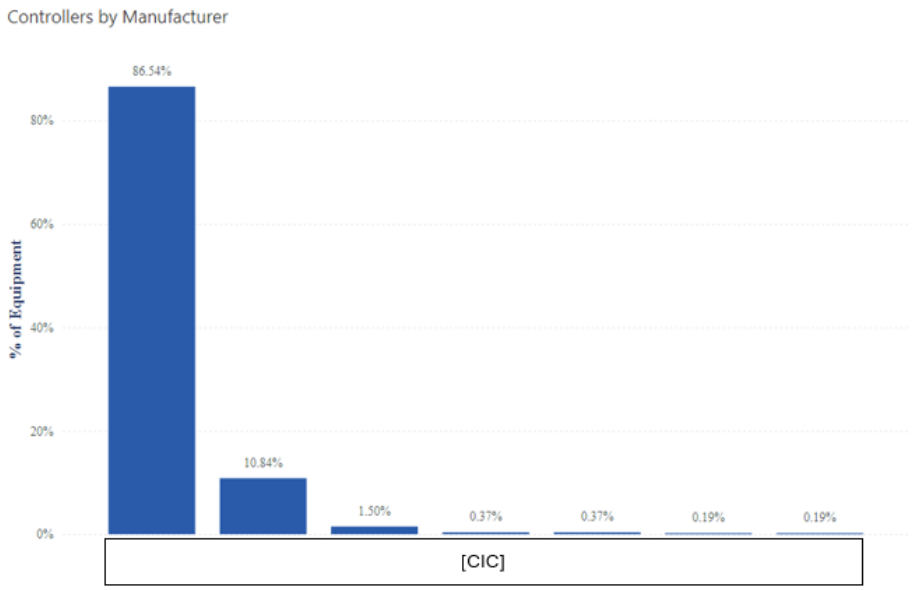


**Figure 2: Pole Top Capacitor Controllers by Manufacturer**




Manufacturers for MV pole top capacitors and are mainly [CIC] and [CIC]. AusNet uses predominantly REFCL LV LBU pole top capacitors and controllers from [CIC] /[CIC] manufacturers.

# 4.3. Age

## 4.3.1. Age Considerations

Understanding the age profile of pole-top capacitors is essential 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.

- **Pole-top Capacitors:** The age profile of pole-top capacitors can indicate potential issues related to component degradation and operational efficiency. Older capacitors may require more frequent inspections and condition assessments to ensure they continue to operate safely and efficiently. For example, proactive testing and monitoring of the capacitor cans, voltage transformers, and switches in older installations can prevent unexpected failures and extend their service life.
- **Capacitor Controllers:** Over time, capacitor controllers can experience component failures and reduced performance due to technological obsolescence and environmental factors. By analysing the age profile, asset managers can identify controllers that are at higher risk of failure and prioritise them for maintenance or replacement. For instance, upgrading older capacitor controllers to more advanced models can improve network reliability, efficiency and safety.

## 4.3.2. Age Profile

The service age profile of the pole-top capacitors and controllers is shown in figures 3 and 4.

Average age of MV pole top capacitors and controllers is about 7.8 years and the oldest being 23 years. The average age of capacitor controllers is about 16 years old the oldest is about 21 years old. The difference in age of pole top capacitor and controllers is due to individual unit replacement of capacitor and controller but not complete unit replacement based on actual failures.

For REFCL, LV LBU pole top capacitors and controllers are much younger, and they were installed under REFCL program, and their average age is about 4.4 years.

**Figure 3: Pole top capacitors by Service Age**

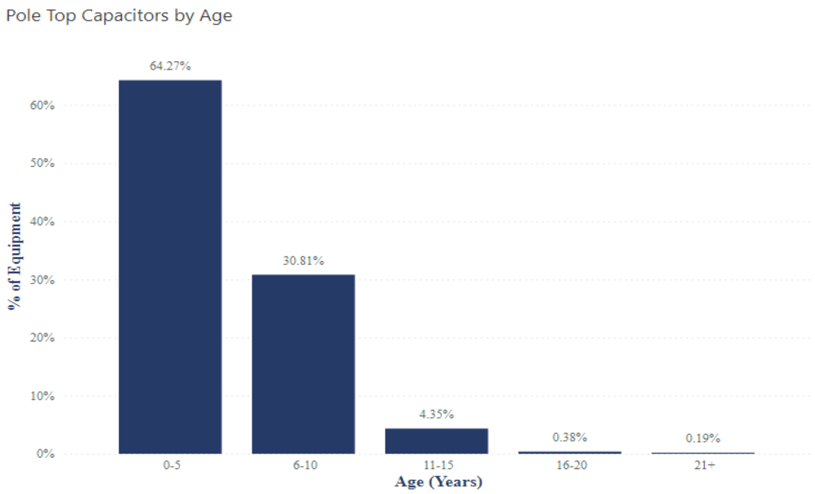
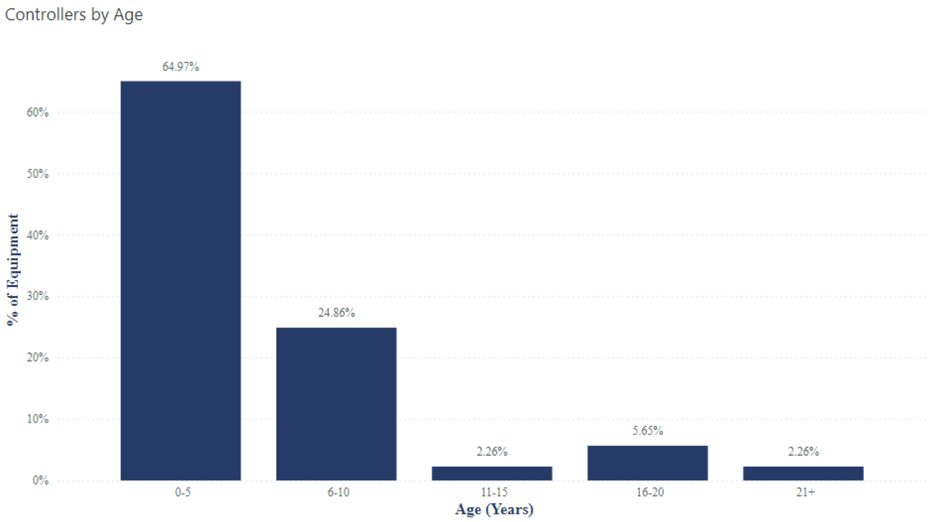



**Figure 4: Pole top Capacitor Controllers by Service Age**



# 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 pole top capacitors.

## 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

#### Application of Failure Modes:

Understanding failure modes is an important tool that supports measuring the criticality of assets, especially when assessing the risk of potential failures and their potential impact on the overall system. By identifying and analysing the various ways in which an asset can fail (including the root causes and mechanisms of failure), asset managers can better predict and mitigate risks. Typical failure modes of pole top capacitors are described below.

#### Typical Failure Modes:

As noted above, assessing failure modes and utilising the detailed information about each mode plays a crucial role in various aspects of Asset Management Planning. Understanding failure modes enhances the effectiveness of risk management efforts and ensures the optimal performance and reliability of assets within the electrical distribution network. Some notable failure modes for pole-top capacitors are detailed below:

- **Insulation Degradation:** The insulation material can degrade over time due to thermal ageing and environmental exposure, leading to reduced electrical performance and potential faults. Example: High temperatures can accelerate the degradation of insulation materials in capacitor cans, compromising their effectiveness.
- **Mechanical Wear:** Components such as switches, connectors, and fuse elements can suffer from wear and fatigue, affecting the device’s ability to operate correctly. Example: Frequent operations of switches 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 in pole-top capacitor installations, leading to premature failure.
- **Moisture Ingress:** Water or moisture can penetrate the capacitor units, leading to corrosion of internal components and reduced insulation effectiveness. Example: In high humidity areas, moisture ingress can corrode the internal components of capacitor controllers, compromising reliability.

- **Thermal Overload:** Excessive current flow can cause the capacitor elements to overheat, leading to thermal degradation and potential failure. Example: Sustained high current can cause capacitors to overheat, leading to failure and network disruptions.
- **Component Fatigue:** Repeated switching operations can cause fatigue in the components, reducing their effectiveness over time. Example: Regular switching of capacitors can wear out the internal components in switches, making them less reliable.
- **UV Degradation:** Ultraviolet (UV) radiation can degrade the external housing of capacitors, particularly in outdoor installations, reducing their mechanical strength and protection. Example: Prolonged exposure to sunlight can cause the plastic housing of capacitor controllers to become brittle and crack, including failure of other internal components due to high ambient temperature.

### 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 pole top capacitors 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 pole top capacitor has the potential of resulting in failing to supply customers with energy and bushfire safety risk. There is also a possibility the failed asset injures an employee or member of the public or affect the environment due to pollution.

Following three key consequences of pole top capacitor failure effects have been considered viewed through three lenses.

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

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. Performance Analysis

In the context of asset management for pole-top capacitors, 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.

### 6.1.1. Performance Profile

Figures 5 to 10 show the Pole top capacitor performance during the current period 2020-2024 against ZA and Zk notifications and damage type for MV and REFCL LV LBU pole top capacitors respectively.

**Figure 5: ZA and Zk notifications by MV Pole Top Capacitors & Controllers – Period 2020-2024**

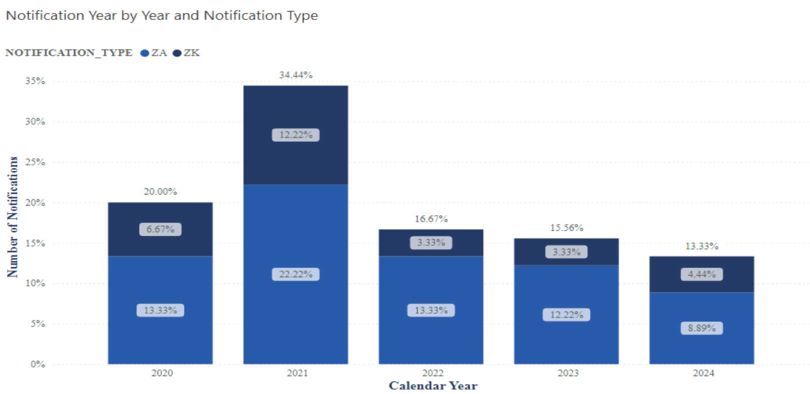



**Figure 6: ZA and Zk notifications by MV Pole Top Capacitors & Controllers Defect type – Period 2020-2024**

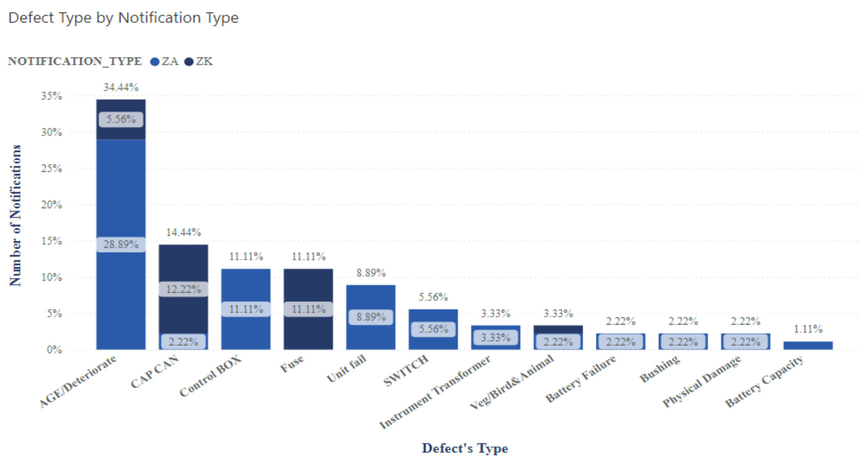


**Figure 7: ZA and Zk notifications by REFCL LV LBU Pole Top Capacitors & Controllers – Period 2020-2024**

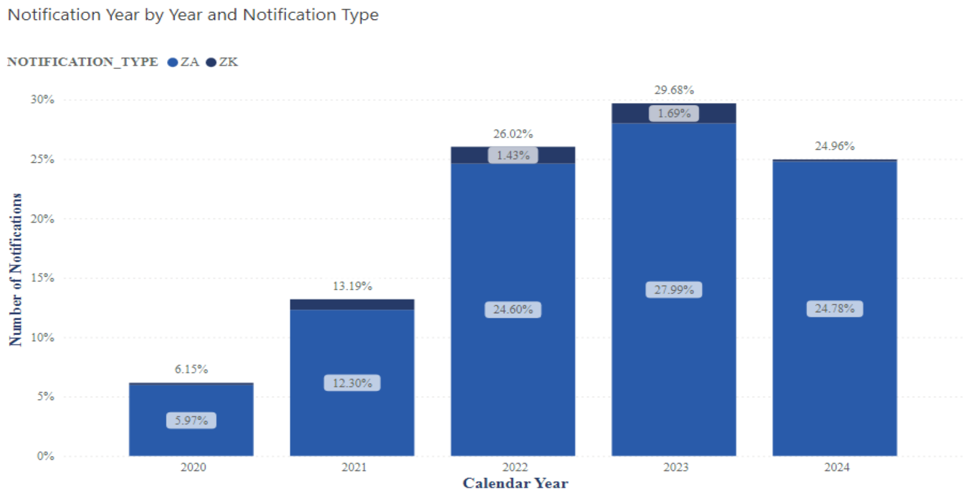



**Figure 8: ZA and Zk notifications by REFCL LV LBU Pole Top Capacitors & Controllers Defect type – Period 2020-2024**

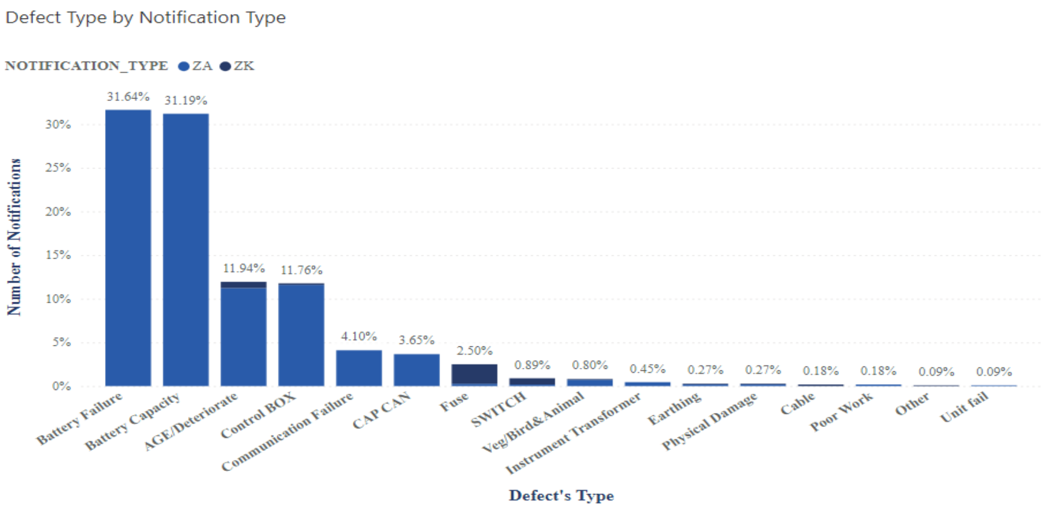



**Figure 9: ZA notification rate table for pole top capacitors (2020-2024 period)**

ZA Notifications

| VOLTAGE_TYPE | Count of Notification | Population | Notitifcations / year/Total population |
|---|---|---|---|
| LV | 1077 | 462 | 40.1% |
| MV | 63 | 75 | 2.3% |

**Figure 10: Zk notification rate table for pole top capacitors (2020-2024 period)**

ZK Notifications

| VOLTAGE_TYPE | Count of Notification | Population | Notitifcations / year/Total population |
|---|---|---|---|
| LV | 49 | 462 | 1.8% |
| MV | 27 | 75 | 1.0% |

Pole top capacitor notification analysis revealed following issues.

1. It is observed the Zk failure notifications contributed to approximately 30% against ZA notifications (70%) over the period 2020 -24 in MV pole top capacitors and note showing a downward trend. (refer figure 5) The key find is capacitor can failures (14.4%), control box issues (11.1%), HV Fuse failures (11.1%) and age/deterioration (34.4%) among other causes reported during the period 2020-2024. (refer figure 6) It is presumed the downward trend in notifications is due to condition-based replacements being carried out.
2. It is observed the Zk failure notifications contributed to approximately 4.3% against ZA notifications (95.7%) over the period 2020 -2024 in REFCL LV LBU pole top capacitors and showing an upward trend. (refer figure 7) The key find is battery associated failures (62.6%), control box issues (11.7%), cap can and fuse failures (6.1%) and age/deterioration (12%) among other causes reported during the period 2020-2024. (refer figure 8)
3. It is also noted that most Zk failure notifications reported in the same period 2020-2024 were associated with LV pole top capacitors (1.8%) against MV pole top capacitors (1.0%) per year /total population. ZA notifications reported for the same period for LV pole top capacitors, and MV pole top capacitors were 40.1% and 2.3% per year per total population. (refer Figure 9 and 10)
4. In comparison with MV pole top capacitors, LV pole top capacitors recorded more than seventeen-fold increase of count of ZA notifications where battery associated issues was the key defect cause. (refer figure 9)

Above observations indicate the following:

1. REFCL LV LBU units are younger (4.4 years) and it is necessary to investigate the root cause for increased number of early life battery associated defects and fuse failures which resulted in increasing number of corrective actions in REFCL LV LBU pole top capacitors during the 2020 -24 period. (Refer section 8.1)
2. In comparison, MV pole top capacitors and controllers have a much older age profile than LV pole top capacitors need replacement based on asset condition/failure. Hence prioritise condition based proactive replacement of pole mounted MV pole top capacitors on planned inspection results or replace on failure. (Refer section 8.4)

# 7. Related Matters

# 7.1. Regulatory Framework

## 7.1.1. Compliance Factors

No compliance consideration for pole top capacitors involved.

### 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.

### 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 Section 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.

# 7.2. External Factors

## 7.2.1. 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 | **Non-Availability of Remote Monitoring**<br>Pole top capacitors are not connected to SCADA system and their functioning will not be known unless there is visual damage of primary equipment visible to the naked eye. Capacitor Controller failure is the common mode of failure and will not be known unless it is tested on site. As no on-line monitoring facilities are available, it is possible that a pole-top capacitor failure may go undetected until annual inspection is done for summer preparedness that again checked only on fraction of pole top capacitors. It is expected that random controller failures may increase with age after 10 years and hence managing pole top capacitor fleet without remote monitoring could become challenging. |

### 7.2.2. Environmental Factors

#### Environmental Management

Effectively managing obligations specific to environmental management is a core element of Asset Class Planning and supports the sustainable operation and management of Civil Infrastructure. Ensuring adherence to relevant environmental laws and standards helps prevent legal and regulatory breaches, which can lead to significant penalties, operational disruptions, and reputational damage.

Refer to section 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.

### 7.2.3. Stakeholder/ Social Factors

#### Social Factors

Understanding social factors is essential for the effective management of critical network infrastructure assets. Social factors, including community expectations, public safety, and environmental impacts, play a significant role in shaping asset management strategies. Ensuring that these social considerations are addressed helps build public trust, maintain social license to operate, and enhance the organisation's reputation. For instance, ensuring that maintenance activities for Civil Infrastructure do not disrupt local communities or pose safety risks is crucial for maintaining public support and compliance with social responsibilities.

#### Stakeholder Factors

Understanding the requirements of stakeholders with a direct interest in the assets associated with the [Civil Infrastructure] asset class is an important aspect of effective asset management. Key stakeholders, including customers, regulatory bodies, and industry partners, have specific expectations that influence asset management strategies and operational decisions. Ensuring clear communication and alignment with these requirements helps maintain regulatory compliance, enhance service reliability, and build robust partnerships. For example, customers expect reliable infrastructure and timely responses to issues, which requires minimal disruption during maintenance activities of Civil Infrastructure. Similarly, regulatory bodies impose standards that must be adhered to, such as safety requirements for buildings and environmental systems, to avoid legal penalties and ensure operational legitimacy.

## 7.3. Internal Factors

### 7.3.1. 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, 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.

### 7.3.2. 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]

### 7.3.3. 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.

### 7.3.4. 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.

## 7.4. Future Developments

### 7.4.1. 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.

### 7.4.2. 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.

### 7.4.3. 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 procure pole-top capacitors in accordance with DES 10-03; |
| 02 | Consider update of controller specification to include SCADA facility for remote monitoring |
| 03 | Investigate root cause for battery associated failures in REFCL LV LBU pole top capacitor controllers and suggest design improvements in replacements and equipment specification improvements for future applications |

## 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.

### Targeted Activities (Inspection and Monitoring Strategies)

| REF | DETAILS OF MATERIAL CONSIDERATIONS |
|---|---|
| 01 | Continue with routine visual inspection program and conduct thermo-vision scans where required |
| 02 | Update and document the inspection criteria in the Asset Inspection Manual (41111-1) for pole top capacitors. |
| 03 | All pole mounted capacitors in HBRA and LBRA areas are subjected to regular condition inspections in conjunction with line asset inspections in accordance with the Asset Inspection Manual (4111-1). |

# 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 | Review the capacitor control method (permanently ON, current or voltage controlled) periodically with distribution network modifications |

# 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 | Maintain strategic spares holding of one complete unit of each MV Line and REFCL LV LBU pole top capacitor assembly with associated major components; controller, vacuum switches and associated instrument transformers, step down distribution transformer per region |
| 02 | Carry out condition based proactive replacement of pole mounted capacitors and controllers on planned inspection results or replace on failure and monitor controller failure rates |
| 03 | Investigate economics of providing SCADA indication and control for summer critical pole top capacitor units, when available |

# 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 |
| VIC | EPA Victoria | Environment Protection Act 1970 |
| VIC | Energy Safe Victoria | Electricity Safety (Bushfire Mitigation) Regulations 2013 |

# 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 | 4111-1 | Asset Inspection Manual |
| 7 | DES 10-03 | Equipment specification for 22kV Pole-Mounted Capacitor Banks |

# 11. Schedule of revisions

| ISSUE | DATE | AUTHOR | DETAILS OF CHANGE | APPROVED BY |
|---|---|---|---|---|
| 0.1 | 07/07/14 | P Seneviratne | Initial Draft | |
| 0.2 | 09/07/14 | S DeSilva | Review the initial draft | |
| 1 | 11/11/14 | P Seneviratne<br>G Jegatheeswaran | Initial AMS | J Bridge |
| 2 | 18/06/2019 | N. Boteju | Review and update of Strategy | P Ascione |
| 3 | 22/01/2025 | N. Boteju | Review and update | |
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