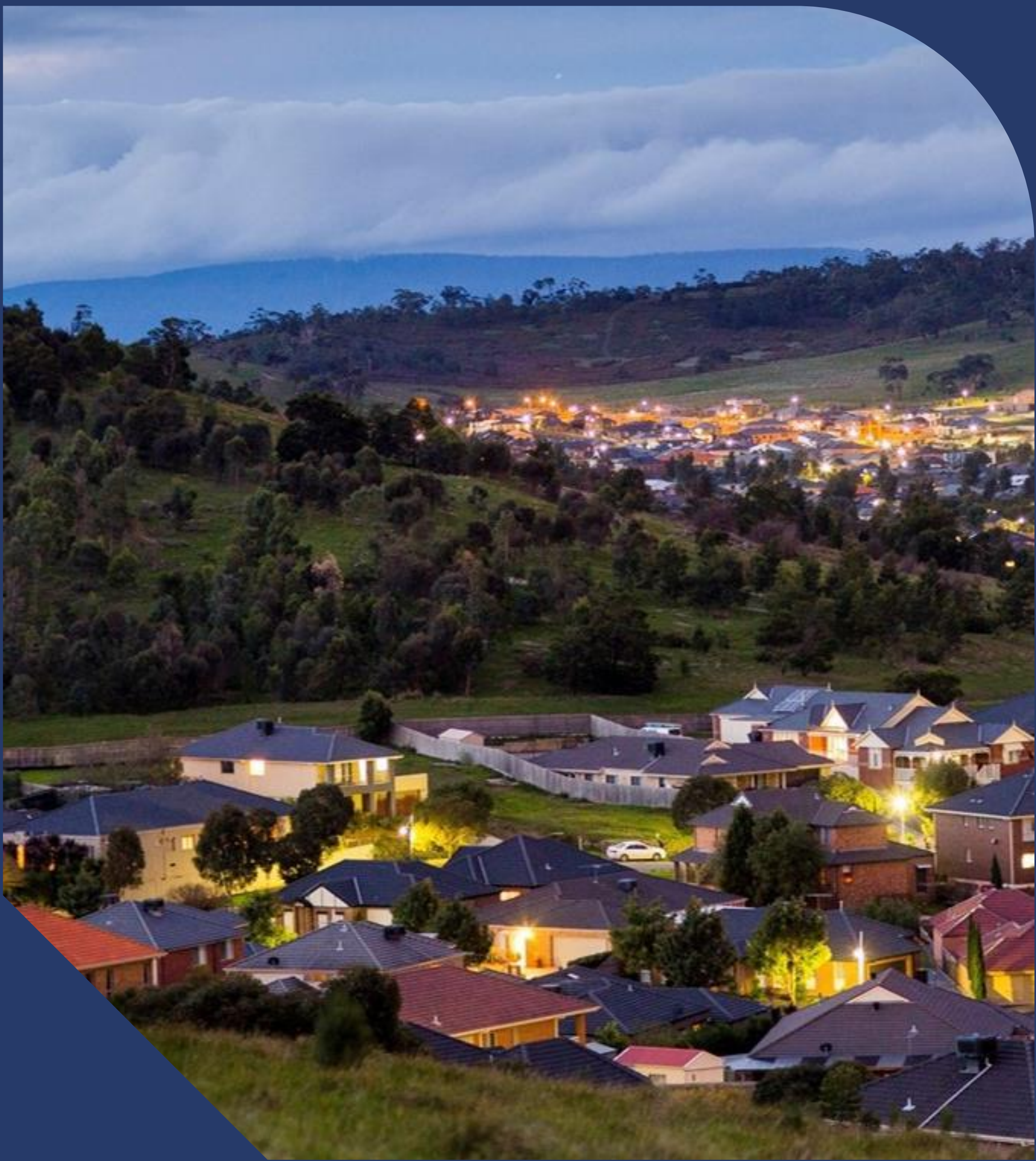
Bare Overhead Conductor

AMS – Electricity Distribution Network



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AusNet

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1. Executive Summary

This document is part of the suite of Asset Management Strategies relating to the 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 Bare Overhead Conductor (BOC)
The summary of proposed asset strategies is listed below.

1.1. Asset Strategies

1.1.1. New Assets

- Utilise Low Voltage Aerial Bundled Cable systems for all new aerial LV circuits constructions.
- Utilise insulated underground cable, Medium Voltage Aerial Bundled Cable or Covered Conductor Cable systems for new MV circuits in codified areas.
- Utilise underground cable, Medium Voltage Aerial Bundled Cable or Covered Conductor Cable systems for new MV circuits in high Fire Loss Consequence areas on a case-by-case basis.
- Utilise AAC and ACSR bare conductors for new aerial MV circuits in low bush fire risk areas and in low Fire Loss Consequence areas.
- Utilise AAC and ACSR bare conductors for new aerial 66 kV circuits.
- Install armour rods and vibration dampers in accordance with AusNet's published technical standards.
- Utilise clamp top insulators and armour rods for all new construction.
- All new REFCL feeder overhead conductors will be three phase capacitive balanced.

1.1.2. Asset Inspection

- Assess conductor, conductor tie, conductor joints, armour rods, vibration dampers and conductor spacer condition in accordance with the criteria established in the Asset Inspection Manual, 4111-1.
- Continually assess the condition of all BOC and maintain accurate condition status in the Asset Management Information System.

1.1.3. Asset Maintenance

- Replace McIntyre and Fargo sleeves (if any left) with compression sleeves and helical splices.
- Replace PG clamps on HV circuits (if any left) with Wedge type connectors.
- Replace LV spreaders on LV spans in high bush fire risk areas in accordance with AusNet's standard VX9/7020/150.
- Replace deteriorated line ties in accordance with the criteria established in the Asset Inspection Manual 4111-1.

1.1.4. Asset Replacement

- Replace deteriorated assets in accordance with the criteria established in the Asset Inspection Manual, 4111-1.
- Replace deteriorated MV BOC circuits in codified areas with underground cable, Medium Voltage Aerial Bundled Cable or Covered Conductor cable systems.
- Replace deteriorated MV BOC circuits in high Fire Loss Consequence areas with Medium Voltage Aerial Bundled Cable or Covered Conductor cable systems on a case-by-case basis.
- Replace deteriorated MV BOC circuits in LBRA and in low Fire Loss Consequence areas with AAC and ACSR bare conductor.

- Replace deteriorated 66 kV BOC circuits with AAC and ACSR bare conductors.
- Proactively replace, as required, poor condition BOC between 2026 to 2031 to manage bushfire ignition risk, conditional asset failures and mitigate reliability impacts.

2. Abbreviations and Definitions

TERM	DEFINITION
AAC	All Aluminium Conductors
ACSR	Aluminium Clad Steel Reinforced Conductors
AMS	Asset Management Strategy
BOC	Bare Overhead Conductor
CoF	Consequence of Failure
Cu	Copper Conductors
HV	High Voltage (66kV)
kV	Kilovolts
LV	Low Voltage (415V)
MV	Medium Voltage (22kV, 11kV and 6.6kV)
PoF	Probability of Failure
V	Volts
SC/AC	Steel Conductor – Aluminium Clad
SC/GZ	Steel Conductor – Galvanized

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 BOC installed in AusNet's 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 and prudent asset management practices by outlining economically justified outcomes.

3.2. Scope

This strategy applies to all BOC including those operating at HV, MV and LV circuits.

For strategies of assets which provide structural support of the BOC refer to documents:

- AMS 20-70 Poles
- AMS 20-57 Crossarms
- AMS 20-66 Insulators – High and Medium Voltage

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

BOC in the electricity distribution network are the "electricity avenue" connecting electricity from Terminal Stations on the transmission network, to consumers and embedded generators.

BOC needs to meet specific electrical and mechanical characteristics to fulfil their function in a safe and reliable fashion.

From an electrical perspective, it needs to have the appropriate current carrying capacity for the respective area of the network.

From a mechanical perspective, it needs to withstand mechanical forces created by stringing tension, thermal heating, and short circuit induced forces.

BOC must also maintain a safe electrical clearance from each other, earthed structures and from the ground.

4.2. Population

4.2.1. Population Considerations

The population profile for BOC 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 BOC and associated fittings are essential for maintaining the integrity and reliability of the network. For example, a particular MV conductor serving a critical industrial area might be deemed essential and require more frequent inspections to ensure uninterrupted service.
- **Allocate resources efficiently:** Plan and allocate maintenance resources effectively by knowing the exact number and location of assets. For instance, knowing that a certain region has a high concentration of MV BOC 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 LV BOC is in high bushfire risk areas, additional protective measures, such as the installation of spacers or spreaders, can be implemented in those areas.
- **Optimise maintenance schedules:** Develop optimised maintenance schedules based on the distribution and condition of assets. For instance, BOC that forms the backbone of MV 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 HV, MV and LV BOC, meets the required standards for reliability and safety. For example, if the profile reveals that certain conductors have outdated or damaged fittings such as conductor ties or joints, 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 MV BOC in a rapidly developing suburban area needs 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 BOC. 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 BOC to significant stress and fatigue. Example: The structural integrity of BOC in alpine areas 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 particular steel, in BOC. Example: The use of steel conductors is restricted in coastal areas.
- **Bushfire Areas:** Bushfire-prone areas, common in many parts of Victoria, pose a risk of fire damage to overhead conductor infrastructure. Example: Strategic vegetation management around conductor installations are essential for reducing this risk.

4.2.3. Population by Asset Type

Bare Conductors

- BOC is exposed conductive wires used for the transmission of electricity across the network. They are not insulated, which means they are directly exposed to the environment. The primary materials used for these conductors are steel galvanised or aluminised (SC/GZ, SC/AC), aluminium clad steel-reinforced (ACSR), all-aluminium conductor (AAC), and copper (Cu).
- BOC is the primary medium for transmitting electrical power from substations to consumers. It needs to handle various environmental conditions while maintaining mechanical and electrical properties.
- In the electrical distribution network, BOC serve as the main pathways for electricity, connecting substations to distribution points and ultimately to end users. It is designed to carry electrical current efficiently and reliably over long distances.
- The primary function of bare conductors is to conduct electricity while withstanding environmental stresses such as wind, corrosion, and mechanical loads.
- There are four main categories of conductor material: steel galvanised or aluminised (SC/GZ, SC/AC), ACSR, AAC, and Cu. Each material has specific properties that make it suitable for different applications within the network.

Conductor Ties

- Conductor ties are devices used to secure BOC to insulators on poles or towers. They ensure that the conductors remain in place and maintain the necessary electrical clearances.
- Conductor ties are essential for the stability and security of the bare conductors, preventing them from dislodging or sagging, which could lead to faults or outages.
- Conductor ties secure conductors to pin type and post type insulators, providing mechanical support and ensuring proper alignment of the conductors.
- All new and replacement post insulators are clamp top insulators, progressively removing the need to use conductor ties.

Joints

- Joints are connections between segments of BOC, allowing for the extension or repair of conductor spans. They are critical components for maintaining continuous electrical pathways and mechanical strength.
- Joints ensure the continuity of electrical conductors, allowing for repairs and extensions without needing to replace entire conductor spans.
- There are several types of joints installed on the AusNet network such as helical splices, compression sleeves, McIntyre sleeves, and Fargo sleeves. When a conductor fails due to falling vegetation, it is usually repaired by means of a full tensioned joint. Non-tension joints, used in conjunction with pole top structures, include Split Bolt clamps, Wedge connectors, and Parallel Groove (PG) clamps.

Spacers

- Spacers are devices used to maintain a consistent distance between conductors, preventing electrical contact and ensuring stable performance of the overhead lines.
- In the network design, spacers ensure the safe operation of multiple conductors running parallel, especially in areas with high wind or other environmental stresses.
- Spacers or spreaders are used to separate different phases of conductors to prevent flashover and conductor clashing. The fitting of fibreglass spreaders to low voltage conductor spans in high bushfire risk areas is a key fire ignition prevention action.

Armour Rods and Vibration Dampers

- Armour rods are protective devices applied to conductors at points of support, to prevent damage from mechanical stress.
- Vibration dampers reduce oscillations caused by wind and other environmental factors, protecting the conductor from fatigue.

4.2.4. Population Profile

The following Figure 1 shows various bare conductor population a parameters

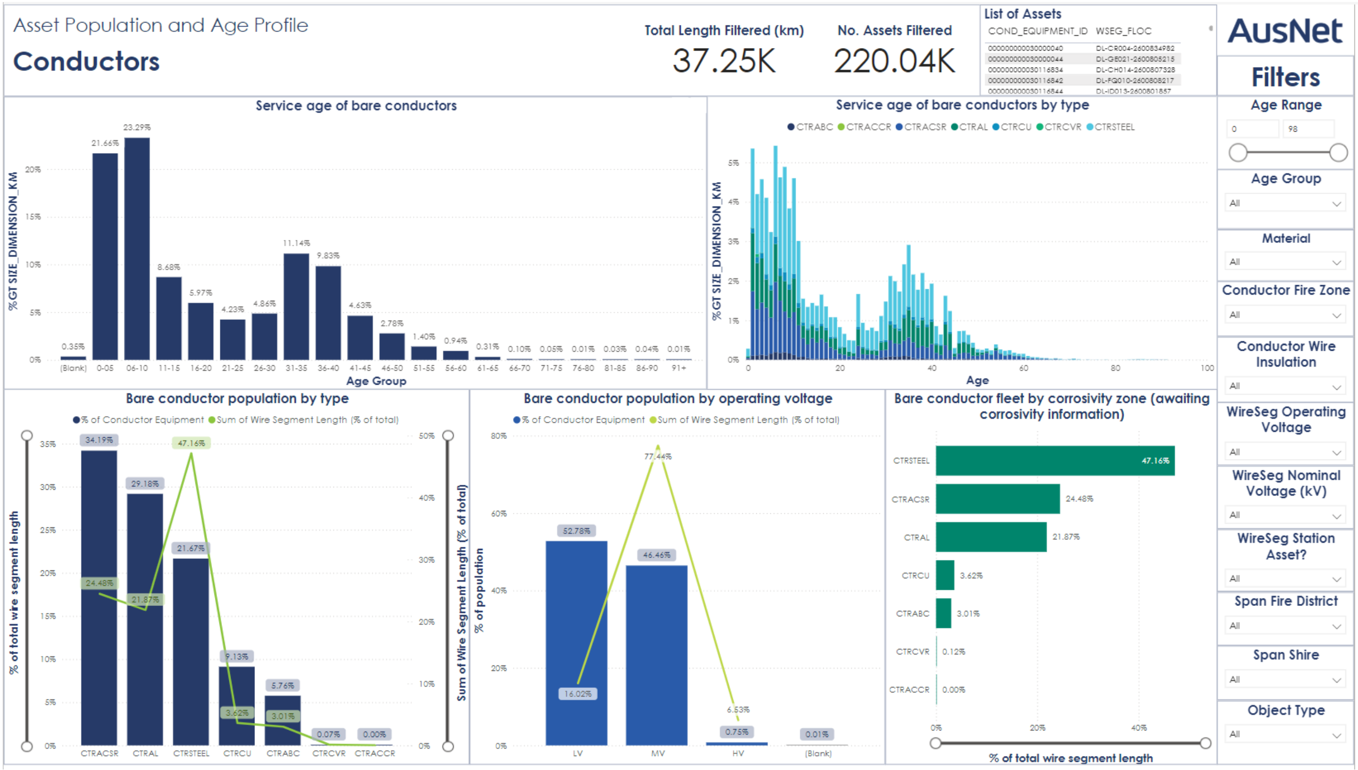

Figure 1 – Asset Population and age profile

4.3. Age

4.3.1. Age Considerations

An in-depth understanding of the age profile of BOC and associated fittings is crucial 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.

- **BOC – HV:** The age profile of high voltage bare conductors can indicate potential issues related to material fatigue and environmental degradation. Older conductors may require more frequent inspections and condition assessments to ensure they continue to operate safely and efficiently. For example, proactive testing and monitoring of tension and corrosion in older high voltage conductors can prevent unexpected failures and extend their service life.
- **BOC - MV:** Over time, medium voltage bare conductors can experience mechanical wear and corrosion due to environmental exposure. By analysing the age profile, asset managers can identify conductors that are at higher risk of failure and prioritise them for maintenance or replacement. For instance, replacing aging ACSR conductors in medium voltage lines can prevent costly outages and enhance network reliability.
- **BOC - LV:** Low voltage bare conductors can suffer from mechanical stress and environmental impacts as they age. Understanding their age profile allows for targeted interventions to replace or refurbish sections of the network that are most vulnerable. For example, replacing sections of low voltage copper conductors in older residential areas can reduce the risk of power outages and improve overall service quality.
- **BOC – Unknown:** Due to poor data, some conductors in the network have unknown age profiles. These unknowns require regular and detailed inspections to determine their condition and prioritise their maintenance or replacement.
- **Conductor Ties:** The age profile of conductor ties can reveal areas where the ties are likely to wear out or fail. Regular inspections and maintenance based on age-related data can ensure these ties remain secure and functional.
- **Joints:** The age profile of joints is essential for identifying potential failure points in the network. Older joints may be more prone to failures due to thermal cycling and mechanical stress. For instance, replacing aging compression sleeves and McIntyre sleeves in older segments of the network can prevent joint failures and ensure continuous electrical service.
- **Spacers:** The age profile of spacers can indicate potential areas of mechanical wear and degradation. Regular replacement of aging spacers based on their age profile can prevent conductor clashing and maintain electrical clearance. For example, replacing old fibreglass spreaders in high bushfire risk areas can reduce fire ignition risks and maintain network safety.
- **Armour Rods and Vibration Dampers:** The age profile of armour rods and vibration dampers helps in identifying components that may be suffering from wear and tear due to environmental exposure. Regular inspections and replacements based on age can prevent conductor damage and ensure long-term reliability.

4.3.2. Age Profile

Refer to Figure 1

5. Strategic Asset Management

5.1. Condition

5.1.1. Condition Assessment Protocols

Condition assessments are a critical element of lifecycle management for BOC and associated fittings. These assessments provide vital information on the current state and performance of conductors, ties, joints, spacers, and dampers, enabling informed decision-making regarding maintenance, repair, and replacement.

Condition assessments involve a systematic evaluation using specific benchmarks and a rating scale to describe the health and performance of these assets. AusNet employs a standard approach to condition assessments that employs a 5-point rating scale to assign assets a condition rating score.

The AusNet 5-point rating scale is designed to categorise assets based on their current condition and performance. AusNet's standard condition assessment protocol follows these high-level scoring criteria:

- **Condition 1 (C1):** A rating of C1 indicates an asset in very good condition, typically with no visible defects and optimal functionality. These assets require minimal maintenance and are expected to have a long remaining service life. Example: A high voltage bare conductor with no signs of corrosion or mechanical damage, ensuring it can continue to conduct electricity efficiently. The standard AusNet Asset Condition scoring card benchmarks the remaining useful life of C1 assets at 95%.
- **Condition 2 (C2):** A rating of C2 reflects good condition, typically with minor wear and tear, requiring routine maintenance to maintain performance. Example: A conductor tie with minor surface wear but no significant degradation, needing routine inspections and minor adjustments to maintain performance. The standard AusNet Asset Condition scoring card benchmarks the remaining useful life of C2 assets at 70%.
- **Condition 3 (C3):** A rating of C3 signifies average condition, typically where the asset shows moderate wear and may require significant maintenance or minor repairs to prevent further deterioration. Example: A joint showing some signs of corrosion but still functional, necessitating proactive maintenance to prevent failure. The standard AusNet Asset Condition scoring card benchmarks the remaining useful life of C3 assets at 45%.
- **Condition 4 (C4):** A rating of C4 indicates poor condition, typically with major defects, necessitating immediate repairs or partial replacement to ensure safe operation. Example: A spacer with significant wear and structural weakening, requiring immediate reinforcement or partial replacement. The standard AusNet Asset Condition scoring card benchmarks the remaining useful life of C4 assets at 25%.
- **Condition 5 (C5):** Finally, a rating of C5 represents assets in very poor condition, typically with critical failures or end-of-life status, requiring urgent replacement to avoid safety hazards and operational disruptions. Example: An armour rod with severe corrosion or failure, requiring urgent replacement to maintain network reliability. The standard AusNet Asset Condition scoring card benchmarks the remaining useful life of C5 assets at 5%.

The condition scoring methodology outlined above provides high-level scoring criteria that can be universally applied across all asset classes within AusNet's electrical distribution network. These scoring criteria offer a broad framework for assessing the general condition and remaining life of assets, ensuring consistency and comparability across asset management activities.

5.1.2. Asset Specific Monitoring Considerations

To accurately evaluate the condition of each specific asset within the BOC and associated fittings asset class, it is essential to further refine the benchmarks associated with condition scoring. Each asset type, such as BOC, conductor ties, joints, spacers, and armour rods and vibration dampers, has unique characteristics and operational requirements that necessitate more detailed benchmarks.

Developing these more granular benchmarks may involve considerations such as:

- **Customising Indicators:** Identifying specific indicators of wear, degradation, and performance relevant to each asset type. Example: Custom indicators for BOC could include measurements of mechanical tension, signs of corrosion, and electrical resistance, ensuring precise evaluations tailored to their specific functions.
- **Detailed Inspections:** Conducting thorough inspections tailored to the asset class, incorporating both visual assessments and technical measurements. Example: Detailed inspections for BOC might include thermographic imaging to detect hotspots, drone surveys for physical damage, and tensile strength tests to assess mechanical integrity.
- **Historical Data Analysis:** Assessing historical performance and maintenance data to establish norms and thresholds for each condition score. Example: Analysing historical failure data for joints can help establish condition thresholds that predict future degradation patterns, guiding proactive replacement strategies.
- **Environmental Factors:** Considering the impact of local environmental conditions, such as exposure to coastal salt air or high wind areas, which can influence asset condition. Example: Evaluating the impact of high humidity and frequent storms on spacers and vibration dampers in certain regions can refine condition assessments and maintenance planning, ensuring targeted and effective asset management.

By incorporating these detailed and specific monitoring considerations, AusNet can ensure a more accurate and effective assessment of the condition and performance of BOC and associated fittings, leading to improved maintenance planning and asset management.

5.1.3. Asset Class Specific Consideration

Steel conductors are assigned a condition rating by comparing them to a standard set of photos showing conductor in various condition grades. Copper is reported when damaged or when it shows signs of blackening which may be a precursor to brittle failure. Other conductors are also assessed visually, and condition status is generally reported based on signs of mechanical or corrosive damage causing loss of cross section rather than surface condition.

The current criteria are generally binary choice; damaged or undamaged. Except for steel, there is no graded scale of deterioration which would allow objective forecasting of future replacement rates. Visual assessment tools as well as site measurements are being investigated to promote objective measurements of deterioration. This will assist in estimating fleet condition, remaining service life and replacement requirements.

Since the previous regulatory submission, forensic analysis has been performed on 3/12 Galvanised Steel conductor which has assisted in the calculation of probabilities of failure. Condition assessment results have been calibrated against historical figures and this forensic analysis. These results have been combined with the Bushfire Consequence Model and incorporated into the optimum time for replacement model.

As an inspection methodology improvement, forensic analysis will also be undertaken on AAC and ACSR conductors. Pro-active investigation will assist in establishing objective condition assessment methodologies before an increase in conductor failures is observed on the network. Forensic analysis will assist in correlating condition with other factors such as:

- Service age
- Geographical location
- Joint and connection condition
- Vibration damage
- Electrical loading
- Fault currents
- Mechanical loading
- Lightning and weather conditions

Investment in further development of smart aerial imaging and processing (SAIP) technology is considered to provide for objective condition assessment of 66kV ACSR conductors. Such methods need to be developed before an increase in failures is seen and will be most applicable in radial sub-transmission networks.

Condition assessments are performed in accordance with the Asset Inspection Manual 4111-1.

5.2. Criticality

To effectively manage the lifecycle of BOC and associated fittings, it is essential to understand the criticality of these assets. This involves evaluating the potential impact of failures. The criticality assessment is a key component of asset management as it helps prioritise maintenance, upgrades, and replacements.

To measure the criticality of assets, AusNet utilises a risk and criticality approach. This approach involves evaluating both the likelihood of failure and the potential impact of such failures. The process starts by identifying key risk factors, including environmental exposure, historical performance data, and the results from regular condition assessments.

The criticality of each asset is determined by considering two main factors: the probability of failure (PoF) and the consequence of failure (CoF). The PoF is influenced by factors such as environmental conditions (e.g., high winds, corrosion, bushfire risk), and historical failure rates. Advanced diagnostic tools and inspections help in quantifying this probability. The CoF is assessed based on the potential impact on network reliability, safety, and service continuity. This includes the number of customers affected, the strategic importance of the asset in the network, and the cost of repairs and downtime.

A criticality matrix is used to map these factors, with the PoF on one axis and the CoF on the other. Assets that fall into the high-risk category (high PoF and high CoF) are prioritised for maintenance, upgrades, or replacement. This approach ensures that resources are allocated efficiently, focusing on assets that pose the greatest risk to network reliability and safety.

Specific Examples of High-Risk vs. Low-Risk Assets:

- **High-Risk Assets:** BOC located in areas prone to bushfires, high winds, or coastal regions where corrosion is accelerated are considered high-risk due to their increased likelihood of failure and significant impact on network reliability if they fail. For example, an HV BOC in a bushfire-prone area that has been assessed with a high probability of failure poses a severe risk to public safety and service continuity.
- **Low-Risk Assets:** Conductor ties in stable, urban environments with minimal environmental stressors are typically considered low-risk. These assets have a lower probability of failure and, if they do fail, the impact on the overall network is less severe compared to high-risk assets. For instance, a conductor tie in a non-corrosive, low-wind area with low customer density may be scheduled for less frequent maintenance due to its lower criticality.

6. Risk

AusNet maintains a risk management system designed in accordance with ISO 31000 Risk Management – Principles and 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 to acceptable levels. 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 BOC.

6.1. 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 detailed methodology used to calculate and derive the probability of a failure considering four key factors: asset life, asset utilisation, location and physical condition.

6.1.1. Failure Causes

BOC failures are classified as assisted or unassisted.

Unassisted failures are caused by corrosion, vibration and component deterioration.

Assisted failures are caused by external factors such as lightning strikes, falling vegetation, bird or animal contact, and vehicle impacts.

6.1.2. 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.

This understanding allows for a more accurate assessment of the probability of failure (PoF) and the consequence of failure (CoF), which is a core aspect of how AusNet approaches determining asset criticality.

Failure Modes of BOC and Associated Fittings by Asset Type

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 the Asset Class BOC and associated fittings are detailed below.

Bare Conductors

- **Corrosion:** Metal components can corrode over time due to exposure to moisture, salt, and pollutants, leading to structural weakness and potential failure. Example: Bare conductors containing steel in coastal areas are susceptible to salt-induced corrosion, which can reduce their mechanical strength and conductivity.

- **Mechanical Wear:** Mechanical stress from wind, vibration, and tension can cause wear and fatigue in conductors and fittings, impacting their performance. Example: BOC not protected by vibration dampers, can wear out at the insulator due to aeolian vibration.
- **Conductor Clashing:** High winds or external forces can cause conductors to clash, leading to arcing, damage, and potential outages. Example: Vegetation falling on overhead lines can cause movement of poles of crossarms, resulting in increased conductor sag and resultant conductor clashing.
- **Environmental Degradation:** Exposure to harsh environments, such as industrial areas with high pollution levels, can lead to degradation of conductors and fittings. Example: Conductors near industrial sites can accumulate pollutants, leading to accelerated corrosion and degradation.
- **Thermal Overload:** Excessive current flow can cause conductors to overheat, leading to thermal degradation and potential failure. Example: High voltage bare conductors carrying excessive load can overheat, causing thermal expansion and increased sag resulting in compromised phase to phase and phase to earth clearances.
- **External Arcing Faults**: Wildlife or vegetation can cause external arcing faults by bridging the air space between conductors and grounded structures. Example: Birds or animals can initiate arcing faults on bare conductors, leading to outages and damage.

Conductor Ties

- **Mechanical Wear:** Conductor ties can wear and break due to constant wind-induced vibration, leading to potential dislodgement of the conductor from its insulator and electrical faults. Example: Conductor ties in high wind areas, such as open plains, often require more frequent replacements due to mechanical wear.
- **Corrosion:** Conductor ties can corrode over time due to exposure to moisture, salt, and pollutants. Example: Conductor ties in coastal areas are susceptible to salt-induced corrosion, which can compromise their mechanical strength.

Joints

- **Corrosion:** Metal components of joints can corrode over time due to exposure to moisture, salt, and pollutants, leading to potential failure. Example: Joints in coastal areas are susceptible to salt-induced corrosion, which can compromise their mechanical strength.
- **Mechanical Wear:** Mechanical stress from wind, vibration, and fault currents can cause wear and fatigue in joints, impacting their performance. Example: Joints can fail due to the rapid heating and mechanical movement caused by fault current.
- **Moisture Ingress:** Water or moisture can penetrate joints that have compromised water ingress seals, leading to corrosion of internal components and reduced insulation effectiveness. Example: McIntyre and Fargo conductor jointing sleeves were found to be the source of tensioned conductor joint failures. Corrosion due to moisture ingress under the sleeve was found to be a common source of failure.

Spacers

- **Mechanical Wear:** Mechanical stress from wind, vibration, and tension can cause wear and fatigue in spacers, impacting their performance. Example: Spacers can wear out due to constant wind-induced vibration, leading to potential dislodgement and electrical faults, or abrasion of the conductor.
- **UV Degradation:** Prolonged exposure to UV radiation can degrade the materials used in spacers, reducing their lifespan. Example: UV radiation can cause the plastic components of spacers to become brittle and crack, leading to potential failures.
- **Environmental Degradation:** Exposure to harsh environments, such as industrial areas with high pollution levels, can lead to degradation of spacers. Example: Spacers near industrial sites can accumulate pollutants, leading to accelerated corrosion and degradation.

Armour Rods and Vibration Dampers

- **Corrosion:** Metal components of armour rods and vibration dampers can corrode over time due to exposure to moisture, salt, and pollutants, leading to potential failure. Example: Armour rods and vibration dampers in coastal areas are susceptible to salt-induced corrosion, which can compromise their mechanical strength.

- **Mechanical Wear:** Repeated mechanical stresses can cause fatigue in armour rods and vibration dampers, reducing their effectiveness over time. Example: Continuous exposure to wind and tension can cause fatigue in armour rods and vibration dampers, leading to reduced mechanical protection of the conductor and resultant damage to the conductor.

6.1.3. Probability of Failure Assessments

As per the methods of calculation described in section 5 of AMS 01-09, the conditional PoF Bare Conductor is derived from health index based on asset life, asset utilisation, location and asset physical condition based on observed condition.

6.2. Consequence

The key consequences resulting from the failure of Bare Overhead Conductor are identified as:

- Bushfire start impact.
- Health and safety impact.
- Value of unserved energy.

AusNet recognises that bare conductor failure presents a high risk of bushfire ignition. Performance monitoring and analysis of bare conductor failures and condition, together with application of the government's Fire Loss Consequence Model are key attributes that are used to identify and prioritise sections of bare conductor for replacement. From this, increased volumes of bare conductor have been identified for replacement over and above that identified from the asset inspection program.

6.3. 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 section 7 of 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 – i.e. replacement is economic.

7. Performance

7.1. Performance Analysis

In the context of asset management for BOC, 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.

7.1.1. Performance Profile

The following Figure 2 shows the various conductor performance data

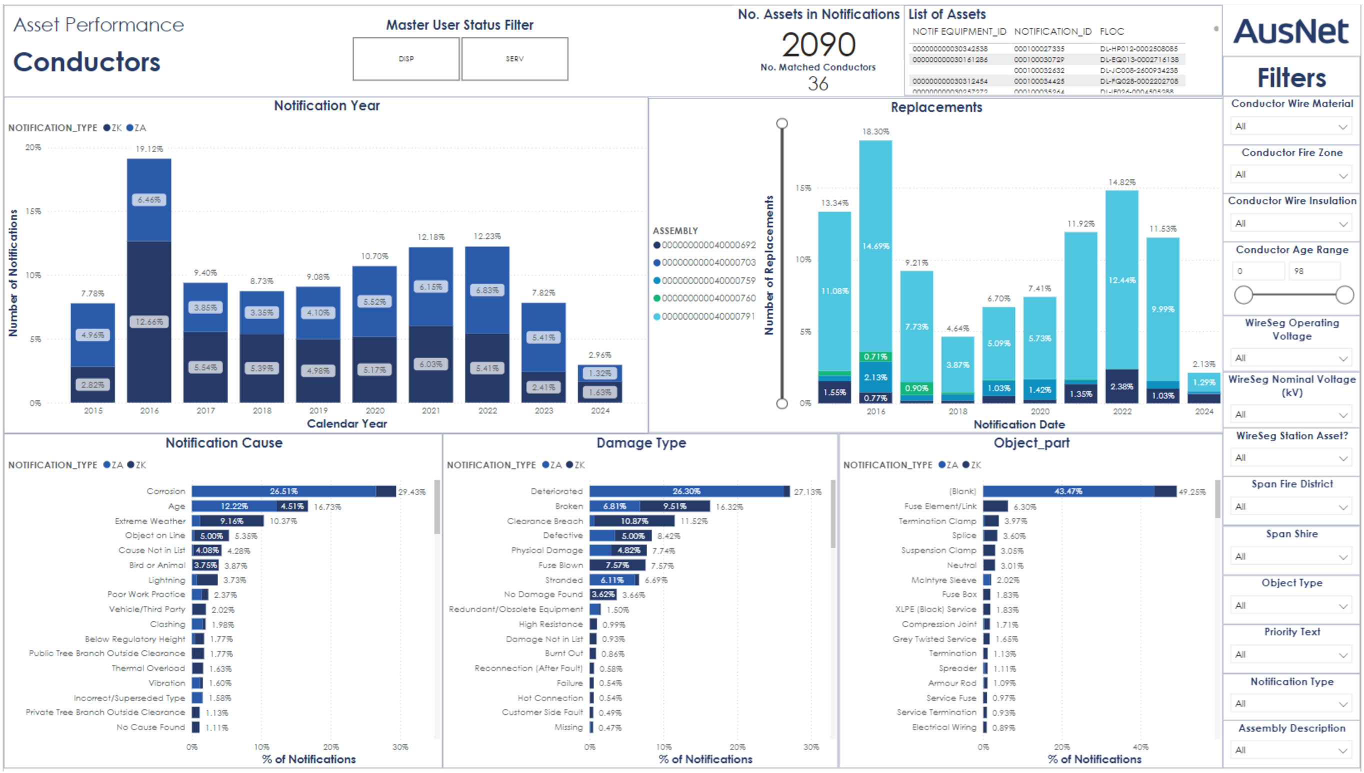

Figure 2 – Bare Conductor Asset Performance

8. Related Matters

8.1. Regulatory Framework

8.1.1. 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.

AusNet must also comply with directives issued by ESV, the Electricity Safety Act 1998 and Electricity Safety (Management) Regulations 2019. One requirement is to submit an Electricity Safety Management Scheme, explaining how a distribution company will operate its network safely. The Conductor Replacement program, Armour Rod and Vibration Damper program and Aerial Spacer Survey program, are examples of projects developed under this scheme to achieve compliance.

8.1.2. 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.

Field audit programs are in place to confirm that construction is in accordance with Overhead Line Design Manual and associated Standard Construction Drawing requirements relating to BOC.

8.2. External Factors

8.2.1. 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.

8.2.2. Environmental Factors

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.

8.2.3. Stakeholder/ 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 BOC do not disrupt local communities or pose safety risks is crucial for maintaining public support and compliance with social responsibilities.

8.3. Internal Factors

8.3.1. 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]

8.3.2. 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 ensures 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.

8.3.3. 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.

9. Asset Strategies

9.1. New Assets

Specific strategies relating to the installation of BOC on new construction are:

- Utilise Low Voltage Aerial Bundled Cable systems for all new aerial LV circuits constructions.
- Utilise insulated underground cable, Medium Voltage Aerial Bundled Cable or Covered Conductor Cable systems for new MV circuits in codified areas.
- Utilise underground cable, Medium Voltage Aerial Bundled Cable or Covered Conductor Cable systems for new MV circuits in high Fire Loss Consequence areas on a case-by-case basis.
- Utilise AAC and ACSR bare conductors for new aerial MV circuits in low bush fire risk areas and in low Fire Loss Consequence areas.
- Utilise AAC and ACSR bare conductors for new aerial 66 kV circuits.
- Install armour rods and vibration dampers in accordance with AusNet's published technical standards.
- Utilise clamp top insulators and armour rods for all new construction.
- All new REFCL feeder overhead conductors will be three phase capacitive balanced.

9.2. Inspections and Monitoring

Specific strategies relating to the inspection and monitoring of BOC on existing construction are:

- Assess conductor, conductor tie, conductor joints, armour rods, vibration dampers and conductor spacer condition in accordance with the criteria established in the Asset Inspection Manual, 4111-1.
- Continually assess the condition of all BOC and maintain accurate condition status in the Asset Management Information System.

9.3. Maintenance

Specific strategies relating to the maintenance of BOC on existing construction are:

- Replace McIntyre and Fargo sleeves (if any left) with compression sleeves and helical splices.
- Replace PG clamps on HV circuits (if any left) with Wedge type connectors.
- Replace LV spreaders on LV spans in high bush fire risk areas in accordance with AusNet's standard VX9/7020/150.
- Replace deteriorated line ties in accordance with the criteria established in the Asset Inspection Manual 4111-1.

9.4. Replacement

Specific strategies relating to the replacement of BOC on existing construction are:

- Replace deteriorated assets in accordance with the criteria established in the Asset Inspection Manual, 4111-1.

- Replace deteriorated MV BOC circuits in codified areas with underground cable, Medium Voltage Aerial Bundled Cable or Covered Conductor cable systems.
- Replace deteriorated MV BOC circuits in high Fire Loss Consequence areas with Medium Voltage Aerial Bundled Cable or Covered Conductor cable systems on a case-by-case basis.
- Replace deteriorated MV BOC circuits in LBRA and in low Fire Loss Consequence areas with AAC and ACSR bare conductor.
- Replace deteriorated 66 kV BOC circuits with AAC and ACSR bare conductors.
- Proactively replace, as required, poor condition BOC between 2026 to 2031 to manage bushfire ignition risk, conditional asset failures and mitigate reliability impacts.

10. Legislative References

STATE	REGULATOR	REFERENCE
VIC	EPA	Environment Protection Act 2017
VIC	ESV	Electricity Safety Act 1998
VIC	ESV	Electricity Safety (Management) Regulations 2019

11. Resource References

NO.	LINK	TITLE
1	4111-1	Asset Inspection Manual
2	4104	Overhead Line Design
3	AMS 01-09	Asset Risk Assessment Overview
4	AMS 20-70	Poles
5	AMS 20-57	Cross-arms
6	AMS 20-66	Insulators – High and Medium Voltage
7	AMS 20-01	Electricity Distribution Network Asset Management Strategy
8	AMS 01-01	Asset Management System Overview
9	ESMS 20-01	Electricity Safety Management Scheme – Electricity Distribution Network

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12. Schedule of Revisions

ISSUE	DATE	AUTHOR	DETAILS OF CHANGE
1	20/10/2008	P. Bryant	First Edition
2	26/10/2009	P. Bryant	Editorial update – remove regulatory life from table 1.
3	17/11/2009	P. Bryant	Update following review by PB consultants.
4	24/11/2009	P. Bryant	PV graph updated
5	13/07/2014	P. Bryant	Steel conductor ties program added
6	16/02/2015	J. Lai T. Gowland	Reviewed strategy for 2015-2020 incorporating Fire Loss Consequence Model. Included Vibration Dampers, Armour Rods, Spacers, Ties and Joints in scope. Removed HVABC from scope.
7	04/06/2019	A. Bugheanu	Update strategy for 2021-2025
8	22/01/2025	S. Few	Updated to new template and general review.

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