Civil Infrastructure

AMS - Electricity Distribution Network

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Table of Contents

ISSUE/AMENDMENT STATUS 2

1 Executive Summary 4

2 Strategies 4

2.1 Buildings 4

2.2 Environmental System 4

2.3 Security Fences 4

2.4 Civil Infrastructure Management 5

3 Introduction 6

3.1 Purpose 6

3.2 Scope 6

3.3 Asset Management Objectives 6

4 Asset Description 7

4.1 Buildings 7

4.2 Environmental Systems 11

4.3 Security Fence 12

4.4 Switchyard 13

4.5 Service Age 20

4.6 Condition Assessment 21

5 Other Issues 27

5.1 Inspections 27

5.2 Maintenance / Refurbishment 27

5.3 Replacement 27

5.4 Research and Development 28

6 Risk and Options Analysis 29

6.1 Buildings 29

6.2 Environmental Systems 29

6.3 Security Fence 30

6.4 Overall Switchyard 30

7 Strategies 31

7.1 Buildings 31

7.2 Environmental System 31

7.3 Security Fences 31

7.4 Civil Infrastructure Management 31

8 Appendix A 32

1 Executive Summary

This document is part of the suite of Asset Management Strategies relating to AusNet Services' 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 civil infrastructure facilities in AusNet Services' Victorian electricity distribution network.

AusNet Services operates about 71 sites that including zone substations, 66kV voltage regulator sites and shared assets in terminal stations, as critical hubs in the electricity distribution network. These sites provide switching and/or transformation functions. The civil infrastructure aspects of these sites affect the environmental performance, safety, security and reliability of the network.

Assets within the classification of civil infrastructure are generally situated within the boundaries of each site. Civil infrastructure includes buildings, environmental systems, security fencing, switchyard, equipment support structures, foundations, cable ducts and trenches, signage and nameplates, access roads, station lighting, transformer enclosures and water supply and drainage systems.

The majority of these assets are maintained by corrective maintenance activities based on condition with limited preventative maintenance specific to civil infrastructure. Condition assessment has been performed on major civil infrastructure assets such as buildings, environmental systems, security fences and switchyards.

The amount work done by AusNet Services on zone substations in the past regulatory periods (2011-2015) and current period (2016-2020) have addressed most of the issues and/or improved the condition of the Civil Infrastructure assets.

There remains only a handful of sites whose buildings and switchyards have asbestos containing materials (ACMs), switchyards need to be improved and security systems required upgrading. The current period will see some of these sites addressed with the rest targeted for the 2022-26 period. The summary of the proposed asset strategies is listed below.

1.1 Strategies

1.1.1 Buildings

- Restore building condition at Bayswater, Benalla, Croydon, Maffra, Morwell North, Newmerella, Thomastown, Wangaratta, Wodonga, and Yallourn (YPS) zone substations to comply to Building Code of Australia by 2025.
- Use modular type buildings in replacing deteriorated control buildings, battery rooms, amenities building etc.
- For the existing buildings whose function has been replaced by the new modular buildings, all asbestos containing materials (ACMs) are to be removed and disposed safely.
- Ensure new buildings comply with the requirements of Building Code of Australia and Australian Standard AS2067: *Substations and high voltage installations exceeding 1000 volts, AC*.

1.1.2 Environmental System

- Improve the environmental systems of Maffra, Moe, Myrtleford, Newmerella and Cann River zone substations to meet the requirements of AS2067: *Substations and high voltage installations exceeding 1000 volts, by* 2025.

1.1.3 Security Fences

- [C.I.C]

- AusNet Services take appropriate actions to restore the security fence condition whenever a damaged fence is identified.

1.1.4 Civil Infrastructure Management

- Re-assess civil infrastructure condition at seventy zone substations before the end of 2023 and record results in Asset Management System (SAP).
- Where possible implement civil works and improved infrastructure security as part of major project/ rebuild works.

2 Introduction

2.1 Purpose

This document outlines the inspection, maintenance and replacement activities required for the economic life-cycle management of civil infrastructure associated with the AusNet Services electricity distribution network.

This document is to be used as reference for asset management decisions and communicate the basis of such activities. It forms part of AusNet Services' Asset Management System for compliance with relevant standards and regulatory requirements. It's intention is to demonstrate responsible asset management practices by outlining econimcally justified outcomes.

2.2 Scope

The scope of this asset management strategy includes civil infrastructure in zone substations, switching stations and voltage regulator sites supporting the electricity distribution network for the period 2022-26. The strategy also includes shared civil infrastructure in terminal stations and power stations which connected to the electricity distribution network.

Civil infrastructure includes buildings, environmental systems, security fence condition and overall switchyard including switchyard surface, access roads, stations lights, cable ducts and trenches, signage and name plates, support structures and foundations that all contribute to the overall function of the station/site.

The security system assets are also covered by;

AMS 20-14: Infrastructure Security.

2.3 Asset Management Objectives

As stated in *AMS 01-01 Asset Management System Overview*, the high-level asset management objectives are:

- Comply with legal and contractual obligations
- Maintain safety
- Be future ready
- Maintain network performance at the lowest sustainable cost, and
- Meet customer needs.

As stated in *AMS 20-01 Electricity Distribution Network Asset Management Strategy*, the electricity distribution network objectives are:

- Improve efficiency of network investments
- Maintain long-term network reliability
- Implement REFCL's within prescribed timeframes
- Reduce risks in highest bushfire risk areas
- Achieve top quartile operational efficiency
- Prepare for changing network usage

3 Asset Description

AusNet Services owns, operates and maintains 61 zone substations in the eastern part of Victoria. In addition to zone substations, two voltage regulator stations located at Seymour (RSME) and Maffra North (RMFN), a Capacitor bank at Erica (CERA), switching station at Bairnsdale, shared assets forming part of the distribution network are located at Yallourn Power Station (YPS), Clover Power Station (CLPS) and Morwell Power Station (MPS) as well as Morwell (MWT), Ringwood (RWT) and Wodonga (WOTS) terminal stations are incorporated in this strategy.

The following sections describe the types of civil infrastructure assets including the materials used and examples of asset condition.

3.1 Buildings

Building code of Australia and AS2067[1] provide guidelines to the design, construction and installation of zone substations.

There are approximately 168 buildings in 71 stations/sites that provide all-weather housing for a range of equipment, including control equipment, protection relays, communication facilities, batteries, switchgear, stores, workshops, worker amenities and office equipment. Table 1 below shows the list of building types within the fleet. These buildings vary in age, condition, type and construction.

Building Category	Number of Assets
Control Room and Switch Rooms	72
Battery Rooms	7
Amenities Building	4
Shed	1
Others (general buildings, stores, workshops, etc.)	84
Total	168

Table 1 – Types of buildings across the fleet

3.1.1 Construction Materials

Different types of building exterior wall cladding in use are concrete, cement sheeting, brick, asbestos containing materials, modular or prefabricated steel, timber and metal sheeting. Due to the replacement of outdoor 22 kV switchyards with indoor metal clad switchgear in several prefabricated buildings; the most common building type is now modular or prefabricated type of building as shown in Figure 1 below.

[1] AS2067 – 2008: Substation and high voltage installation exceeding 1 kV.

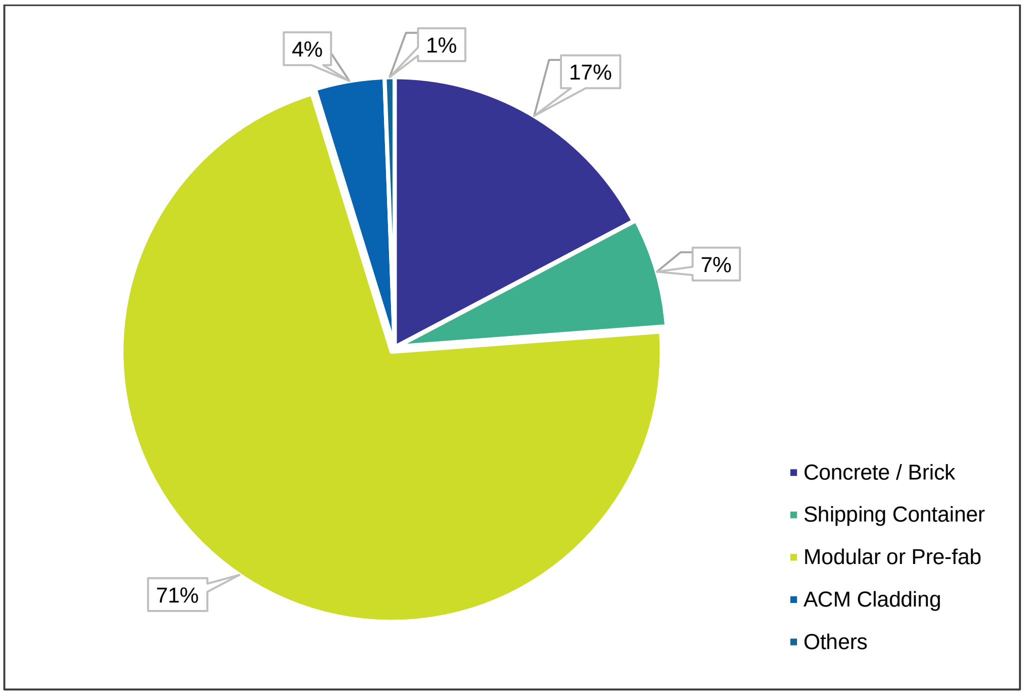

Figure 1 – Types of building materials found in zone substations

3.1.2 Roofing Materials

Different types of roofing material are used for the buildings in zone substations. These materials can be broadly categorised into four types as shown in Figure 2 below.

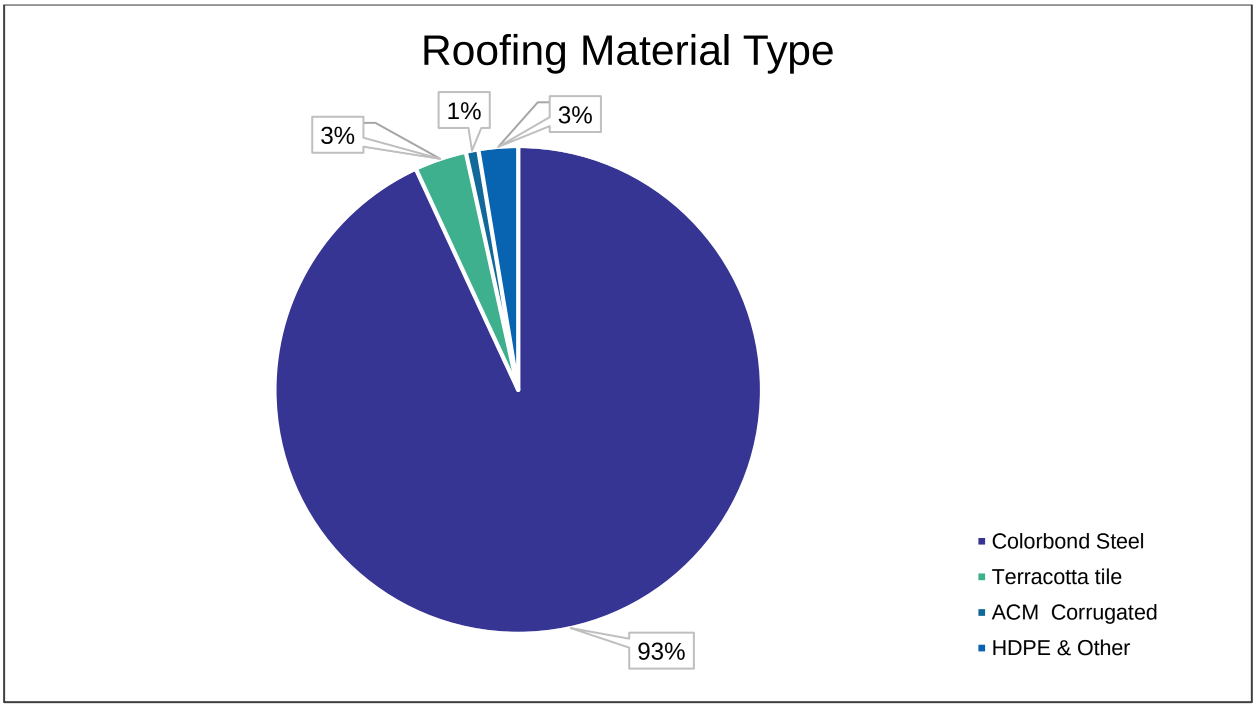

Figure 2 – Types of Roofing Material Used in Buildings

The most common roof material type is Colorbond steel followed by terracotta tiles. There are a few shipping containers used as control buildings which has the same body material used as the roof. The prefabricated buildings most commonly used today have Colorbond steel roofs.

3.1.3 Prefabricated (Modular) Buildings

Seventy one percent of buildings inside AusNet Services' sites are modular or prefabricated type. Typically these buildings are sheet-metal cladding over a galvanised steel frame with plaster board linings and laminated timber floors on a concrete pad or pile footing. Constructed offsite; multifunctional modular buildings have minimal installation costs and are currently most economic for new infrastructure and station rebuilds. These constructions have an engineering life in excess of 40 years. Figure 3 below shows modular type building located at Lysterfield zone substation (LYD).

Figure 3 – Prefabricated buildings at Lysterfield zone substation (LYD)

In two stations, Kilmore South (KMS) and Cann River (CNR), shipping containers also have been used as modular buildings. These buildings are supported by the concrete pad footings or slab foundation depending on the geotechnical conditions of the site. An example of shipping container type control building at CNR zone substation is shown in Figure 4.

Figure 4 – Shipping container type control building at Cann River zone substation (CNR)

3.1.4 Concrete and Brick Buildings

Approximately seventeen percent of buildings have been constructed with brick veneer and concrete slab flooring. As a cladding material, brick has excellent fire resistance and security performance. Tilt-slab concrete construction has also been used for control rooms and 22 kV indoor switchgear buildings. Entrance landings and steps to these buildings are also built on concrete slabs. Figure 5 below shows concrete slab and brick wall control building located at Croydon zone substation (CYN).

Figure 5 – Brick control building at Croydon zone substation (CYN)

3.1.5 Asbestos Clad Buildings

Asbestos, which have been actively targeted for removal, is still present in 5% of AusNet Services' zone substation sites with varying levels of volume and risk. These buildings induce potential health and environmental risks to the personal who are onsite. Seven buildings at four zone substations contain asbestos in different components including exterior wall cladding, eave linings, doors, windows, floor tiles or roof sheeting or ceiling linings. These buildings usually have a hardwood timber frame and are mounted on either concrete flooring slabs or concrete or timber stumps. In other cases there are still small amounts of asbestos found within the cladding, at the rear of relay mounting panels and in doors and window frames. Figure 6 below shows the the control building at Thomastown zone substation (TT) which has DC and relay panels, isolating transformer cubicle and main distribution board with asbestos. These are non-friable and in Good to Fair condition so the risk to personnel is low (i.e. Residual Risk rating of IV).

Figure 6 –Thomastown zone substation (TT) control building

has ACM panels, transformer cubiles, etc.

3.1.6 Weather-board or Hardie plank Clad Buildings on Stumps

One percent of AusNet Services' buildings are Hardie plank or timber weatherboard clad structures. These buildings are typically built on timber or concrete stumps with a timber floor and frame. Where they have been built on stumps, wooden slats have been installed as a skirt between the floor and ground level to restrict entry to secondary cabling. Cable trenches in these buildings finish under the edge of the building and exposed cables then run along ground directly to a point underneath the secondary panel in which they terminate. Figure 7 shows a typical weather board clad control building located at Warragul zone substation (WGL).

Figure 7 – Wood board cladded control building at Warragul zone substation (WGL)

3.2 Environmental Systems

Two differing oil-management methods are used in zone substations based on their age. The first one used in old stations is to allow oil leaks to settle onto a gravel surface and be absorbed into the local soil. The second is to capture leaking oil in a sealed bund to ensure the oil cannot contaminate any environmentally sensitive areas.

In addition to the overall oil management system used in transformer bays and switchyards; each station is fitted with spill containment and oil clean-up kits. Oil-handling vehicles also have spill kits installed to assist the safe management of accidental oil spillage or leakage.

New transformers are installed with concrete-floored sealed bunds and appropriate oil handling drainage. These installations use materials and seals that are impervious to oil. Drainage includes flame traps, valves, oil interceptor pits and Puraceptor separation system allow rainwater to drain but trap oil. This design has proven to be the most effective way to minimise the risk of transformer oil having an environmentally significant impact. New constructions for oil containment on the distribution network are compliant with AS 2067[2] and AS1940[3] as required:

- A full volume holding tank/ Triple interceptor tank for primary sedimentation and oil separation
- Concrete bunding area with drainage pit
- Oil transfer pipe line network with flame trap
- Oil Water Separator unit / system to limit the discharge to less than 5ppm

Figure 8 – Concreted bunded area at Bayswater zone substation (BWR)

3.3 Security Fence

Approximately 25 km of security fencing encloses approximately 71 sites to deter and prevent unauthorised entry into HV switchyards, installations and buildings.

The majority of security fences utilise a chain-wire mesh panel mounted on galvanised posts topped with multiple strands of barbed wire or barbed tape. Other types of fencing panels used are timber palings, metallic panels, PVC coated wire mesh and welded mesh panels. As per AS2067[4] the current requirement for a HV enclosure fencing installation to minimize the risk of unauthorized access through easy climbing or excavation is as following.

- Minimum height 2.5 m.
- Barbed wire (or similar) topping with at least four strands.
- Maximum gap of bottom wire with ground 50 mm.

[2] AS 2067 Substations and High Voltage Installations Exceeding 1 kV.

[3] AS 1940 The storage and handling of flammable and combustible liquids.

[4] AS 2067: Substation and high voltage installation exceeding 1 kV.

In addition to the minimum standard requirements AusNet Services periodically reassesses security risks using a purpose built Infrastructure Security Risk Assessment Tool (ISRAT). Refer to AMS 20 – 14 Security Infrastructure for further details. In accordance with the assessed security risks improved security fencing which includes the following features is being implemented:

- Concrete plinth to resist burrowing or tunnelling
- Top and bottom metallic rails to resist loosening of wire mesh
- Razor wire toppings in concertina configuration to increase the overall effective height to minimum 2.9 m to resist climbing

In addition to condition based treatment, AusNet Services also plans to increase the security controls at high-risk sites. Measures to increase security above the existing standard include electrified fences; weldmesh or palisade fence construction; electronic access to buildings and stations; intruder detection in stations and buildings and in conjunction with electric fencing; remote-control lighting, motion detection recording and cameras; padlocks on outdoor electrical control boxes. Installation of remote-control lighting and cameras will require sufficient communications infrastructure available at the site.

Figure 9 a and b illustrate an early type of fence which had additional security features added, i.e. topping of barb wires, in accordance with assessed security risk during a planned asset replacement project. AusNet Services likewise take appropriate actions to restore the security fence condition whenever a damaged fence is identified.

Figure 9 a and 9b - Security fence & gate at Mt. Beauty zone substation (MBY), before & after augmentation

3.4 Switchyard

Overall switchyard includes switchyard surface, support structures and foundations, access roads, storm water system, station lighting, cable trenches and ducts.

3.4.1 Switchyard Surface

Switchyards have been surfaced using crushed rock, bitumen sealed surfaces, to create a safe work environment. Crushed rock surfacing provides a resistive layer which helps reduce the step and touch potentials within the acceptable limits in compliance to design and safety standards[5].

The crushed rock that is used to provide the switchyard surface has two primary functions. The first is to provide a stable surface and the second is to provide a resistive layer as part of the earth grid system. Each function contributes to the health and safety performance of the station.

[5] AS 2067: Substation and high voltage installation exceeding 1 kV.

Over time soil and fines can build up in the surfacing, allowing weed and moss growth. This process degrades the electrical performance of the surface layer. In stations that have high fault levels and/or poor earth-grid performance this can increase the electrocution hazard to unacceptable levels. Surface renewal restores the electrical performance of the surface and returns the surface to a flat and stable standard.

Figure 10 shows the unsurfaced switchyard at Watsonia zone substation (WT).

Figure 10 – Unsurfaced Switchyard surface at Watsonia zone substation (WT)

Figure 11 shows the switchyard with weed and moss growth at Numeralla zone substation (NLA).

Figure 11 – Condition of switchyard surface at Numeralla zone substation (NLA)

Switchyard surfaces that exhibit soft spots or depressions due to slumping from previous excavation works require levelling and extra rock to increase stability in order to restore a firm level surface suitable for mobile plant to be operated safely.

Furthermore, heavy vehicles and trenching for cables can cause depressions to form within the switchyard. The uneven surface is a hazard to pedestrians and mobile plant. Mobile plant may become unstable on the edge of a depression or in a soft spot.

Some stations have been benched at several levels across the site depending on the local topographical and geometrical conditions. Typically some form of retaining wall is required to stabilise the fill or slope areas and protect equipment from possible slippages and slope failures. Recently, the retaining wall along the access road at Warragul zone substation (WGL) has been replaced as part of its rebuild as shown in Figure 12.

Figure 12 – Retaining Wall at Warragul zone substation (WGL)

3.4.2 Structures and Foundations

There are numerous structures supporting electrical plant in substations. Most of these structures are typically galvanised steel bolted lattice or welded component arrangements whereas transformer support structures are reinforced concrete platforms or slabs. Modern support structures are designed in accordance with AS 3600[6] or AS4100[7].

Circuit breaker, switch structure and bus support structure foundations are steel reinforced concrete. Current practice mounts the steel structures on concrete foundations with weather-sealing grout installed under their feet.

Minor issues include corrosion and physical damage. The original design can exhibit corrosion at the interface of the concrete and steel or steel and ground (where mounted directly into the ground) in some cases. If that is the case individual steel members can often be replaced or treated rather than the entire structure. Identification of minor corrosion simply requires removal of the corroded surface and treatment with a zinc-rich paint.

Typically, foundations will last as long as the structures and equipment that they support. However, since foundations have been occasionally re-used during equipment replacements, depending on their suitability and condition in some cases they are older than the structure they support. Although, they are generally in good condition some have slightly deteriorated due to corrosion of the included steel reinforcement and hold-down bolts, or due to physical damage.

Foundations can also undergo settlement issues depend on the geotechnical soil condition of the site, especially if the foundations are built on top of fills. Foundation settlement issues can cause significant damage to the supporting plant if not identified in the early stages and an appropriate remedy taken.

3.4.3 Access Roads

Roadways within the station sites consists of a mixture of sealed and unsealed surfaces. These roads provide all-weather access for construction, maintenance, mobile plant and transformer delivery vehicles without subsidence or permanent compression.

Sealed roads typically have barrier kerb and channel edges or concrete spoon drains on both edges. Unsealed roads are surfaced with either crushed aggregate or gravel and are suitable for light operational traffic. The movement of major plant such as 20/33 MVA transformers usually requires augmentation of unsealed access roads.

Figure 13 shows the access road located at Warragul zone substation (WGL).

[6] AS3600 – 2009: Concrete Structures.

[7] AS4100 – 1998: Steel Structures

Figure 13 – Access road surface located at Warragul zone substation (WGL)

Sealed roadways within stations are typically not heavily utilised and exhibit low rates of wear compared to public roads. The low rate of traffic can allow weeds to grow in cracks and accelerate the break-up of the road surface. These roads can easily be repaired by patches or by being resealed and should be targeted during station rebuilds where road condition necessities arise. Figure 14 below shows the condition of the main access drive to Clover Flat zone substation (CF).

Figure 14 – Main Access Drive at Clover Flat zone substation (CF)

The majority of switchyard roads are unsealed (gravel surfaced) and require minor ongoing maintenance to retain stability and a level surface for all-weather heavy vehicle access. However, their life span is relatively shorter than the sealed surfaces and therefore only serviceable for a short period of time compared to sealed roads.

The need to gain access to switchyards with mobile plant presents a problem where kerbs have been employed. Typically field staff have found a way to bypass the kerb but in some cases this has caused erosion issues and may present a tipping hazard and resulting health and safety issues for the mobile plant.

3.4.4 Stormwater Drainage

Station stormwater drainage systems include spoon drain or kerb and channel, entry pits at the surface level and below ground drainage pipes. During a storm event, spoon drains, kerb and channel drains surface water into the below ground storm water drains via entry pits and then into the local area stormwater network. In some regional areas, the storm water is drained outside the station property without a defined drainage system.

Surface drains within switchyards are more typically pre-cast spoon drains and some have moved significantly since installation due to traverse of maintenance vehicles. While in most cases they do not cause problematic flooding within the station, they may pose as a pedestrian tripping hazard if not properly designed and installed.

3.4.5 Station Lighting

External lighting of buildings and switchyards helps safe access for operators and maintenance staff at night. A number of lighting technologies have been employed, including sodium vapour; metal halide and mercury vapour fluorescent types.

In a few stations, lights have been fitted on the existing primary plant supporting structures, therefore eliminating the need for additional poles or posts to be erected. In newer stations; lights are installed on the dedicated galvanised steel posts which are supported by concrete pad footings. Figure 15 shows switchyard lighting used at Sale zone substation (SLE).

Figure 15 – Switchyard Lighting at Sale zone substation (SLE)

The current station lighting strategy is to replace at next opportunity after failure or when some civil infrastructure works on the station, such as a rebuild or augmentation, deems it economically viable. Improving station lighting acts as a deterrent on possible theft during the construction stage which is discussed further in *AMS 20-14: Infrastructure Security*.

3.4.6 Cable Ducts and Trenches

The cable trenches in zone substations are largely comprised of preformed concrete trenching with concrete covers however, plastic ducts and direct buried conduits are also used at a few stations. The cable ducts are covered by either concrete covers or galvanized steel covers to provide safe passage to maintenance vehicles and equipment without impacting the cables in ducts.

Some stations contain the direct buried cables coupled with a pit and conduit system; therefore no cable trenches are employed. Figure 16 shows the cable trench located at Mt Beauty zone substation (MBY) and its physical condition.

Figure 16 – Cable trench and cover lids at Mount Beauty zone substation (MBY)

The cable trenches have a number of issues including condition, strength and capacity. Therefore, their condition varies widely across the zone substations.

In some cases the preformed duct walls are starting to break causing the surrounding soil and rocks to enter the cable duct. This also causes the loss of the top lip of the tray that holds the concrete lid allowing it to fall onto the cable. The lids are breaking down in the same way and causing them to fall on the cables or giving the users a false sense of security and then fail under load. Therefore, some of the yards have now become tripping hazards due to the holes in the cable trenches or the failure of the cable lids under foot.

Revisions to works practices due to health and safety learning have resulted in increased use of mobile plant, scissor and boom lifts to access across the trenches when originally ladders would have been used to access electrical equipment. In many cases the design of the trenches did not envisage such loads traversing them. This has resulted in lid failures and is a potential source of cable damage, which could lead to undiscovered failures or mal-operation of primary equipment.

3.4.7 Signage and Nameplates

Australian Standards[8] require that key parts of the station installation, for example busbar systems, switchgear, bays, conductors, protection indication equipment are clearly, legibly, durably and uniquely labelled. Therefore, many equipment nameplates and signs have been installed in zone substations to physically identify these assets. These operational name plates help the safe and reliable operation and maintenance of other electrical assets. Figure 17 shows the operational nameplate mounted on support structures at Mount Beauty zone substation (MBY).

[8] AS1319 – 1994: Safety signs for the occupational environment.

Figure 17 – Operational nameplates at Mount Beauty zone substation (MBY)

Station perimeter signage advises the public on site ownership, security warnings, and electrical hazards of the station and contact telephone numbers. Figure 18 shows perimeter signage used at Merrijig zone substation (MJG).

Figure 18 – Perimeter and Gate Signage at Merrijig zone substation (MJG)

Operational nameplates are typically white text on a black background and have reasonable resistance to fading. Their location within the switchyard minimises exposure to vandalism and as a result life expectancy is 10 years.

Many operational nameplates within AusNet Services' stations are becoming hard to read therefore, warrant replacement to avoid increasing human error incidents that could cause safety incidents. In a five-year period it is prudent to replace 50 per cent of operational nameplates. Figure 19 shows Faded Nameplates at 22 kV switchyard at Seymour zone substation (SMR).

Figure 19 – Faded nameplates at 22 kV Switchyard Seymour zone substation (SMR)

3.5 Service Age

Most of the civil infrastructure within the zone substation is established with the initial development of the station and therefore, the site establishment date is representative of the age profile of the station civil infrastructure. As shown in Figure 20 below, over half of the stations are more than 50 years old.

Partial or full replacement of civil infrastructure as part of station rebuild works or targeted refurbishment projects within last 10 years has contributed toward a better balance in the civil infrastructure service age and condition profiles. Several stations[9] have had complete rebuilds (including civil infrastructure works) while two new stations[10] were installed on the network during the last 10 years. Furthermore, the completion of asset replacements and refurbishments at a selected number of stations has reduced the overall service age of civil infrastructure at targeted stations.

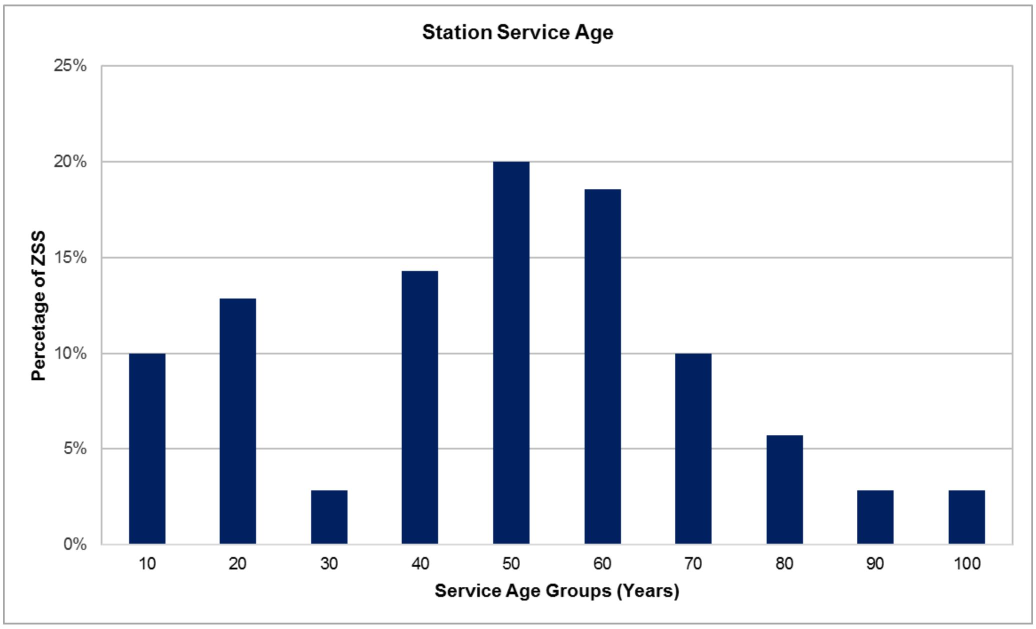

Figure 20 – Service age profile of zone substations

[9] Bright (BRT), Lilydale (LDL), Traralgon (TGN), Pakenham (PHM), Bairnsdale (BDL) and Rubicon (RUB A)

[10] Cranbourne (CRE) and South Morang (SMG)

3.6 Condition Assessment

In many cases existing civil infrastructure dates back to initial station construction. Over the last decade, there have been some zone substation rebuilds and civil infrastructure replacements undertaken during major equipment replacement programs. However, a major equipment replacement does not automatically include replacement of associated civil and supporting structures. The existing infrastructure has remained in service wherever economic to do so.

Condition assessment (using the standard C1 to C5 scoring methodology) has been performed on major civil infrastructure assets such as buildings, environmental systems, security fences and switchyards.

3.6.1 Buildings

Table 2 – Condition description of building assets demonstrates the condition score, description and estimated remaining life of building assets.

Condition Assessment Score	Building Condition Description	Remaining Service Life (Years)
C1	New buildings in good condition generally compliant with current Building Code of Australia	More than 50
C2	Buildings with replaced Colorbond roof with poor condition signs in less than 10% of building components	40 – 50
C3	Buildings with good roof, windows, insulation, with minor poor condition signs visible in 10 to 20% of the building components)	20 – 40
C4	Asbestos clad buildings with poor condition signs in 20 to 40 % of the building components	10 – 20
C5	Asbestos clad buildings with asbestos in multiple components and poor condition visible in more than 40% of the building components	Less than 10

Table 2 – Condition description of building assets

Figure 21 below shows the condition profile of buildings at 71 stations / sites.

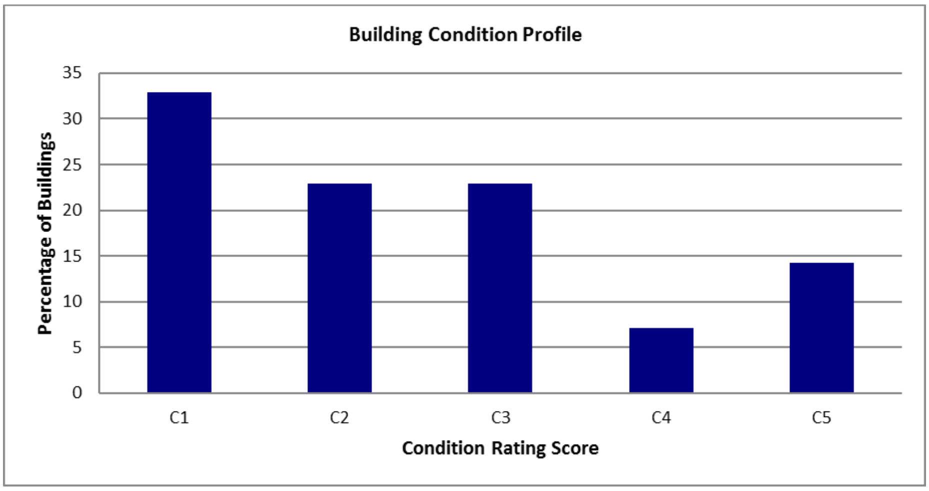

Figure 21 – Condition profile of building assets

Overall 33% of buildings in the 71 sites are in C1 condition and comply with the current building code of Australia. Most of these stations have been built recently or undergone rebuild or significant refurbishment.

Fourteen percent of the buildings are in C5 condition. These buildings exhibit poor condition such as damaged claddings, rusted roof, cracked or loose tiles, and damaged ceilings. This is mainly due to the poor condition of the buildings due to their service age and lack of maintenance. Most of these stations are more than 50 years old and have not undergone any significant infrastructure rebuild or refurbishment.

3.6.2 Environmental Systems

The condition has been assessed based on the number of transformers (volume of oil), number of leaking transformers and overall transformer condition, possible environmental impact due to escape of oil (contamination of water body), site factor (slope and closeness to storm water drainage and current bunding and environmental system provisions. Refer to Table 3 which demonstrates the condition score and description.

Condition Assessment Score	Environmental Condition Description	Replacement/Improvement Action Required (in years)
C1	Low environmental risk – good transformer condition, transformers fully bunded, water treatment system complies with AS1940	50
C2	Little environmental risk – good transformer condition, sealed transformer bunds, ROCLA water treatment system	40
C3	Moderate or average environmental risk – minor transformer oil leaks, effective transformer bunds, little potential for contaminated storm water to escape site	20 – 40
C4	Above average environmental risks – transformer oil leaks, partially effective transformer bunds, potential for contaminated storm water to escape site to nearby agricultural land or storm water drains	10 – 20
C5	High environmental risks – significant transformer oil leaks, ineffective transformer bunds, sloping site with potential for contaminated storm water to escape to nearby river or significant waterway	Less than 10

Table 3 – Condition profile of environmental systems

Figure 22 below shows the environmental condition profile for the 71 stations / sites.

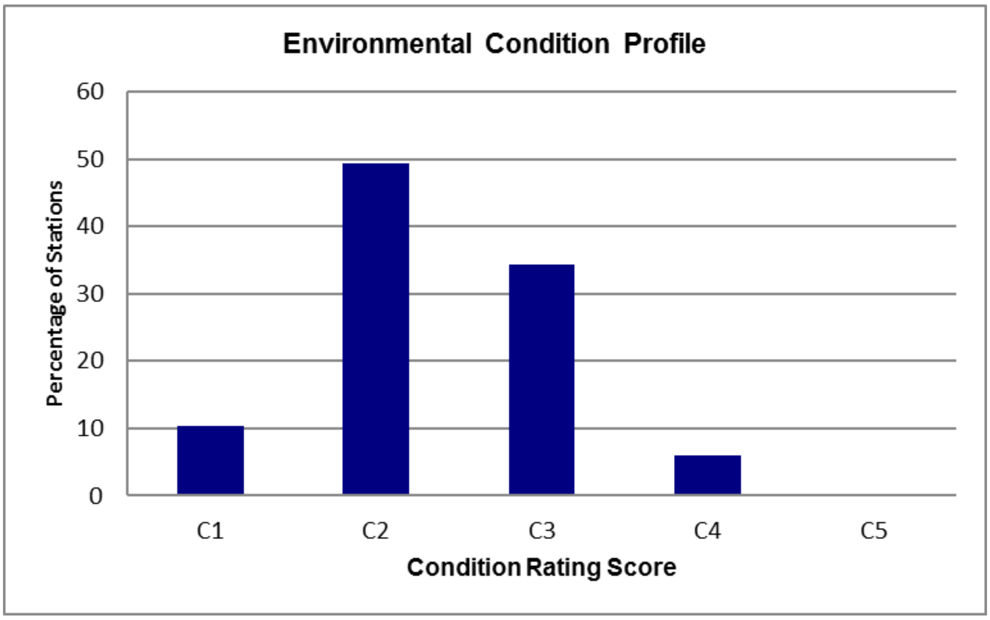

Figure 22 – Environmental system condition profile

Ten percent of the station sites have environmental systems that are in C1 condition. Oil management systems at these stations include concrete floored and bunded transformer bays with appropriate drainage and oil separation mechanism which consists of flame traps, valves, oil interceptor pits and Purcaceptor to allow rainwater to drain but trap oil. These stations comply with the current EPA and Australian Standards, specifically AS1940: Storge and Handling of Flammable and Combustible Liquids.

Oil management systems at 49% of stations are in C2 condition where oil leaks, oil escape risk and environmental impact is low.

Six percent of station sites have oil management systems that are in C4 condition which exhibit above average oil escape risk with potentially high environmental impact due to nearby waterways. This is mainly due to the fact that older stations were not designed to capture and separate oil therefore they do not comply with current standards and impose higher risk of environmental impact. The completion of environmental upgrade projects during the past two periods, i.e. FY2010-2014 and FY2015-2020 have assured no station has a high risk of environmental contamination.

3.6.3 Security Fence

Each zone substation has been assessed based on lacking additional safety measures (ASM) and condition of existing fencing against the effectiveness of fencing to deter intrusions. Table 4 demonstrates the condition score and description.

Condition Assessment Score	Fencing Condition Description	Remaining Service Life (Years)
C1	New fences, all ASM installed and compliant to current standard AS2067	50
C2	Chain wire mesh with plinth and topping, top and bottom rails, no deterioration signs, all of the ASM installed	40
C3	Topping with additional height, lacking plinth or topping, good condition mesh/ timber, no deterioration sign, lacking 1 or 2 ASM	20 – 40
C4	Barbed wire but no plinth, no top and bottom rails, mixed condition, rusting signs, non-standard height, lacking up to 3 ASM	5 – 20
C5	No topping, no plinth, no top and bottom rails, on most of the fencing, ageing signs (rusting or cracking), non-compliant heights (< 2.5m) and lacking all or up to 4 ASM	Less than 5

Table 4 – Fencing condition assessment

As shown in Figure 23, the condition of security fences varies significantly across zone substations. Fifty two percent of the stations are fenced with PVC coated wire mesh; razor tape and plinth and top and bottom rails. These are in accordance with the current standard AS2067. Fences at 13% of sites are C2, 10% at C3 and 24% at C4. Only 1% of substations are not up to the current standards without any topping, plinth and top and bottom rails, in most of the cases exhibiting potential risk of compromised security due to lack of additional security measures.

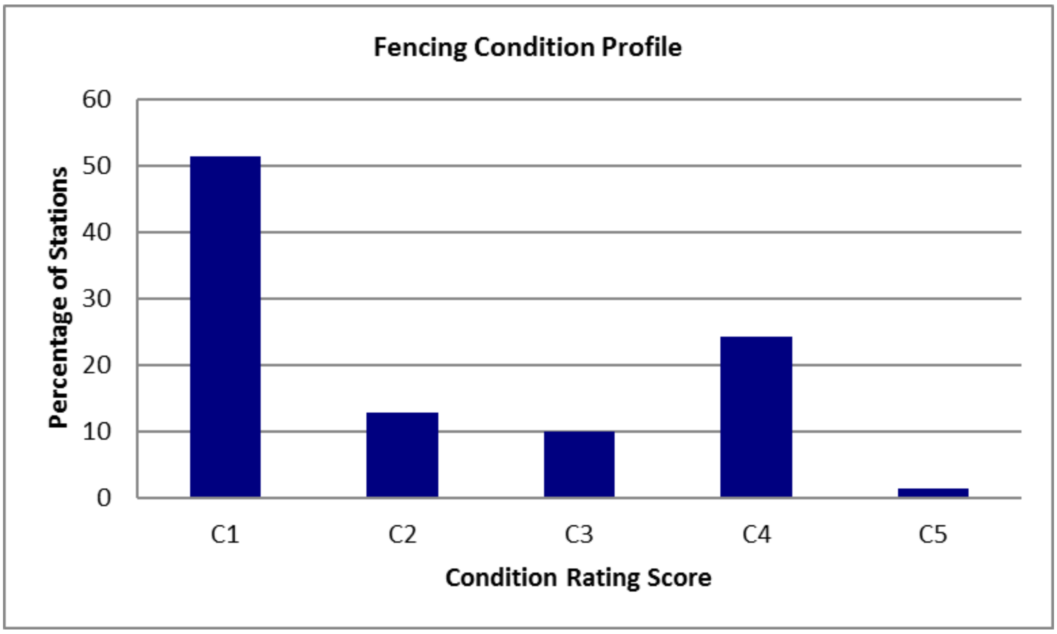

Figure 23 – Condition profile of fences in stations

Asset condition of some of the "Very Poor" (C5) security fences will be addressed by station rebuild projects to improve security at stations with higher risk[11]. For stations which are not scheduled for a rebuild 2022-26, a risk assessment is undertaken to ascertain the need for an infrastructure project to improve the station security which is composed of the fence, lights and other ASMs including monitoring systems.

3.6.4 Switchyard

Based on the condition of the switchyard surface, along with the other associated assets such as support structures and foundations, access roads, storm water system, station lighting, cable trenches and ducts condition of the overall switchyard at 71 stations / sites have been evaluated using the criteria from table 5 below.

Condition Assessment Score	Overall Switchyard Condition Description	Remaining Service Life (Years)
C1	New switchyard with no issues with all other switchyard assets	50
C2	New switchyard with most of the switchyard assets in good with minor issues for less than 5% of switchyard assets	40
C3	Switchyard with poor condition (damaged or uneven or soft) surfaces, water loggings, potholes, excessive weed growth, ground subsidence) for less than 5 - 20% of switchyard assets	20 – 40
C4	Switchyard with poor condition (damaged or uneven or soft) surfaces, water loggings, potholes, excessive weed growth, ground subsidence) for 20 - 40% of switchyard assets	5 – 20
C5	Switchyard with poor condition (damaged or uneven or soft) surfaces, water loggings, potholes, excessive weed growth, ground subsidence) for more than 40% of switchyard assets	Less than 5

Table 5 – Switchyard condition profile of switchyard assets

Analysis shows that 26% of stations have switchyards which are in C1 condition with no issues. As shown in Figure 24, 37% of station switchyards are in C3 condition.

Works currently in progress and future planned works will impact on the surface condition at switchyards, increasing the capacity to provide a safe, all-weather operational and working environment.

[11] Refer to AMS 20 – 14 for further information

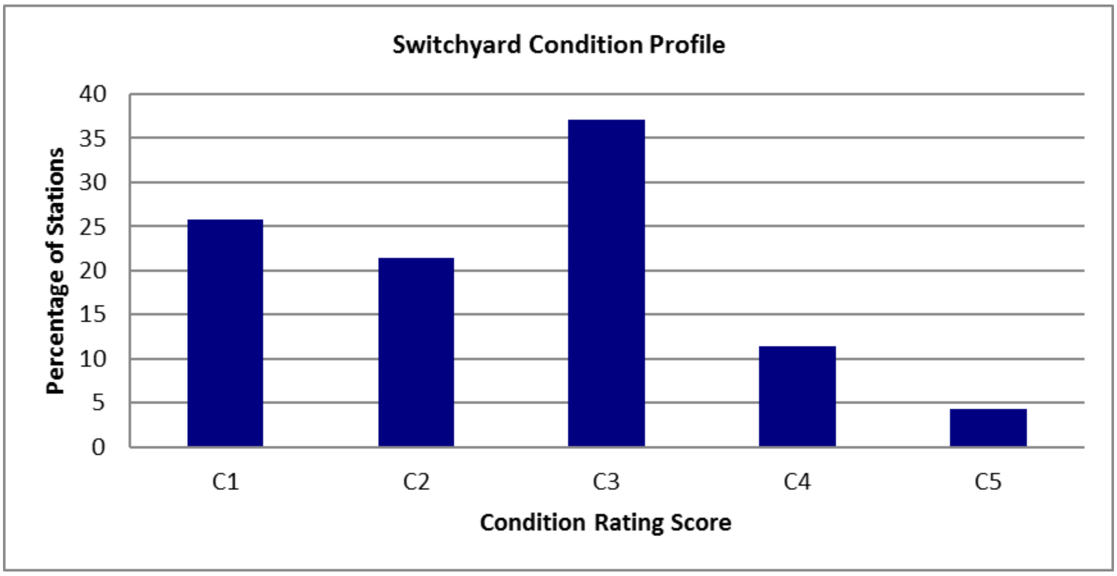

Figure 24 – Condition profile of switchyard assets

4 Other Issues

4.1 Inspections

Stations are inspected at regular intervals as per SMI 67-10-05: Routine Station Inspections. It classifies stations, both terminal stations and zone substations as either being Low Risk or High Risk.[12]

All stations are inspection three monthly which start with the perimeter such as fences, gates, warning signs and locks; checking for signs of vandalism, forced entry and other security breaches; major oil or water leaks; environmental breaches; and filter element in the Puraceptor interceptor tank.

Inspection on general items include items such as asset signage, missing or damaged covers/gratings, stormwater drainage system, cracks in the buildings, cleanliness of the toilets, yard lighting, earthing connections and copper earth grids.

For the control buildings and COMMS room, the inspector makes sure that the following items are operational: lighting, doors & windows are able to be secured, panel lights are operational, the air conditioning systems are operational, any signs of vermin and that the vermin guards are adequate.
The station fire protection is likewise inspected monthly which include fire extinguishers, fire hydrants, automatic sprinkler, detection system and identifying any fire hazard.

Environmental systems include the bund area, interceptor pit, oil-water separator, waste management in rubbish bins, noise levels from inside the stations and vegetation.

4.2 Maintenance / Refurbishment

Items identified by the stations inspection as needing maintenance or refurbishment are to be flagged using the Corporate Asset Management System (SAP) by raising a ZA notification (condition-based maintenance) with the appropriate priority rating.

Items that are expected to go beyond the maintenance budget for a particular activity shall have a ZD Notificaiton (i.e. project-based activity) raised for its rectification. For certain parts of a station, e.g. access roads, transformer bunds, security fence, switchyard resurfacing, etc., the cost for maintenance or refurbishment is such that for it to be economic, the work has to be incorporpated into a program or as part of the station rebuild. To facilitate decision making, a risk assessment can be undertaken to ascertain that the risk levels are acceptable.

4.3 Replacement

Items which are beyond repair, not as per current standard or meeting regulatory requirement must be replaced albeit at an economic manner. Similar to maintenance and refurbishment works, replacement works are usually undertaken as part of a program - such as station refurbishment or station rebuild. Stand-alone replacement works are done if the risk assessment supports the urgency of the works.

[12] Low Risk – stations that have electrical fences and continuous monitoring; High Risk – stations which don't have the said security enhancements.

4.4 Research and Development

New monitoring systems are available in the market which can analyse water quality with respect to water quality and pollution levels – assuring that the discharge from environmental systems are within the EPA Guidelines and complies with the company requirement of having particulate levels of not greater than 5 ppm. These systems can be remotely accessed providing real-time capability for environmental management.

A system has been installed at the Kinglake Zone substation with further installations being considered as part of coming station rebuilds/refurbishment works.

5 Risk and Options Analysis

There are varying risks associated for each component of a station’s Civil Infrastructure, ranging from asset and public safety for the security system/fence, environmental contamination for environmental systems and personnel safety with regards to buildings and switchyard condition.

Depending on the nature and scale of the deficiencies of the civil infrastructure assets, solutions vary from targeted asset replacement, station refurbishment or whole station rebuild. The integration of civil infrastructure upgrades should be considered during the scope development phases of such projects as it’s been proven to be the most economic solution.

A semi-quantitative risk analysis for the different components of the civil infrastructure was undertaken based on the condition of the asset and using criticality values from penalties caused by non-compliance to relevant regulations, as well as unit rates for repair/replacement from previous projects.

5.1 Buildings

Asbestos is a major concern in regards to building occupational health and safety, as well as non-compliance to the Buidling Code of Australia (BCA). Figure 25 provides a graphical representation of the risk assessment findings which is assessed in accordance with the Corporate Risk Matrix of AusNet Services.

			CONDITION					
		Building Incident Consequence Cost ($)	C1	C2	C3	C4	C5	Cosequence / Refurbish Cost Ratio
CRITICALITY	Cr 5	> 750k	0	0	0	0	0	> 10
	Cr 4	225k - 750k	12	6	8	4	6	3.0 - 10.0
	Cr 3	75k - 225k	15	7	4	2	6	1.0 - 3.0
	Cr 2	25k - 75k	0	0	0	0	0	0.3 - 1.0
	Cr 1	0k-25k	0	0	0	0	0	0 - 0.3

Figure 25 – Risk Martix for Buildings inside Zone substations

Sixteen sites which currently are in Risk Level IV (i.e. C4 or C5 condition, with a criticality rating of Cr3 or Cr 4) will be subject to asbestos removal and other building improvements.

7-sites will have new modular buildings as part of the station refurbishment works, while 8-sites will have the asbestos containing materials (ACM) removed as part of station upgrade program. [C.I.C]

5.2 Environmental Systems

The environmental risk profile for zone substations and sites are shown in Figure 26. There are 6-sites that are in Risk Level IV, having a criticality of Cr4 with a C4 condition score.

			CONDITION					
		Environmental Consequence Cost ($)	C1	C2	C3	C4	C5	Cosequence / Replacement Cost Ratio
CRITICALITY	Cr 5	> 3,000k	0	0	0	0	0	> 10.0
	Cr 4	900k - 3,000k	0	22	14	6	0	3.0 - 10.0
	Cr 3	300k - 900k	5	10	9	2	0	1.0 - 3.0
	Cr 2	90k - 300k	0	0	0	0	0	0.3 - 1
	Cr 1	0k-90k	0	0	0	0	0	0 - 0.3

Figure 26 – Environmental risk matrix

Of these six sites, one station will have its environmental system completely upgraded by 2020, one site will be completed as part of REFCL Tranche 2, 3-sites will be refurbished during the 2022-26 EDPR period, while one site, [C.I.C]

5.3 Security Fence

Refer to *AMS 20-14 Infrastructure Security* for the risk assessment of security fences.

5.4 Overall Switchyard

There are 3 sites which currently have a switchyard condition in Risk Level IV. The switchyard risk profile of those zone substations can be minimised by resurfacing the yard, refurbishing the road and replacing items that are defective such as pit covers, lighting, etc. hence resulting in far better overall risk profile (Figure 27) across the switchyard fleet.

			CONDITION					
		Swyd Incident Consequence Cost ($)	C1	C2	C3	C4	C5	Cosequence / Refurbish Cost Ratio
CRITICALITY	Cr 5	> 1,000k	0	0	0	0	0	> 10.0
	Cr 4	300k - 1,000k	0	0	1	1	0	3.0 - 10.0
	Cr 3	100k - 300k	2	6	11	2	2	1.0 - 3.0
	Cr 2	30k - 100k	15	6	18	6	1	0.3 - 1.0
	Cr 1	0k-30k	0	0	0	0	0	0 - 0.3

Figure 27 – Overall switchyard risk matrix

The switchyard of these stations will be refurbished during the 2022-26 EDPR period as part of station rebuild/ refurbishment programs.

6 Strategies

6.1 Buildings

- Restore building condition at Bayswater, Benalla, Croydon, Maffra, Morwell North, Newmerella, Thomastown, Wangaratta, Wodonga, and Yallourn (YPS) zone substations to comply to Building Code of Australia by 2025.
- Use modular type buildings in replacing deteriorated control buildings, battery rooms, amenities building etc.
- For the existing buildings whose function has been replaced by the new modular buildings, all asbestos containing materials (ACMs) are to be removed and disposed safely.
- Ensure new buildings comply with the requirements of Building Code of Australia and Australian Standard AS2067: *Substations and high voltage installations exceeding 1000 volts, AC*.

6.2 Environmental System

- Improve the environmental systems of Maffra, Moe, Myrtleford, Newmerella and Cann River zone substations to meet the requirements of AS2067: *Substations and high voltage installations exceeding 1000 volts, by* 2025.

6.3 Security Fences

- [C.I.C]
- AusNet Services take appropriate actions to restore the security fence condition whenever a damaged fence is identified.

6.4 Civil Infrastructure Management

- Re-assess civil infrastructure condition at seventy zone substations before the end of 2023 and record results in Asset Management System (SAP).
- Where possible implement civil works and improved infrastructure security as part of major project/ rebuild works.

7 Appendix A

Item	ZSS	Building	Switch yard	Fence	Env.
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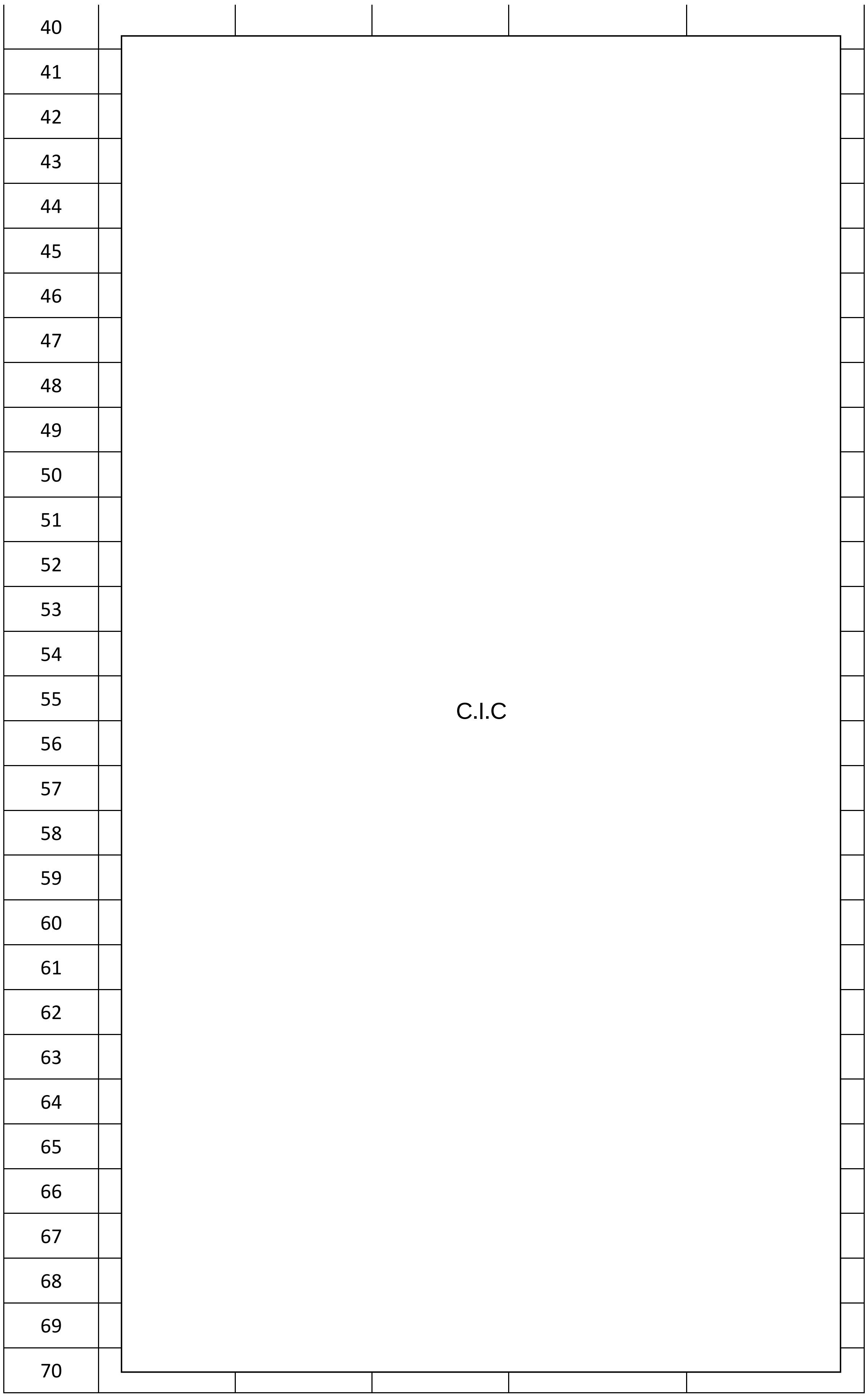
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