# REFCL Compliance Maintained Planning Report Wodonga Terminal Station (WOTS) Zone Substation

## AMS – Electricity Distribution Network

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## Disclaimer



## Contact

This document is the responsibility of the Regulated Energy Services division of AusNet Services.

Please contact the indicated owner of the document with any inquiries.

T Langstaff
AusNet Services
Level 31, 2 Southbank Boulevard
Melbourne Victoria 3006
Ph: (03) 9695 6000

# Contents

# 1 Project overview

*The Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016* came into effect on 1 May 2016 amending the *Electricity Safety (Bushfire Mitigation) Regulations 2013* (the **Regulations**). The Regulations specify the Required Capacity for Rapid Earth Fault Current Limiter performance. The Regulations also specify the 22 zone substations on AusNet Services' network that must comply with the Regulations.

The *Electricity Safety Amendment (Bushfire Mitigation Civil Penalties Scheme) Act 2017* (the **Act**) sets out the significant financial penalties enforceable for non-compliance. Refer to Appendix A for further information.

Wodonga Terminal Station (**WOTS**) is included in Tranche 2 of the AusNet Services REFCL Program with compliance required to be achieved by 1 May 2021. This report investigates and seeks funding for the most prudent and efficient approach to maintain compliance with the Regulations at WOTS during the 2022-26 regulatory control period.

By the Tranche 2 compliance deadline of 1 May 2021, WOTS will have two standard Arc Suppression Coils installed which, for planning purposes, are assumed to have a capacitive current limit of 100 Amperes (**A**) for a total 200A for the 22 kV distribution zone substation beyond which it may not be able to achieve the Required Capacity. The zone substation demand is within the zone substation rating and the zone substation assets are in good condition. Hence, the increasing capacitive current is driving the need to invest in WOTS to ensure AusNet Services can maintain compliance with the Regulations.

This report reviews various options considered by AusNet Services to manage the capacitance growth. The preferred option, which is the option found to be the most economically efficient and technically feasible, recommends that a new REFCL-protected zone substation (**ZSS**) is installed at the location near Baranduda, shown in Figure 4.2, and associated network reconfiguration works are carried out.

Following approval, AusNet Services will complete the following works:

- Acquire land near Baranduda as shown in Figure 4.2;
- Establish a new 2x10 MVA 66/22 kV rural Zone Substation with one REFCL;
- Build new double circuit 22kV line sections totalling 2.0 km to connect up WOTS13, WOTS24 and WOTS11;
- Build a new 66 kV line along the existing WOTS11 line reducing further customer impact; and
- Network reconfiguration to balance load on the existing WOTS 22kV buses.

The expected cost is $29.3 million ($'real, 2019) and is the identified technically feasible option with least risk.

# 2 Background

## 2.1 Purpose of this report

This report investigates any constraints that are forecast to occur at WOTS, identifies and assesses potential options, and seeks funding for the preferred option. WOTS is included in Schedule 1 of the *Electricity Safety (Bushfire Mitigation) Regulations 2013*, and must meet the Required Capacity defined in the Regulations.

The constraints investigated include:

- Forecast demand;
- Network constraints; and
- Capacitive current and compliance with the Regulations.

The following sections of this report describe the compliance obligations, the technologies available to achieve those obligations, constraints at the zone substation and options to mitigate any issues.

## 2.2 Compliance obligations

The Victorian Government has mandated, through the Regulations, that electricity distribution companies increase safety standards on specific components of their networks to reduce bushfire risk. The Regulations set challenging performance standards (the **Required Capacity**) for 22 of AusNet Services' zone substations. The dates for compliance are separated into three tranches based on a prioritising points system, and occur on 1 May 2019, 1 May 2021 and 1 May 2023. In addition, the Victorian Government has enforced timely compliance of the Regulations by introducing significant financial penalties though the *Electricity Safety Amendment (Bushfire Mitigation Civil Penalties Scheme) Act 2017* (**the Act**).

Distribution businesses have found that the Required Capacity can only be met by installing Rapid Earth Fault Current Limiters (**REFCLs**) in zone substations. In addition, the Victorian Government's Powerline Bushfire Safety Program also identified REFCLs as the preferred solution for meeting the Required Capacity[1].

The Act provides for the Governor-in Council to grant exemptions and for a Major Electricity Company to request the modification of due dates and periods.

Details of the Act, the Regulations and the penalties are in Appendix A.

## 2.3 REFCL technology

There are various types of technology that fall under the REFCL umbrella, however the only type of REFCL currently considered suitable by the Victorian Electric Supply Industry (**VESI**) for bushfire safety is known as the Ground Fault Neutraliser (**GFN**), a proprietary product by Swedish Neutral. Presently, the GFN is the only device that can meet the performance criteria of the Regulations. All references to REFCLs in the remainder of this document are referring to the GFN type.

REFCLs are comprised of the following key components:

- Arc Suppression Coil (**ASC**) – which is a large inductorthat compensates for the capacitive current during an earth fault.

[1] REFCL fact sheet 2016 111216, Introducing best knowledge and technology, Powerline Bushfire Safety program, Dec 2016

- Residual Current Compensator (**RCC**) – also referred to as the inverter, which is located in the zone substation control building or switchroom. It is used to reduce fault current by compensating for the active current during an earth fault
- Control Panels and software, which control the equipment.

## 2.4 REFCL constraints

The REFCL's ability to successfully detect, manage and locate phase to earth (also referred to as ground) faults on the 22kV network[2] is dependent on a complex combination of network conditions which, when correctly managed, allow continued operation of the REFCL protection in compliance with the Required Capacity.

The following network conditions and physical constraints impact the continued correct operation of the REFCL and its ability to continue meeting the Required Capacity:

**Network damping factor**

The network damping factor is defined as the ratio of the resistive current losses to the capacitive current ($I_R/I_C$) measured across the zero-sequence network. A higher damping factor is undesirable as it limits the ability of the REFCL to detect a high impedance fault, and thus operate in the time required to comply with the Required Capacity. The higher the damping factor the lower the capacitive current limit of the ASC.

**Network topology**

Most modern residential developments are constructed using underground cables which have a higher capacitance than overhead lines. As the 22kV network grows due to increased demand, new customer connections and overhead conductor to underground cable conversions, the additional cable installations will increase the total capacitive current on the network. If the network capacitive current exceeds the capacitive current limit of the ASC, network investment is required to maintain compliance with the Regulations.

**Capacitive current limit of the ASC**

There are two capacitive current limits:

- **Per ASC:** The typical configuration for REFCLs is one ASC per supply transformer and therefore per bus. The limit of an ASC is dependent on the damping characteristics of the network. However, the actual damping characteristics specific to the network can only be measured once a GFN is operating. At locations where a GFN is not yet operational, an ASC planning limit of 100A is assumed to determine indicative, but conservative, augmentation timing.
- **Per feeder:** To enable differentiation of the feeder experiencing a fault, the maximum capacitive current that is allowable per individual feeder is 80A.

**Software limitations**

Currently Swedish Neutral (manufacturer of the GFN) has not deployed a software solution that will allow the use of three GFNs at one zone substation. Hence, a planning constraint of a maximum of two REFCLs per zone substation has been used.

## 2.5 Prudent and efficient investment

AusNet Services has taken the approach of incremental funding requests to maintain compliance with the Regulation to ensure minimal long term cost to customers. This is prudent and efficient as it enables:

[2] SWER, which operates at 12.7kV, is excluded from the Required Capacity and is subject to its own requirements.

- Minimum works to be carried out just in time to maintain compliance with the Regulation until 2026;
- Planning to be based on the most up-to-date network growth and capacitive current information; and
- Application of the latest development in REFCL technology in this rapidly developing field. For example, should Swedish Neutral deploy a software solution that enables the use of three REFCLs at a zone substation, it may enable deferral of a new zone substation.

# 3 WOTS zone substation overview

Wodonga Terminal Station (**WOTS**) is located south of Killara on the outskirts of the city of Wodonga approximately 255km north east of Melbourne.

WOTS is principally a transmission asset serving the Victoria/NSW interconnector and providing a 66kV sub-transmission connection to the distribution business. In 1987, a 22kV zone substation was installed adjacent to the transmission substation.

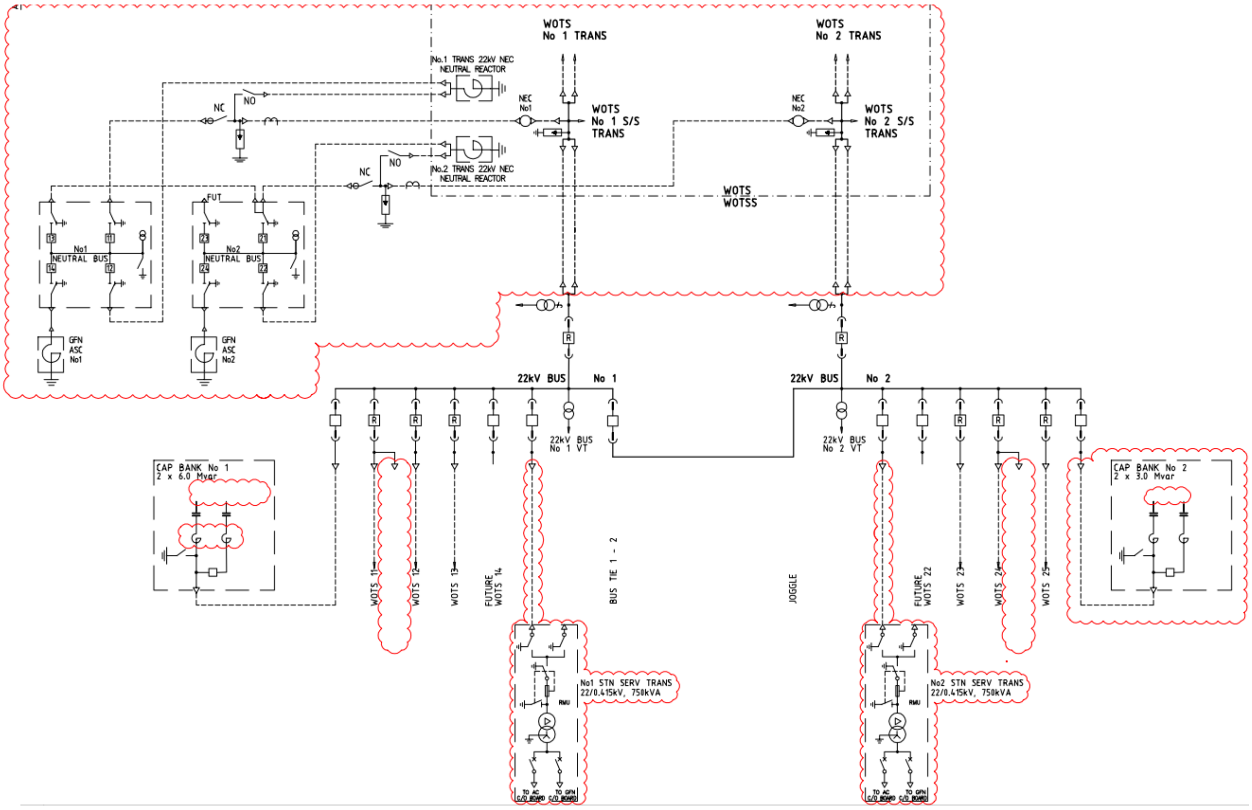
The 22kV zone substation is supplied from tertiary windings of two transmission transformers (330kV/66kV/22kV) that supply two buses and six feeder circuit breakers with allowance for future feeder circuit breakers to be installed.

Reverse power flow occurs on feeders at this substation and that needs to be considered when assessing options at WOTS.

Two REFCLs will be commissioned at WOTS by 1 May 2021 as part of Tranche 2 of the AusNet Services REFCL Program to achieve compliance with the Regulations.

The Single Line Diagram, including the future REFCL, is shown in Figure 3.1. Given the limitation of a maximum of two REFCLs per zone substation, it is not possible to install another REFCL at this site.

**Figure 3.1 WOTS ZSS Single Line Diagram**




Source: AusNet Services

An aerial view of the 22kV feeders originating from WOTS electricity distribution area is shown in Figure 3.2. The distribution area includes some urban areas within Wodonga but predominately services rural area outside of Wodonga and into the Victorian Alpine region.

The Wodonga network is geographically large and the majority is made up of overhead construction with feeders extending radially out from the zone substation. This topography makes it difficult to implement network solutions such as load transfers.

The breakdown of overhead conductors and underground cables per feeder is shown in Table 3.1. Overhead feeders contribute a lower amount of capacitive current compared to underground cables.

**Table 3.1 Overhead and underground conductor lengths**

| Feeder | Overhead (km) | Underground (km) | Total length (km) |
|---|---|---|---|
| WOTS11 | 294.6 | 13.1 | 307.7 |
| WOTS12 | 21.5 | 5.4 | 26.9 |
| WOTS13 | 348.7 | 2.5 | 351.2 |
| WOTS23 | 0.0 | 1.0 | 1.0 |
| WOTS24 | 641.3 | 1.7 | 642.9 |
| WOTS25 | 130.1 | 17.6 | 147.7 |
| **Grand Total** | **1436.1** | **41.3** | **1477.4** |

**Figure 3.2 WOTS ZSS Aerial Layout (underground conductor shown in dark maroon)**

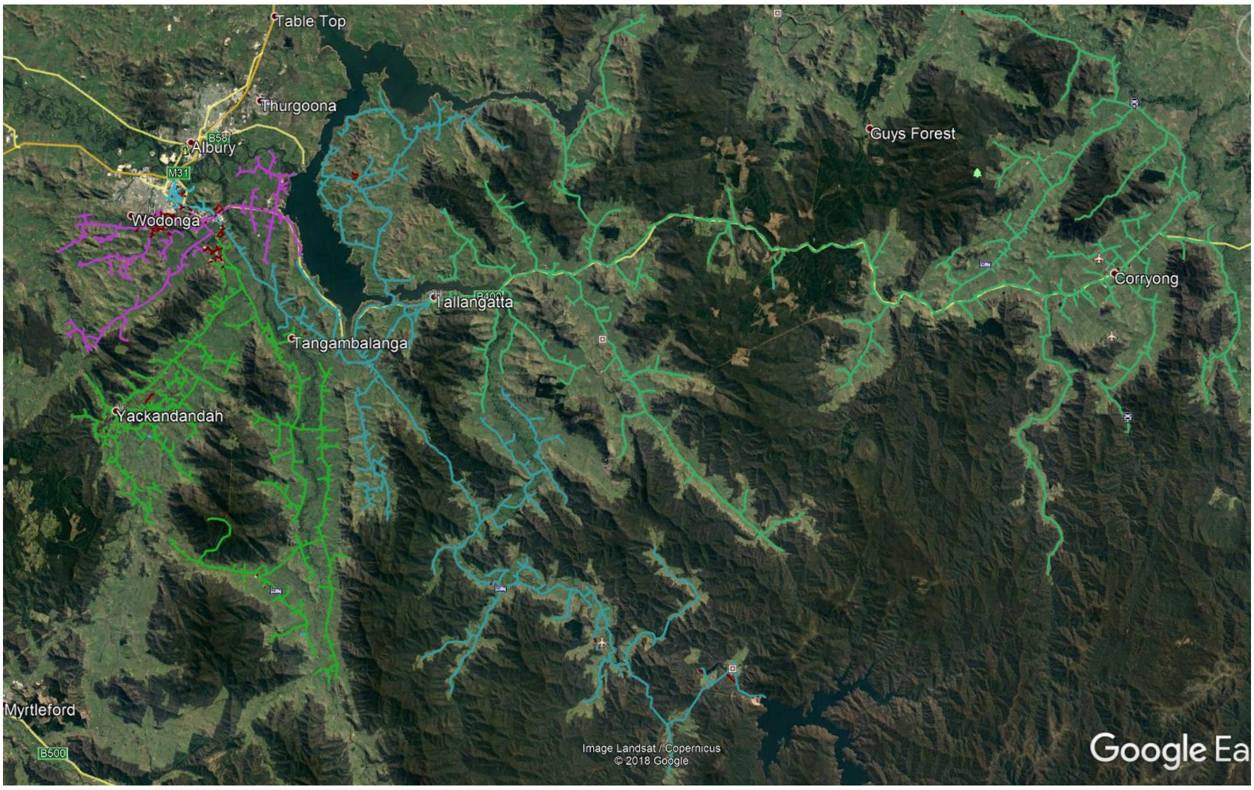



**Figure 3.3 WOTS ZZ Aerial layout of only underground cable feeder sections**

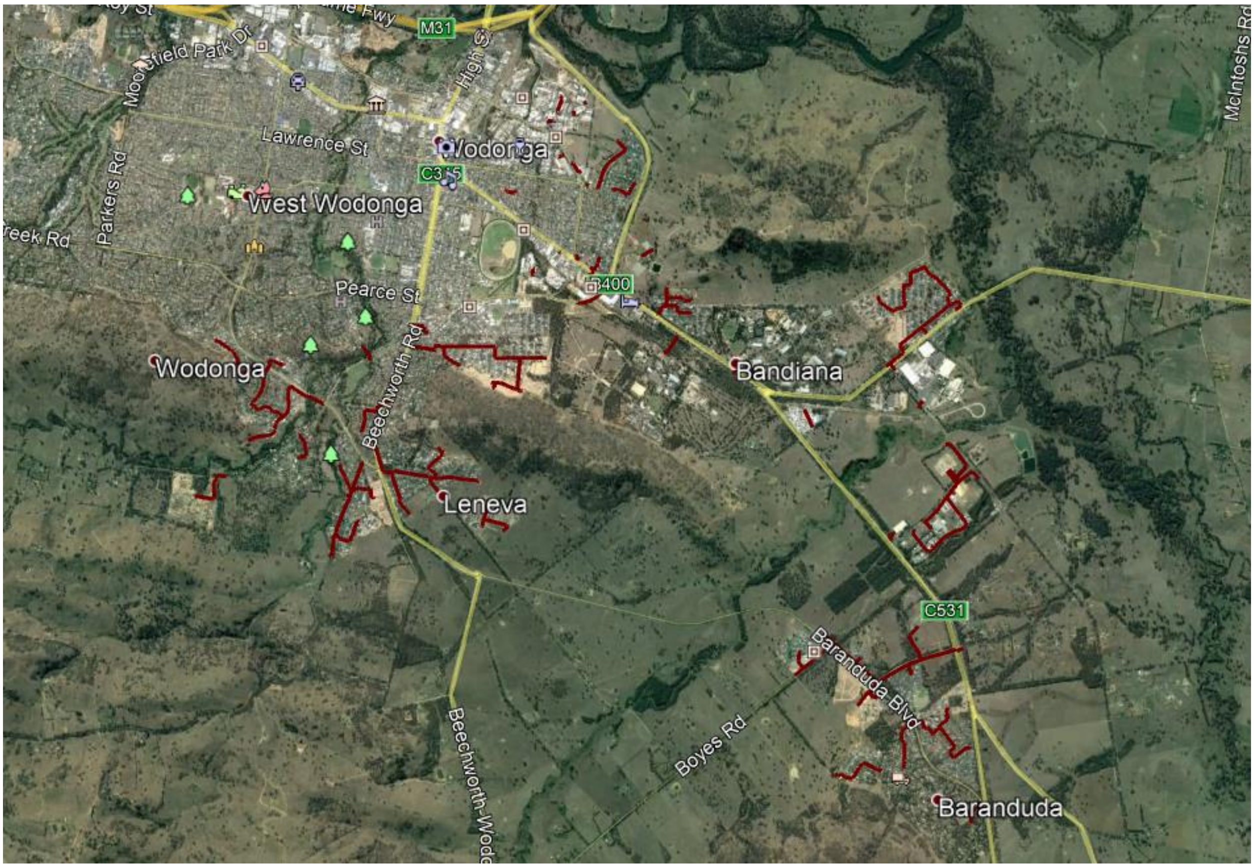


Figure 3.3 shows that the underground sections are concentrated in the urban areas of Wodonga and are mostly on feeders WOTS11 and WOTS25.

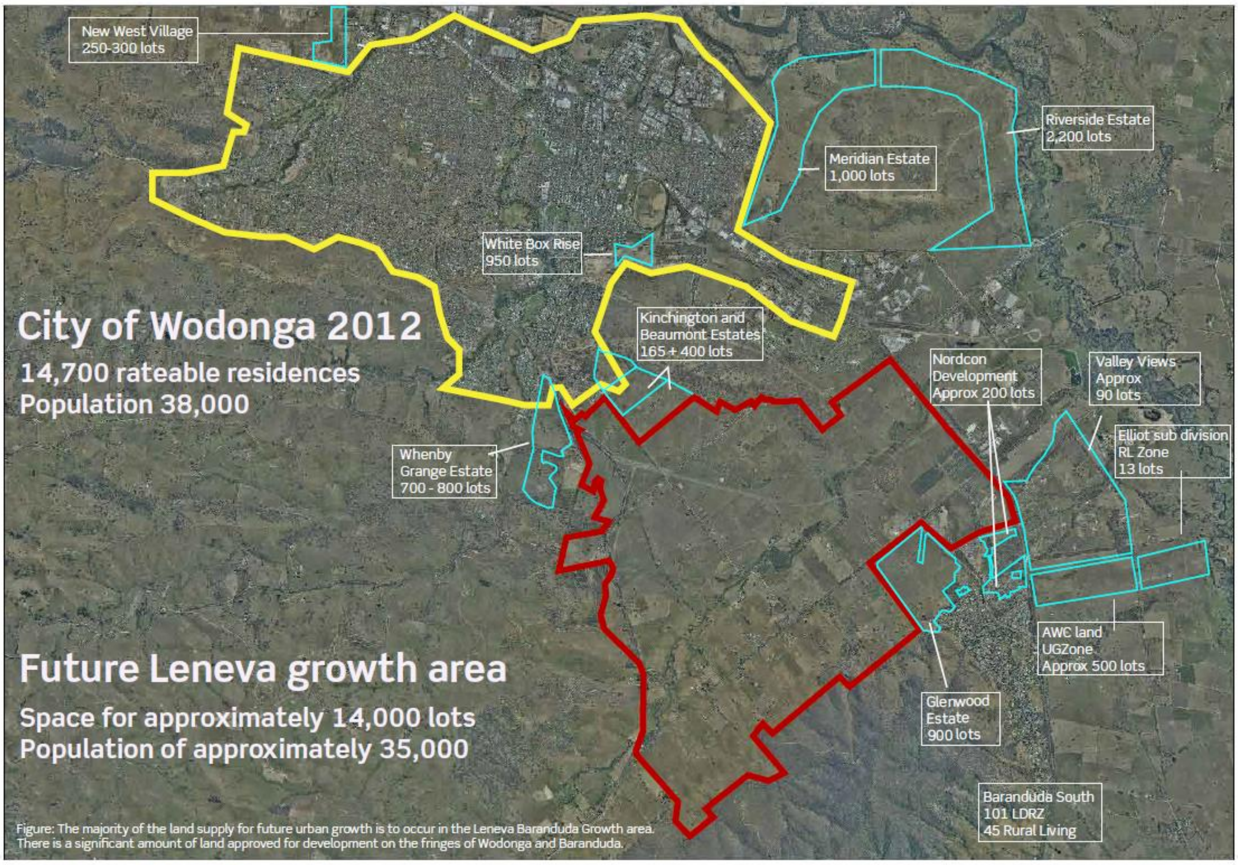
Wodonga Council has identified approximately 19 km$^2$ of vacant land, shown in Figure 3.4, in Leneva Valley for development as residential land for medium to long-term population growth requirements in Wodonga area. The existing built up area of Wodonga and the township of Baranduda will be extended further into the Leneva Valley as per the development plans and are supplied mainly by WOTS 24 and WOTS25 feeders. This area has been subjected to a number of subdivisions in the last few years and it is still continuing to be developed, resulting in increasing demands on the WOTS ZSS feeders, particularly on WOTS25 feeder.

The increasing development has resulted in the need for one new feeder and augmentation is planned for load in the 2016-2020 regulatory control period. In addition, the following guidance has been provided to developers in this area by the council:

- All new electricity supply infrastructure (excluding infrastructure to support cables with a voltage greater than 66kV) must be provided underground (excluding substations); and
- The design of subdivision electricity infrastructure must consider the practicality of removing existing above ground electricity lines in the local and arterial road network, both within and abutting the subdivision, and re-routing lines underground through the subdivision.

These requirements as well as existing development approvals will continue to increase capacitance experienced by WOTS.

**Figure 3.4 City of Wodonga development plans**



## 3.1 Network forecast

This section discusses the demand and capacitive current forecasts to identify if either attribute is exceeding the capacity of the zone substation and when it is expected to occur. This will identify the need and drive the type and timing of any intervention or investment that may be required.

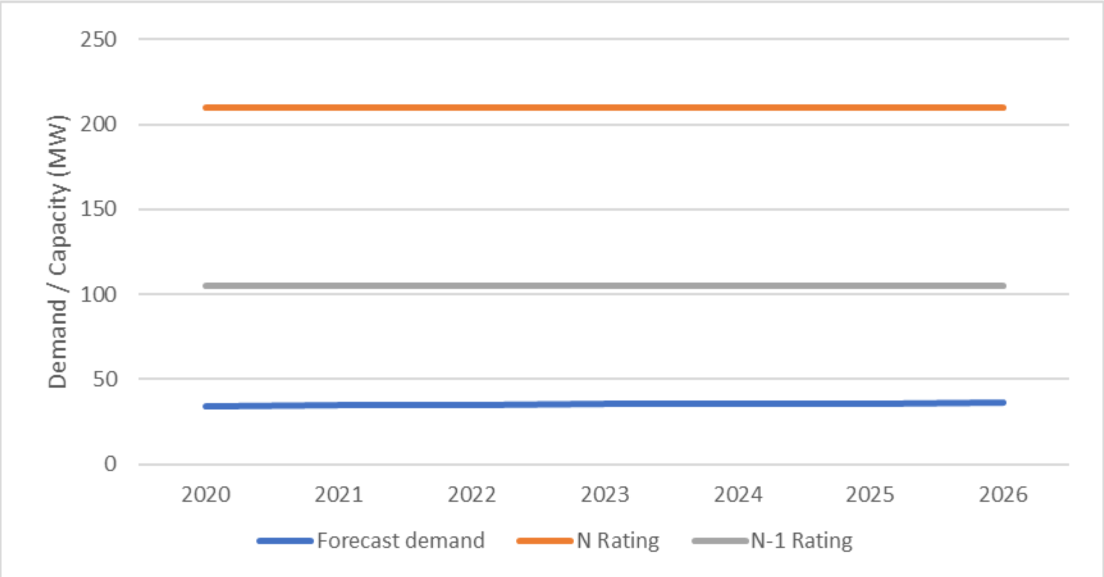
### 3.1.1 Demand forecast

The table below shows the WOTS maximum demand forecast (MVA) between 2020 and 2026. By 2026, the summer demand is expected to increase by approximately 1.9 MVA. However, the current and forecast demand is well within the capacity of the zone substation as shown in Figure 3.5.

**Table 3.2 Maximum Demand (MVA) Forecast for WOTS – 2019 to 2026**

| | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|---|---|---|---|---|---|---|
| **WOTS Winter (50POE)** | 37.8 | 38.2 | 38.4 | 38.7 | 38.9 | 39.0 | 39.1 |
| **WOTS Summer (50POE)** | 34.0 | 34.3 | 34.6 | 34.9 | 35.2 | 35.6 | 35.9 |
| **WOTS Winter (10POE)** | 39.4 | 39.8 | 40.1 | 40.4 | 40.7 | 40.9 | 41.0 |
| **WOTS Summer (10POE)** | 34.7 | 35.0 | 35.4 | 35.7 | 36.0 | 36.3 | 36.6 |
| **WOTS Consolidated Forecast[3]** | 34.2 | 34.5 | 34.8 | 35.2 | 35.5 | 35.8 | 36.1 |

**Figure 3.5 Demand forecast**




The N-1 rating shown in Figure 3.5 assumes the largest transformer is out of service.

### 3.1.2 Capacitance forecast

The network capacitance forecast was developed based on the characteristics of each zone substation supply area, the standard topology of cables installed for URDs and other known network augmentation.

3 The forecast is the weighted sum of the summer forecasts, calculated as 30% of the 10POE summer forecast plus 70% of the 50POE summer forecast.

Since the growth in capacitance is strongly related to the growth of URDs, the forecast was made in 5 year increments as the timing of growth on an annual basis is not certain. The growth is expected to be a step function of new URDs that are being established, rather than a smooth and gradual increase each year. However, the capacitive current growth has been extrapolated to create an indicative annual trend, as shown below, to provide indicative timing of when intervention is likely to be required.

As stated in section 2.4, the ASC limit is dependent on the damping characteristics of the network that individual zone substation supplies, including the effect of earth resistivity in the zone substation supply area and pollution (salt) on insulators. AusNet Services has attempted to model network damping to forecast ASC limits. The models were based on Tranche 1 zone substations so the outputs could be compared to measured data to test accuracy. The models developed to date have not accurately calculated the damping as measured in Tranche 1 and investigations are continuing. As a result, the actual damping characteristics specific to each network can only be measured once a REFCL installation is operating.

The ASC limit of 100A that is used for planning purposes is based on learnings from the Tranche 1 installations and consideration of differences with the Tranche 2 zone substation network supply areas.

AusNet Services is acting prudently to address the network capacitive limits at each Tranche 2 zone substation by deferring investment until the network damping can be accurately measured when the REFCL is brought online whilst working on refining network damping modelling. Where the capacitance is identified to be greater than the ASC limit and compliance with the Regulatory obligations cannot be met, AusNet Services will utilise the time extension provisions in the Regulations to implement solutions to achieve the Required Capacity.

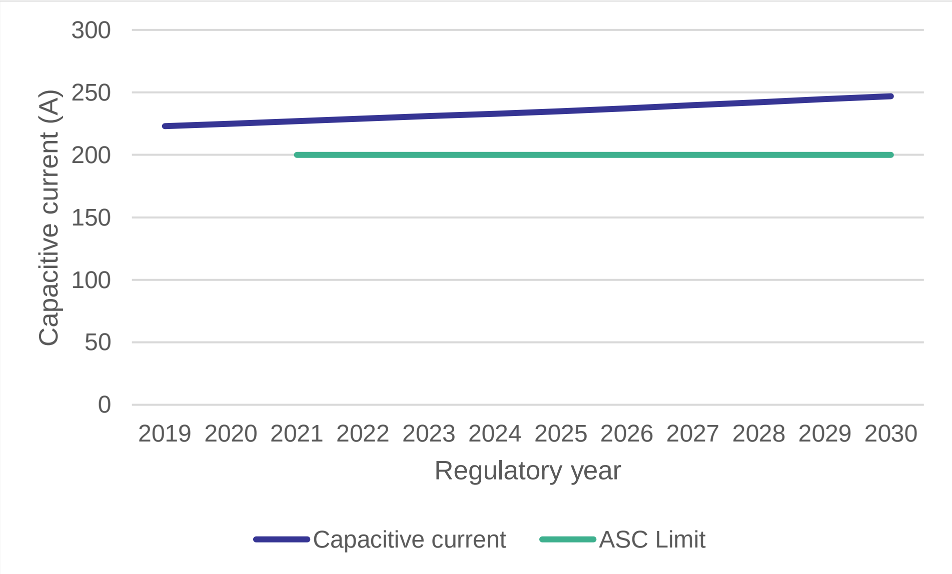
WOTS will have two standard ASCs installed which, for planning purposes, is assumed toprovide a capacitive current limit of 200A, as shown in Table 3.3.

Based on the planning scheme and guidance for underground construction provided by the City of Wodonga, the capacitive current is forecast to continue to increase.

**Table 3.3 Capacitive current forecast**

| | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 |
|---|---|---|---|---|---|---|---|
| **WOTS capacitive current** | 225 | 227 | 229 | 231 | 233 | 235 | 237 |
| **ASC Limit** | NA | 200 | 200 | 200 | 200 | 200 | 200 |
| **Excess capacitive current** | | 27 | 29 | 31 | 33 | 35 | 37 |

**Figure 3.6 Capacitive Current Forecast for WOTS – 2019 to 2030**



Overhead feeders contribute a lower amount of capacitive current compared to underground cables. To estimate the capacitive current ($I_{CO}$) per feeder, the total current was split proportionally based on the amount of underground cable per feeder (see Table 3.4). This identifies if any feeders are expected to exceed the individual feeder limit of 80A and also where the greatest capacitive current reduction can be achieved.

Table 3.4 shows that the $I_{CO}$ may exceed the capacitive current limit of two REFCLs. The current is split reasonably evenly across the buses with Bus 1 forecast to reach 121A and Bus 2 forecast to reach 116A by 2026. Also, by 2026 WOTS25 is forecast to exceed the limit for an individual feeder (80A) and WOTS11 is forecast to be approach that limit.

**Table 3.4 Estimated Capacitive Current contribution per feeder**

| Feeder | Forecast $I_{CO}$ (A) 2026 |
|---|---|
| WOTS11 | 75.5 |
| WOTS12 | 31.3 |
| WOTS13 | 14.4 |
| WOTS23 | 5.6 |
| WOTS24 | 9.5 |
| WOTS25 | 101.1 |
| **Grand Total** | **237.4** |

### 3.1.3 Transfer capacity

Review of the network has identified that while there are adjacent zone substations with interconnections that are Scheduled, capacity and voltage constraints mean permanent transfers are not viable.

## 3.2 Identified need

As shown in section 3.1, due to expected network growth in AusNet Services' network, additional works will be required to maintain compliance with the Required Capacity in the Regulations during the 2022-2026 regulatory control period.

The forecast continued residential growth and network augmentation in the WOTS supply area, particularly URDs which increase the capacitive current on the network, means that the capacitive current capacity of the REFCLs at WOTS may be exceeded:

- The zone substation is forecast to exceed its overall planning limit of 200A (two REFCLs installed).
- Both buses, considered individually, are forecast to exceed the 100A planning limit during the 2022-2026 regulatory control period.
- WOTS11 is forecast to be approaching its individual limit of 80A by the end of the 2022-2026 regulatory control period.
- WOTS25 is forecast to exceed its individual limit of 80A during the 2022-2026 regulatory control period.

The asset condition and capacity at WOTS do not present a risk to supply and therefore do not warrant any augmentation or replacement capital expenditure.

AusNet Services needs to identify the most economic option to address the capacitive current constraints affecting REFCL compliance.

# 4 Options analysis

The options identified below are based on the best knowledge currently available on the network, including ASC limit and forecast capacitive current growth.

AusNet Services has identified eight options that could maintain compliance with the Regulations. These are summarised in Table 4.1.

Initial assessment of the eight options found that six were found to be non-credible on a technical or cost basis. The reasons for this assessment are set out in in Table 4.1.

Two of the options (options 6, and 8) were found to be credible and are discussed in further detail in sections 4.1 and 4.2.

**Table 4.1 Options Reviewed**

| Option | Discussion | Credible |
|---|---|---|
| Option 1 - Business as Usual | The Business as Usual option maintains the status quo at WOTS which will entail no additional investment at WOTS to manage the impact of the capacitive current.<br>With an increasing capacitive current forecast, WOTS may become non-compliant with the Regulations, the community served by the WOTS zone substation would be exposed to increased risk of fire starts from 22kV phase-to-earth faults, and AusNet Services will be subject to penalties under the Act.<br>On this basis, Option 1 is not a credible option. | N |
| Option 2 - Capacitance/Load Transfer | No transfers exist that can be maintained permanently. WOTS network is on the border of AusNet Services distribution area. Load transfer limits exist due to load and voltage constraints for transfers between existing WOTS feeders and for transfer for adjacent zone substations.<br>Hence, this option is not technically feasible and therefore a non-credible option. | N |
| Option 3 – Install third REFCL on existing bus | This option proposes to install a third REFCL on an existing bus to manage the increased capacitive current.<br>Based on the technology currently available, it is not possible to install three REFCLs at a single zone substation. Therefore, this is not a credible option as it is not technically feasible. | N |
| Option 4 - Install Isolation transformer on feeder | This option proposes to install an Isolation Transformer to isolate an entire feeder.<br>Use of Isolation Transformers requires that all conductors downstream of the isolation transformer are underground cables and it requires and exemption to be granted by the Governor in Council.<br>The WOTS network is comprised of large rural feeders with overhead and underground sections. Hence significant undergrounding of lines would be required for this option to be eligible for an exemption. To achieve the required capacitance reduction with least capex, 651km of overhead line would need to be converted to underground cable on WOTS25 and isolated.<br>This option is estimated to cost approximately $455.7 million.<br>Therefore, this option does not present cost effective isolation opportunities and is not considered as a viable option. | N |
| Option 5 - Install isolation transformer and undergrounding work | This option proposes to install one or more Isolation Transformers to sections of feeders to reduce the capacitive current experienced at WOTS zone substation. However, there are no continuous underground cables of sufficient length that will allow a reduction of capacitance through the use of isolation transformers to achieve compliance.<br>Hence, this option is not technically feasible and therefore a | N |

| Option | Discussion | Credible |
|---|---|---|
| | non-credible option. | |
| Option 6 - Remote REFCL | The remote REFCL solution is currently under development by AusNet Services. It isolates part of a feeder and protects that isolated section with its own REFCL.<br>The remote REFCL can be located no closer than 100m to the zone substation due to earthing issues.<br>This option is considered credible and is discussed further in section 4.1. | Y |
| Option 7 - Undergrounding Overhead in HBRA areas and seek ESV exemption for ZSS | WOTS is comprised of 1,436 km of overhead line. The cost, including converting overhead distribution transformers and switches to underground assets, is estimated at $1 billion and therefore is not a credible option. | N |
| Option 8 - New Zone Substation | Installing a new zone substation to reduce the capacitive current at WOTS is a technically viable option.<br>This option is considered credible and is discussed further in section 4.2. | Y |

## 4.1 Option 6– Remote REFCL

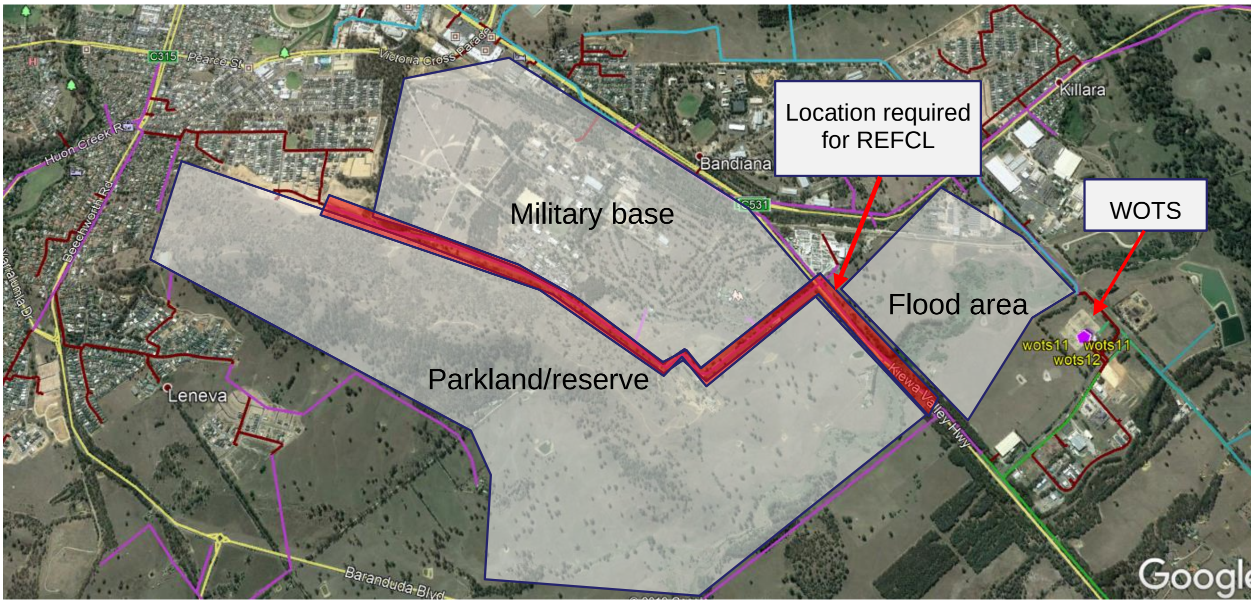
This option proposes to install a Remote REFCL to reduce the capacitive current experienced at WOTS. The remote REFCL solution is currently under development by AusNet Services. It isolates part of a feeder and protects the isolated section with its own REFCL to ensure the Required Capacity can be achieved. The remote REFCL must be located no closer than 100m to the zone substation due to earthing issues.

As stated in section 3.2, remote REFCLs would be required on WOTS11 and WOTS25. The capacitive current reduction expected to be possible from these two feeders is 60A in total, with WOTS25 enabling a reduction of 40A and WOTS11 enabling a reduction of 20A. The remote REFCL on WOTS25 is required or there will be insufficient reduction for this to be a credible option.

Upon more detailed investigation into the network topology and locations of cables, the location where WOTS25 is required to be located in order to provide a sufficient reduction to the capacitive current, is a military base on one side of the existing easement and a wildlife reserve on the other side. Outside of this segment, the location would be too close to WOTS or is in urban area where it would not be possible to acquire land.

Figure 4.1 below shows a map with the areas of constraint identified. It clearly shows that it is unlikely for land to be available where required to enable this option to be considered credible.

**Figure 4.1 Land constraints for WOTS25**




The cost, excluding land, is estimated at $15m ($'real,2019). The NPC is expected to be $12.4 million (in 2019 terms) including a nominal cost of land and network reconfiguration.

This option is not recommended based on technical constraints. It is not considered prudent to rely on this option due to the uncertainty regarding the acquisition of suitably located land within the required timeframe.

## 4.2 Option 8 – New zone substation

This option proposes to establish a new REFCL-protected zone substation, transfer load to the new zone substation and balance the load on the existing WOTS buses.

The key items in this scope of work include:

- Acquire land near Baranduda as shown in Figure 4.2;
- Establish a new 2x10 MVA 66/22 kV rural Zone Substation with one REFCL;
- Build new double circuit 22kV line sections totalling 2.0 km to connect up WOTS13, WOTS24 and WOTS11;
- Build a new 66 kV line along the existing WOTS11 line reducing further customer impact; and
- Network reconfiguration to balance load on the existing WOTS 22kV buses.

Installing a new zone substation is a technically viable option. The cost of a new single transformer ZSS (with one REFCL) is $29.3 million. The identified location for the new zone substation is still undeveloped but has land available.

This solution also provides more long-term benefit for development in the area compared to the remote REFCL option as it provides significantly more capacitive current capacity for a similar cost.

This option has the following key disadvantages:

- Additional capacity (demand MW) is not currently required based on current load forecast; and

- Ability to acquire land in an appropriate location and to obtain the necessary easements for the new 66kV line and distribution feeder exits. AusNet Services will attempt to utilise the existing overhead network within the road reserves to minimise this risk.

Advantages of this option are:

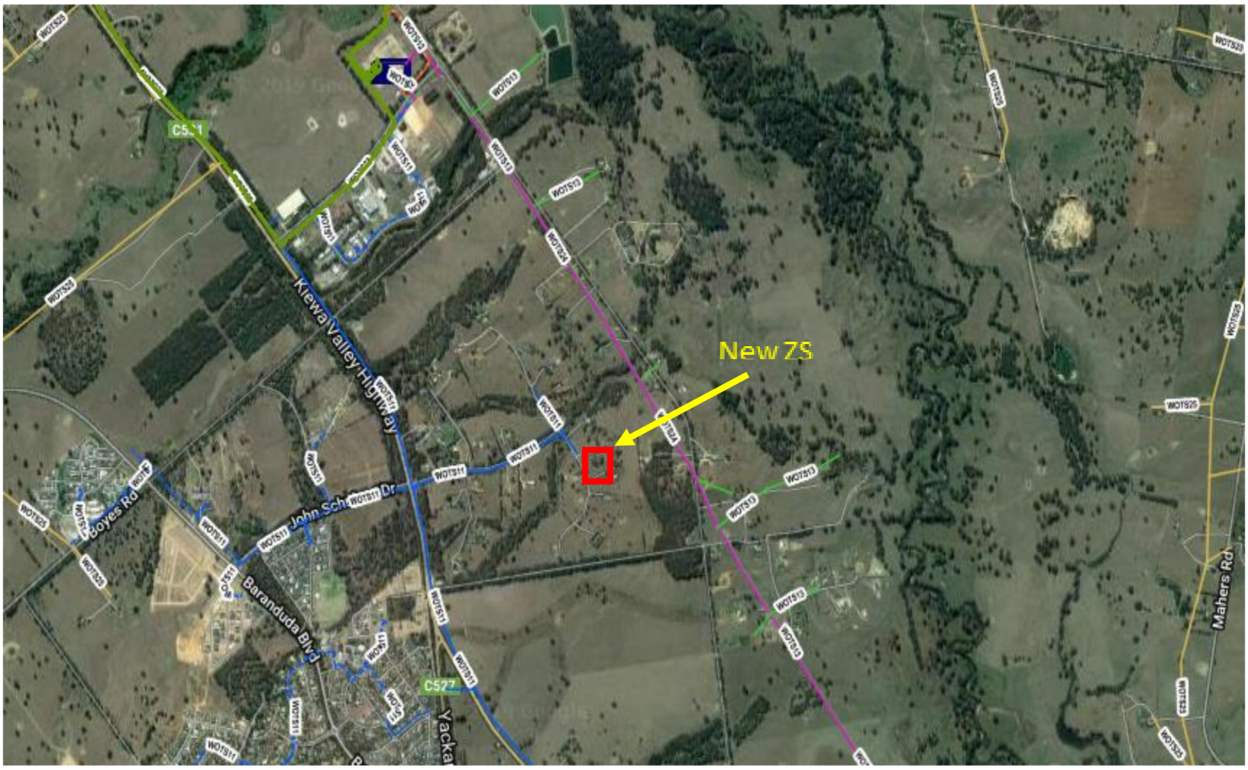
- Least cost technically feasible option; and
- Provides the real option for additional demand and capacitive current capacity as required in the future.

Therefore, this option is considered credible. As the least risk technically feasible option that has been identified, this option is recommended. If required, subject to the network damping being measured once the WOTSREFCLs are operational, a time extension may be requested.

The zone substation is estimated to cost $29.3 million ($'real, 2019) with an NPC of $24.3 million ($'real, 2019).

This option is recommended.

**Figure 4.2 Proposed location for the new zone substation near Baranduda**




## 4.3 Option comparison

The two viable options studied in this report are summarised below.

The comparison of the options shows that Option 8 is the preferred option. The cost is real total capex, the Net Present Cost (NPC) is discounted to 2019 dollars to show the benefits of project timing.

**Table 4.2 Feasible Options Comparison**

| Option | Technical feasibility | Cost | NPC | Maintains Compliance | Social impact | Preferred |
|---|---|---|---|---|---|---|
| Option 6 - Remote REFCL | Suitable land to | $15M | >$12.4 M | Yes | Yes | No |

| | | | | | | |
|---|---|---|---|---|---|---|
| | place REFCL not available | | | | | |
| Option 8 - New ZSS | Yes | $29.3 M | $24.3 M | Yes | No | Yes |

# 5 Recommendation

It is recommended that Option 8, construction of a new REFCL ZSS at the identified location, is approved.

Following approval, AusNet Services will procure and install the new REFCL ZSS at the identified location and complete the following works:

- Acquire land near Baranduda as shown in Figure 4.2;
- Establish a new 2x10 MVA 66/22 kV rural Zone Substation with one REFCLs;
- Build new double circuit 22kV line sections totalling 2.0 km to connect up WOTS13, WOTS24 and WOTS11;
- Build a new 66 kV line along the existing WOTS11 line reducing further customer impact; and
- Network reconfiguration to balance load on the existing WOTS 22kV buses.

The expected cost is $29.3 million ($'real, 2019) and is the only technically feasible option identified.

# 6 Appendix A

## 6.1 The Regulation stipulates the requirements

AusNet Services' network's geographical location means that it is exposed to extreme bushfire risk. These conditions warrant significant investment to mitigate the risk of bushfires that may occur following earth faults on the distribution network.

The Victorian Bushfire Royal Commission, established in 2009, made several recommendations with respect to fires initiated from electricity distribution networks. Subsequently, the Victorian Government established the Powerline Bushfire Safety Taskforce (**PBST**) to investigate new cost efficient and effective technologies and operational practices to reduce catastrophic bushfire risk.

The PBST identified Rapid Earth Fault Current Limiters (**REFCLs**) installed in zone substations as an efficient and effective technology.

The *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016* (**Amended Bushfire Mitigation Regulations**), which came into operation on 1 May 2016, set out new requirements for major electricity companies including the requirement for Polyphase Electric Lines (defined as multiphase distribution between 1 kV and 22 kV) at selected zone substations to have the following abilities:

- to reduce the voltage on the faulted conductor for high impedance faults to 250 volts within 2 seconds
- to reduce the voltage on the faulted conductor for low impedance faults to
    - i. 1900 volts within 85 milliseconds; and
    - ii. 750 volts within 500 milliseconds; and
    - iii. 250 volts within 2 seconds; and
- Demonstrate during diagnostic tests for high impedance faults to limit
    - i. Fault current to 0.5 amps or less; and
    - ii. The thermal energy on the electric line to that resulting from a maximum $I^2t$ value of 0.10 $A^2s$;

The Amended Bushfire Mitigation Regulations define the low and high impedance faults as follows:

- High impedance = a resistance value in ohms that is twice the nominal phase-to-ground voltage. This is equal to 25.4 kilohms or a fault current of 0.5 amps on a 22 kV network.
- Low impedance = resistance value in Ohms that is the nominal phase-to-ground network voltage divided by 31.75. This is equal to 400 Ohms or a fault current of 31.75 Amps on a 22 kV network.

## 6.2 The Act stipulates non-compliance penalties

The penalties for not complying with the requirements set out in the Regulations are set out in the *Electricity Safety Act 1998* (the **Act**). The Act states that there will be a fine of up to $2 million for each point less than the prescribed number of points that must be achieved at each of the three specified dates and an ongoing fine of $5,500 per day that compliance is not achieved.

The detail of the fines is set out in Clause 120M (3) which states a major electricity company is liable to pay:

**a** *if subsection (1)(a) or (b) [(1)(a) - A major electricity company must ensure that for the initial period, a sufficient number of zone substations in its supply network are complying substations so that the total number of allocated substation points prescribed in respect of all of the complying substations is not less than 30 (the period 1 minimum points); and (1)(b) for the intermediate period, a sufficient number of zone substations I its supply network are complying substations so that the total number of allocated substation points prescribed in respect of all of the complying substation is not less than 55 (the period 2 minimum points)] is contravened, a pecuniary penalty not exceeding $2 000 000 for every point forming the difference between the total number of allocated substation points prescribed in respect of all of the complying substations and, as the case require:*

**i** *the period 1 minimum points; or*

**ii** *the period 2 minimum points; and*

**b** *if subsection (1)(c) [on or after 1 May 2023, of if Energy Safe Victoria specifies a later date under section 120X, that date, all zone substations in its supply network are complying substations] is contravened, a pecuniary penalty not exceeding $2 000 000 for every allocated substation point prescribed in respect of each zone substation that is not a complying substation; and*

**c** *if there is a continuing contravention of subsection (1)(a), (b) or (c), a pecuniary penalty that is a daily amount not exceeding $5500 for each day that contravention continues after service on the major electricity company by Energy Safe Victoria of notice of that contravention.*

## 6.3 Exemptions and time extensions

Electricity businesses can seek an exemption from both the Act and Regulations.

Exemption from the Act can be sought under section 120W of the Act from the requirements under section 120M of the Act. An exemption requires the Director of ESV to consult with the Minister for Energy, Environment & Climate Change and Governor in Council approval. The process can take up to 6 months.

Clause 13 of the Regulations allows for the electricity businesses to apply for exemptions from complying with the requirements of (7)(1)(ha) and - (7)(1)(hb).

***13 Exemptions***

**2** *Energy Safe Victoria may, in writing, exempt a specified operator or major electricity company from any of the requirements of these Regulations.*

**3** *An exemption under subregulation (1) may specify conditions to which the exemption is subject.*

Time extension requests under S120X of the Act can be made to the Director of Energy Safe Victoria clearly stating the reasons for the request.