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 Network Management 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 the installation of two remote REFCLs at locations shown in Figure 4.1 and three 300kVA isolation transformers on WOTS25. Permanent transfer from WOTS25 to WO31 is also required to ensure per feeder capacitance on WOTS25 is well below the 80A feeder planning limit. Installation of these remote REFCLs, isolation transformers and permanent transfers are required to ensure capacitance on all the buses and feeders at WOTS are below the 100A and 80A planning limits respectively.

The expected cost is $13.5 million and is the identified least cost and technically feasible solution.

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 inductor that 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.

2.3.1 Remote REFCL

As conceived and implemented to date REFCL technology has been installed within the Zone Substation environment. This has been dictated by the requirement to access the neutral of the transformers supplying the network emanating from the station.

A Remote REFCL concept has been developed by AusNet Services to increase technical optionality of meeting and maintaining the Required Capacity. This concept endeavours to create a REFCL protected network within an individual distribution feeder (22 kV) when a zone substation reaches its ultimate REFCL capacity.

Remote REFCL consist of an Isolation transformer and REFCL (ASC+RCC) that creates a separate REFCL network downstream that is distinct and isolated from the supporting Zone Substation.

Through the use of the remote REFCL it is planned that expenditure to maintain the Required Capacity can be minimised.

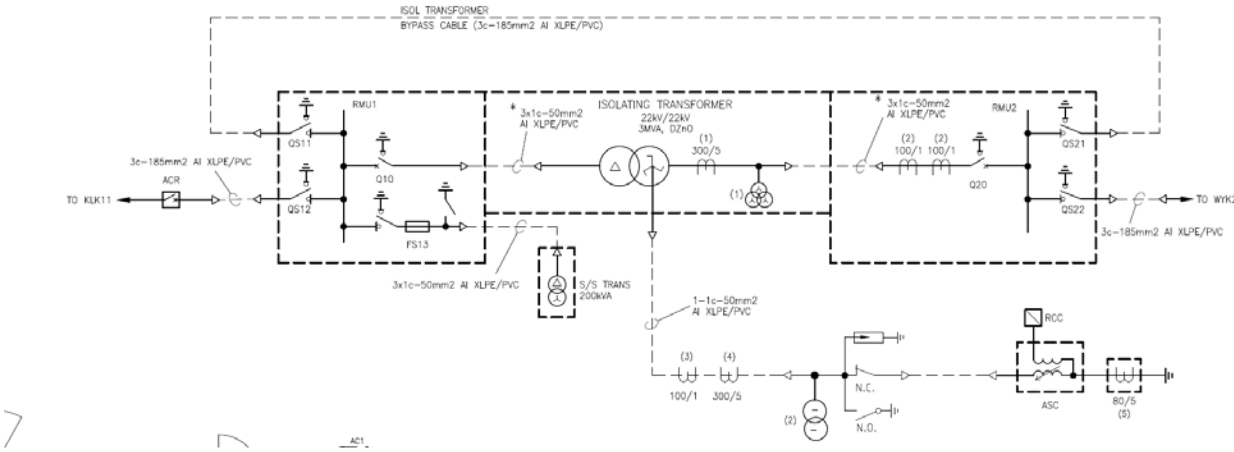


Figure 1 Remote REFC SLD

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:

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

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.

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:

- 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.

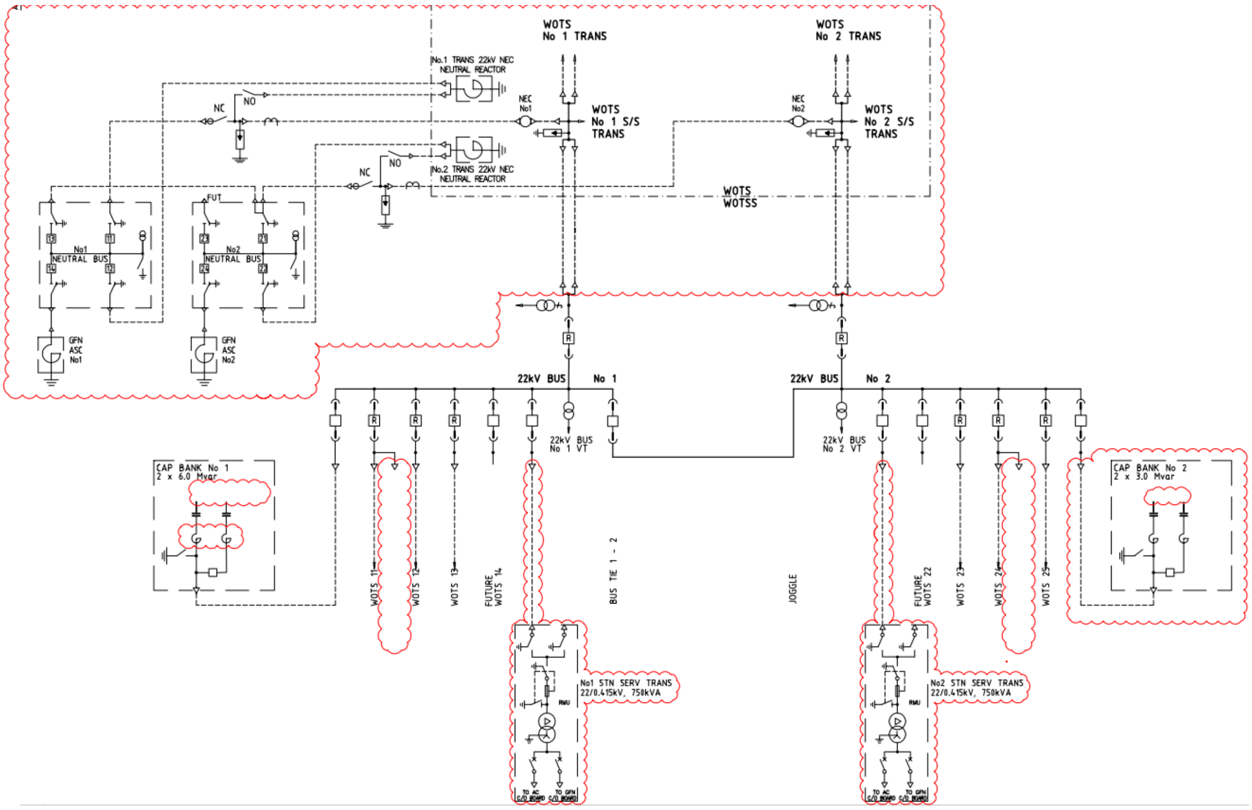
WOTS is principally a transmission asset serving the Victoria/NSW interconnector and providing a 66kV sub-transmission connection to the distribution business. In 1987, a 22kV zone substation was installed adjacent to the transmission substation.

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 REFCLs, is shown in Figure 3.1.

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)

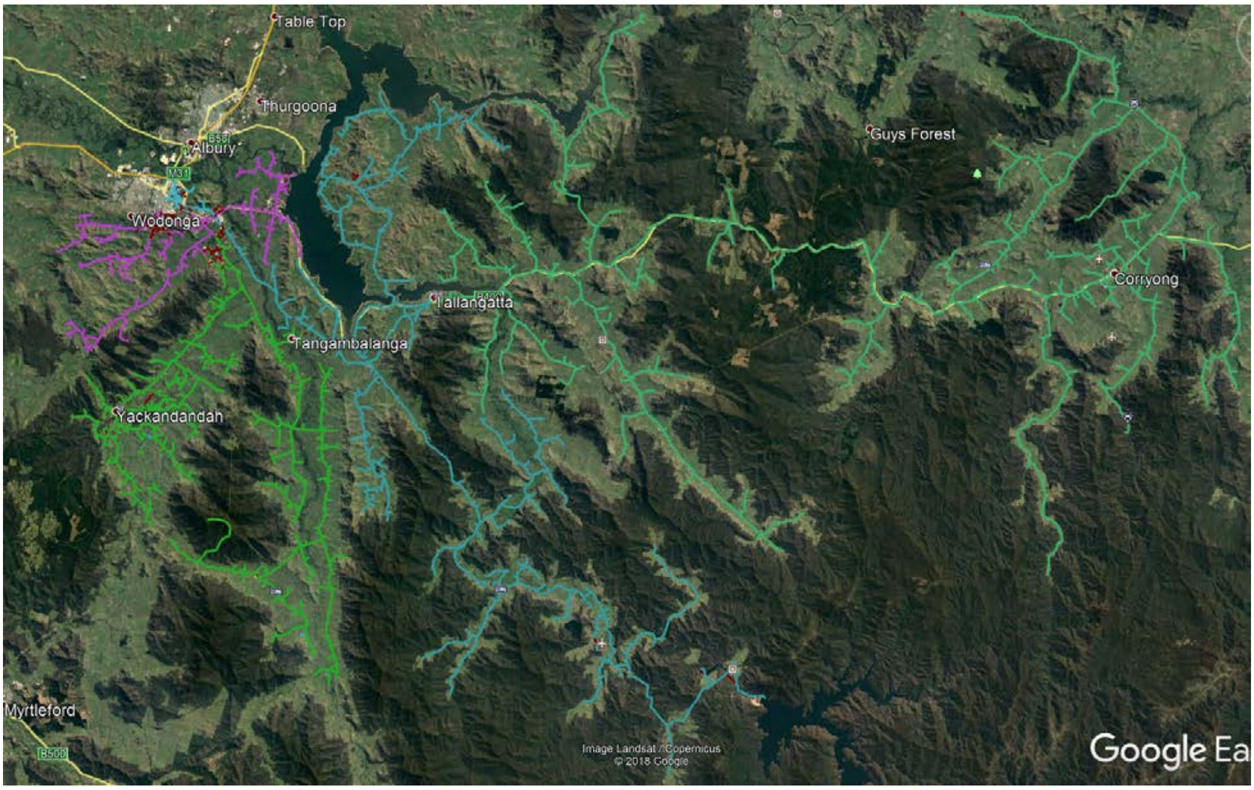


Figure 3.3 WOTS ZZ Aerial layout of only underground cable feeder sections

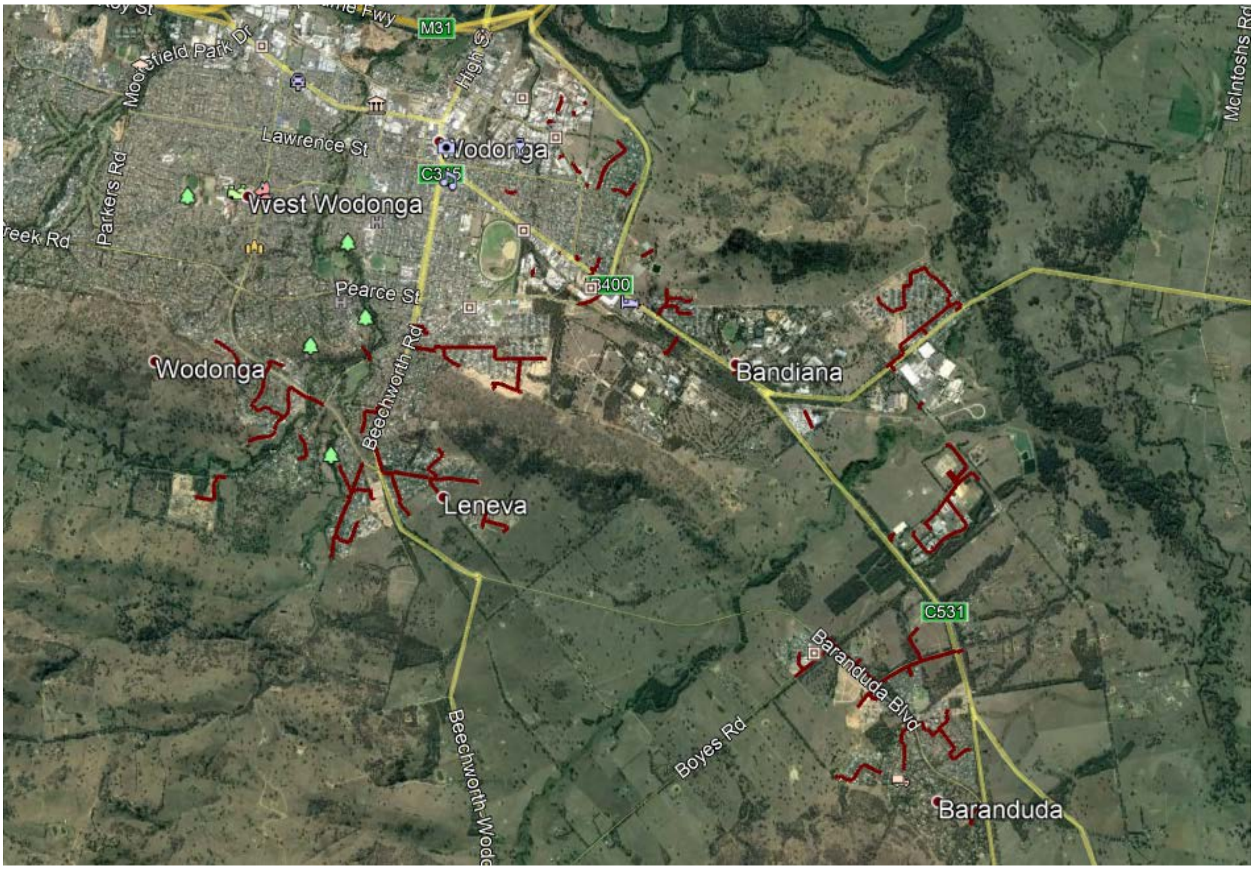


Figure 3.3 shows that the underground sections are concentrated in the urban areas of Wodonga and are mostly on feeders WOTS11 and WOTS25.

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.

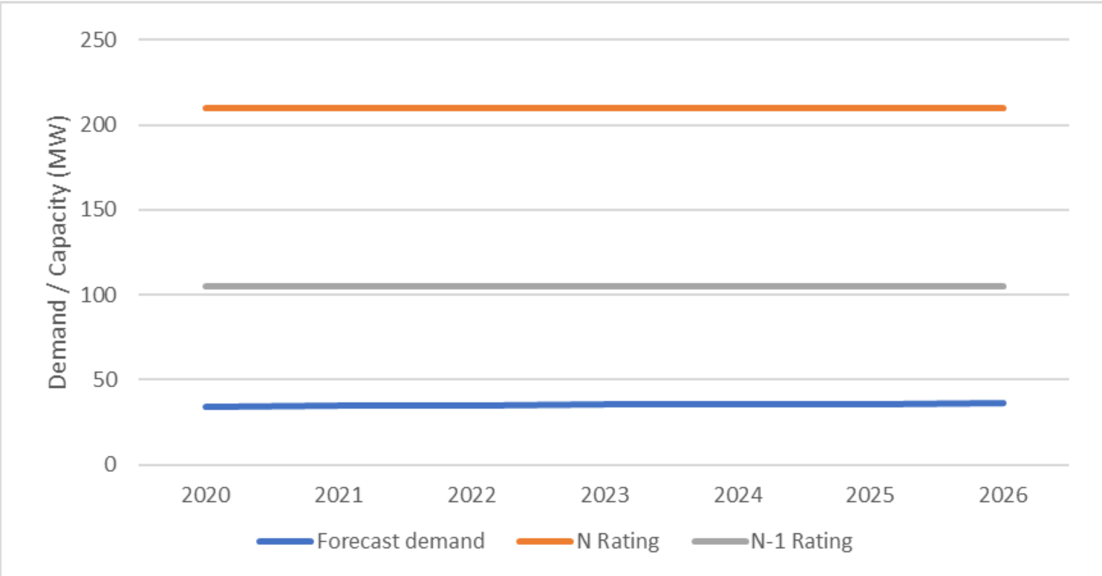
3.1.1 Demand forecast

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 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 3.4 Demand forecast



The N-1 rating shown in Figure 3.5 assumes the largest transformer is out of service. N and N-1 rating are shown based on the cyclic rating of 1.4 times nameplate capacity.

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 five 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 to provide a capacitive current limit of 200A. As shown in Table 3.3 and Figure 3.6, this limit is forecast to be exceeded in 2021. 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	248	250	253	255	258	260	262
ASC Limit	N/A	200	200	200	200	200	200
Excess capacitive current		50	53	55	58	60	62

Figure 3.5 Capacitive Current Forecast for WOTS – 2020 to 2026

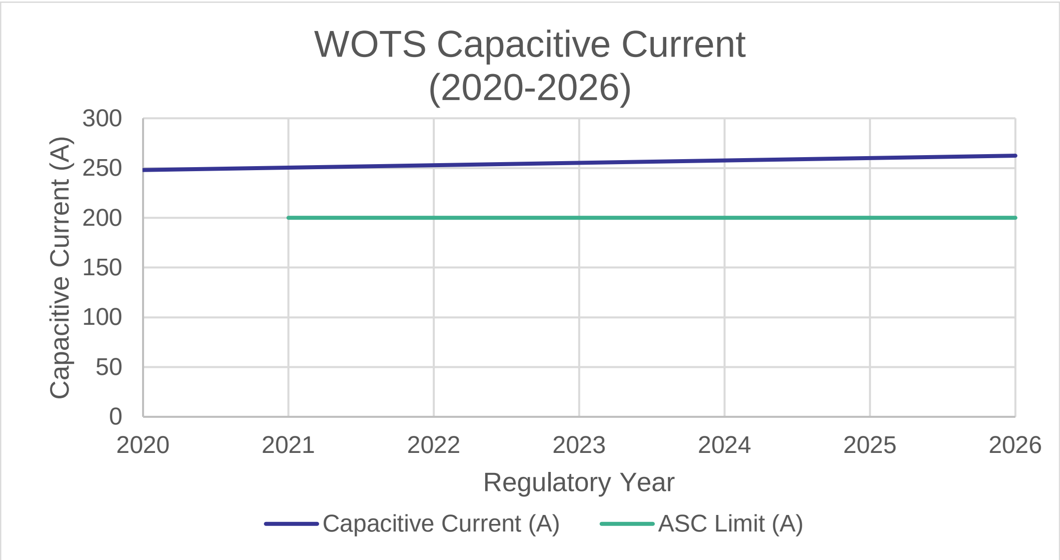


Table 3.4 presents the estimated capacitive current (I_{CO}) per feeder and per bus. This identifies if any feeders are expected to exceed the individual feeder limit of 80A and also where the greatest capacitive current reduction can be achieved.

Table 3.4 shows that, by 2026, WOTS25 is forecast to exceed the limit for an individual feeder (80A) and WOTS11 is forecast to be approach that limit. Also, Bus 1 is forecast to reach 120A and Bus 2 is forecast to reach 143A, which is above the 100A planning limit for an individual ASC.

Table 3.4 Estimated Capacitive Current contribution per feeder

Feeder	Forecast I_{CO} (A) 2026
WOTS11	64
WOTS12	20
WOTS13	35
Total Bus 1	**120**
WOTS23	3
WOTS24	55
WOTS25	84
Total Bus 2	**143**
Grand Total	**262**

3.1.3 Transfer capacity

Review of the network has identified that while there are adjacent zone substations with interconnections that are capacity and voltage constrained meaning 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 forecasted to exceed its overall planning limit of 200A (two REFCLs installed).
- Both buses, considered individually, are forecasted to exceed the 100A planning limit.
- WOTS11 is forecasted to be approaching its individual limit of 80A by the end of the 2022-2026 regulatory control period.
- WOTS25 is forecasted 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. 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. 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. 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. As there are only two transformers and buses at WOTS, a third REFCL is not possible, therefore, a non-credible option.	N
Option 4 - Install isolation transformer and undergrounding work	This option proposes to install an Isolation Transformer to isolate an entire feeder. Use of Isolation Transformers requires that all conductors downstream of the isolation transformer are underground cables. 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 achieve the required capacitance reduction with least capex, 130km of overhead line would need to be converted to underground cable and isolated on WOTS25 and 295km on WOTS11. This option is estimated to cost approximately $300 million. Therefore, this option does not present cost effective isolation opportunities and is not considered as a viable option.	N
Option 5 - Install Isolation transformer on feeder	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. Hence, this option is not technically feasible and therefore a non-credible option.	N
Option 6 - Remote REFCLs	The remote REFCL solution is currently under development by	Y

Option	Discussion	Credible
and isolation transformers	AusNet Services. It isolates part of a feeder and protects that isolated section with its own REFCL. The remote REFCL can be located no closer than 100m to the zone substation due to earthing issues. Two remote REFCLs will be required for WOTS. In addition, two REFCLs will also be required at the ZSS (already funded). This option, along with installation of small isolation transformers and permanent transfer, is considered credible and is discussed further in section 4.1.	
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. This option is considered credible and is discussed further in section 4.2.	Y

4.1 Option 6– Remote REFCLs and Isolation Transformers

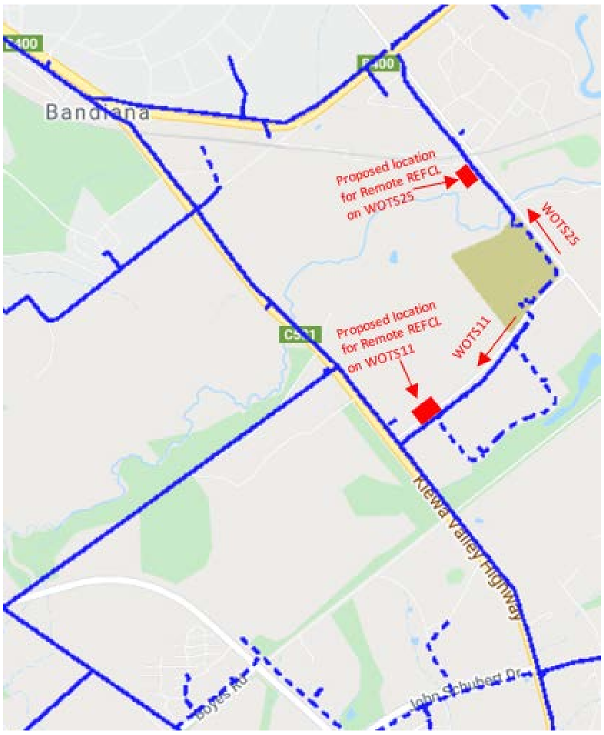
This option proposes to install two Remote REFCLs and isolation transformers to reduce the capacitive current experienced at WOTS. The remote REFCL solution is currently under development by AusNet Services. It isolates part of a feeder and protects the isolated section with its own REFCL to ensure the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

As per the capacitive forecast shown in section 3.2, remote REFCLs would be required on WOTS11 and WOTS25 to ensure capacitance is reduced on both buses to below the 100A planning limit. The capacitive current reduction expected to be possible from these two feeders is approximately 140A in total, with WOTS25 enabling a reduction of approximately 80A and WOTS11 enabling a reduction of approximately 60A.

Figure 4.1 below shows a map with the proposed locations for the two remote REFCLs. In addition to the remote REFCLs, three 300kVA isolation transformers are proposed in the following locations to ensure per feeder capacitance on WOTS25 is below the 80A limit:

- Pole 5202955 – results in 1.8A capacitance reduction
- Pole 5202711 – results in 2.0A capacitance reduction
- At the intersection of Mortimer Terrace and Streets Road – results in 1.5A capacitance reduction

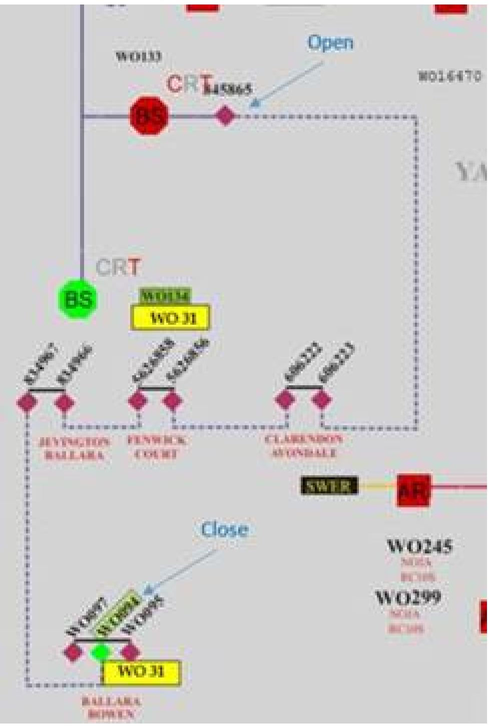
Figure 4.1 Proposed Remote REFCL locations



In addition to the remote REFCLs and three 300kVA isolation transformers, the below permanent transfer from WOTS25 to WO31 is required to ensure per feeder capacitance on WOTS25 is well below the 80A limit.

- Close WO994 and open gas switch 845865
- Approximate capacitance transfer from WOTS25 – 10A onto WO31

Figure 4.2 Proposed permanent transfer



Expected cost for two remote REFCL solutions and three 300kVA pole top isolation transformers is expected to be $13.5M.

However, the following risks/issues have been identified that require further consideration:

- Each remote REFCL requires at least 22m x 11m land size in a developed urban area which maybe difficult to acquire or lease. An initial desktop assessment has been carried out for the proposed sites which needs to be followed up by site visits and discussions with councils and land owners;
- There will be a negative impact on the community through the installation of new large infrastructure in residential areas;
- The additional transformers create an additional maintenance item in the network;
- For the remote REFCLs to achieve its purpose, the selected locations for the remote REFCLs assumes new development will be down stream of the remote REFCLs, however, locations of new development cannot be predicted; and
- The effectiveness of a remote REFCL to isolate capacitance from new development growth will be limited by feeder thermal constraints.

This option is recommended as it is technically feasible and cost effective compared to the other option.

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.

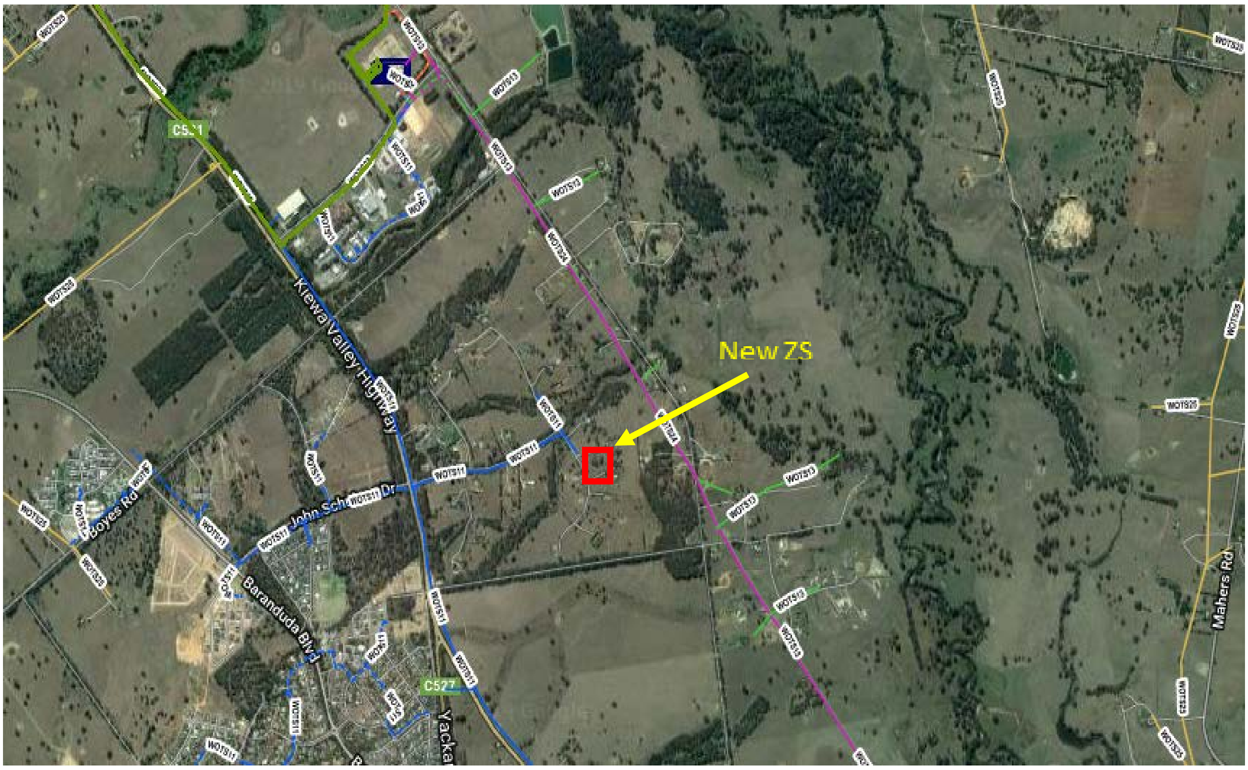
The cost of a new single transformer ZSS (with one REFCL) is $29.3 million. The identified location for the new zone substation is still undeveloped but has land available. The new ZSS would have the option to move WOTS11 (64A), WOTS24 (55A) and WOTS13 (35A). WOTS 25 would need the 300kVA isolations using isolation transformers and transfers as discussed in Option 6.

This option however has the following key disadvantages:

- Additional capacity (demand MW) is not currently required based on current load forecast;
- There is a long lead time to procure the equipment and install a brand new substation, whereas as a more immediate solution is required to address the concerns at WOTS;
- This creates additional maintenance in the network;
- There will be a negative impact on the community through the installation of new large infrastructure in residential areas; and
- Difficulty to acquire land in an appropriate location and to obtain the necessary easements for the new 66kV line and distribution feeder exits.

Therefore, although this option is a technically suitable solution, this option is not recommended based on the above disadvantages and cost.

Figure 4.3 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 6 is the preferred option as it is the least cost and technically feasible solution.

Table 4.2 Feasible Options Comparison

Option	Technical feasibility	Estimated Cost (real $ 2020)	Regulatory feasibility	Social impact	Preferred
Option 6 - Remote REFCLs and isolation transformers	Yes, however, it will be difficult to find suitable land	$13.5 M	Yes	Yes	Yes
Option 8 - New ZSS	Yes, however, it will be difficult to find suitable land	$29.3 M	Yes	Yes	No

5 Recommendation

It is recommended that option 6, two remote REFCLs and three 300kVA isolation transformers, is approved. Permanent transfer from WOTS25 to WO31 is also required to ensure per feeder capacitance on WOTS25 is well below the 80A feeder planning limit. Following approval, AusNet Services will be required to acquire or lease land near WOTS as shown in Figure 4.1 to install the two remote REFCLs on WOTS11 and WOTS25.

The expected cost is $13.5 million and is the least cost and technically feasible solution 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.