REFCL Compliance Maintained Planning Report Wonthaggi (WGI) Zone Substation

AMS – Electricity Distribution Network

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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.

Wonthaggi (**WGI**) zone substation (**ZSS**) is included in Tranche 2 of the AusNet Services REFCL Program with compliance to be achieved by 1 May 2021[1]. This report investigates and seeks funding for the most prudent and efficient approach to maintain compliance with the Regulations at WGI during the 2022-26 regulatory control period.

WGI ZSS has had one standard Arc Suppression Coil (**ASC**) installed with a measured capacitive current limit of 153 Amperes (**A**) and latest measured capacitance is 161 A. The limit of the ASC has been exceeded and AusNet Services will not be able to continue to demonstrate Required Capacity at WGI under all network conditions.

The zone substation demand is within the zone substation rating when operated with the bus tie closed, and the zone substation assets are considered to be in good condition. Hence, the increasing capacitive current is driving the need to invest to ensure AusNet Services can maintain compliance with the Regulations at WGI.

This report reviews various options considered by AusNet Services to manage the capacitance growth and local conditions in order to maintain compliance with the Regulations. It is recommended that the option of installing a second REFCL on existing bus and replacing supply No.3 transformer is approved. Given that there will be lead time to procure and install the second REFCL and No.3 transformer, it is recommended to install five pole top isolation transformers in the near term. This manages increases in capacitive current until the second REFCL is commissioned.

In summary, following approval, AusNet Services will complete the following works:

- Install five 300kVA pole top isolation transformers
- Install a second REFCL on a new neutral bus kiosk and associated secondary protection;
- Install one (1) REFCL Type 3 Room;
- Relocate existing RCC inverter and Grid Balancing unit from the existing REFCL Type 1 Room into the new REFCL Type 3 Room;
- Install two (2) 750kVA Kiosk Type substations; and
- Replace Transformer No. 3 with a 20/33MVA transformer.

The estimated cost for this solution is $9.6 million.

[1] WGI was originally included as part of Tranche 1 of the REFCL Program however was transferred to Tranche 2 due to delays as a result of the replacement of underground cables. Funding for WGI was approved in the Tranche 1 contingent project application decision by the Australian Energy Regulator (AER)

2 Background

2.1 Purpose of this report

This report investigates any constraints that are forecast to occur at WGI, identifies and assesses potential options, and seeks funding for the preferred option. WGI 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[2].

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.

2 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[3] 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. WGI has one operational REFCL with a measured ASC limit of 153A.
- **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;

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

- 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.

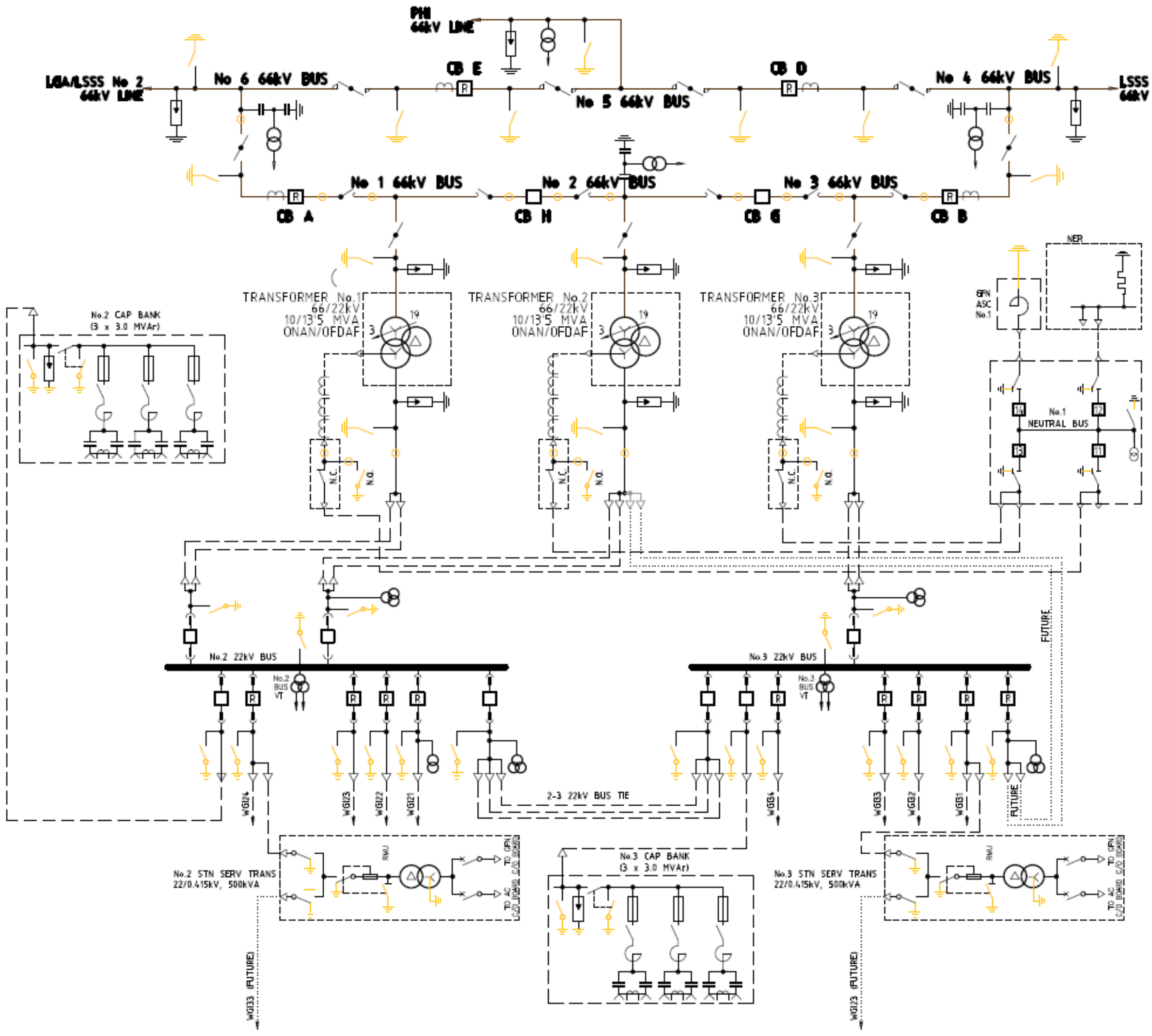
3 WGI zone substation overview

Wonthaggi (**WGI**) Zone Substation (**ZSS**) is located in the town of Wonthaggi approximately 132km east of Melbourne. It is currently comprised of three transformers feeding two buses.

Originally part of Tranche 1, the WGI REFCL was commissioned in November 2019 as part of Tranche 2 of the AusNet Services REFCL Program to achieve compliance with the Regulations.

The Single Line Diagram, including the existing REFCL, is shown in Figure 3.1. It is possible to install a second REFCL at this site.

Figure 3.1 WGI ZSS Single Line Diagram



Source: AusNet Services

An aerial view of the 22kV feeders originating from the WGI electricity distribution area is shown in Figure 3.2. The distribution area includes both residential and commercial suburban areas around Wonthaggi, as well as urban and rural areas along the coast from Phillip Island through to Venus Bay.

The image shows that the feeders are predominately overhead with the breakdown of overhead and underground conductors per feeder shown in Table 3.1. Overhead feeders contribute a lower amount of capacitive current compared to underground cables.

The underground sections are concentrated in the urban areas of Wonthaggi and Inverloch but are spread fairly evenly across multiple feeders.

Table 3.1 Overhead and underground conductor lengths

Feeder	Overhead (km)	Underground (km)	Total length (km)
WGI21	2.5	4.1	6.6
WGI22	45.8	3.4	49.2
WGI23	110.2	3.9	114.1
WGI24	117.2	1.6	118.8
WGI31	41.2	6.4	47.6
WGI32	65.3	8.6	73.9
WGI33	19.1	3.8	22.9
WGI34	209.7	1.4	211.1
Grand Total	**611.0**	**33.2**	**644.2**

There are only three interconnections to other adjacent ZSS:

- WGI32 connects to Phillip Island (PHI11) to the west;
- WGI23 and WGI34 connect to Lang Lang (LLG13) to the north; and
- WGI24 and WGI34 connect to Leongatha (LGA23) to the east.

Out of the three connecting substations listed above, only LLG is a Scheduled zone substation and is included in Tranche 3 for implementation by 1 May 2023. Hence, load transfers can only be implemented to LLG. The connections to PHI and LGA cannot be used to transfer load and capacitive current.

Figure 3.2: WGI ZSS Aerial Layout (underground conductor shown in dark maroon)

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

Table 3.2 shows the WGI maximum demand forecast (MVA) between 2020 and 2026. By 2026, the demand is expected to increase by approximately 3.0MVA.

Figure 3.3 shows that the forecast demand will exceed the N-1 cyclic rating of the substation within the 2022-2026 regulatory control period. These supply transformers are considered to be in good to fair condition, hence the probability of failure is low and the probability weighted value of energy at risk does not warrant capacity augmentation to be undertaken at WGI.

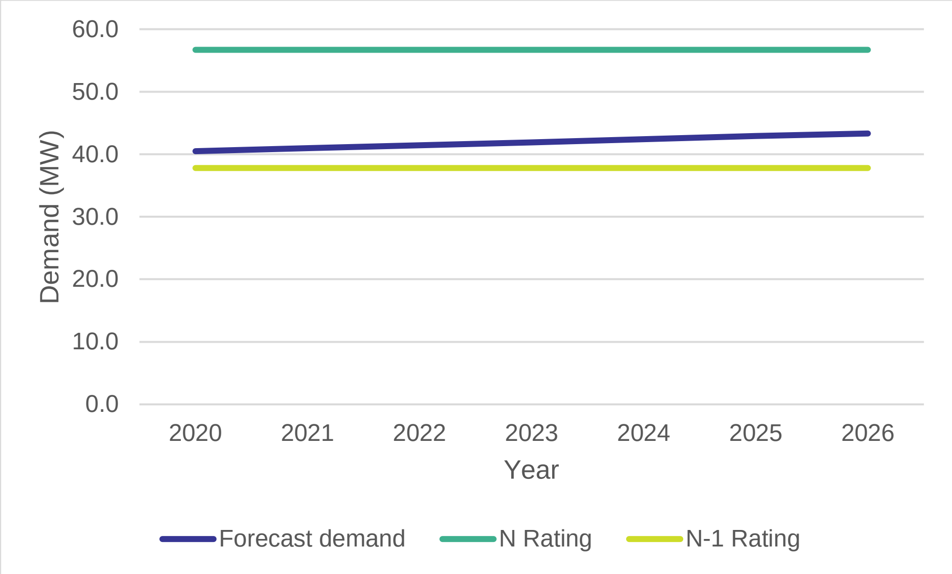
While the probability of transformer failure is unlikely and the short term cyclic rating of the transformers reduces the energy at risk, the station will need to be operated in a split bus configuration if a second REFCL is installed. When operating with a split bus, transformer 3 will be overloaded based on nameplate rating. As this would be in normal operation, the continuous rating must be considered and not the short term cyclic rating.

Table 3.2: Maximum Demand (MVA) Forecast for WGI – 2020 to 2026

	2020	2021	2022	2023	2024	2025	2026
WGI Winter (50POE)	32.0	31.8	31.5	31.2	31.0	30.7	30.4
WGI Summer (50POE)	40.1	40.6	41.0	41.5	42.0	42.5	42.9
WGI Winter (10POE)	34.4	34.1	33.9	33.6	33.3	33.0	32.7
WGI Summer (10POE)	41.4	41.9	42.4	42.9	43.4	43.9	44.3

	2020	2021	2022	2023	2024	2025	2026
WGI Consolidated Forecast[4]	40.5	41.0	41.4	41.9	42.4	42.9	43.3

Figure 3.3 Demand forecast



The N-1 rating shown in Figure 3.3 assumes one 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 was developed based on the characteristics of each zone substation supply area, the standard topology of cables installed for underground residential developments (**URDs**) and other known network augmentation.

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 an 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.

WGI has one standard ASC installed and commissioned with a measured capacitive current limit of 153A. The table and chart below demonstrate the capacitive current limit at WGI has exceeded and REFCL augmentation will be required to ensure ongoing compliance with the Regulations.

4 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.

Table 3.3 Capacitive current forecast

	2020	2021	2022	2023	2024	2025	2026
WGI Capacitive Current	161	164	167	169	172	175	178
ASC Limit	153	153	153	153	153	153	153
Excess Capacitive Current	8	11	14	16	19	22	25

Figure 3.4 Capacitive current forecast for WGI – 2020 to 2026

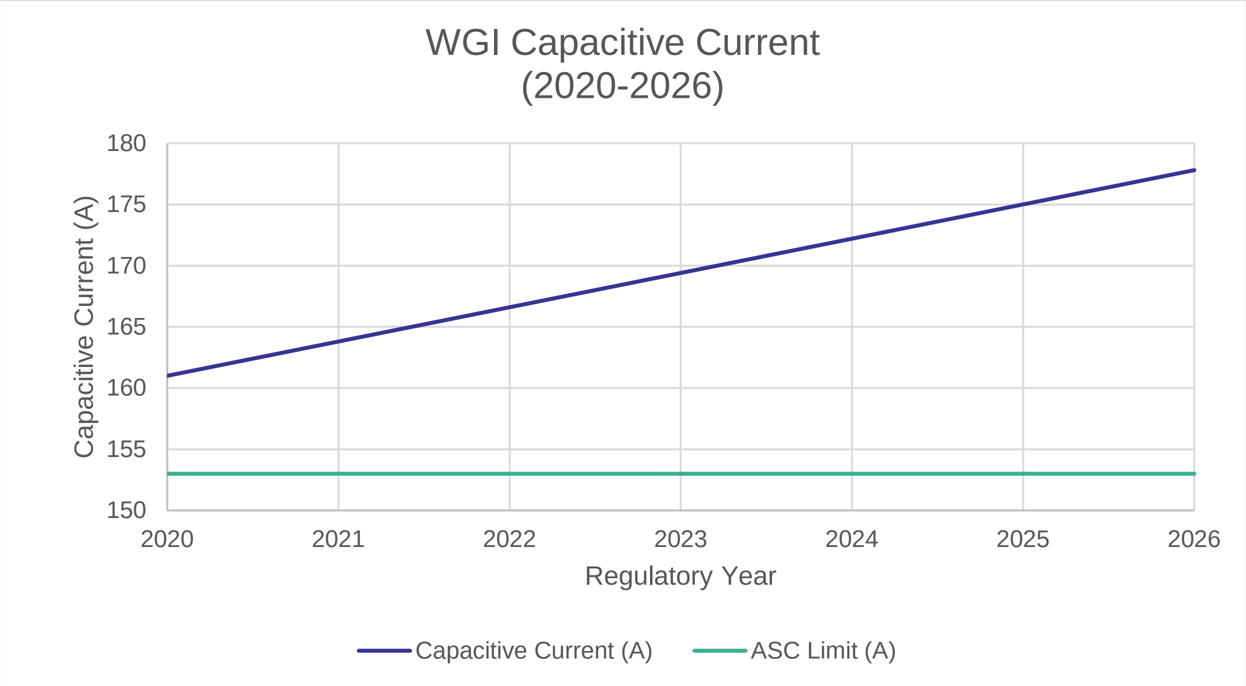


Table 3.4 shows the forecast capacitive current (I_{CO}) per feeder. This identifies that there are no feeders that are expected to exceed the 80A limit. The I_{CO} is forecast to exceed the capacity of a single ASC and the capacitive current is not split evenly across the buses with Bus 2 having 76A and Bus 3 having 102A. The capacitive current on each bus individually is forecast to remain below the measured 153A limit per ASC beyond 2026.

Table 3.4 Estimated Capacitive Current contribution per feeder

Feeder	Forecast I_{CO} (A) 2026
WGI21	16
WGI22	17
WGI23	25
WGI24	18
Total Bus 2	**76**
WGI31	28
WGI32	28
WGI33	20
WGI34	26
Total Bus 3	**102**
Grand Total	**178**

3.2 Identified need

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

The forecast continued residential growth, network augmentation in the WGI supply area, particularly URDs which increase the capacitive current on the network, means that the zone substation has exceeded its overall limit of 153A (one REFCL installed).

While the N-1 capacity of the substation is exceeded and presents a heightened risk, the value of the expected energy at risk due to transformer failure does not currently warrant any capacity augmentation. However, when the bus is split, the capacity of Transformer 3 will be exceeded. Split operation is required if a second REFCL is to be installed.

AusNet Services needs to identify the most economic option to address the capacity and capacitive current constraints that will affect the zone substation during the 2022-2026 regulatory control period.

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 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 3 and 5) 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 WGI which will entail no additional investment at WGI to manage the impact of the capacitive current. With an increasing capacitive current forecast, WGI may become non-compliant with the Regulations, the community served by the WGI 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	Investigation of the network found that there are three options for transferring load away from WGI, however, only one is to another Scheduled zone substation. LLG is expected to have the capacity to accept capacitance in 2023 when it must become compliant with the Regulation. However, this is not enough to maintain compliance at WGI without creating a compliance issue at LLG. Hence, this option is not technically feasible as a permanent solution but maybe used in the interim, if required.	N
Option 3 – Install second REFCL on existing bus	WGI has space for a second REFCL and the technology allows two REFCLs at a single zone substation. This is a credible option and is discussed further in section 4.1.	Y
Option 4 - Install Isolation transformer on feeder	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.	N

Option	Discussion	Credible
	The WGI 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, WGI21 and WGI31 would need to be undergrounded as a minimum. This option is estimated to cost approximately $24 million. Therefore, this option does not present cost effective isolation opportunities and is not considered as a viable option.	
Option 5 - Install isolation transformer and undergrounding work	This option proposes to install an Isolation Transformer to a section of a feeder(s). There are various underground cable sections that can be isolated, however, not sufficient amount of capacitance can reduced to maintain compliance until 2026. Therefore, this should be considered in conjunction with Option 3. This is discussed further in section 4.2.	Y
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. The plant can be located no closer than 100m to the zone substation due to earthing issues. The following issues were identified with this option: - they require at least 22m x 11m land size in a rural area which will be difficult and expensive to acquire - to reduce the capacitive current sufficiently at WGI one Remote REFCL would be required in 2021. Likely candidate feeders is WGI32 plus some feeder reconfiguration works. This results in a cost of $9.6 million plus the cost of land acquisition and feeder reconfiguration. - AusNet Services has observed capacitance and network growth across all feeders at WGI, therefore, the effectiveness of a remote REFCL would be limited. Therefore, this option is considered non-credible due to difficulty and risk of purchasing land and high cost.	N
Option 7 - Undergrounding of overhead in HBRA areas and seek ESV exemption for ZSS	WGI is comprised of 611km of overhead line. The cost, including converting overhead distribution transformers and switches to underground assets, is estimated at $427 million, and therefore is not a credible option.	N
Option 8 - New Zone Substation	Installing a new zone substation to reduce the capacitive current at WGI is a technically viable option. However, the cost of a new single transformer ZSS (with REFCL) is a minimum of $20 million depending on the location and proximity to a sub transmission line and its load. There would also be a significant negative social impact due to the land area required to accommodate a new zone substation and given that this is an established area it will be very difficult to find available land for the ZSS. Hence, this option is considered non-credible due to the cost	N

4.1 Option 3 – Install second REFCL on existing neutral bus and replace transformer

To meet the performance criteria set out in the *Electricity Safety (Bushfire Mitigation) Regulations 2013*, installation of a second REFCL has been identified as an option. This option will result in an increase in capacitive current that can be managed at WGI from 153A to 296A. This will allow the zone substation to operate in a bus-tie open configuration while not exceeding ASC limits until at least 2030 based on current forecasts.

Review of the bus and transformer loading identified that there is a risk of overloading the No.3 Transformer under reverse power as a result of local weather conditions when a cool change occurs during hot summer days with the following scenario:

- Wonthaggi Wind Farm generating at full capacity;
- high residential solar photovoltaic (**PV**) generation; and
- reduction of air-conditioner load.

The weather patterns in the Wonthaggi area makes this scenario more likely, due to correlation between high winds and high solar output. The current feeder allocation will overload the No.3 Transformer under split bus operation. Therefore, to mitigate this and allow for the successful operation of the second REFCL, this option will require replacing the No.3 Transformer with one of a higher capacity.

Current figures show there is a buffer of approximately 3.5MVA, but the solar forecast shows an additional 5.8MW of PV being installed on the network by 2025. Hence, it is prudent to replace the No.3 Transformer with a larger capacity transformer to ensure reliability of supply when a second REFCL is installed.

The *Electricity Safety (Bushfire Mitigation Civil Penalties Scheme) Act 2017* provides for penalties to be applied based on a points system that is assigned in Schedule 2 of the regulations and for each day that each of the Scheduled zone substations is not compliant. When including the assessment of the cost of non-compliance and assuming a range of probabilities of non-compliance occurring, we found that it is most efficient to implement this option as soon as possible with the NPC increasing as the project is delayed due to increasing penalties.

Hence, it is recommended that the installation of the second REFCL under this option is planned for as early in the 2022-2026 regulatory control period as possible to mitigate the risk of non-compliance.

The associated works for this option will include:

- Install a second REFCL on a new neutral bus kiosk and associated secondary protection;
- Install one (1) REFCL Type 3 Room;
- Relocate existing RCC inverter and Grid Balancing unit from the existing REFCL Type 1 Room into the new REFCL Type 3 Room;
- Install two (2) 750kVA Kiosk Type substations; and
- Replace Transformer No. 3 with a 20/33MVA transformer.

This option has the least risk as it is a known asset type and does not require the purchase of any new land or installation of new assets in urban areas. This also minimises the potential for any negative social impacts.

Given that there will be lead time to procure and install the second REFCL and No.3 transformer, it is recommended to install a number of pole top isolation transformers to manage increases in capacitive current until the second REFCL is commissioned. This is further discussed in section 4.2.

4.2 Option 5 – Install isolation transformers and undergrounding work

This option proposes to install isolation transformers to reduce the capacitive current the ASC is subjected to. The requirement for this approach is that all conductors downstream of the isolation transformer are underground.

The scope of work to implement this option is:

- Installation of a 300kVA pole top isolating transformer on pole 2810803 to isolate the downstream underground cable. Isolating this cable is expected to reduce the capacitive current by 5.4A. This option will also allow the retirement of the adjacent balancing capacitor (LV CAP THE CRANNY 4). This section of the cable is on a spur of WGI32 feeder.
- Installation of a 300kVA isolating transformer on pole 5715654 to isolate the downstream underground cable. Isolating this cable is expected to reduce the capacitive current by 1.6A. This section of the cable is on a spur of WGI32 feeder.

- Installation of a 300kVA isolating transformer on pole 2810257 to isolate the downstream underground cables. Isolating these cables is expected to reduce the capacitive current by 3.6A. This section of the cable is on a spur of WGI31 feeder.
- Installation of a 300kVA isolating transformer on pole 2027761 to isolate the downstream underground cable. Isolating this cable is expected to reduce the capacitive current by 1.6A. This section of the cable is on a spur of WGI23 feeder.
- Installation of a 300kVA isolating transformer on pole 2801528 to isolate the downstream underground cable. Isolating this cable is expected to reduce the capacitive current by 1.6A. This section of the cable is on a spur of WGI22 feeder.

Table 4.2 Estimated Capacitive Current contribution per feeder

Feeder	Forecast I_{CO} (A) 2022	Capacitance Reduction	Revised Forecast I_{CO} (A) 2022
WGI21	16	0	16
WGI22	16	-1.6	14.4
WGI23	23	-1.6	21.4
WGI24	16	0	16
Total Bus 2	**71**	**-3.2**	**67.8**
WGI31	26	-3.6	22.4
WGI32	26	-7	19
WGI33	17	0	17
WGI34	26	0	26
Total Bus 3	**96**	**-10.6**	**85.4**
Grand Total	**167**		**153.2**

Installation of 300kVA isolation transformers at the five proposed locations will reduce the total capacitive current at WGI by approximately 14A, as shown in Table 4.2, and maintain compliance at WGI until **2022/23**. Capital expenditure for the installation of these five isolation transformers is $750,000 and it is recommended to install them to manage increases in capacitive current until the second REFCL is commissioned as per option 3.

4.3 Option comparison

The two viable options studied in this report are summarised below. The comparison of the options shows that option 3 is the preferred option in parallel with option 5 as a temporary solution.

Table 4.3 Feasible Options Comparison

Option	Technical feasibility	Estimated Cost (real $ 2020)	Regulatory feasibility	Social impact	Preferred
Option 3 - Install additional GFN on existing neutral bus and replace transformer	Yes	$9.6 M together for option 3 and option 5	Yes	No	Yes
Option 5 - Install isolation transformer and undergrounding work	Feasible as a temporary solution until 2022/23		Yes	Minor	Yes, but in conjunction with Option 3

5 Recommendation

It is recommended that option 3 (install second REFCL on existing bus and replace supply transformer) be approved. Given that there will be lead time to procure and install the second REFCL and No.3 transformer, it is recommended that option 5 is also approved to allow installation of a number of pole top isolation transformers in the near term. This manages increases in capacitive current until the second REFCL is commissioned.

Installation of a second REFCL is an established solution which has already been implemented at other zone substations and will enable continued compliance with the Regulations. Replacing the No.3 Transformer with a larger capacity transformer will ensure sufficient capacity is available at the zone substation to supply existing and forecast demand under split bus arrangements.

In summary, following approval, AusNet Services will complete the following works:

- Install five 300kVA pole top isolation transformers
- Install a second REFCL on a new neutral bus kiosk and associated secondary protection;
- Install one (1) REFCL Type 3 Room;
- Relocate existing RCC inverter and Grid Balancing unit from the existing REFCL Type 1 Room into the new REFCL Type 3 Room;
- Install two (2) 750kVA Kiosk Type substations; and
- Replace Transformer No. 3 with a 20/33MVA transformer.

The estimated cost for this solution is $9.6 million.

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.