REFCL Compliance Maintained Planning Report Ringwood North (RWN) Zone Substation

AMS – Electricity Distribution Network

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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**). These 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.

Ringwood North (**RWN**) zone substation (**ZSS**) 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 RWN during the 2022-26 regulatory control period.

By the Tranche 2 compliance deadline of 1 May 2021, RWN will have one standard Arc Suppression Coil (**ASC**) installed which, for planning purposes, is assumed to have a capacitive current limit of 100 Amperes (**A**), 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 RWN 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 second REFCL is installed to meet the Required Capacity.

The new REFCL can be installed by utilising the existing REFCL control room and space in the ZSS. The following works will be undertaken:

- Install one (1) REFCL and associated secondary and communications equipment;
- Install one (1) switched neutral bus kiosk;
- Install two (2) 750kVA Kiosk Type Station Service Transformers; and
- Install one two (2) 3MVAR modular capacitor bank on the No.2 bus.

The estimated capital cost for the REFCL and associated works is $5.23 million ($'real, 2019).

2 Background

2.1 Purpose of this report

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

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. Currently, 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 RWN zone substation overview

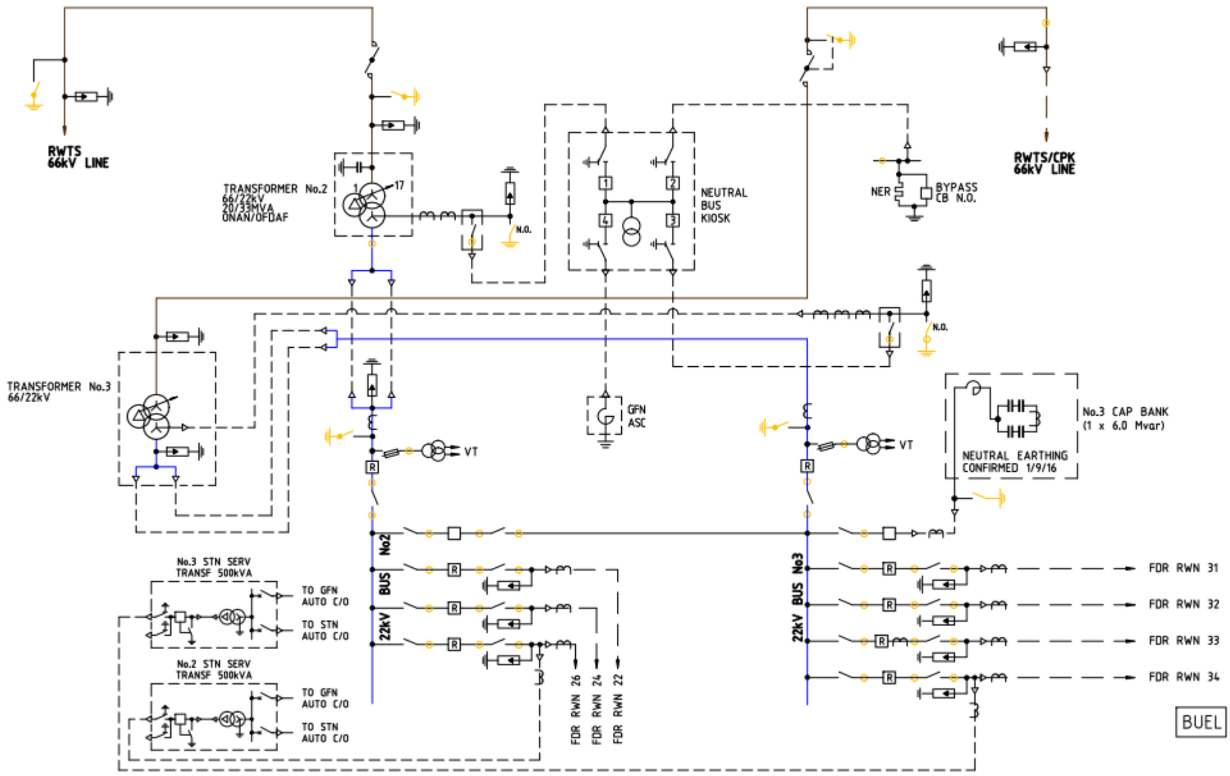
Ringwood North (**RWN**) zone substation (**ZSS**) is located in the centre of the suburb of Ringwood North, approximately 24km east of Melbourne. Originally constructed in 1976, it is currently comprised of two transformers feeding two 22kV buses.

A REFCL will be commissioned at RWN on Bus 2 as part of Tranche 2 of the AusNet Services REFCL Program to achieve the 1 May 2021 compliance deadline.

The Single Line Diagram, including the future REFCL, is shown in Figure 3.1. Note that Bus 1 does not exist but is allowed for in the ultimate layout of the zone substation.

It is currently possible to install up to one more REFCL at this site.

Figure 3.1 RWN ZSS Single Line Diagram



Source: AusNet Services

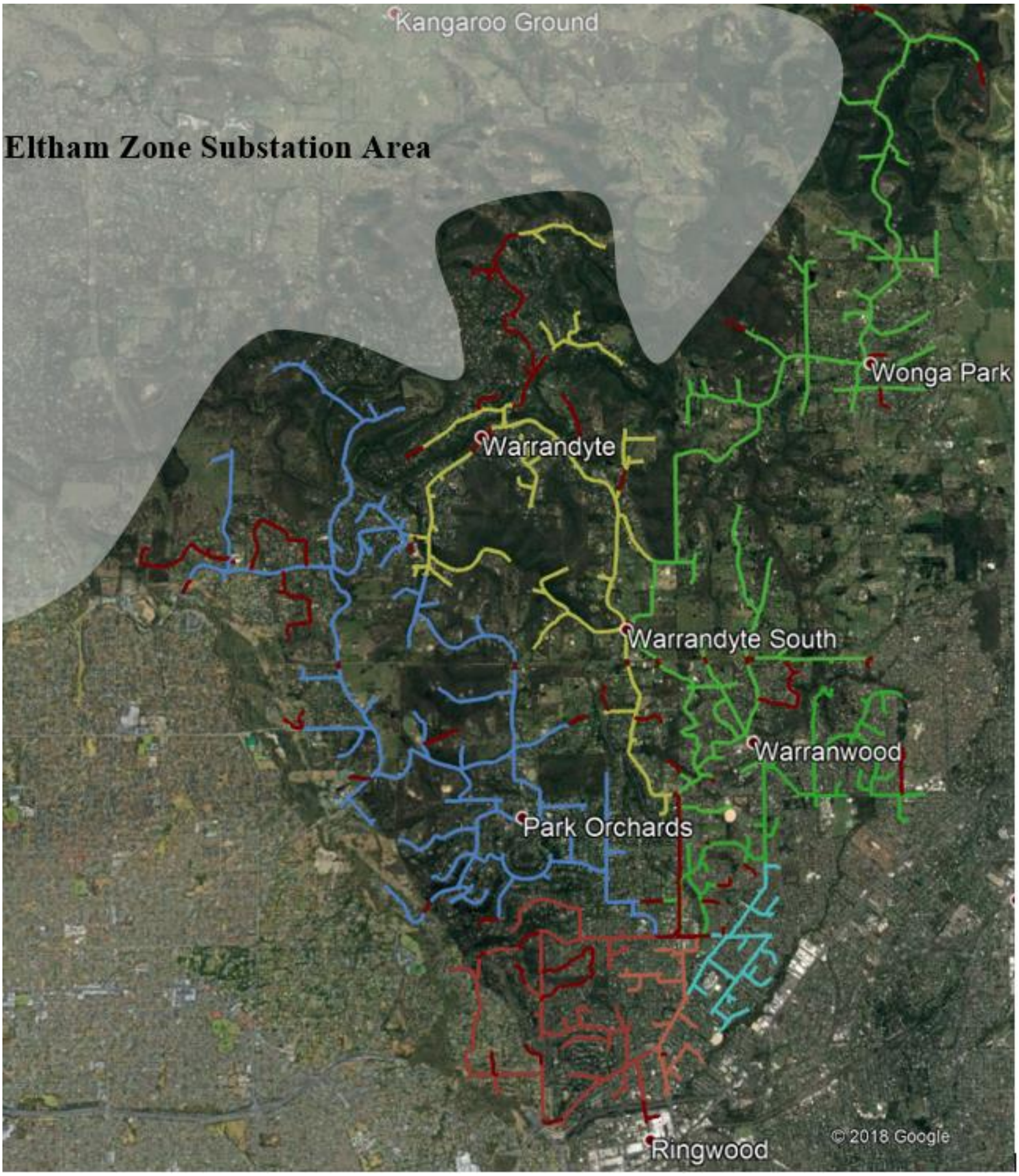
An aerial view of the 22kV feeders originating from RWN electricity distribution area is shown in Figure 3.2. The distribution area includes both residential and commercial suburban areas around Ringwood North, as well as semi-urban areas between the suburbs of Park Orchards and Warrandyte that are heavily tree-covered, steep and have limited access.

The feeders are predominately overhead with the breakdown of overhead conductors and underground cables per feeder shown in Table 3.1. Overhead conductors 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)
RWN22	13.7	1.6	15.2
RWN24	23.0	4.9	27.9
RWN26	41.5	7.3	48.8
RWN31	44.1	4.2	48.2
RWN32	5.7	0.4	6.1
RWN33	7.3	0.6	7.8
RWN34	22.3	6.3	28.5
Grand Total	**157.4**	**25.2**	**182.6**

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



RWN has 22kV feeder connections to Eltham (**ELM**), Croydon (**CYN**) and Chirnside Park (**CPK**). Of the three zone substations adjacent to RWN, only ELM is a Scheduled zone substation and therefore planned to be REFCL protected. A permanent transfer from a REFCL feeder to a non-REFCL feeder would require a technical exemption from the Governor in Council.

ELM has high existing and forecast network capacitance. To maintain compliance with the Regulations at ELM, a new Diamond Creek (DCK) Zone Substation is proposed to be constructed during the 2022-2026 regulatory control period. Hence, it will not be possible to transfer load to ELM on a permanent basis due to the different timeframes of the network constraints arising and forecast capacitive current growth rates.

3.1 Network forecast

This section discusses the demand and capacitive current forecasts to identify if and when either attribute is expected to exceed the capacity of the substation or ASC, respectively. 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

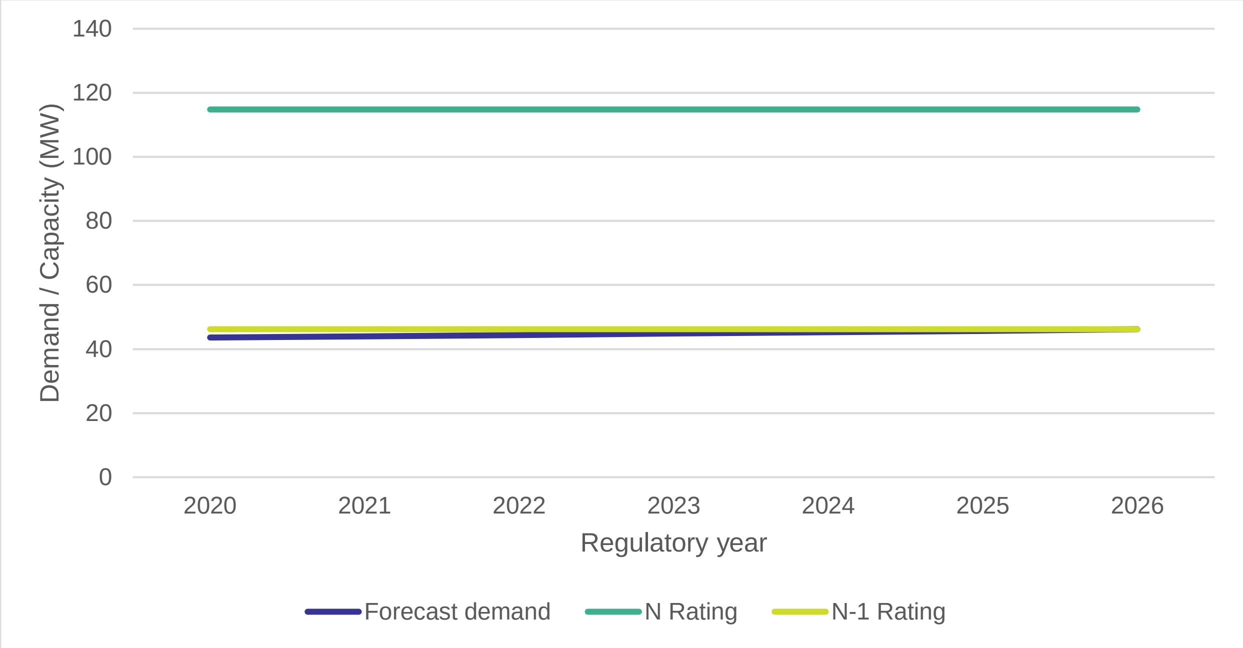
The table below shows the RWN maximum demand forecast in MVA between 2020 and 2026. By 2026, the summer demand is expected to increase by approximately 2.7MVA which will approach, but not exceed, the N-1 cyclic rating of the substation. In addition, these supply transformers are considered to be in fair to very good condition, hence the probability of an outage is low and does not warrant capacity augmentation to be undertaken.

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

	2020	2021	2022	2023	2024	2025	2026
RWN Winter (50POE)	34.8	34.7	34.5	34.3	34.1	33.9	33.7
RWN Summer (50POE)	42.5	42.9	43.3	43.8	44.2	44.6	45.1
RWN Winter (10POE)	35.8	35.7	35.6	35.4	35.2	35	34.8
RWN Summer (10POE)	46.1	46.5	47	47.4	47.9	48.4	48.9
RWN Consolidated Forecast[3]	43.6	44.0	44.4	44.9	45.3	45.7	46.2

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.

Figure 3.3 Demand forecast



Note: The N-1 rating shown in

Figure 3.3 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 underground residential developments (**URDs**) and other known network augmentation.

Since the growth in capacitance is strongly related to the growth of URD, 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. In the event 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.

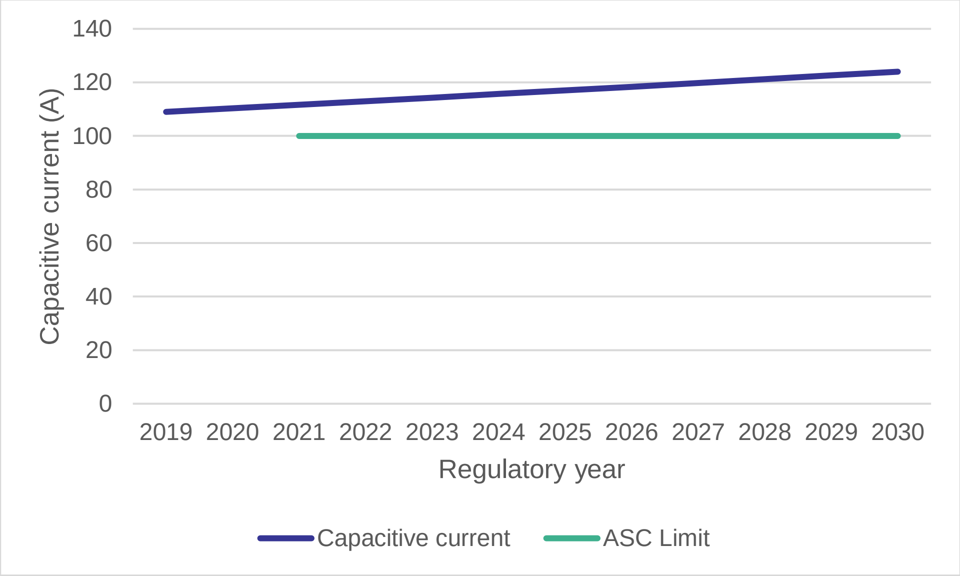
By 31 May 2021, RWN will have one standard ASC installed which, for planning purposes, is assumed to have a capacitive current limit of 100A.

The table and chart below indicate that the capacitive current limit may be exceeded as soon as 2021.

Table 3.3 RWN capacitive current forecast

Feeder name	2020	2021	2022	2023	2024	2025	2026
RWN capacitive current	110	112	113	114	116	117	118
ASC Limit		100	100	100	100	100	100
Excess capacitive current		12	13	14	16	17	18

Figure 3.4: Capacitive Current Forecast for RWN – 2019 to 2030



Overhead feeders contribute a lower amount of capacitive current compared to underground cables. Table 3.4 presents estimates of the capacitive current (I_{CO}) per feeder. The total current was split proportionally based on the amount of underground cable per feeder. 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.

RWN26 and RWN 34 have the highest amount of capacitive current and are therefore considered in more detail in section 4.2. However, they are both well below the individual feeder limit of 80A. Both buses are also well below the per bus ASC planning limit of 100A.

Table 3.4 Estimated Capacitive Current contribution per feeder

Feeder	Forecast I_{CO} (A) 2026
RWN22	7.3
RWN24	23
RWN26	34.2
RWN31	19.6
RWN32	1.8
RWN33	2.6
RWN34	29.5
Grand Total	**118.0**

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 of continued residential growth and network augmentation in the RWN supply area, particularly URDs which increase the capacitive current on the network, means that the capacitive current capacity of the REFCL at RWN may be exceeded as soon as 2021.

As the demand growth and asset condition are not identified to be constraints for the zone substation, AusNet Services needs to identify the most economic option to address the capacitive current constraint that will affect 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 nine options that could maintain compliance with the Regulations. These are summarised in Table 4.1. Initial assessment of the nine options found that seven 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 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 RWN which will entail no additional investment at RWN to manage the impact of the capacitive current. With an increasing capacitive current forecast, RWN may become non-compliant with the Regulations, the community served by the RWN 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	Eltham (ELM) Zone Substation is an adjacent substation. However, ELM has high existing and forecast network capacitance and to maintain compliance with the Regulations at ELM, a new Diamond Creek (DCK) Zone Substation is proposed to be constructed during the 2022-2026 regulatory control period. Hence, it will not be possible to transfer load to ELM. On this basis, Option 2 is not a credible option.	N
Option 3 - Install second REFCL on existing Bus 3	RWN has space for a second REFCL and the technology allows for two REFCLs at a single zone substation. This is a credible option and is discussed further in section 4.1.	Y
Option 4 – Install second REFCL on new bus	RWN is in an established area. This option would require increasing the zone substation footprint which is very difficult as it would require acquisition and re-zoning of adjacent land. This is likely to take time and cost more for land acquisition and the additional bus, without providing any additional benefit compared to Option 3. Hence, this option is considered non-credible on the basis of cost and planning feasibility.	N

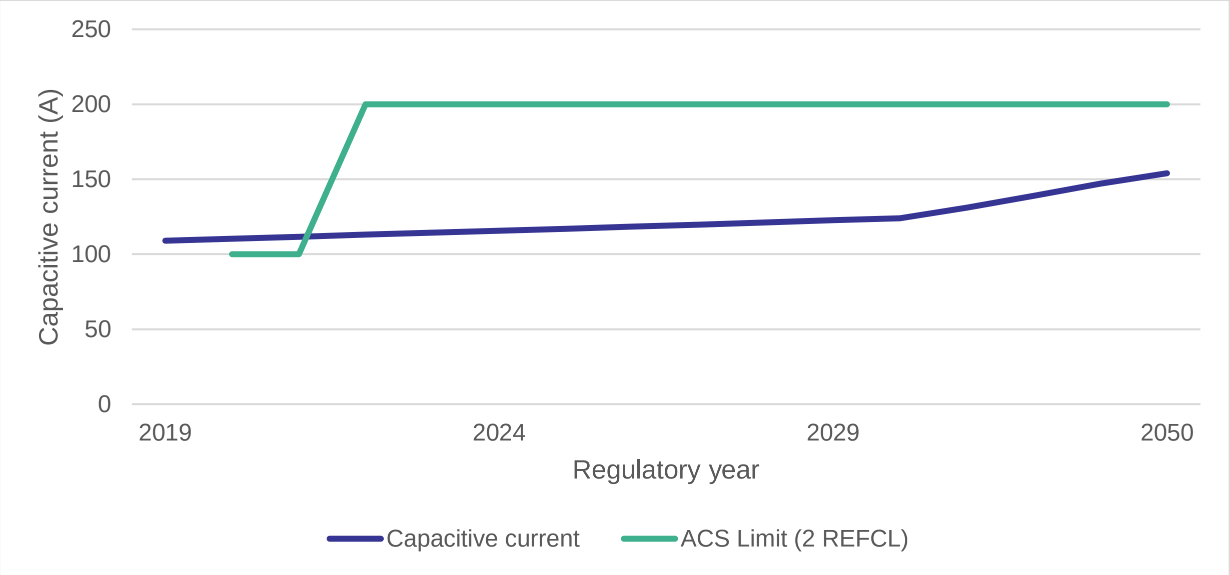
Option	Discussion	Credible
Option 5 - Install isolation transformer and undergrounding work	There are various underground cable sections that can be isolated. However, finding land would be difficult for the isolation transformers as mentioned above. This option is credible and is discussed further in 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 remote REFCL can be located no closer than 100m to the zone substation due to earthing issues. The following issues were identified with this option: - at least to remote REFCLs are required by 2026 assuming they can be placed in the ideal locations for isolation purposes. - they require at least 30m x 30m land size in a developed urban area which will be difficult and expensive to acquire - the cost to maintain compliance to 2026, excluding land, is estimated at $14m, which is more expensive than other options. Therefore, this option is considered non-credible due to difficulty and risk of purchasing land and higher cost compared to other options.	N
Option 7 - Undergrounding Over Head in High Bush Fire Risk Area	RWN is comprised of 787.1 km of overhead line. Conversion of a Scheduled zone substation to underground would also require an exemption from the Regulations. An exemption for an entire zone substation has not been granted (at the time of submitting this report) so there is a higher risk to obtaining the exemption. The total cost of this option is forecast to be $551 million and therefore is not a credible option.	N
Option 8 – Insulating Over Head in High Bush Fire Risk Area	RWN is comprised of 157 km of overhead line. The cost, including converting associated assets to be converted to Aerial Bundled Cable (**ABC**) or Covered Conductor, is estimated at $110 million and requires a technical exemption which have not been applied for in the past. This option is therefore not considered a credible option.	N
Option 9 - New Zone Substation	Installing a new zone substation to reduce the capacitive current at RWN 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. 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 bus

To meet the performance criteria set out in the Electricity Safety (Bushfire Mitigation) Regulations 2013, the installation of a second REFCL has been identified as a feasible option. This option is assumed to result in an increase in the capacitive current that can be managed at RWN from 100A to 200A, as shown in Figure 4.1. This will allow the zone substation to operate in a bus-tie open configuration while not exceeding ASC planning limits until at least 2050 based on current forecasts.

This option does not require any feeder reconfiguration or load transfers. The existing double REFCL control room and space in the ZSS can be used to install the second REFCL. Note, until the second REFCL is installed, the capacitive current limit is forecast to be slightly exceeded by 12A. However, the 100A limit should be considered as a typical rating only for planning purposes. As identified in section 3.1.2, the actual limit maybe more than 100A when the network characteristics are confirmed after the first REFCL is in operation.

Figure 4.1 Increased total capacitive limit at RWN with second REFCL



The associated works for this option will include:

- Install one (1) REFCL and associated secondary communication equipment;
- Install one (1) switched neutral bus kiosk;
- Install new RCC inverter and Grid Balancing unit (for the new REFCL) into the existing control room at RWN;
- Install two (2) 750kVA Kiosk Type Station Service Transformers. No civil works are required as this will be installed in situ on the existing 500kVA Station Service Transformer footings; and
- Install one 2 x 3MVAR modular capacitor bank on the No.2 bus.

Hence, it is recommended that the installation of the second REFCL and associated works under this option occurs.

This option has the least risk as it is a known asset type and does not require the purchase of any new land, installation of new assets in urban areas or any exemptions from Governor in Council. This also minimises the potential for any negative social impacts as all new infrastructure will be housed within the existing zone substation site.

Capital expenditure for the installation of a second REFCL and associated works is $5.23 million ($'real, 2019). The net present cost is $4.6 million ($'real, 2019).

This is the least cost technically feasible option and hence it is recommended as the preferred option.

4.2 Option 5 – Install isolation transformer and undergrounding work

This option proposes to install isolation transformers to reduce the capacitive current to which the ASC will be subjected. This option will require an exemption from Governor in Council. However, there is precedence in receiving exemptions for this approach and is an established process. This option will require all conductors downstream of the isolation transformer to be undergrounded.

After carrying out detailed assessment of the network, it was found that the following two feeders would be suitable for isolation transformers:

- RWN34, which has approximately 20A of capacitive current caused by cable beyond the switch LD15144. In a 7.6 km segment, 1.9 km is comprised of High Voltage Aerial Bundled Cable (**HV ABC**) and the remainder is underground; and
- RWN26, which as approximately 5A of capacitive current beyond switch RW506. This is comprised of 1.7 km of 185mm² underground cable.

The scope of work to implement this option is:

- Installation of two isolation transformers ($2 million each including land);
- appropriately located land; and
- undergrounding 1.9km of overhead HV ABC plus associated distribution transformers and switches.

The estimated cost of the option, excluding land, is $5.3m. There is high risk in being able to acquire the land in the necessary locations. There is also very little ability to change the location and still achieve the same capacitive current reduction. Non-ideal placement of isolation transformer will significantly increase the cost due to the need of additional overhead to underground conversion.

We note that this will provide an expected benefit of a reduction of 25A of capacitive current. This will only enable RWN to remain compliant until 2030 when the next intervention will be required. The net present cost of this option is $4.7 million $'real, 2019).

This option has high risk due to the uncertainty regarding the ability to acquire land in the appropriate locations and the cost of the land. The option will require an exemption to be granted by the Governor in Council and will impact the visual amenity through new large infrastructure being located in an urban residential environment. The additional transformers also create an additional maintenance item and ongoing electrical losses on the network.

While technically feasible and AusNet Services is likely to obtain the exemptions, the solution is not the most cost efficient nor the most technically optimal from a network management and losses perspective.

This option is not recommended.

4.3 Option comparison

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

Since the Option 3 and Option 5 have very similar costs but a different risk profile and duration of the benefit they provide, we considered the needs at RWN over a longer time period to identify the more prudent and efficient option. Option 3 is expected to require the second REFCL around 2022, which will ensure compliance until 2050 with a NPC of $4.6 million

($’real,2019). Option 5 will require installation of isolation transformers around 2022 and then a second REFCL around 2030, which results in an NPC of $8.9 million ($’real, 2019).

This assessment results in the selection of Option 3 as the preferred option.

Table 4.2 shows a comparison of the options, further demonstrating Option 3 as the preferred option.

Table 4.2 Feasible Options Comparison

Option	Technical feasibility	Cost	NPC	Maintains Compliance	Social impact	Preferred
Option 3 – Install second REFCL on existing bus	Yes	$5.23 M	$4.6 M	Yes	No	Yes
Option 5 - Install isolation transformer and undergrounding work	Yes	$5.3 M	$4.7 M ($8.9 M with second REFCL in 2030)	Needs exemption	Yes	No

5 Recommendation

It is recommended that Option 3 (install second REFCL on existing bus) is approved. This is an established solution which has already been deployed at other zone substations and it is the most cost effective and technically feasible option that meets the compliance requirements.

Following approval, AusNet Services will procure and install the second REFCL at RWN and complete the following works:

- Install one (1) REFCL and associated secondary communication equipment;
- Install one (1) switched neutral bus kiosk;
- Install a new RCC inverter and Grid Balancing unit (for the new REFCL) into the existing control room at RWN;
- Install two (2) 750kVA kiosk type station service transformers. No civil works are required as this will be installed in situ on the existing 500kVA station service transformer footings; and
- Install one 2 x 3MVAR modular capacitor bank on the No.2.

The estimated capital cost for the REFCL and associated works is $5.23 million ($’real, 2019).

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
    1. 1900 volts within 85 milliseconds; and
    2. 750 volts within 500 milliseconds; and
    3. 250 volts within 2 seconds; and
- Demonstrate during diagnostic tests for high impedance faults to limit
    1. Fault current to 0.5 amps or less; and
    2. 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.