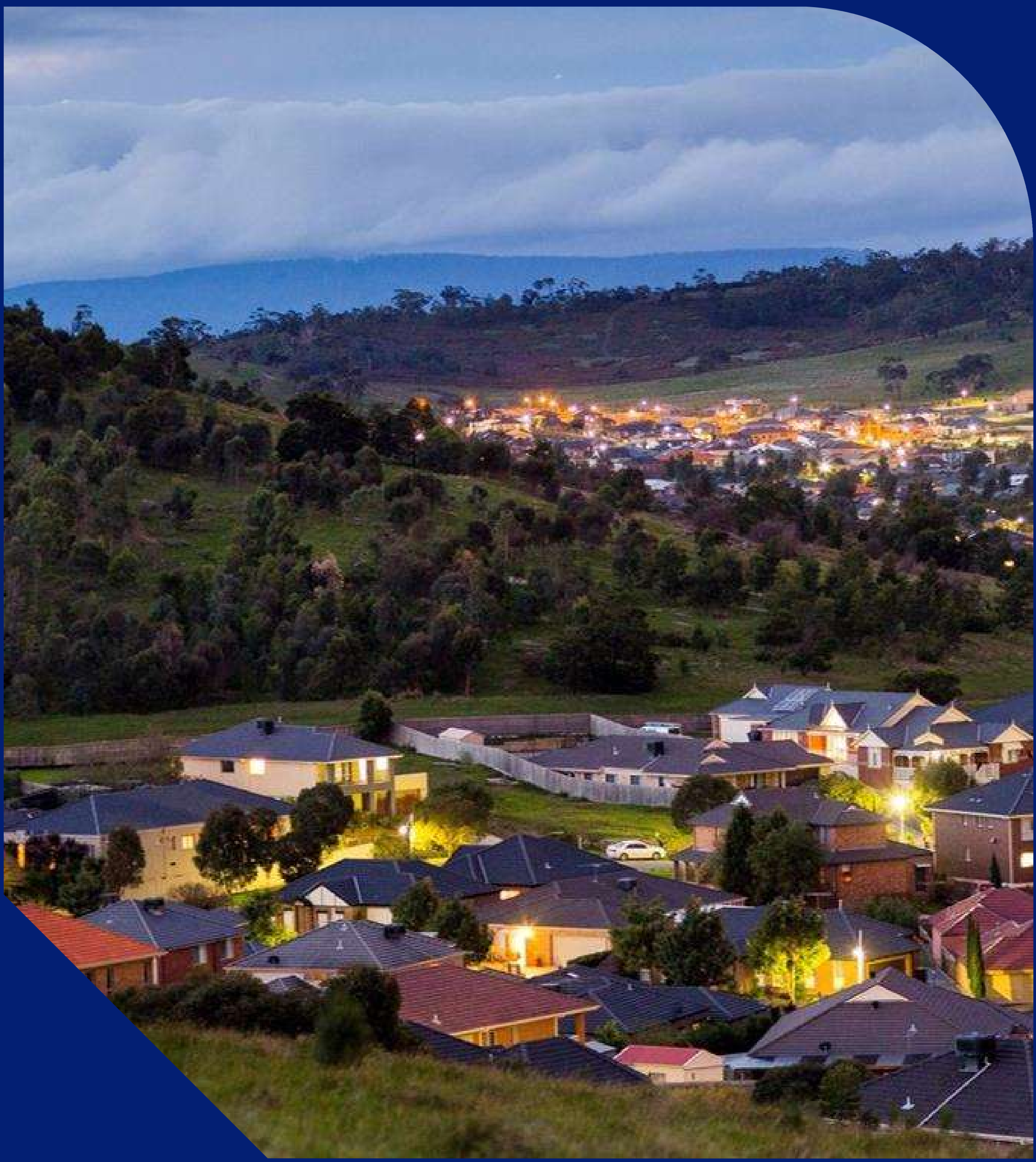
Electricity Distribution Price Review (EDPR 2027-31)

Business case: REFCL

Date: 31 January 2025



Contents

1 Executive summary

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 (REFCL) 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.

The following zone substation (**ZSS**) / feeder sites are included in the AusNet Services 2026-31 REFCL Program: **Location (ZSS)**	
SMR	Seymour
WOTS22[1]	Wodonga Terminal Station 22kV
WYK	Woori Yallock
KLK	Kinglake

This report investigates and seeks funding for the most prudent and efficient approach to maintain compliance with the Regulations during the 2026-31 regulatory control period.

Increasing capacitive current is driving the need to invest in further mitigation efforts to ensure AusNet Services can maintain compliance with the Regulations.

This report reviews various options considered by AusNet Services to manage the capacitance growth. It is recommended that combination of Option 2 – installation of Isolating transformers and Option 3 - Remote REFCL is approved across four geographic REFCL areas.

The expected aggregate cost for this option is $65.6 million and is the least cost, technically feasible solution with no social impact.

[1] This site is a Terminal Station (WOTS - Wodonga Terminal Station) – whilst a transmission asset, Ausnet 22kV distribution feeders come from WOTS.

2 Background

2.1 Purpose of this report

This report investigates constraints that are forecast to occur at Ausnet's prescribed REFCL network areas, identifies and assesses potential options and seeks funding for the preferred option. A total of four zone substations are to be augmented to comply with *Electricity Safety (Bushfire Mitigation) Regulations 2013*.

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.

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

2.3 REFCL technology

There are various types of technology that fall under the REFCL umbrella and the Victorian Electric Supply Industry (VESI) considers this suite of technologies as having the capability to meet performance requirements. A common example is the 'Ground Fault Neutraliser'.

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.
- Residual Current Compensator (**RCC**) – also referred to as the inverter, which is located in the zone substation. 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.

Network conditions, topology and physical constraints (such as damping factor and capacitive current limits) impact the continued correct operation of the REFCL and its ability to continue meeting the Required Capacity.

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.

More detailed technical information is provided on the subject in the appendices.

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;
- 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

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

3 Identified need

The following network Zone Substations (**ZSS**) are requiring interventions to maintain REFCL compliance:

Location (ZSS)		Count of existing REFCL apparatus	
		ZSS REFCLs	Remote REFCLs
SMR	Seymour	2	0
WOTS[4]	Wodonga TS 22kV	2	0
WYK	Woori Yallock	2	0

As the majority of the zone substation sites above have two existing REFCLs (and are configured with two or more 22kV buses), it is necessary to identify which bus has an exceeded ASC limit:

Location (ZSS)	Capacitive current limitation[5] (A)		
	Bus 1	Bus 2	Bus 3
SMR	92	115	N/A
WOTS	111	111	N/A
WYK	87	119	N/A

Table 3.1: Forecast indicates limit exceeded

In addition to the ASC limit associated with the zone substation bus, individual 22kV FDRs (in some cases) have a sub limit of 80A.

Further, the configuration of each ZSS site outlined above (together with forecasts and downstream network topology) will determine the suite of solutions available to those sites.

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 demand forecast (expressed in Apparent Power and measured in MVA) has been developed for all sites within this business case and indeed all ZSS and FDRs throughout the network. It is

[4] This site is a Terminal Station (WOTS - Wodonga Terminal Station) – whilst a transmission asset, Ausnet 22kV distribution feeders come from WOTS22.

[5] The limit chosen is the *Summated Ic ELSPEC*, as measured in the latest test reports.

not however, expected to materially impact the outcomes or scope of works outlined in this document.

Only the capacitance forecast (discussed in the next section) is of interest here.

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

Constraints at the nominated ZSS locations (as outlined above) are characterised by capacitive current limits. As shown in the tables below, this limit is forecast to be exceeded (represented by the “Excess capacitive current” below) and will continue to increase.

Table 3.2 Capacitive current forecast[6] (A)

Location	2026	2027	2028	2029	2030	2031
SMR (Bus 2)	109	112	114	117	120	122
WOTS (Bus 1)	138	141	144	146	149	151
WYK (Bus 1)	108	109	109	110	110	111

Table 4.3 Excess capacitive current (A)

Location	2026	2027	2028	2029	2030	2031
SMR (Bus 2)	0	0	0	2	5	8
WYK (Bus 1)	21	21	22	22	23	23
WOTS (Bus 1)	27	30	33	35	38	40

Further details on the capacitive forecast (i.e. contrast between the capacitance forecast and the ASC limit) are provided in the particulars for each site in their respective appendices.

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 upcoming regulatory control period.

The forecast continued residential growth and network augmentation in the nominated supply areas (particularly URD which increase the capacitive current on the network) means that the capacitive current capacity of the existing REFCLs around the Ausnet network may be exceeded.

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 constraints that will affect compliance with the Regulations during the upcoming regulatory control period.

There are two specific areas where the capacitive current capacity is exceeded:

[6] Source: 2023 SoW to Design solutions

- The zone substation 22kV bus
- Along the outgoing ZSS 22kV feeders

It is possible for the bus limit to be exceeded but the FDR has adequate capacity and vice-versa - specifics of each of these constraints are discussed in the subsections below.

3.2.1 Capacitive current limitations within the zone substation

Each of the ZSS sites outlined within this report are configured with a minimum of two 22kV buses. Each bus has a varying capacitive current limit ("ASC limit", as outlined earlier in this section).

- WYK, WOTS and SMR all have a binding constraint on one of their buses;

3.2.2 Capacitive current limitations on individual feeders

The following is a summary of FDRs impacted by capacitive current constraints, where the individual feeder limit of 80A is exceeded:

Table 4.4 Actual capacitive current forecast[7] (A)

FDR	2026	2027	2028	2029	2030	2031
KLK11	81	83	85	86	88	90
WOTS25	80	83	85	87	89	92
WYK13	85	85	85	86	86	86
WYK24	86	87	88	89	90	91

Forecast indicates limit exceeded

[7] Source: *EDPR FORECASTS_V1_With worst case Damping value*

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.

Seven options were considered for this project as summarised below, with only three deemed as credible. These are contrasted with the "do nothing" option below – the remaining non-credible options are discussed in the appendices.

Table 4.1 Options Reviewed

Option	Discussion	Credible
Option 1 – "Do nothing"	The Business-as-Usual option maintains the status quo which will entail no additional investment to manage the impact of the capacitive current. With a capacitive current forecast exceeding the thresholds used for forecasting purposes, the sites mentioned above may become non-compliant with the Regulations, the community served by those zone substations 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 – installation of Isolating transformers	Installing one or more isolation transformers has the effect of offloading capacitive current from the network. It is applicable to underground sections of the network only, ensuring that capacitive current from these sections does not adversely contribute to REFCL ASC limits. This is the simplest (and most mature) option technically – thus is deemed credible.	Y
Option 3 - Remote REFCL	The remote REFCL solution is a current and compliant solution utilised at KLO, BGE and BN. 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. This option can be deployed as a standalone solution or along with network augmentation and installation of small isolation transformers. This option is considered credible and is discussed further in sections below.	Y
Option 4 - New Zone Substation	Installing a new zone substation to reduce the capacitive is a technically viable option if the load transferred is serviced by underground cables or a REFCL is being installed at the new zone substation This option is considered credible and is discussed further in sections below.	Y

Note: An NPV nor other detailed financial analyses have not been performed for this business case. This is due to the punitive nature of penalties explicit within the Act – compliance with it and the Regulations is mandatory. Similarly, "energy at risk" type analyses are not applicable here.

4.1 Do nothing

As outlined, this option is the "counter-factual" and is not recommended.

4.2 Installation of isolation transformers

This option proposes to install isolation transformers to reduce the capacitive current the ASC is subject to. Rather than install additional apparatus (ASCs) at the ZSS, a similar result may be achieved by installing smaller isolation transformers along the feeder.

The requirement for this approach is that all conductors downstream of the isolation transformer are underground cables, thereby offloading the capacitive current draw of that section of the FDR.

4.2.1 Balance of plant and sundry works

For each ISO transformer, several other works will be required to facilitate tie-in to the network. This includes the following:

- New pole and crossarms
- Re-conductoring of one or more spans about the new pole
- New ACR and associated apparatus
- Secondary works
- Testing and commissioning

4.3 Remote REFCL

This option involves the installation of another REFCL outside the ZSS, on a FDR where the capacitance limit is forecast to be exceeded and no underground sections can be found to install isolation transformers on.. It is a similar solution to the installation of one or more isolating transformers.

Remote REFCLs are considered a mature technology and Ausnet has some of these units in service – as an example BGE (a site within the scope of this report) has one.

The advantage of this solution is that it provides a more permanent, long-term solution compared to isolating transformers.

4.4 New Zone Substation

Installing a new REFCL protected zone substation is a technically viable option. The cost of a new REFCL-protected ZSS is likely to exceed $40 million[8].

The scope of this option will include:

- Construction of a new Zone Substation
- Transfer sufficient load and capacitance from existing ZSS buses to the new ZSS (offloading existing ZSS REFCL)
- This will require completion of the 66kV line construction, construction of the ZSS, possible 22kV construction to replace areas that are being converted to 66kV

Advantages of this option are that in some cases the land for the new ZSS is already owned by AusNet Services and the 66kV line is already partially constructed (operating at 22kV).

However, this option has risks and disadvantages:

- Additional capacity (demand MW) is not currently required in the upcoming regulatory control period based on current load forecast.

[8] Indicative cost from ZSS area plans within the Demand Driven Augex segment of Ausnet's EDPR submission

- As existing feeders will be transferred to this new REFCL-protected zone substation, a S120W exemption is required.
- Long lead time.

Therefore, although this option is considered credible, it is not recommended due to the highlighted key disadvantages.

5 Preferred option

The recommendations for each site are summarised in the table below:

SMR			
Options	**Preferred option**	**Technical feasibility**	**Costs**
Installation of Isolating transformers	No	It is not possible to reduce capacitance on SMR bus 2 with isolations due to all underground sections already isolated.	N/A
Remote REFCL	Yes	Remote REFCL on SMR24 will reduce the capacitance on SMR bus 2 by the required amount. Least cost technically acceptable option.	$12.3M
New Zone Substation	No	Not least cost technically acceptable	N/A

WOTS[9]			
Options	**Preferred option**	**Technical feasibility**	**Costs**
Installation of Isolating transformers	No	It is not possible to reduce capacitance on WOTS Bus 1 and WOTS25 by the required amount with isolation transformers due to all underground sections already isolated.	N/A
Remote REFCL	Yes	Remote REFCL on WOTS25 will reduce the capacitance on WOTS25 by the required amount and is the least cost technically acceptable option. Remote REFCL on WOTS Bus 1 will reduce the capacitance on Bus 1 by the required amount and is the least cost	$24.6M

[9] This site is a Terminal Station (WOTS - Wodonga Terminal Station) – whilst a transmission asset, Ausnet 22kV distribution feeders come from WOTS.

		technically acceptable option.	
New Zone Substation	No	Not least cost technically acceptable	N/A

WYK- Woori Yallock			
Options	**Preferred option**	**Technical feasibility**	**Costs**
Installation of Isolating transformers	Yes	To reduce capacitance below 80A on WYK24 it is proposed to install 11 x 300kVA isolation transformers over 5 years.	$4.1M
Remote REFCL	Yes	To reduce capacitance on WYK bus 1 below the 87A limit it is proposed to install a Remote REFCL on WYK13. This will also bring the capacitance on WYK13 below 80A	$12.3M
New Zone Substation	No	Not least cost technically acceptable	N/A

KLK			
Options	**Preferred option**	**Technical feasibility**	**Costs**
Installation of Isolating transformers	Yes	It is not possible to reduce capacitance on KLK11 with isolations due to all underground sections already isolated.	N/A
Remote REFCL	Yes	To reduce capacitance below 80A on KLK11 it is proposed to install a Remote REFCL on KLK11.	$12.3M
New Zone Substation	No	Not least cost technically acceptable	N/A

Table 5.1 Excess capacitive current (A) after proposed projects.

Location	2026	2027	2028	2029	2030	2031
SMR (Bus 2)	0	0	0	0	0	0
WYK (Bus 1)	0	0	0	0	0	0
WOTS (Bus 1)	0	0	0	0	0	0

Table 5.2 Capacitive current forecast (A) after proposed projects.

FDR	2026	2027	2028	2029	2030	2031
KLK11	41	43	45	46	48	50
WOTS25	40	43	45	47	49	52
WYK13	45	45	45	46	46	46
WYK24	73	74	75	76	77	78

The funding sought by this business is an aggregate of all works associated with REFCL compliance for the entirety of the scope outlined, across the entire network.

Total maintain REFCL costs of $65.6M

5.1.1 Capex

It is the intention for all expenditure to be fully capitalised, as is reflected in the estimates.

5.1.2 Opex

N/A

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 Order in Council approval. The process can take up to 6 months or longer depending on the complexity of the exemption.

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.

7 Appendix x: Technical background

A number of technical limitations impact the ability of the network to meet its REFCL obligations. These are outlined as follows:

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 (located on the ZSS bus):** 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

Previously, Swedish Neutral (manufacturer of the GFN) had not deployed a software solution that allowed the use of three GFNs at one zone substation. This is no longer the case, with another DNSP having demonstrated an operational and successful 3 GFN station.

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 REFCL 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. However, it is noted zone substations in rural areas can have higher damping characteristics and there is a high probability that ZSS ASC limitations will be higher than 100A.

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.

8 REFCL test results and further reading

Limitations on capacitive current for ZSS and FDR locations are informed by test reports, including the *Initial Capacity Test Report* and/or the *Annual Validation Test Report* for each ZSS on the Ausnet network.

In order to determine the limit that triggers augmentation of REFCL installations, the *Latest SUMMATED Ic – ELSPEC* has been deemed as the capacitive current limit, based on guidance from SMEs within the secondary asset performance group at Ausnet.

It is this figure that is then compared against the capacitance forecast to drive augmentation and subsequent investment.

Note that for each site, the historical limit has been provided in its respective appendix to contrast against the latest ELSPEC limit described above.

Other particulars in the test report directly address the performance requirements stipulated in the Regulations (e.g. the time to achieve a voltage of < 250V).

9 Detailed scope

Remote REFCL Scope:

The scope of this project is to install a new 10MVA Isolation Transformer including

- One (1) 10MVA Isolation Transformer
- One (1) 300kVA Station Services Transformer
- One (1) 200Ah Outdoor Battery Enclosure
- One (1) 80A Trench Arc Suppression Coil
- One (1) Control Building
- One (1) Upstream ACR
- 22kV line augmentation works
- In addition to these works, other tasks to be undertaken include:
    - Customer negotiation and land acquisition
    - Outage planning
    - Updating Asset data base and master data records – SAP, SDME and DOMS

Isolation transformer scope:

- Allow for replacement of existing pole with one (1) new 15.5m/12kN concrete pole.
    - Allow for one (1) SL26 cross-arm.
    - Allow for one (1) SL12 cross-arm.
- Allow for cutting in a slack termination on pole
- Re-conductor existing 3 phases of bare conductors
- Install one (1) new 3 Phase, 300kVA pole mounted Isolation Transformer

- Install a new pole-mounted NOJA ACR (RC-20) including a control box on this pole. This installation includes:
    - One (1) pole-mounted NOJA ACR (RC-20) including RC-20 control cubicle.
    - One (1) pole-mounted 1 phase VT supplied by NOJA (VT comes with mounting brackets)
- Allow for installation of cross-arm mounted fuses on primary side as per STND – 0331290 - 001 which includes the below:
    - One (1) pole-mounted fuse assembly and fault tamer per STND-0027091-001 Assembly "E".
    - Two (2) cross-arm mounted fuse assemble and fault tamer per STND-0027091-001 Assembly "F".
- Allow for HV Earthing per STND-0331289-002 which includes the following:
    - 75mm thick circumferential layer of compacted 20mm crushed rock (10sqm).
    - 150mm thick circumferential layer of Type L Asphalt pavement to Vic Roads specification 407(10sqm).
    - Install six (6) earth electrodes.
    - Allow 25 m of 19/2.0 Cu conductor for grading ring and radial earth.
- Allow for site specific soil test.
- Allow for HV cable testing.

ACR Secondary Works at Iso Tx

- Assess and update relevant protection and control settings for ACR and issue in PACSIS (incl. providing a tripping scheme for the new ACR) (Allow for one (1) engineer for 3 days)
- Update SCADA database and HMI to include new NOJA ACR (Allow 1 day for RSG team)
- Install and commission one (1) 4G modem at the new NOJA ACR
- Order and bench test one (1) new 4G modem for NOJA ACR (Allow two (2) days for two (2) testers and two (2) ENS team members and one (1) engineer)
- Complete signal strength testing of the modem at ACR site

Testing and commissioning

- Allow for testing and commissioning of underground cable connections.
- Allow for testing and commissioning of new 300kVA isolation transformer (Allow one (1) day for two (2) testers).

10 Appendix A: Non-credible options

Option	Discussion	Credible
Capacitance Transfer	As part of the REFCL Program and other capital works programs, capacity and capacitive current management projects are being undertaken. Review of the network connections and conditions did not find suitable options to transfer enough capacitance to consider this option credible. In other less-densely populated areas,	N

Option	Discussion	Credible
	neighboring ZSS sites are too far away to make this option credible	
Install isolation transformer on entire 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. The sections of network under consideration are comprised of large rural feeders with overhead and underground sections. Hence, significant undergrounding of lines would be required for this option. Capacitance on buses need be reduced to below the planning limits, therefore, one feeder on each bus will need to be considered. Undergrounding of overhead line will cost approximately $700k per km. Therefore, this option does not present cost effective isolation opportunities and is not considered as a credible option.	N
Undergrounding Over Head line in High Bush Fire Risk Area	Not credible due to prohibitive cost of undergrounding (as per above option)	N
Install third REFCL	This option is not least cost technical acceptable as in a lot of the above cases it requires extensive station rebuild, therefore, a non-credible option.	N