energysafe VICTORIA

Rapid earth fault current limiters (REFCL) operations

Consultation paper, January 2024

VICTORIA State Government

Contents

Summary **3**

How to provide feedback **6**

1 Background **8**

1.1 Electricity distribution businesses 8
1.2 Installation of REFCLs 8
1.3 Legislative framework 10

2 Current state **13**

2.1 REFCL operations commitments in ESMSs and BMPs 13
2.2 Current record keeping and reporting 17

3 Key considerations **18**

3.1 Public safety benefits 18
3.2 Ensuring the efficacy of REFCLs 19
3.3 Impacts on reliability of electricity supply 19
3.4 Bushfire risk indicators 20

4 Preliminary views and expectations **23**

4.1 Operating frequency 23
4.2 Operating settings 25
4.3 Maintaining REFCL performance 28
4.4 Consideration of broader use of REFCL protection 29
4.5 Record keeping and reporting 30

5 Next steps **32**

Summary

Electricity distribution businesses have installed rapid earth fault current limiters (**REFCLs**) in high bushfire risk areas across Victoria to reduce the likelihood of bushfires starting from powerlines. REFCLs act like a large safety switch by cutting power on relevant parts of the supply network when a fault occurs that could cause a bushfire or electrocution. They are one of several initiatives being driven by the Victorian Government's Powerline Bushfire Safety Program to reduce the risk of powerline-related bushfires following the 2009 "Black Saturday" bushfires.

REFCLs can be operated at different settings which make them more or less sensitive to faults, and therefore more or less likely to cut power when a fault occurs. Electricity distribution businesses currently operate them at their highest sensitivity settings on Total Fire Ban days to provide maximum protection for the community when the conditions are the most dangerous for a fire.

This paper seeks feedback on Energy Safe Victoria's preliminary views on how the electricity distribution businesses should operate REFCLs, particularly on non-Total Fire Ban days, to protect the community while balancing supply reliability considerations. It also sets out some of our expectations around the distribution businesses potentially broadening the use of REFCLs across Victoria's electricity supply network and records the distribution businesses should keep to demonstrate compliance with their regulatory obligations.

Rapid earth fault current limiters

REFCLs play a crucial role in protecting the Victorian community by mitigating the risk of bushfires started by powerlines. When a phase to earth fault occurs such as when one line on a polyphase powerline falls and touches the ground or a tree falls on it, REFCLs rapidly detect the fault and reduce the voltage on the affected line. This prevents electrical current being released into dry grass or other vegetation, potentially arcing or igniting the vegetation and causing a bushfire. REFCLs also protect against electrocution by, for example, activating when an operator of heavy machinery hits an overhead line while working.

While REFCLs provide significant public safety benefits in terms of bushfire mitigation and electrocution risk reduction, there are also supply reliability considerations. Unlike traditional fault protection devices, a REFCL can avoid unnecessary power outages by maintaining supply to customers while it determines whether a fault is temporary. But, when a fault persists, REFCLs are currently configured to cut the supply to all customers on the relevant section of the supply network until the distribution business locates and fixes the fault. Because of where REFCLs are installed in the supply network (at zone substations), it is likely that a greater number of customers will lose power when this occurs compared with traditional fault protection devices. It is also currently likely for distribution businesses to take longer to locate a fault, meaning customers can be without supply for longer periods compared with traditional fault protection devices.

Over time we expect to see faster restoration of supply following REFCL operation as the distribution businesses improve their ability to locate faults and limit outages to small network sections. However, we acknowledge that there may presently be a balance to be struck between realising the public safety benefits of REFCLs and minimising supply interruptions to customers.

Legislative framework

The Victorian Government introduced prescribed requirements in the *Electricity Safety Act 1998* (Vic) (**Act**) and associated regulations in 2017 for AusNet Electricity Services Pty Ltd (**AusNet Services**), Powercor Australia Ltd (**Powercor**) and Jemena Electricity Networks (Vic) Ltd (**Jemena**) to install REFCLs at 45 zone substations supplying the highest bushfire consequence areas of Victoria. The prescribed requirements include a staged roll-out of REFCLs with installation at all 45 zone substations needing to be completed by

2023. There are no prescribed requirements in the Act and associated regulations for United Energy Distribution Pty Ltd (**United Energy**) and CitiPower Pty Ltd (**CitiPower**) to install REFCLs, however, United Energy has installed REFCLs at three zone substations.

Importantly, all the distribution businesses have general duties under the Act to minimise as far as practicable the hazards and risks to the safety of people and property and the bushfire danger arising from their supply networks. Each of the distribution businesses must prepare and submit to Energy Safe an electricity safety management scheme (**ESMS**) and a bushfire mitigation plan (**BMP**) to explain how they will meet their general duties and their proposals for the mitigation of bushfires. We note that a distribution business does not meet their general duties by simply adhering to prescribed requirements (i.e., distribution businesses can be obliged to install REFCLs at zone substations to meet their general duties even where installation is not a prescribed requirement under the Act and associated regulations).

We accept an ESMS or BMP if we consider it appropriate for the supply network to which it relates. The Act provides that we may have regard to the reliability and security of electricity supply when considering an ESMS or BMP. We can prosecute a distribution business for non-compliance with their accepted ESMS or BMP, and a distribution business can rely on compliance with their accepted ESMS or BMP as a defence against a prosecution for a breach of their general duties.

Preliminary views and expectations

We expect the distribution businesses to have gained significant knowledge and experience during their roll-out of REFCLs since 2017. Now that installation to meet the prescribed requirements is complete, we expect the distribution businesses to reflect on the lessons learned to date and to review and update their ESMSs and BMPs with respect to how they will operate REFCLs to protect the community.

Our preliminary views, which we are seeking feedback on through this consultation, is that the distribution businesses should make the following commitments as a minimum:

- REFCLs will be in-service (that is, switched on and operating to mitigate bushfires and reduce the risks of electrocution) continuously throughout the year except in limited circumstances, such as for planned maintenance or emergency works. The distribution businesses should provide enforceable in-service availability commitments in their ESMSs and BMPs.
- REFCLs will be operated at the highest sensitivity settings to provide the highest practicable level of fault protection on declared Total Fire Ban days. This is when the risk of bushfires is greatest, and bushfires that occur are more likely to lead to a catastrophic outcome involving loss of life.
- REFCLs will be operated at high sensitivity settings to provide a high level of fault protection during the declared Fire Danger Period and on any other day throughout the year when the Australian Fire Danger Rating System (**AFDRS**) level for the relevant area is ‘High’ or above. This is when there is a heightened risk of bushfires, and bushfires that occur are more likely to spread quickly and become dangerous.
- REFCLs ***may*** be operated at lower sensitivity settings to provide a lower level of fault protection outside the declared Fire Danger Period so long as the AFDRS level is ‘Moderate’ or below and the risks of electrocution will still be mitigated. This is when there is a lower risk of bushfires, and bushfires that occur are expected to be able to be controlled.
- REFCLs will not be bypassed or disabled when a sustained or permanent fault is confirmed to reduce adverse supply reliability impacts. REFCLs that are bypassed or disabled do not mitigate bushfires or reduce the risks of electrocution.

We consider the above enables the distribution businesses to balance public safety benefits alongside considerations of supply reliability. However, we do acknowledge that there may be some situations that arise where the above may not be the best or most appropriate approach. The distribution businesses must specify in their ESMSs and BMPs the operating settings they will apply to meet the above and any circumstances in which they may apply an alternative approach. We expect the distribution businesses to justify their approach in their supporting submissions, including the extent to which they have consulted and considered feedback from affected communities.

It is also our expectation that the distribution businesses will:

- Regularly test and maintain REFCLs throughout the year to ensure they operate effectively and provide the expected level of fault protection when needed. The distribution businesses must have well planned testing and maintenance programs that ensure that, where practicable, works occur ahead of the declared Fire Danger Period.
- Consider whether it is practicable to install or re-configure their settings to operate REFCLs on parts of their supply network where it is not a prescribed requirement under the Act and associated regulations. The distribution businesses must justify their position in their ESMS and BMP submissions. This includes explaining how they have assessed the hazards and risks arising from their supply networks and have implemented controls to minimise those hazards and risks as far as practicable in accordance with their general duties.
- Maintain records demonstrating how they have operated REFCLs in accordance with their accepted ESMSs and BMPs. The distribution businesses must be able to produce these records to Energy Safe when requested.

While we welcome comments on these last three issues, we are not specifically seeking feedback on whether our expectations on these issues are appropriate.

Next steps

We intend to publish a final position on the issues outlined in this paper following this consultation.

We note that, while the obligation is on the distribution businesses to determine and submit their ESMSs and BMPs, we will only accept an ESMS or BMP if we are satisfied that it is appropriate for the supply network to which it relates. In this context, we consider it important to be transparent about what our minimum expectations will be unless it is demonstrated that an alternative approach is more appropriate.

We will therefore expect our final positions to be reflected in submissions made by the distribution businesses when they next submit their ESMSs and BMPs for acceptance unless they can demonstrate that an alternative approach is more appropriate for their supply network.

How to provide feedback

Interested parties are invited to provide written submissions on our preliminary views, or on any other matter relevant to REFCL operations by **8 July 2024**.

Submissions can be emailed to consultation@energysafe.vic.gov.au or posted to:

Consultations
Energy Safe Victoria
PO Box 262
Collins Street West, Victoria 8007

All submissions will be treated as public and assumed able to be published on our website unless the submitter requests confidentiality. Any information that is commercially sensitive or confidential should be clearly marked. Names and other personal information will be removed from submissions prior to publication.

We are also open to meeting with individual stakeholders to discuss specific feedback.

If you have any questions or would like to arrange a meeting, please contact us at consultation@energysafe.vic.gov.au.

Consolidated list of questions for consultation

As a guide for submissions, we have included some questions in this document, which are consolidated here for ease of reference. However, we are happy to receive any relevant comments.

Section 3 – Key considerations - **Public safety benefits (mitigation of bushfire and electrocution risks)** - **Ensuring efficacy of REFCLS (locating and fixing system defects and network asset weaknesses)** - **Impacts on reliability of electricity supply (potential positive and negative impacts)** - **Bushfire risks (bushfire risk areas and bushfire risk ratings/levels)**
1. Do you agree that the issues outlined here are the key issues to inform how the distribution businesses should be expected to operate REFCLs?
2. Do you consider any of the issues to be irrelevant to the operation of REFCLs?
3. Do you have any information or data about the positive or adverse impacts of REFCLs on supply reliability?
4. Are there other issues that we should consider in relation to the operation of REFCLs?

Section 4 – Preliminary views and expectations - **Operating frequency (how often REFCLs are in-service)** - **Operating settings (how sensitive REFCLs are to faults and use of bypass modes)** - **Ensuring REFCL performance (testing and maintenance programs)** - **Broader use of REFCLs (considering the installation and use of REFCLs on additional parts of the supply network)** - **Record keeping and reporting (demonstrating REFCLs are operated in accordance with an accepted ESMS and BMP)**

5. Do you agree with the benefits and risks of the options for operating frequency of REFCLs? Do you consider there to be any benefits and risks that have not been captured in the examples?
6. Do you agree that REFCLs should be in-service continuously throughout the year?
7. Should different expectations about operating frequency apply to REFCLs that have been installed to meet prescribed requirements under the Act and associated regulations compared with those that have been installed for other reasons?
8. Are there any other considerations we should have regard to about the operating frequency of REFCLs?
9. Do you agree with the benefits and risks of the options for operating settings of REFCLs? Do you consider there to be any benefits and risks that have not been captured in the examples?
10. Do you agree that operating settings are the appropriate way to balance public safety benefits alongside considerations of supply reliability?
11. Are the AFDRS levels appropriate for guiding the operating settings of REFCLs? Do you agree with the way we have applied the AFDRS levels in our preliminary views?
12. Should different expectations about operating settings apply to REFCLs that have been installed to meet prescribed requirements under the Act and associated regulations compared with those that have been installed for other reasons?
13. Are there any other considerations we should have regard to about the operating settings of REFCLs?
14. Do you have any comments in relation to testing and maintenance of REFCLs?
15. Do you have any comments on the broader installation and use of REFCLs?
16. Do you have any comments on record keeping and reporting by the distribution businesses?

1 Background

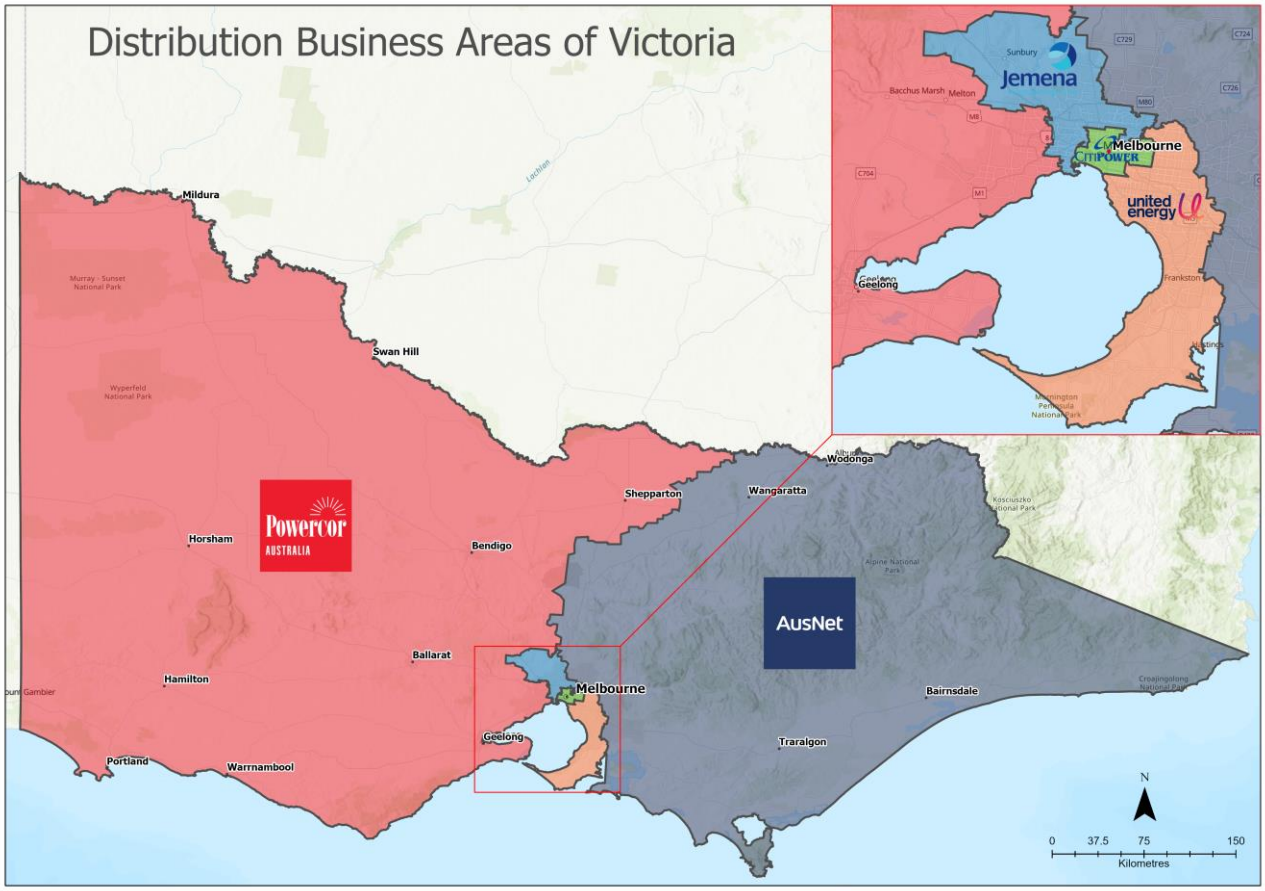
This section provides some information on the Victorian electricity distribution businesses, the introduction of prescribed requirements to install REFCLs and the energy safety legislative framework that is most relevant to the issues covered in this paper.

1.1 Electricity distribution businesses

There are five electricity distribution businesses that own and operate supply networks in Victoria, each with defined areas as shown in Figure 1.

Two distribution businesses own and operate most of the rural powerlines – Powercor in the west of the state and AusNet Services in the east. Jemena and United Energy own and operate a relatively small number of rural powerlines on the outskirts of Melbourne and on the Mornington Peninsula. CitiPower, which owns and operates the powerlines in the Melbourne CBD and inner suburbs, does not own or operate any rural powerlines.

Figure 1: Electricity distribution areas



1.2 Installation of REFCLs

On Saturday 7 February 2009 (“Black Saturday"), Victoria experienced the most devastating bushfires in its history resulting in a catastrophic loss of life as well as public and private property. The Victorian Bushfires Royal Commission (**VBRC**), established to inquire into and report on the circumstances and causes of the

fires, found that some of the most devastating fires were ignited by faulted powerlines. The VBRC recommended the replacement of powerlines by putting them underground, insulating overhead powerlines or by using technology that greatly reduces bushfire risk.

The Victorian Government subsequently established the Powerline Bushfire Safety Taskforce (**PBST**) to investigate the optimal ways of implementing the VBRC's recommendations. The PBST's recommendations included that the distribution businesses should:

- install new technology that greatly reduces bushfire risk, that is, by installing:
  - REFCLs at specific points in their supply network to reduce the risk of 22 kilovolt polyphase powerlines starting fires (explained below)
  - new generation Automatic Circuit Reclosers (**ACRs**) on Single Wire Earth Return (**SWER**) lines to reduce the risk of SWER lines starting fires (devices that can be used to remotely turn off powerlines when faults occur)
- put powerlines underground or insulate conductors in the areas of highest bushfire risk.

A REFCL is installed in a zone substation that supplies the high voltage polyphase powerlines it protects. It operates like a safety switch, rapidly detecting a phase to earth fault on a powerline and reducing voltage to mitigate bushfire and electrocution risks. A phase to earth fault occurs when a connection is made between one line on a polyphase powerline and the ground, such as when a line falls and touches the ground, a tree falls onto the line or wildlife touches the pole and line at the same time. If the fault is only temporary, power supply is maintained to customers. However, if the fault persists, the REFCL instructs a circuit breaker to switch power off and all customers serviced by the powerline lose supply until the distribution business locates and fixes or bypasses the fault.

While some of the distribution businesses had plans to trial REFCLs on some parts of their supply networks between 2016-2020, more widespread rollout of the technology was not anticipated to occur until later. The Victorian Government therefore amended the Act and associated regulations to require the distribution businesses to install REFCLs at 45 zone substations supplying the highest bushfire consequence areas of Victoria by specified dates (table 1). Twenty-two of these are in each of AusNet Services' and Powercor's supply area, while one zone substation is in Jemena's supply area.

Table 1: Zone substations where installation of REFCLs is a prescribed requirement

Completed by April 2019	Completed by May 2021	Completed by May 2023
• Barnawartha	• Ararat	• Benalla*
• Camperdown	• Bairnsdale	• Coolaroo
• Castlemaine	• Ballarat North	• Corio**
• Eaglehawk	• Ballarat South	• Ferntree Gully
• Gisborne	• Belgrave	• Geelong**
• Kilmore South	• Bendigo	• Hamilton
• Kinglake	• Bendigo Terminal	• Kalkallo
• Maryborough	• Charlton	• Koroit
• Myrtleford	• Colac	• Lang Lang
• Rubicon	• Eltham	• Merbein
• Seymour	• Lilydale	• Sale
• Wangaratta	• Mansfield	• Stawell
• Winchelsea	• Moe	• Waurn Ponds

• Woodend	• Ringwood North	
• Woori Yallock	• Terang	
	• Wodonga	
	• Wonthaggi	

*Note: AusNet Services was granted an extension to 1 November 2023 to complete the installation of REFCL at Benalla.

**Note: Powercor received an exemption and built a new zone substation at Gheringhap instead to provide REFCL protection for powerlines in hazardous bushfire risk areas formally supplied by Corio and Geelong. No powerlines originating from the zone substations at Corio and Geelong are REFCL protected.

1.3 Legislative framework

Purpose of the Act and Energy Safe's functions

The Act establishes the regulatory requirements that apply to the distribution businesses, which are monitored and enforced by Energy Safe.

The purpose of the Act is to make provision relating to:

- the safety of electricity supply and use
- the reliability and security of electricity supply, and
- the efficiency of electrical equipment.[1]

Energy Safe's functions under the Act include (but are not limited to):

- to encourage and monitor the use of ESMS
- to regulate, monitor and enforce the prevention and mitigation of bushfires that arise out of incidents involving electric lines or electrical installations, and
- to monitor and enforce compliance with the Act and the regulations.[2]

In performing a function or exercising a power under Part 8 or 10 of the Act, or regulations made for the purposes of those Parts, Energy Safe may have regard to the reliability and security of electricity supply.[3]

Regulation of distribution businesses' supply networks under the Act

Part 10 of the Act establishes a general duties framework together with obligations for the distribution businesses to submit ESMSs and BMPs outlining how they will meet their general duties and what their proposals are for the mitigation of bushfire. Further detailed requirements relevant to the content and submission of ESMSs and BMPs are set out in regulations.

Part 10A of the Act also legislates the requirement for the distribution businesses to install technology on certain parts of their supply networks to meet the 'required capacity' and to undertake annual compliance testing (further on this below). Further detailed information relating to the requirements under Part 10A is set out in regulations.

General duties

Under Division 1, Part 10 of the Act, the distribution businesses have a general duty to design, construct, operate, maintain and decommission their supply networks to minimise hazards and risks as far as

[1] Section 1 of the Act

[2] Section 7 of the Act

[3] Section 7A of the Act

'practicable'. This includes hazards and risks to the safety of people, hazards and risks of property damage, and bushfire danger.[4]

'Practicable' is defined as practicable having regard to:

- the severity of the hazard or risk in question
- the state of knowledge about the hazard or risk and any ways of removing or mitigating the hazard or risk
- the availability and suitability of ways to remove or mitigate the hazard or risk, and
- the cost of removing or mitigating the hazard or risk.[5]

Non-compliance with their general duty is a criminal offence under the Act.[6] However, the distribution businesses can rely on compliance with an ESMS or BMP that has been accepted by Energy Safe as a defence to prosecution for non-compliance with their general duty.[7]

ESMSs and BMPs

Under Division 2, Part 10 of the Act, the distribution businesses must prepare and submit to Energy Safe an ESMS which outlines the safety management system they will follow to meet their general duty. An ESMS must include the prescribed particulars set out in the regulations.[8]

Also, under Division 2A, Part 10 of the Act, the distribution businesses must prepare and submit to Energy Safe a BMP that outlines their plan and proposals for mitigation of bushfire. A BMP must include the prescribed particulars set out in the regulations.[9]

Energy Safe must accept an ESMS or BMP if it is satisfied that the ESMS or BMP is appropriate for the supply network to which it applies and complies with the Act and the regulations.[10]

The distribution businesses must review and submit a revised ESMS and BMP to Energy Safe at least every five years, or sooner if circumstances change or Energy Safe requires a revision.[11]

Non-compliance with an accepted ESMS or BMP is a criminal offence under the Act.[12]

Legislated installation of REFCLs

Under Division 2, Part 10A of the Act, the distribution businesses must ensure that zone substations prescribed by the regulations are 'complying substations' – that is, the powerlines they supply have the 'required capacity'.[13] While the Act and the regulations do not specifically refer to REFCL, REFCL is currently the only technology that can achieve the performance level known as 'required capacity'.

'Required capacity' is defined as the ability to do the following in the event of a phase to ground fault:

- to reduce the voltage on the faulted conductor in relation to the station earth when measured at the corresponding zone substation for high impedance faults to 250 volts within 2 seconds, and
- to reduce the voltage on the faulted conductor in relation to the station earth when measured at the corresponding zone substation for low impedance faults to—
  - 1900 volts within 85 milliseconds
  - 750 volts within 500 milliseconds, and

[4] Section 98 of the Act

[5] Section 3 of the Act

[6] Section 98 of the Act

[7] Section 113 of the Act

[8] Section 99 of the Act

[9] Section 113A of the Act

[10] Sections 102 and 83BE (as applied by section 113C).

[11] Sections 107, 108, 109 and 113A.

[12] Sections 106 and 113B.

[13] Section 120M and 120L.

  - 250 volts within 2 seconds
- during diagnostic tests for high impedance faults, to limit—
  - fault current to 0·5 amps or less, and
  - the thermal energy on the electric line to a maximum I^2t value of 0·10.[14]

Non-compliance with these requirements is a civil offence under the Act.

Reporting obligations

Section 120P of the Act requires the distribution businesses to give a written report to Energy Safe by 1 August each year that includes information about details of work carried out or planned. The report must be in the form, and include the information, specified by Energy Safe. We publish a copy of the reports on our website at annual bushfire reports.

Regulation 7(1)(t)(vii) of the *Electricity Safety (Bushfire Mitigation) Regulations 2023* (Vic) (**Bushfire Mitigation Regulations**) also requires the distribution businesses to report to Energy Safe the results of testing undertaken before the specified bushfire risk period each year. The specified bushfire risk period in the Act commences 1 November and ends 31 March the following year. The testing is intended to ensure that the supply network is capable of operating to meet the 'required capacity'.

[14] Section 120K and regulation 7 of the *Electricity Safety (Bushfire Mitigation Duties) Regulations 2017*.

2 Current state

This section provides an overview of the distribution businesses' current commitments relating to how they operate REFCLs as well as the current record keeping and reporting arrangements.

2.1 REFCL operations commitments

The distribution businesses' commitments to installing and operating REFCLs on their supply networks are currently set out in their BMPs. The REFCL operating settings that are to apply from time to time are typically linked to the declared Total Fire Ban Days, declared Fire Danger Period and the Fire Behaviour Index or AFDRS levels (explained in more detail in section 3).

As summarised in table 2, the distribution businesses that have prescribed requirements to install REFCLs have committed to operating those REFCLs at settings that provide the performance level prescribed in the definition of 'required capacity' on days of heightened bushfire risk, such as declared Total Fire Ban days and Code Red days.[15] The distribution businesses take a range of approaches for operating REFCLs on other days throughout the year.

Note that Powercor's operating settings refer to 3 setting groups for earth fault detection as follows:[16]

Setting group	Sensitivity	Remarks
1	25.4 kΩ	Sensitivity at the threshold defined by required capacity (0.5 amps)
2	≈12.7 kΩ	Very high level of earth fault sensitivity (≈1.0 amps)
3	≈6 – 8 kΩ	High level of earth fault sensitivity (≈1.6 - 2.1 amps)
No REFCL	≈1.4 kΩ	Typical current based sensitive earth fault protection (≈9 amps)

[15] Code Red was a feature of the Australian fire danger rating system prior to revision in 2022.

[16] Powercor BMP, https://www.powercor.com.au/network-planning-and-projects/network-safety/bushfire-mitigation/, October 2023, p. 14.

Table 2: Overview of the distribution businesses' REFCL operating settings[17]

Distribution business	Operating settings		Application
Powercor[18]	**Fire Risk** Utilises the Soft Fault Confirmation technique: • When a fault is detected the REFCL compensates and reduces the voltage on the faulted phase to < 250V at the zone substation. • After a configurable delay time, Powercor's control relay requests a Soft Fault Confirmation test to confirm both the permanence of the fault and the identity of the faulted feeder. • If a permanent feeder target is identified, the affected feeder circuit breaker or nearest upstream REFCL compatible smart ACR are directly tripped.	Uses setting group 1 (i.e., sensitivity at the threshold defined by required capacity (0.5 amps)). Configured to provide the optimal settings for bushfire safety.	Total Fire Ban days, including when fire danger rating is "Catastrophic" when FDI is 30 or greater.
		Uses setting group 2. The combination of Fire Risk mode and setting group 2 provides superior earth fault protection whilst maintaining operational flexibility of the network.	Total Fire Ban days when FDI is below 30 and Fire Dange Period when fire danger rating is greater than "Moderate".
		Uses setting group 2. The combination of Fire Risk mode and setting group 2 provides superior earth fault protection whilst maintaining operational flexibility of the network. Configured to provide superior earth fault protection whilst maintaining operational flexibility of the network. Uses setting group 2.	Fire Danger Period when fire danger is "Moderate" and "No rating".
	Bypass Reverts to conventional earthing when permanent fault identified. • When a fault is detected the REFCL compensates and reduces the voltage on	Uses setting group 3. Bypass mode may be used for fire danger ratings "No rating" and "Moderate" during the declared fire danger period to enable fuse and fault indicator operation, which will expedite fault finding and fault restoration.	Fire Danger Period when fire danger is "Moderate" and "No rating".

[17] All information presented in this table is summarised from the distribution businesses' publicly available BMPs.

[18] Powercor, https://www.powercor.com.au/network-planning-and-projects/network-safety/bushfire-mitigation/, October 2023, pp. 14-15.

	the faulted phase to < 250V at the zone substation. • After a configurable delay time, Powercor's control relay requests a confirmation test to confirm permanence of the fault. • If a permanent feeder target is identified, the Low Impedance Ground Circuit Breaker is closed.	Uses setting group 3. Subject to reliability and system performance metrics.	Outside the Fire Danger Period.
	All Operational switching activities on the network which involve switching the 22kV network will be undertaken using setting group 3. Bypass mode may be used to facilitate fault finding in accordance with operational procedures.		Operational switching, including for fault finding.
AusNet Services[19]	**Fire Risk** Provides the 'required capacity' performance standard (0.5 amps). When REFCL detects a phase to earth fault it will compensate for up to 20 seconds before interrupting supply to the affected distribution feeder.		Total Fire Ban days and Code Red days. Exceptions include: • Switching associated with fault and emergency works. • 'Standard' may be applied if fire behaviour index (FBI) is below 30.
	Standard Reduced sensitivity (target range > 0.5 amps and < 2.5 amps)		Non-Total Fire Ban days. Typically applied during declared fire danger period or for fire danger ratings 'High' and above.
	REFCL-NER Reduced sensitivity (> 2.5 amps)		Non-Total Fire Ban days Typically applied during winter period or for fire danger ratings below 'High'.
Jemena[20]	**Bushfire Mitigation Enabled** If an earth fault does not self-clear after an adjustable time delay (to be determined), the relevant protection will trip the circuit breaker of the affected feeder.		This mode will be enabled on Total Fire Ban days when immediate isolation of the faulty feeder is required. Hence, on such days, a greater number of customers may experience supply interruption because conventional earth fault protection downstream of the feeder circuit breaker (such as

[19] AusNet Services, https://www.ausnetservices.com.au/About/Network-Regulation/Regulatory-Publications, November 2022, pp. 33-34.

[20] Jemena, https://jemena.com.au/about/document-centre/electricity/bushfire-mitigation-management, October 2021, pp. 95-99.

		ACRs, fuses and HV customer protections) will not be sensitive enough to detect and isolate the faulty section.
	Bushfire Mitigation Disabled Mode If an earth fault does not self-clear after an adjustable time delay (to be determined), the NER will automatically bypass the ASC of the REFCL	This mode is enabled on all days except on Total Fire Ban days.
	REFCL Disabled In this mode the REFCL is switched off and the COO zone substation is earther via the NER.	This mode will be enabled for inspection and maintenance purposes of the REFCL. This mode may also be used when the Live Line sequence protection is required.
United Energy[21]	**Earth Fault Discrimination Disabled** United Energy expects the sensitivity to be better than 12.7 kΩ on days of total fire ban. In this mode the ground fault neutraliser (GFN) will automatically trip the feeder circuit breaker if the earth fault is sustained. If the GFN is unable to determine which feeder has the fault, it will close the NER circuit breaker to allow conventional sensitive earth fault protection to clear the fault (if it can detect it).	This mode will be used for high fire risk days.
	Earth Fault Discrimination Enabled In this mode the GFN will close the NER circuit breaker if the earth fault is sustained and allow conventional sensitive earth fault protection to clear the fault. If the earth fault is back fed through a distribution transformer winding or is very high impedance fault and therefore cannot be detected using conventional sensitive earth fault protection, the GFN will trip directly trip the feeder circuit breaker.	This mode will be enabled at all other times, for non-high fire risk days.

[21] United Energy, https://www.unitedenergy.com.au/network-management/network-safety/bushfire-mitigation/, June 2019, pp. 65-67.

2.2 Current record keeping and reporting

We currently require the distribution businesses to include the following in their section 120P reports:

- Works carried out during the reporting period:
  - REFCL program status to ensure electric lines originating from the prescribed zone substations have the required capacity, including: progress on implementation of REFCLs at each prescribed zone substation; the date on which each milestone (initiation, design, procurement, construction, testing and commissioning) was achieved; and the date on which a zone substation was formally accepted by Energy Safe as a complying substation (if applicable).
  - Insulating or undergrounding bare high voltage electric lines within an electric line construction area, including: route kilometres of each type at the start and end of the reporting period.
  - Installation of ACRs on SWER lines, including: ACRs name, feeder and completion date.
- Plans of work to be carried out during the next reporting period in relation to each of the above.

The reports pursuant to regulation 7(1)(t)(vii) of the Bushfire Mitigation Regulations contain the results of the testing done during the year to ensure that the supply network is capable of operating to meet the 'required capacity'.

We also require the distribution businesses to provide us with data on each REFCL operation that occurs on their supply network during the fire season (1 September to 30 April each year). This enables us to monitor compliance with their accepted BMPs and to understand how often REFCLs are operating to protect the community.

More information on this reporting is available in the *MEC Incident and safety performance reporting guidelines*.[22]

[22] https://www.esv.vic.gov.au/industry-guidance/electrical/electrical-installations/electrical-safety-management-schemes.

3 Key considerations

This section outlines the issues that have informed our preliminary views on how the distribution businesses should operate REFCLs, which are outlined in section 4.

3.1 Public safety benefits

Bushfire mitigation

The primary objective of the prescribed requirement for the distribution businesses to install REFCLs was to reduce the likelihood of powerlines starting bushfires in the highest bushfire consequence areas of Victoria.[23]

When a phase to earth fault occurs, such as when one line on a polyphase powerline falls and touches the ground or a tree falls on it, REFCLs rapidly detect the fault and reduce the voltage on the affected line. This prevents electrical currents being released into dry grass or other vegetation, potentially arcing or igniting the vegetation and causing a bushfire. Notably, when there is low vegetation moisture content and little air movement electric arcs can ignite very quickly, in two to three hundredths of a second for relatively high fault currents and a few tenths of a second for relatively low fault currents. REFCLs are designed to detect a fault and reduce the flow of current to near-zero quickly enough to prevent the current from starting a fire even in these short timeframes.

The use of REFCLs has already proven to be a valuable mechanism that has reduced the risk that electricity distribution powerlines start bushfires. According to the *Electricity Safety (Bushfire Mitigation) Regulations 2023 Regulatory Impact Statement*, REFCLs directly contributed to preventing at least 33 potential bushfire starts during the 2019-20 bushfire season.[24]

Electrocution and arc flash risk reduction

REFCLs also deliver other safety benefits in the form of a significant reduction in electrocution and arc flash risk faced by workers and the community.

Electrocution and arc flash can occur when a person or machinery touches a live powerline. If the touched line is on a polyphase powerline protected by REFCLs, the flow of current and the voltage level on that line is reduced to near-zero quickly enough to transform a high voltage contact into a low voltage contact. This reduces the likelihood of death or serious injury, or allows someone to avoid injury altogether.

For example, the 2020 REFCL Functional Performance Review identified one instance where workers operating machinery underneath high voltage powerlines accidentally and repeatedly made contact with a powerline without incident. It was observed that, as a result of REFCL operation, no one was injured and no equipment was damaged as would typically be expected when contacting a high voltage powerline.[25]

Over the last 7 years, there have been an average of 58 contact incidents involving high voltage distribution powerlines each year. The distribution businesses have been changing their work practices to have REFCLs operational during live line work given the safety benefits.

[23] ACIL Allen, Regulatory Impact Statement, Bushfire Mitigation Regulations Amendment, November 2015, p. 8.

[24] https://engage.vic.gov.au/bushfire-mitigation-regulations.

[25] https://www.esv.vic.gov.au/about-us/our-organisation/reports/rapid-earth-fault-current-limiter-refcl-reports.

3.2 Ensuring the efficacy of REFCLs

REFCLs comprise a diverse array of primary (high voltage) equipment and secondary (computer) equipment and software that also link to other network assets. All these parts may perform or operate differently under different conditions or develop weaknesses and defects. Operating REFCLs under various conditions throughout the year is an effective way of identifying any weaknesses or defects under lower risk conditions so that they can be fixed before the reliable operation of the system becomes critical.

For example, when a REFCL detects a fault, it initially reduces the voltage on the affected line but increases the voltage on unaffected lines to keep supply on while it determines whether the fault is temporary or not. This voltage change occurs on all powerlines protected by the same REFCL system. If network assets are not strong enough to withstand the increased voltage, there can be an asset failure that causes a second fault – one at the original fault site that triggered REFCL operation and one at the location of the failed asset, which could be anywhere on the REFCL protected network. This is otherwise known as a cross-country fault.

A REFCL will not operate effectively when two faults occur at different locations (e.g., on different powerlines) on the network and will therefore cease to provide protection following the second fault in the case of a cross-country fault. The consequences of this occurring on a high bushfire risk day can be far greater as there will be two potential ignition sites. In this scenario traditional fault protection devices take over, but they do not provide the same level of fault protection as REFCLs and therefore the risk of bushfire ignition at both sites is higher.

We expect that testing and replacement or upgrades of electrical equipment during implementation of REFCLs will have addressed existing network asset weaknesses and system defects. However, new ones can arise over time, particularly as assets age and degrade or software needs to be updated. We consider it important that REFCLs are operated as often as possible throughout the year so that these can be quickly identified and fixed.

3.3 Impacts on reliability of electricity supply

A reliable supply of electricity is essential for modern society and the welfare of the community. For example, some vulnerable members of the community, including the very young, elderly and sick, rely on electricity supply for medical equipment, heaters during cold weather and air conditioning during heatwaves. A reliable supply is also essential during emergency events to ensure communications can be maintained and equipment is able to be powered (e.g., pumps for fuel or water). A loss of electricity supply can also affect animal welfare where power is necessary to provide appropriate conditions for the animals (e.g., cooling in housing facilities or pumping water to where it is needed).

Potential positive impacts

REFCLs can improve supply reliability compared with traditional fault protection devices by avoiding unnecessary outages.

With traditional fault protection devices, once a fault is detected the device causes the power to be cut off to all customers who are downstream of where the device is located. Customers experience a loss of supply even in instances where there are no ongoing safety risks. This may be an intermittent or sustained loss of power depending on the nature of the fault and whether the distribution business needs to attend the location of the fault site before restoring power.

In contrast, REFCLs allow the supply to customers to be maintained while it works out whether the fault is temporary or not. When a REFCL detects a phase to earth fault it rapidly reduces the voltage on the affected line but maintains supply to customers by increasing the voltage on the unaffected lines. If the fault is only temporary, the REFCL stops compensating for the fault and supply is restored to all lines without the customers ever losing power or even being aware that there was a fault. Data

from the distribution businesses indicates that, under the current operating settings discussed in section 2, supply reliability has improved on many powerlines since the implementation of REFCLs. As discussed below, we also expect any adverse impacts to diminish over time.

Potential adverse impacts

REFCLs can result in a greater number of customers being without power, and for a longer period, compared with traditional fault protection devices.

With traditional fault protection devices, only customers who are downstream of the device lose supply when a fault occurs. This limits the number of customers who are impacted when the power is cut. It also enables the distribution business to quickly locate and attend the site to fix the fault, if necessary, by narrowing the search area.

In contrast, when a REFCL confirms that a phase to earth fault is sustained or permanent, it cuts the power to all customers who are supplied by the affected powerline. This means a relatively larger number of customers can be without power until the fault is repaired or the network is reconfigured to restore supply (also known as network switching). It also means there is a wider area for the distribution business to cover to locate the source of the fault such that customers are likely to be off supply for longer.

The operating settings can also have an impact. When a REFCL is operated at very high sensitivity settings it can struggle to differentiate between fault signals and noise in the system resulting in unnecessary outages. For example, when insulators and poles that support powerlines become wet it can create pathways to the ground that allow small amounts of energy to discharge. While this does not result in a safety risk, a REFCL on a very high sensitivity setting can mistake it for a phase to earth fault. For this reason, it can be appropriate to reduce the sensitivity of REFCLs in wet weather to reduce nuisance trips.

Data from the distribution businesses indicates that, under the current operating settings discussed in section 2, these adverse impacts have been most acute on a small number of powerlines that typically had poor reliability prior to the implementation of REFCLs. This is due to their network configuration and environmental factors; they are powerlines with limited switching capability that run through forests.

We expect the potential adverse impacts on supply reliability to diminish over time as the distribution businesses deploy REFCL compatible ACRs and fault locating devices. Distribution businesses should also continually be looking at ways to improve their asset and vegetation inspection and maintenance programs, and the implementation of new fault anticipation technology, to reduce the number of faults that occur thereby impacting supply to customers. However, we acknowledge that there may presently be a balance to be struck between realising the public safety benefits of REFCLs and maintaining an uninterrupted supply to customers.

3.4 Bushfire risk indicators

Bushfire consequence areas

The REFCLs installed to meet prescribed requirements protect the powerlines that supply the highest bushfire consequence areas of Victoria as identified at the time the requirements were put in place. These are the areas that are considered to have a higher risk of loss of life and/or property if a bushfire ignites due to the nature of the surrounding environment.

This does not necessarily mean that all high bushfire risk areas in Victoria are now protected by REFCLs. For example, the Act defines ‘hazardous bushfire risk area’ as an area that is not an urban area or which a fire authority has assigned a fire hazard rating of ‘high’ regardless of whether the area is an urban area. The Minister for Planning also designates ‘bushfire prone areas’ under section 192A

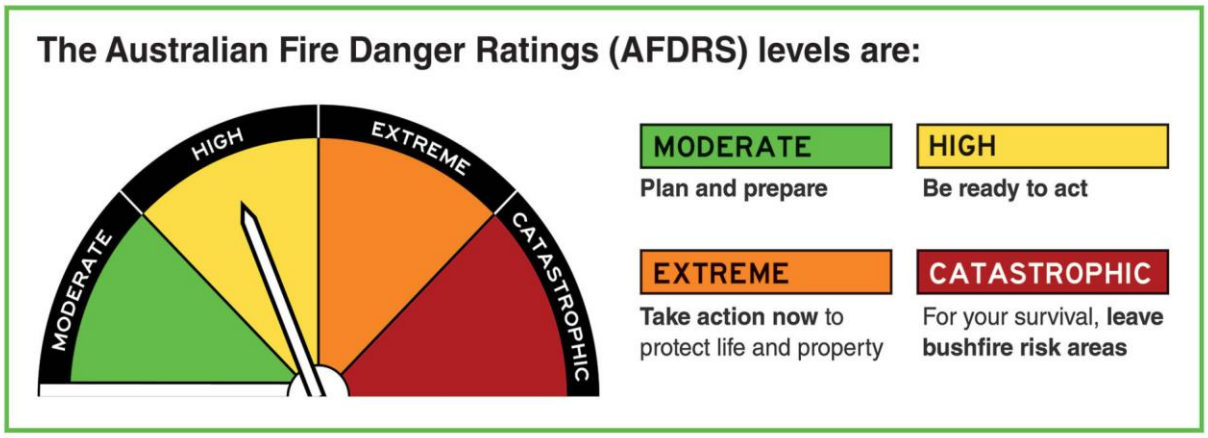
of the *Building Act 1993* (Vic) based on its bushfire hazard level.[26] These areas are not entirely protected by REFCLs and are regularly reviewed to account for changes in the environment and land use over time, which may impact the relative bushfire hazard rating of a particular area. It is possible for additional areas beyond those previously prescribed to become a high bushfire risk area.

We expect the distribution businesses to remain up-to-date on the bushfire risks associated with their supply areas and to review their approach and REFCL coverage over time to ensure they remain appropriate.

Australian Fire Danger Rating System

The distribution businesses have typically linked their REFCL operating settings to the declared Total Fire Ban Days, declared Fire Danger Period and the Fire Behaviour Index or AFDRS.

The AFDRS is intended to indicate how dangerous a fire could be if one starts. It was updated in 2022 to simplify the fire danger rating levels. The current AFDRS levels are as follows:



Note: The white bar under Moderate indicates No Rating for days where no proactive action is required by a community. This does not mean that fires cannot happen, but that any fires that start are not likely to move or act in a way that threatens the safety of the community. Source: https://afdrs.com.au/.

In terms of bushfire risk, the AFDRS levels assume the following:

- **Moderate:** Most fires can be controlled.
- **High:** Fires can be dangerous.
- **Extreme:** Fires will spread quickly and be extremely dangerous.
- **Catastrophic:** If a fire starts and takes hold, lives are likely to be lost.

This means that, whenever the AFDRS level is 'High' or above, there is a real risk that a bushfire start could lead to a dangerous situation and become an uncontrolled fire.

In addition to the AFDRS levels the CFA's Chief Officer may also declare a day to be a Total Fire Ban day. When doing so, the Chief Officer considers additional factors such as current fires in the landscape, resource commitment and increased likelihood for human and lightning induced fires. Therefore, a Total Fire Ban can be declared for areas that have not reached an 'Extreme' level under the AFDRS.[27]

The CFA also declares a Fire Danger Period each year for each municipality, which is the period when the CFA restricts the use of fire in the community to help prevent fires from starting. It varies based on factors such as the amount of rain, grassland curing rate and other local conditions and is intended to indicate the period during which fires are more likely to occur. A Fire Danger Period may be declared

[26] https://www.planning.vic.gov.au/guides-and-resources/guides/all-guides/bushfire-map-reviews

[27] https://www.cfa.vic.gov.au/warnings-restrictions/total-fire-bans-fire-danger-ratings/about-total-fire-bans

as early as October in some municipalities, and typically remains in place until the fire danger lessens, which could be as late as May.[28]

Questions for consultation
1. Do you agree that the issues outlined here are the key issues to inform how the distribution businesses should be expected to operate REFCLs?
2. Do you consider any of the issues to be irrelevant to the operation of REFCLs?
3. Do you have any information or data about the positive or adverse impacts of REFCLs on supply reliability?
4. Are there other issues that we should consider in relation to the operation of REFCLs?

[28] https://www.cfa.vic.gov.au/warnings-restrictions/fire-danger-period-restrictions/about-the-fire-danger-period

4 Preliminary views and expectations

We expect the distribution businesses to have gained significant knowledge and experience during their roll-out of REFCLs since 2017. Now that installation to meet the prescribed requirements is complete, we expect the distribution businesses to reflect on the lessons learned to date and to review and update their ESMSs and BMPs with respect to how they will operate REFCLs to protect the community.

This section outlines our preliminary views on how the distribution businesses should operate REFCLs to protect the community, which have been informed by the key considerations in section 3. We note that, while the obligation is on the distribution businesses to determine and submit their ESMSs and BMPs, Energy Safe will only accept an ESMS or BMP if we are satisfied that it is appropriate for the supply network. In this context, we consider it important to be transparent about what our expectations of the distribution businesses will be unless they can demonstrate that an alternative approach is more appropriate.

This section also sets out some of our expectations around the distribution businesses testing and maintaining REFCLs, potentially broadening the use of REFCLs and records the distribution businesses should keep to demonstrate compliance with their regulatory obligations. While we are open to receiving comments on these issues addressed in sections 4.3 – 4.5, we are not specifically seeking feedback on whether our expectations are appropriate.

4.1 Operating frequency

Operating frequency refers to how often a REFCL is in-service (that is, switched on and operating to mitigate bushfires and reduce the risks of electrocution). Operating settings, such as the level of fault detection sensitivity and how a REFCL responds when it detects a phase to earth fault, are discussed in section 4.2.

Discussion

It is possible for REFCLs to be in-service continuously throughout the year, or alternatively REFCLs could be operated only during a specified period or on specified days. For illustrative purposes, we set out the relative benefits and risks of these options having regard to the key considerations outlined in section 3. It is noted that these options do not consider the different operating settings, rather, they simply compare the relative benefits and risks of REFCLs being in-service.

Option 1 – REFCLs in-service continuously throughout the year

Benefits

- Public safety benefits (particularly mitigation of the risks of powerline-related bushfires and injuries/death associated with contact incidents) are most likely to be realised under continuous operation.
- When REFCLs are in continual operation there is the opportunity for system defects and network asset weaknesses to be revealed under conditions where it will not cause a catastrophe, so that they can be fixed before the correct operation of the system becomes vital for bushfire mitigation.

- The supply reliability benefits of REFCLs (i.e., the ability of REFCLs to reduce the frequency of momentary outages due to temporary faults) are most likely be realised under continuous operation.

Risks

- When REFCLs are in continual operation there can be an increase in the likelihood and impact of prolonged power outages with more customers likely to be off supply for longer compared with traditional fault protection devices.

Option 2 – REFCLs in-service only during specified periods or on specified days, such as declared Fire Danger Period or Total Fire Ban days

Benefits

- REFCLs in-service during the Fire Danger Period or on Total Fire Ban days will mitigate bushfire risk during the period of greatest risk.
- Likelihood and impact of prolonged power outages outside the bushfire season is notionally reduced compared with continuous operation throughout the year.

Risks

- The mitigation of risks associated with contact incidents will only be realised for part of the year, which notionally increases the risk of serious injuries and death occurring.
- Given system defects and asset weaknesses can only be picked up when REFCLs are in-service, this option increases the likelihood of REFCLs not performing effectively when the correct operation of the system becomes vital for bushfire mitigation.
- Customers may be exposed to an increased number of momentary outages caused by temporary faults that would otherwise be avoided with REFCLs in-service.

Preliminary view

We consider it critical that REFCLs are in operation as often as possible. If a REFCL is out-of-service, it provides no bushfire mitigation or electrocution risk reduction. Also, while the distribution businesses have testing and maintenance programs to find and fix system defects and asset weaknesses, maximising the period that REFCLs are in-service provides the best opportunity for these to be revealed under lower risk conditions. This allows issues to be fixed before the correct operation of the system is vital for bushfire mitigation.

We acknowledge that there are times when REFCLs will need to be out-of-service due to planned or unplanned outages. Unplanned outages, for obvious reasons, cannot be scheduled to avoid the risk that they occur on days of high bushfire risk. However, we still expect any such outages to be efficiently managed so that the length of time that a REFCL is out-of-service is minimised.

We also acknowledge that continuous operation of REFCLs can potentially lead to a greater number of customers experiencing power outages when a sustained or permanent fault occurs, and potentially for a longer period of time compared with traditional fault protection devices. However, as discussed in section 4.2, we consider the operating settings to be the appropriate avenue through which the distribution businesses can look to strike a balance between realising the public safety benefits of REFCLs and minimising supply interruptions to customers.

Accordingly, our preliminary view is that the distribution businesses should commit to having REFCLs in-service continuously throughout the year, except in limited circumstances. The time that a REFCL is out-of-service should be strictly limited to where it is absolutely necessary, such as for planned maintenance or emergency works. The distribution businesses should provide enforceable in-service availability commitments in their ESMSs and BMPs.

We note that we consider this to be the case for all REFCLs, regardless of whether a REFCL has been installed to meet prescribed requirements under the Act and associated regulations.

Questions for consultation
5. Do you agree with the benefits and risks of the options for operating frequency of REFCLs? Do you consider there to be any benefits and risks that have not been captured in the examples?
6. Do you agree that REFCLs should be in-service continuously throughout the year?
7. Should different expectations apply to REFCLs that have been installed to meet prescribed requirements under the Act and associated regulations compared with those that have been installed for other reasons?
8. Are there any other considerations we should have regard to about the operating frequency of REFCLs?

4.2 Operating settings

Operating settings refers to the level of fault detection sensitivity and how a REFCL responds when it detects a phase to earth fault.

Discussion

REFCLs are configurable in that they can be operated to provide varying levels of fault detection sensitivity, utilise different types of fault confirmation tests and respond in different ways to a confirmed fault. While configuring REFCLs to achieve the 'required capacity' performance level may minimise hazards and risks and bushfire danger in many situations, it may not always be the best or most appropriate approach.

A very high sensitivity setting, such as that required to achieve the 'required capacity' performance level, enables detection of high impedance faults up to 25.4 kilo-ohms (**kΩ**) (detection of 0.5 ampere (**A**) fault current). Tests by the PBST found that this was the performance level required to prevent all fire ignitions arising from phase to earth faults. The PBST also found that reducing fault detection sensitivity by half to around 1.0 amps would likely prevent most but not all fires. It is noted that contact incidents leading to electrocution or arc flash are typically lower impedance faults that will likely be reliably detected with lower sensitivity settings such as between 1.0 – 2.0 amps.

While it is possible for REFCLs to be operated at a very high sensitivity setting at all times, as noted above, this may not be the best or most appropriate approach. Using different sensitivity settings at different times may still provide benefits while balancing other concerns, such as impacts on the reliability of electricity supply. For illustrative purposes, we set out the relative benefits and risks of options having regard to the key considerations outlined in section 3.

Option 1 – REFCLs operated at very high or high sensitivity setting throughout the year

Benefits

- Provides high level of fault protection year round and greatest likelihood that public safety benefits (mitigation of risks of powerline-related bushfires and electrocution or arcing leading to injury or death) will be realised.

Risks

- Likely leads to more frequent prolonged power outages for a larger number of customers compared with traditional fault protection devices. However, this may diminish over time as the distribution businesses deploy REFCL compatible ACRs and fault locating devices.
- Heightened levels of sensitivity can result in nuisance trips, particularly on wet days and during major storm events, as REFCLs struggle to distinguish between real faults and disturbances resulting from partial discharge as tracking occurs over wet insulators.
- Limits network switching capacity, which impacts supply restoration times for customers impacted by faults who could otherwise be switched to be supplied from a different zone substation.

Option 2 – REFCLs operated at very high or high sensitivity setting when bushfire risks are high, lower sensitivity settings at other times

Benefits

- Provides a high level of protection during high bushfire risk periods that will mitigate risks of bushfire starts while also providing a level of protection year round that will mitigate risks of electrocution or arcing leading to injury or death.
- Reduces susceptibility to nuisance trips on wet days and during major storm events, noting that these typically occur at times other than when bushfire risks are high.
- Provides more flexibility for network switching during times of lower sensitivity, which may enable faster supply restoration.

Risks

- Lower level of sensitivity notionally increases the risk that detection and response to a phase to earth fault does not sufficiently mitigate the risk of electrocution and bushfires could still be ignited that cause a public safety risk.

It is also noted that realising the public safety benefits discussed in section 3 relies on voltage and electrical current being effectively reduced at the fault site. However, the ‘required capacity’ performance level is measured at the zone substation where the REFCL is installed. The same performance level may not be achieved at the fault site due to a range of reasons such as line length and load levels. The REFCL operating settings should therefore also take into account the expected performance level at the fault site. For example, the performance level may diminish as the fault site moves further away from the zone substation. This means settings may need to be adjusted to achieve the desired performance level at the fault site compared with the performance level measured at the zone substation.

In terms of fault confirmation tests, after a time delay, REFCLs allow a stepped increase in voltage on the faulted powerline to determine whether the fault has cleared. A high impedance fault requires a higher voltage to be detected. The ‘required capacity’ performance level caps the fault current and thermal energy allowed to be released for this testing. To achieve this, the process needs to be completed very quickly with a small number of large voltage steps, which can be cause for concern if the fault is only slightly higher than the preceding voltage step. A much higher voltage and therefore fault current will flow at the next voltage step, which notionally increases the risk of bushfire ignition. An alternative approach is to complete the process with a greater number of smaller voltage steps. This reduces the risks associated with large voltage steps but results in a greater amount of energy being released overall, which would exceed the limits set out in the required capacity.

Responses to a confirmed sustained or permanent fault may include instructing a circuit breaker to switch power off to all customers supplied by the affected powerline or allowing REFCL to be bypassed or disabled so that traditional fault protection devices take over. With respect to bypassing or disabling REFCLs when a sustained or permanent fault is confirmed, it is observed that:

- REFCLs will still provide public safety benefits (mitigation of the risks of powerline-related bushfires and electrocution) in the case of temporary faults.
- Supply reliability benefits of REFCLs (i.e., the ability of REFCLs to reduce the frequency of momentary outages due to temporary faults) will still be realised.
- Distribution businesses are potentially able to locate a fault faster than when REFCL instructs the circuit breaker to shut off power supply, therefore enabling the fault to be fixed and power to be restored faster.
- However, notionally increases the risk of power-line related bushfires or electrocution because increased fault current is allowed to flow once the REFCL is bypassed or disabled.

Preliminary view

As outlined in section 4.1, we consider that REFCLs should be in-service continuously throughout the year except in limited circumstances. As such we consider the operating settings to be a key mechanism through which the distribution businesses can look to balance safety benefits alongside considerations of supply reliability.

We note the distribution businesses have typically linked their REFCL operating settings to the declared Total Fire Ban Days, declared Fire Danger Period and the Fire Behaviour Index or AFDRS. We consider these levels continue to be an appropriate and transparent way to show how those settings link to the mitigation of bushfire risk. In particular, we note that whenever the AFDRS level is 'High' or above, there is a real risk that a bushfire start could lead to a dangerous situation and become an uncontrolled fire. We also consider the declared Total Fire Ban days and declared Fire Danger Period to be particularly relevant to when REFCLs should be operated at the highest sensitivity settings to provide a high level of fault protection.

We accept that it may be appropriate for REFCLs to be operated at lower sensitivity settings at other times throughout the year to balance safety benefits alongside considerations of supply reliability. We note that the risks of a bushfire start leading to a dangerous situation or uncontrolled fire is likely to be low whenever the AFDRS level is 'Moderate' or below.

Therefore, having regard to the benefits and risks outlined above, our preliminary view is that the distribution businesses should make the following commitments as a minimum:

Fire danger	REFCL operation
Declared Total Fire Ban day	Operated at the highest sensitivity settings to provide the highest practicable level of fault protection. In most cases we expect this to be a setting that can detect high impedance faults or fault current of 0.5 amps or more, as is the case under the 'required capacity' performance level.
• **Declared Fire Danger Period** • **Any other day throughout the year when the AFDRS level for the relevant area is 'High' or above**	Operated at high sensitivity settings to provide a high level of fault protection. We expect this to be a setting that is able to prevent most bushfire starts (i.e., detects high impedance faults or fault current of 1.0 amps or more).
All other times so long as the AFDRS level is 'Moderate' or below	***May*** be operated at lower sensitivity settings to provide a lower level of fault protection. We expect this to be a setting that is still able to prevent risks of electrocution and arcing leading to serious injury or death (i.e., detects low impedance faults or fault current of 2.0 amps or more).

While we note that REFCLs may be bypassed or disabled when a sustained or permanent fault is confirmed to reduce adverse supply reliability impacts, our view is that the distribution businesses

should avoid doing so unless absolutely necessary and only for a very limited period. We expect the distribution businesses to focus on advancing their fault-finding and restoration capabilities.

In terms of fault confirmation tests, we expect the distribution businesses to configure an approach that will deliver the greatest overall safety benefit, noting the benefits and risks of various approaches.

We consider the above enables the distribution businesses to balance public safety benefits alongside considerations of supply reliability. However, we do acknowledge that there may be some situations that arise where the above may not be the best or most appropriate approach. We expect the distribution businesses to clearly specify in their ESMSs and BMPs the operating settings they will apply to meet the above and any circumstances in which they may apply an alternative approach. We also expect the distribution businesses to justify their approach in their supporting submissions, specifically how their approach will minimise hazards and risks (including bushfire ignition and electrocution) as far as practicable when also taking into account other tools available to mitigate these hazards and risks.

Further, we note that there are prescribed and non-prescribed REFCLs deployed on supply networks throughout Victoria. It is our view that the requirements included in this paper should apply regardless of whether the REFCL was prescribed or not. The key factor is whether the relevant zone substation supplies electricity to a high bushfire risk area and whether there are appropriate controls in place to mitigate electrocution risks. That said, we understand that REFCLs that have been installed for reasons other than to meet prescribed requirements in the Act and regulations may not yet be capable of operating at the 'required capacity' performance level. This will be a relevant consideration when assessing what is proposed by the relevant distribution business.

Questions for consultation
9. Do you agree with the benefits and risks of the options for operating settings of REFCLs? Do you consider there to be any benefits and risks that have not been captured in the examples?
10 Do you agree that operating settings are the appropriate way to balance public safety benefits alongside considerations of supply reliability?
11. Are the AFDRS levels appropriate for guiding the operating settings of REFCLs? Do you agree with the way we have applied the AFDRS levels in our preliminary views?
12. Should different expectations apply to REFCLs that have been installed to meet prescribed requirements under the Act and associated regulations compared with those that have been installed for other reasons?
13. Are there any other considerations we should have regard to about the operating settings of REFCLs?

4.3 Maintaining REFCL performance

Discussion and expectations

The REFCLs installed on Victorian distribution networks are not duplicated, meaning that if a REFCL fails there is no back-up REFCL protection. While traditional fault protection devices will still operate, they will not detect and respond to faults at the same performance standard, thus notionally increasing risks. Therefore, regardless of the operating frequency and settings, it is critical that REFCLs are regularly tested and maintained to ensure they are reliable and will be effective when required to provide protection.

As noted in section 3, REFCLs are very complex systems comprising a diverse array of primary (high voltage) equipment and secondary (computer) equipment and software. We consider it important that

the distribution businesses have adequate forward plans for testing and maintenance of all parts of the system. We would also expect that network maintenance and hardening works relating to REFCLs are undertaken outside of a fire danger period and concluded at least several months prior to the fire danger period to allow appropriate time for remediation should an issue arise. This may mean, as far as practicable, these types of works are concluded no later than August/September each year.

We note that the Bushfire Mitigation Regulations requires the distribution businesses to include in their BMPs details of testing that will be undertaken before the specified bushfire risk period each year to ensure their supply networks can operate to meet the 'required capacity'. We expect that the distribution businesses will also explain how they will ensure the works will be undertaken in an efficient manner to minimise out-of-service time and minimise hazards and risks as far as practicable.

Additionally, improved asset and vegetation inspection and maintenance programs can reduce the number of faults that occur on the network that may trigger REFCLs, leading to adverse supply reliability impacts. We expect the distribution businesses to have robust inspection programs for all their supply networks that ensure issues are identified and addressed as quickly as practicable to maximise the benefits and minimise the risks of REFCLs.

Questions for consultation
14. Do you have any comments in relation to testing and maintenance of REFCLs?

4.4 Broadening the use of REFCLs

Discussion and expectations

The distribution businesses have installed REFCLs at 45 zone substations to meet prescribed requirements under the Act and associated regulations. However, we note that a distribution business does not meet their general duties by simply adhering to prescribed requirements.

The distribution businesses have general duties to minimise as far as practicable the hazards and risks and bushfire danger arising from their supply networks. The Act establishes practicability as having regard to:

- the severity of the hazard or risk in question
- the state of knowledge of the hazard or risk and any ways of removing or mitigating it
- availability and suitability of ways to remove or mitigate it, and
- the cost of removing or mitigating it.

It is possible that additional deployment of REFCL technology or extending the coverage of existing REFCLs is a practicable means by which relevant hazards and risks are mitigated, and therefore should be done to meet their general duties. For example, the area supplied from the Cobden zone substation represented as the grey area bordered by Colac (CLC), Camperdown (CDN) and Terang (TRG) in Figure 2 is not currently REFCL-protected. It could be practicable to extend supply to that area from, say, the REFCL-protected Camperdown zone substation during periods of heightened bushfire risk or to establish REFCL protection at the Cobden zone substation.

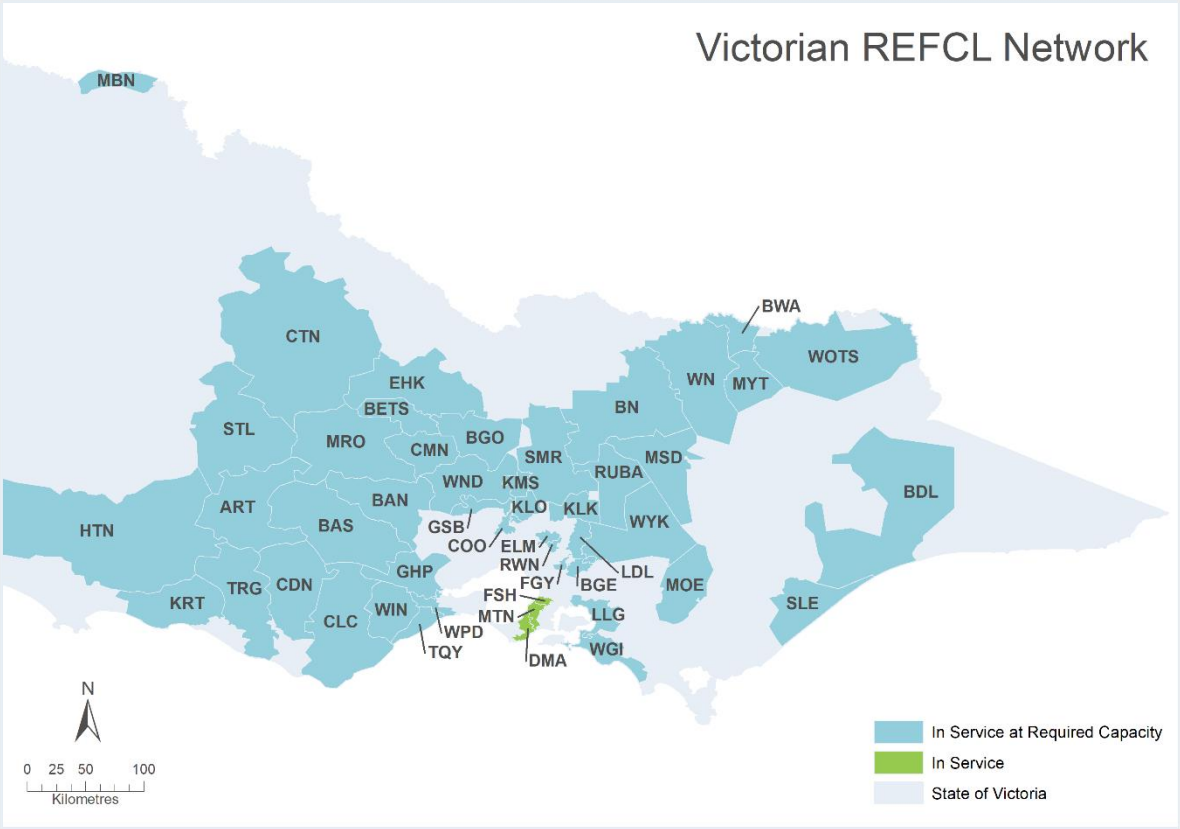
We accept that it may not be practicable for REFCLs to be deployed to all parts of a distribution businesses supply network, for example, where the bushfire risk is relatively low and there are other controls in place that mitigate electrocution risks. We also acknowledge that extending the coverage of existing REFCLs increases the number of customers supplied from a zone substation and therefore increases the number of customers likely to be impacted when power is cut due to a fault. However, we do consider that there may be several non-prescribed zone substations supplying areas where REFCL protection may be practicable and requires further assessment.

When submitting their ESMSs and BMPs, the distribution businesses must show how they have identified all the hazards and risks arising from their supply network as well as the risk control measures available to eliminate, prevent or reduce the safety risks and:

- implement the most effective controls or combination of controls to eliminate each safety risk where that is possible, or
- where it is not possible to eliminate a safety risk, implement all feasible controls that contribute to the reduction of the safety risk.

As part of this, we expect the distribution businesses to show they have considered the use of REFCLs on additional parts of their supply network to minimise hazards and risks as far as practicable in accordance with their general duties.

Figure 2: REFCL network coverage as of November 2023



Questions for consultation
15. Do you have any comments on the broader installation and use of REFCLs?

4.5 Record keeping and reporting

Discussion and expectations

Appropriate monitoring and record keeping by the distribution businesses is critical to ensure REFCL operations are in line with their regulatory obligations and, when necessary, can be provided to Energy Safe when requested to demonstrate compliance.

As noted at section 2.2, the distribution businesses currently keep records and provide the following reports or information to Energy Safe for the following purposes:

- An annual compliance report under section 120P of the Act, by 1 August each year, that includes information about details of work carried out or planned. The report must be in the form, and include the information, specified by Energy Safe. We publish a copy of the reports on our website at annual bushfire reports.
- An annual capacity testing report under regulation 7(1)(t)(vii) of the Bushfire Mitigation Regulations, before the start of each specified bushfire risk period (1 November – 31 March), that contains the results of the testing done during the year to ensure that their supply network is capable of operating to meet the required capacity.
- Information and data relating to REFCL-protected parts of the supply network during the fire season.

We expect the distribution businesses to continue to keep these records and report them to Energy Safe under current arrangements. However, we also expect the distribution businesses to keep specific records demonstrating how they have operated REFCLs in accordance with their accepted ESMSs and BMPs. The distribution businesses must be able to produce these records to Energy Safe when requested.

Therefore, in addition to any records that must be kept to generate the reports currently required under the Act and associated regulations, we will be expecting the distribution businesses to keep records relating to:

- For each REFCL, the amount of time it was in-service each week throughout the year.
- If a REFCL was out-of-service at any time, the dates and times it was out-of-service and the reason why it was out-of-service.
  - In the case of a planned REFCL outage, the purpose of the outage mapped to the planned testing and maintenance program.
  - In the case of an unplanned REFCL outage, the cause of the outage and any actions taken to minimise the risk of reoccurrence.
- For each REFCL, the settings that were applied at each point throughout the year mapped to the REFCL operational settings outlined in the accepted ESMS and BMPs.
- Details of each fault that occurs on the network, including the date, time and location of the fault, whether it was temporary or sustained/permanent, the cause, whether REFCL operated when the fault occurred and the REFCL settings that were applied at the time.

To ensure the consistency of records being kept, we would welcome views from the distribution businesses on the potential format and template for these records. We would also welcome views from the distribution businesses on how to streamline the record keeping and reporting requirements.

Questions for consultation
16. Do you have any comments on record keeping and reporting by the distribution businesses?

5 Next steps

Interested parties are invited to provide written submissions on our preliminary views, or on any other matter relevant to REFCL operations by **8 July 2024**. Following this consultation, we intend to publish a final position on the issues outlined in this paper.

We note that, while the obligation is on the distribution businesses to determine and submit their ESMSs and BMPs, we will only accept an ESMS or BMP if we are satisfied that it is appropriate for the supply network. In this context, we consider it important to be transparent about what our minimum expectations will be unless it is demonstrated that an alternative approach is more appropriate.

We will therefore expect our final positions to be reflected in submissions made by the distribution businesses when they next submit their ESMSs and BMPs for acceptance unless they can demonstrate that an alternative approach is more appropriate for their supply network.