

Electricity Distribution Code – Review of voltage standards for bushfire mitigation

Final Decision

14 August 2018

An appropriate citation for this paper is:

Essential Services Commission 2018, Electricity Distribution Code – Review of voltage standards for bushfire mitigation: Final Decision, 14 August

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Executive Summary

In 2016, the Electricity Safety (Bushfire Mitigation) Regulations 2013 were amended requiring major electricity companies to increase the safety standards of their networks in order to reduce bushfire risk.¹ This mandated the roll out of powerline bushfire mitigation equipment, known as Rapid Earth Fault Current Limiters (REFCL) across Victoria. REFCLs are a type of equipment intended to be installed at distribution zone substations in areas of high bushfire risk, where high voltage electricity powerlines exist.

To reduce bushfire risk, REFCLs are designed to respond when an abnormal scenario occurs on the network. For example, when a power line fails and comes into contact with the ground, which could occur during extreme weather events, REFCLs operate to rapidly reduce the potential of an electrical spark occurring at that point. However, the operation of REFCLs will also lead to an increase in voltage levels experienced by the electricity distribution system, which are likely to exceed the limits set out in the Electricity Distribution Code (the code).²

In this final decision, we have made amendments to the code to enable REFCLs to operate compliantly. When making decisions, we are guided by our legislative objective to promote the long term interests of Victorian consumers³ and we had particular regard to the requirements of the Electricity Safety (Bushfire Mitigation) Regulations 2013. We also considered the operational issues associated with the implementation of REFCLs and the distribution network. In making our final decision, we invited stakeholders to provide written feedback on our draft decision.

Our final decision includes the following changes to the code:

- Introducing new voltage variation limits that apply when a REFCL responds to distribution system faults, such as electrical infrastructure faults during bushfire events. These amendments do not specify phase-to-earth voltage variation limits, but retain the existing phase-to-phase voltage variation limits on the high voltage distribution network. This also clarifies the responsibilities of distributors and affected parties during the operation of REFCL technology.
- Introducing new obligations for the provision and exchange of information between distributors and customers related to the installation and operation of REFCL technology.
- Introducing consequential changes to the code to support the new voltage variation limits, such as modifying existing definitions, and expanding monitoring requirements for distributors.

¹ Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016.

² Electricity Distribution Code – December 2015, version 9.

³ Essential Services Commission Act 2001, section 8.

1. Introduction

The Essential Services Commission (commission) is responsible for licensing electricity distributors in Victoria. As part of our licensing functions under the Electricity Industry Act 2000 (Vic), we set licence conditions for distributors which include the requirement to comply with the Electricity Distribution Code (the code).

The code regulates activities relating to the distribution of electricity so they are undertaken in a safe, efficient and reliable manner. This includes setting standards relating to the quality of supply in our distribution network, including voltage standards. The voltage standards in the code set the limits of voltage levels that can be experienced by the electricity distribution system. These standards apply to all parties connected to the electricity distribution system, which includes distributors and high voltage customers.⁴

In July 2010, the Victorian Bushfires Royal Commission found that certain fires on Black Saturday 2009 were started by faults with electricity infrastructure. This included the Kilmore East fire which was responsible for 119 of the 173 Black Saturday related fatalities.

To reduce the risk of future bushfires being ignited by faults with electricity infrastructure, the royal commission recommended installing “other technology that delivers greatly reduced bushfire risk”.⁵

In response, the government accepted these recommendations and introduced regulatory measures to facilitate their adoption. This included amending the Electricity Safety (Bushfire Mitigation) Regulations 2013 in May 2016 to mandate the roll out of powerline bushfire mitigation technology, such as Rapid Earth Fault Current Limiter (REFCL) technology, in 45 locations. The practical outcome of the regulations is that Victorian electricity distributors will be required to roll out REFCLs into parts of the 22kV distribution system from 2019 to 2023. The Electricity Safety Act 1998 also imposes bushfire mitigation requirements on Victorian electricity distributors.

REFCLs are plant and equipment installed on high voltage networks that help reduce bushfires related to electricity asset faults. However, when they are used, REFCLs increase the affected part of the system’s voltage levels beyond the limits of the voltage standards in our code.

⁴ The code applies to the customer via the distributor connection agreement entered into by the customer.

⁵ 2009 Victorian Bushfires Royal Commission, Final Report – Summary, July 2010, p. 29.

1.1. Purpose of the review

The commission is currently undertaking a review of the Electricity Distribution Code to ensure that it is fit for purpose for the current Victorian electricity networks.

The purpose of this specific voltage standards review is to propose changes to the code to enable the operation of bushfire mitigation equipment, such as REFCL technology, to operate on high voltage networks as mandated by the Electricity Safety (Bushfire Mitigation) Regulations 2013. Following this specific review, the commission will continue its wider review of the Electricity Distribution Code from late 2018.

1.2. Process of the review

In February 2018, we released a project scope for this review. The scope outlined our objectives in considering whether amendments are necessary to the voltage standards so that distributors can operate REFCLs without breaching the code, in the context of the bushfire mitigation requirements on Victorian electricity distributors.

Prior to our draft decision, we undertook consultation with stakeholders, which included a workshop on 6 April 2018 attended by 33 people who represented relevant stakeholders. Stakeholders were invited to present their experiences and provide feedback on key elements to inform the draft decision. Our initial consultation involved distributors, high voltage customers or their representatives, and retailers. We also consulted with industry bodies, the Australian Energy Regulator, Energy Safe Victoria and the Department of Environment, Land, Water, and Planning. During this time, we also conducted a review of standards and approaches adopted by other international jurisdictions.

Following our draft decision on 22 May 2018, we received feedback from 11 stakeholders, including high voltage customers, distribution businesses, Energy Safe Victoria, the Australian Energy Regulator and the Minister for Energy, Environment and Climate Change. We also held a stakeholder briefing on our draft decision on 13 June 2018. We considered the feedback of stakeholders in making our final decision, as described throughout this report.

1.3. Structure of this document

Our final decision has the following sections:

- Section 2 explains how the operation of REFCL interacts with the voltage standards of the current code.
- Section 3 sets out the changes to the code as per our final decision, including the feedback received from stakeholders.
- Section 4 summarises our final decision.

1. Introduction

2. Background

This section provides background to the voltage standards of the code and briefly explains the operation of REFCL technology. It also describes how the operation of REFCL interacts with the existing code.

2.1. Voltage standards in the code

The code is a broad and multi-faceted regulatory instrument that we administer. The code regulates activities involving the distribution of electricity by a distributor, technical aspects of the electrical connection of customers and embedded generators to the system, and the transfer of electricity within the distribution systems. Therefore the code applies to licensed entities, entities exempt from holding a licence, as well as customers, with the aim to ensure that the distribution of electricity is undertaken in a safe, efficient and reliable manner.

The code also contains technical limits to govern how the distribution system is designed and operated. The code sets out appropriate voltage variation limits for the system to operate within, as follows:

- **Phase-to-earth voltage variation limits.** These limits relate to the voltage levels measured from a single live power line (a phase) relative to the general mass of the ground (the earth), where the ground is considered as having zero voltage.
- **Phase-to-phase voltage variation limits.** These limits relate to the voltage levels measured between any two different live power lines (phases). Of note, this is a measure between the two power lines and not the ground (the earth).

The code also contains other technical parameters and obligations that support the effective operation of the electricity distribution system.

2.2. Rapid Earth Fault Current Limiters (REFCLs)

The basic underlying technology of REFCLs has been available around the world for several decades. However, the incorporation of modern electronics has imparted significant improvements to their traditional capabilities. Furthermore, the application of this technology for the purposes of reducing bushfire risk is innovative and a world first. In Victoria, REFCLs have been undergoing field trials at select sites over the past few years and are poised for wider scale deployment. REFCLs are intended to be installed at distribution zone substations in areas of high bushfire risk, where high voltage 'polyphase' electricity lines exist. A polyphase line consists of three electricity lines with each carrying a single phase of electricity.

To reduce bushfire risk, REFCLs are designed to trigger (i.e. respond to a fault) when an abnormal condition occurs, such as when a power line fails and comes into contact with the ground (known as an ‘earth fault’). This may occur during extreme weather events. When triggered, the REFCL very rapidly reduces the amount of abnormal current flowing through the downed line, significantly reducing the potential of an electrical spark igniting a fire.

As a consequence of the REFCL triggering, the phase-to-earth voltage on the remaining two unfaulted polyphase lines simultaneously ‘spikes’ from its normal operating range by up to 90 per cent, which is an inherent response with REFCL technology on the electricity distribution system. During the time of the voltage spike, the REFCL will test whether the original fault is legitimate. If the REFCL confirms the fault, the REFCL will disconnect power to the affected circuit to remove the potential for a bushfire. Distributors have advised that the process of determining a fault takes approximately one minute.

2.2.1. The interaction of REFCL operation with the code

For REFCLs to be commissioned, tested or used to respond to a fault, they are likely to increase voltage levels in that part of the distribution system beyond the allowable range specified in the code. However, the operation of REFCLs does not lead to all voltage limits specified in the code being exceeded. Only the 22kV phase-to-earth voltage variations limits in the code are affected with the current roll-out of REFCLs in Victoria. We have also considered phase-to-phase voltage variations in this review, as shown in figure 2.1.⁶ Distributors and high voltage customers are both required to comply with these voltage standards.

Figure 2.1 Extract of voltage variation limits in the Electricity Distribution Code

Table 1

STANDARD NOMINAL VOLTAGE VARIATIONS				
Voltage Level in kV	Voltage Range for Time Periods			Impulse Voltage
	Steady State	Less than 1 minute	Less than 10 seconds	
< 1.0	+10% - 6%	+14% - 10%	Phase to Earth +50%-100% Phase to Phase +20%-100%	6 kV peak
1-6.6	± 6 %	± 10%	Phase to Earth +80%-100% Phase to Phase +20%-100%	60 kV peak
11	(± 10 %)			95 kV peak
22	Rural Areas)			150 kV peak
66	± 10%	± 15%	Phase to Earth +50%-100% Phase to Phase +20%-100%	325 kV peak

Area of code review where REFCL operation interacts with voltage variation limits

⁶ This is because when a phase-to-earth fault occurs, the operation of REFCLs can move the neutral reference of the distributor zone substation transformer such that the two unaffected phase to earth voltages moves towards the phase-to-phase voltage levels.

2. Background

The code currently allows maximum phase-to-earth voltage to rise up to 80 per cent above the normal phase-to-earth voltage level, for up to 10 seconds.⁷ For phase-to-phase voltages this can be 20 per cent above the normal phase-to-phase voltage levels, for up to 10 seconds.⁸

Where REFCLs are operated, the phase-to-earth voltages in the affected distribution area can rise up to 90 per cent above its normal phase-to-earth voltage levels, and this can be sustained for longer period than current practice. The installation of REFCLs also changes the fundamental operating principles of that part of the electricity distribution system from a solid or restricted earthing system to that of a resonant earthing system. A resonant earthing system will have characteristics like an isolated neutral distribution system, which is designed to operate at phase-to-phase voltage levels.⁹ Under an isolated neutral distribution system, phase-to-earth voltage limits become less relevant. Of note, the phase-to-phase voltage variation limits currently set out in the code are still relevant when REFCLs are in operation.

2.2.2. The effect of REFCLs on the distribution system

REFCLs will be installed at a distributor's zone substation supplying the high voltage electricity network. The Electricity Safety (Bushfire Mitigation) Regulations 2013 have specified the installation of REFCLs at 45 specific zone substations which focus on the 22kV network.

Because REFCL operation affects phase-to-earth voltages on the high voltage network, anyone who operates equipment connected to the high voltage network will be affected. Equipment connected to the high voltage network during the operation of a REFCL will be subjected to increased voltages, beyond the existing limits set out in the code. Therefore, distributors and customers connected to the high voltage network may need to conduct technical assessments of their assets to ensure they can operate within these increased voltages variations. Affected assets could consist of distributor assets, customers' electrical installations and electricity retailers' metering equipment. Most retail electricity customers are connected to the low voltage part of the distribution system, and are supplied by distribution transformers that isolate these customers from the increased voltages resulting from REFCL operation. Therefore, most retail electricity customers would not be affected by these increased voltages.

⁷ A review of some international jurisdictions identified that their regulations do not set phase-to-earth voltage limits. The phase-to-earth voltage variation limits in the Electricity Distribution Code may have been in place since the 1980s. These limits may account for abnormal network conditions that may occur when technology, known as neutral earthing resistors (NERs), are operated. NERs are an older technology with far less technical capability compared to REFCLs.

⁸ In general, distribution systems are designed in such a way that the phase-to-phase voltages are higher than phase-to-earth voltages, even though the phase-to-earth voltage appears to have a higher limit.

⁹ The Victorian distribution system is primarily designed and operated as a solid or restricted earthing system and not as an isolated neutral system.

2. Background

3. Changes to the code

The commission is responsible for setting the licence conditions for electricity distributors, which includes the requirement to comply with the code.

When considering amendments to the code, we consider how it could better achieve the commission's objectives to promote the long term interests of Victorian consumers with regard to the price, quality and reliability of essential services as outlined in section 8(2) of the Essential Services Commission Act 2001, and to give effect to relevant government policy.¹⁰ For this review, we also had particular regard to the relevant health, safety, environmental or social legislation that applies to the industry.¹¹ We also considered stakeholder feedback in making our final decision and have provided our responses throughout this section.

Our final decision is summarised as follows:

1. **The voltage standards of the code are to be amended.** The changes will enable the compliant operation of mandated bushfire technology equipment, and clarify the existing scope of liability for a distributor and customer when this equipment responds upon detection of a fault.
2. **New voltage variation limits will apply.** These new limits will apply when applicable bushfire mitigation equipment, such as REFCLs or any other similar technology, responds upon detection of a fault.
3. **We have amended and introduced obligations for the provision and exchange of information.** This will lead to greater information provision to the general public and affected high voltage customers prior to distributors installing and operating the relevant bushfire mitigation equipment.
4. **Other consequential amendments are also required.** These amendments are extensions of existing obligations in the code, but relate to the operation of REFCLs or similar technology.
5. **The code changes will take effect on 20 August 2018.**

¹⁰ Electricity Distribution Code, clause 1.7.

¹¹ Essential Services Commission Act 2001 (Vic), sections 8A (d).

3.1. Amending the voltage standards to enable REFCL operation

Our final decision is to amend the voltage standards of the code, resulting in new voltage standards related to the operation of REFCLs, as detailed further in section 3.2 of this paper.

In making our final decision, we considered the relevant legislation and regulations that apply to the industry. In particular, we considered the amendments to the Electricity Safety (Bushfire Mitigation) Regulations 2013 that came into effect on 1 May 2016. Amending the code means that the bushfire mitigation equipment intended by these regulations under the Electricity Safety Act 1998, such as REFCLs or any other type of suitable technology, can be operated in compliance with the code.

What would happen if we did not amend the code?

Because high voltage customers privately own and manage their electrical assets directly connected to the network, it is likely that affected high voltage customers will need to review and where necessary, upgrade their assets, to safeguard against the increased voltages when REFCLs operated – several high voltage customers confirmed this would be the case.¹² This could include the hardening of high voltage customer equipment to strengthen against the voltage spikes during REFCL operation, installing isolation transformers that are designed to withstand voltage spikes or electing to become a low voltage customer.

In response to our draft decision, the Department of Defence suggested that we keep the existing obligations and not change the code, as distributors would need to fund the protection of their customers' private assets.¹³ If the current code was not amended, distributors would be obligated to take into account the voltage spike effect of REFCL operation on the private assets of high voltage customers. Furthermore, the operation of REFCLs by distributors would breach the voltage standards of the existing code and under clause 4.2.7 of the code, distributors would also be required to compensate any person whose private assets are damaged due to voltage variations

¹² Pacific Energy Victorian Hydro, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p. 1.; Metro Trains Melbourne, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p. 2.; Gippsland Water, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p. 1.; Department of Defence, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018 p. 2.; Saputo Dairy Australia, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p. 1.

¹³ Department of Defence, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p. 2.

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outside the prescribed limits. To reduce the risk of liability under clause 4.2.7 of the current code, distributors would likely request additional funding to protect these assets.

Several stakeholders also noted the potential costs associated with upgrading their private assets.¹⁴ We recognise that these costs are different for each high voltage customer, and that the cost may be significant for customers in some specific cases. However, the Bushfires Royal Commission found, in its final report, that it “considers it inappropriate that electricity consumers bear the entire cost of implementing those recommendations” relating to bushfire mitigation and electrical infrastructure.¹⁵

We also recognise that the Victorian government has developed a High Voltage Customer Assistance Program (HCAP) that includes assistance measures for affected high voltage customers. Further information regarding HCAP can be found at the Department of Environment, Land, Water and Planning website (www.energy.vic.gov.au/safety-and-emergencies/powerline-bushfire-safety-program).

A new definition related to a REFCL condition

Our draft decision proposed a new definition that described the application of a REFCL when it responds upon detecting a fault in the network. Four distributors sought clarity on what constitutes the proper operation of a REFCL.¹⁶

For clarity, the commission considers the proper operation of a REFCL leading to a REFCL condition to be when it is responding to a distribution system fault, which means that:

- A REFCL is operating when it is monitoring to detect the presence of a fault within the network.
- Once a fault is detected, the REFCL responds to the fault and that leads to changes in voltages experienced by the network – this means that the distribution system neutral reference

¹⁴ Pacific Energy Victorian Hydro, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, p. 1.; Metro Trains Melbourne, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, p. 1.; Gippsland Water, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, p. 1.; Saputo Dairy Australia, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, p. 1.

¹⁵ 2009 Victorian Bushfires Royal Commission, Final Report Volume II: Fire Preparation, Response and Recovery, July 2010, pp. 158.

¹⁶ AusNet Services, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, p. 6.; CitiPower, Powercor and United Energy, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, p. 5.

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becomes displaced and the two un-faulted phases, specifically their respective phase-to-earth voltages, will rise in magnitude.

- Under full neutral displacement, the two un-faulted phase-to-earth voltages will rise to approach a magnitude value close to the phase-to-phase voltage levels. Based on findings from WSP regarding international experience, this rise in voltage magnitude of the two un-faulted phase-to-earth voltages is ordinarily managed by distributors to not exceed the phase-to-phase voltage magnitude value.¹⁷

Our final decision introduces a new definition related to a 'REFCL condition', which describes the functional outcome of a REFCL detecting and responding to a fault, resulting in changes to the phase-to-earth voltages.

Clarifying the conditions of liability for distributors and customers

In making changes to the code, we have clarified the conditions of liability for distributors and parties connected to the electricity distribution system. This means that distributors will need to compensate customers in a scenario where the new voltage variation limits are exceeded under a REFCL condition, and where it results in damage to customer assets.

Customers, such as high voltage customers, will also need to take reasonable measures to safeguard their own equipment during a REFCL condition. The clauses related to the conditions of liability for distributors and business customers such as high voltage customers are existing provisions of the code. The final decision expands the respective obligation for each party to include the operation of a REFCL.

The Department of Defence sought clarification on whether there would be any bushfire mitigation obligations on high voltage customers, particularly where an isolation transformer was installed at their connection point.¹⁸ The Electricity Safety Act 1998 imposes bushfire mitigation requirements on Victorian electricity distributors as well as a 'specified operator', which could be a high voltage customer satisfying the conditions of the Electricity Safety Act 1998.¹⁹ Other relevant legislative responsibilities, such as those related to occupational health and safety, are also associated with

¹⁷ If this example was applied in a Victorian context, the original two un-faulted phase-to-earth voltage magnitudes of 12.7kV would rise due to the neutral displacement, and approach the phase-to-phase voltage magnitudes of approximately 24.2kV.

¹⁸ Department of Defence, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p. 2.

¹⁹ Electricity Safety Act 1998 (Vic), section 83A.

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owning and operating high voltage assets. It is expected that high voltage customers will take appropriate action to fulfil these responsibilities, including under the bushfire mitigation regulations.

We also recognise that high voltage customers will require appropriate information from their distributors to make informed decisions related to the operation of REFCLs. Distributors will also need information from customers in order to design, install and operate REFCLs. The commission has introduced new obligations for both distributors and high voltage customers related to the provision and exchange of information, which are detailed in section 3.3 of this paper.

Amending the voltage standards to allow REFCLs to also operate in other modes

Our draft decision invited stakeholders to comment on whether REFCLs should be permitted to operate for other purposes including reliability, as long as they do not undermine the intent of the Electricity Safety (Bushfire Mitigation) Regulations 2013.

Four of the five Victorian distributors suggested that the voltage standards should support the operation of REFCLs for safety and reliability benefits.²⁰ CitiPower, Powercor and United Energy also suggested that a definition linked to the ‘required capacity’ definition, set out in the Electricity Safety (Bushfire Mitigation) Regulations 2013, could prevent a REFCL from being tested or calibrated to operate compliantly with the new voltage standards:

The effect of the definitions is that ... it would not apply to REFCLs that are unable to meet required capacity nor would it apply to REFCL commissioning prior to the achievement of required capacity.²¹

Saputo Dairy Australia, a high voltage customer, commented on the increased damage risk to customer equipment if a REFCL is operated for non-safety purposes.²² However, the Powerline Bushfire Safety Committee, in its advice to Energy Safe Victoria’s submission, suggested that changes to the code should support the use of REFCLs for public and industry safety benefits in reducing the risk of high-voltage electrocution.²³ The committee also noted that the Regulatory

²⁰ CitiPower, Powercor and United Energy, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, p. 3., AusNet Services, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, p. 5.

²¹ CitiPower, Powercor and United Energy, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, p. 3.

²² Saputo Dairy Australia, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, p. 1.

²³ Energy Safe Victoria, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, pp. 10-11.

3. Changes to the code

Impact Statement supporting the recommendation of the REFCL roll-out estimated the supply reliability benefits of the technology, and that the “reliability of supply is indirectly a key bushfire safety issue”.²⁴

Although our final decision has been made in accordance with the bushfire mitigation legislation and regulations, we recognise that REFCLs can be operated in modes that offer benefits that are recognised by other regulators. Energy Safe Victoria for example could also accept these types of operating modes as proposed by distributors in their Electricity Safety Management Scheme (ESMS) or Bushfire Mitigation Strategy Plans (BMPs). These modes have been approved by Energy Safe Victoria in the past, under the Electricity Safety Act 1998.

Our final decision is to define REFCLs as any type of plant, equipment or technology that reduces the effect of distribution system faults which may lead to a REFCL condition, and have been approved by Energy Safe Victoria. This will enable the compliant operation of a REFCL on the 22kV network, as long as it has been installed and operated pursuant to the Electricity Safety Act 1998, for bushfire mitigation, public safety and reliability purposes where accepted by Energy Safe Victoria. Importantly, this allows technology such as REFCLs to be operated as per the ‘required capacity’ definition under the Electricity Safety (Bushfire Mitigation) Regulations 2013.

We are aware that the new definition of a REFCL could be interpreted as including neutral earthing resistors, which is equipment that has been installed and operating in the Victorian electricity network for a number of decades. This means that neutral earthing resistors have been in operation with the existing voltage standards of the code (Table 1 of the code) for some time. To avoid doubt, the final definition of a REFCL in our code specifically excludes neutral earthing resistors.

These changes will also be supported by further information provision obligations on distributors, when operating a REFCL for reliability and safety purposes. These obligations are outlined in section 3.3 of this paper.

3.1.1. How the amendments will apply

Our final decision is to amend clause 16(c) of the code to clarify that affected customers must take reasonable measures to safeguard their own assets in the event of a REFCL condition. We will also extend clause 4.2.7 to include the REFCL condition such that should distributors exceed the

²⁴ Energy Safe Victoria, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, p. 10.

new voltage variation limits (as set out in section 3.2 of this paper) and damage customer equipment, they will be required to compensate the customer.

Our final decision also includes new and clarified definitions to support the changes to the code, and to support the operation of REFCLs for bushfire mitigation purposes, as well as for other safety purposes accepted or approved by the relevant regulators. These definitions are:

Energy Safe Victoria means the body established pursuant to section 4 of the *Energy Safe Victoria Act 2005 (Vic)*.

Rapid Earth Fault Current Limiter or **REFCL** means plant, equipment or technology (excluding neutral earthing resistors) which is:

- (a) designed to reduce the effect of **distribution system** faults and which when operating as intended may lead to a **REFCL condition**; and
- (b) approved by **Energy Safe Victoria** in an electricity safety management scheme or bushfire mitigation plan pursuant to the **Electricity Safety Act 1998 (Vic)**.

REFCL condition means an operating condition on the 22kV **distribution system** arising from the proper operation of **REFCL** which results in the neutral reference of the **distribution system** moving to allow the un-faulted Phase to Earth voltage magnitude to approach a value close to the Phase to Phase voltage. The term ‘operating condition on the 22kV **distribution system**’ in this term extends up to, but not beyond any device or plant which is functionally equivalent to an isolating transformer.

relevant voltage means either phase to phase or phase to earth as applicable.

voltage means the electronic force or electric potential between two points that give rise to the flow of electricity expressed as the root mean square (RMS) of the phase to phase voltage (except in the case of impulse voltage).

3.2. New voltage variation limits will apply

Our final decision is to amend version 9 of the code by specifying new voltage variation limits under a REFCL condition. The new voltage variation limits will involve:

- retaining existing phase-to-phase voltage variation limits during a REFCL condition, and
- not specifying any phase-to-earth voltage variation limits during a REFCL condition.

When REFCLs are not in operation, both existing phase-to-earth and phase-to-phase voltage variation limits will apply as per the existing Table 1 of the code.

3. Changes to the code

Not specifying phase-to-earth voltage variation limits during a REFCL condition

Our final decision has been made with regard to the Electricity Safety Act 1998, and we have also considered the potential operational issues associated with the implementation of REFCLs and the distribution network. The existing phase-to-earth voltage variation limits specify that the system may operate in voltages within +80 per cent to -100 per cent of nominal phase-to-earth voltage for less than 10 seconds.

As discussed with stakeholders at our initial workshop and outlined in stakeholder feedback, it is likely that the operation of REFCLs will lead to voltages exceeding and rising up to +90 per cent of nominal phase-to-earth voltage for longer than 10 seconds. Removing the phase-to-earth limits will allow REFCLs to operate without breaching the code. Distributors will, however, still be required to operate REFCLs in a way that does not breach the existing phase-to-phase voltage variation limits of the code.

The electrical connection between the distributor and high voltage customer is generally unique to the characteristics and requirements of the high voltage customer and that part of the distribution system. Removing the phase-to-earth variation limits should allow some flexibility in the code that can facilitate discussions between a customer and a distributor towards an appropriate outcome bespoke to their situation. That is, distributors may likely pursue upgrades to a connection point that allows the effective operation of REFCLs for bushfire mitigation, and high voltage customers may likely pursue solutions appropriate for their needs. Given each connection point between distributors and high voltage customers in Victoria is considered unique, the commission was unable to determine a phase-to-earth voltage variation limit in the code that is appropriate for all cases.

Prior to our draft decision, some stakeholders suggested we prescribe new phase-to-earth voltage variation limits in the code. We engaged technical consultants, WSP, to undertake a review of the regulations in other countries where REFCLs have been implemented or operated – this included New Zealand, Ireland, Sweden, China and Russia. We found that the regulations in these countries did not specify any phase-to-earth voltage variations, despite the operation of REFCLs on their networks. However, these countries did regulate phase-to-phase voltage variation limits.

WSP, as part of their review, also found that technical standards of equipment specification regarding a REFCL conditions took differing approaches. For example, standards for new metering voltage transformers under a REFCL conditions can be specified to withstand up to +90 per cent from nominal phase-to-earth voltage for up to 8 hours. However, standards for new switchgears require testing to withstand up to 50kV, which is +394 per cent from nominal phase to earth voltage, but for one minute. Given these inconsistencies, the commission could not find an appropriate basis to prescribe new limits for the effective operation of REFCLs.

3. Changes to the code

A number of stakeholders supported our removal of phase-to-earth voltage variation limits during a REFCL condition.²⁵ The Australian Energy Regulator stated:

We note that based on international practice, you propose to not apply any phase-to-earth voltage limit when a REFCL is operating. Although the Commission has not adopted our proposed phase-to-earth voltage limits for REFCL operation, we recognise the superior merit of your alternative and support its adoption.²⁶

Similarly, the Powerline Bushfire Safety Committee, in its advice to Energy Safe Victoria's submission, commented that:

This change should be welcomed as logical, supportive of the Regulations, and consistent with international best practice.²⁷

While our final decision is to remove the phase-to-earth voltage variation limits when REFCLs are operating, we will retain the existing phase-to-phase voltage variation limits under a REFCL condition. Removing phase-to-earth voltage limits entirely would be inappropriate for the vast majority of existing customers of the distribution system who will continue to receive supply from areas that are unaffected by the operation of REFCLs.²⁸

It should also be noted that a REFCL conditions or the new voltage standards do not extend downstream to the lower voltage circuit of a transformer, whether it involves isolation or distribution transformers converting voltage from 22kV to a lower voltage. This means that distributors, and in some cases embedded network operators, would still need to manage their respective distribution system downstream in the lower voltage circuits of a transformers in accordance with the voltage standards in Table 1 of the code – even during a REFCL conditions. Additionally, it is expected that

²⁵ AusNet Services, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018; Jemena, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018; Hon. Lily D'Ambrosio MP, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018; Australian Energy Regulator, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018; Energy Safe Victoria, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018; CitiPower, Powercor and United Energy, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018.

²⁶ Australian Energy Regulator, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p. 1.

²⁷ Energy Safe Victoria, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p. 5.

²⁸ REFCLs are installed at specific zone substations, which only affect the areas connected to that substation, including those areas where supply is transferred to a REFCL connected substation from time to time.

3. Changes to the code

industry documents such as the Victorian Services and Installation Rules will be updated with appropriate information related to the requirements and operation of REFCLs.

Considering the application of the new voltage standards to areas below the 22kV high voltage network

Our draft decision proposed that the new voltage standards should only apply to the 22kV level of the Victorian network. Several stakeholders suggested that we expand the scope of the new voltage standards to apply to areas of the high voltage network between 1kV and 22kV, so that the potential benefits of REFCLs could be applied to other parts of the network in the future.²⁹

As suggested by Energy Safe Victoria, we recognise that there may be a range of benefits associated with a REFCL in areas outside of the 22kV high voltage network.³⁰ However, this particular review has focussed on the requirements of the Electricity Safety (Bushfire Mitigation) Regulations 2013 and in particular the current roll-out of REFCLs on the 22kV network. We were also not made aware of any immediate plans by distributors to install REFCLs below the 22kV networks.

This review of voltage standards has particularly focussed on the bushfire mitigation requirements on the 22kV distribution network system. In late 2018, the commission will be continuing our wider review of the code, with a focus on amending the code to better serve the operation of the Victorian electricity network for customers. This wider review will also allow other stakeholders, such as residential and high voltage customers below the 22kV network to comment on the potential operation of REFCLs for non-bushfire related purposes on those sections of the high voltage network.

3.2.1. How the amendments will apply

Our final decision is to introduce a new table of voltage variation limits into the code that are only applicable when REFCLs operate in accordance with an approved mode. This also includes the commissioning, testing and maintenance of a REFCL. Furthermore, we will retain the phase-to-earth and phase-to-phase voltage variation limits when REFCLs are not operating.

²⁹ Jemena, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p. 2., CitiPower, Powercor and United Energy, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p. 5.

³⁰ Energy Safe Victoria, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, pp. 2 and 5.

3. Changes to the code

These changes will introduce a new Table 1A to the code, as shown in figure 3.1. Also within the code, clause 4.2.2 will be amended to reflect new Table 1A of clause 4.2.2A and insert new clause 4.2.2A defining the REFCL compliant voltage standards.

Figure 3.1 New Table 1A to the code

4.2.2A During the period in which a *REFCL condition* is experienced on the *distribution system* (including when a *REFCL condition* arises from the commissioning and testing of a *REFCL*):

- (a) the Phase to Earth voltage variations in Table 1 of clause 4.2.2 do not apply; and
- (b) the Phase to Phase voltage variations in Table 1A apply to that part of the 22kV *distribution system* experiencing the *REFCL condition*.

Table 1A

PHASE TO PHASE NOMINAL VOLTAGE VARIATIONS				
Voltage Level in kV	Voltage Range for Time Periods			Impulse Voltage
	Steady State	Less than 1 minute	Less than 10 seconds	
22	± 6 % (± 10 % rural areas)	± 10%	Phase to Phase +20%-100%	150kV peak

3.3. New obligations for the provision and exchange of information

Our final decision requires distributors to provide public information regarding any intentions or plans to install future REFCLs within their distribution area. Distributors will also need to notify high voltage customers when they choose to use REFCLs in modes outside the ‘required capacity’ as stated in the Electricity Safety (Bushfire Mitigation) Regulations 2013. The code will also contain new obligations that require distributors and high voltage customers to provide and exchange information with each other to support the installation of a REFCL.

These new information provision obligations are important in supporting the new voltage standards applicable under a REFCL condition. Affected parties will need access to appropriate information to make informed decisions about potential impacts to their operations, and for satisfying their own bushfire mitigation obligations under the Electricity Safety Act 1998, where relevant.

3. Changes to the code

Expanded obligations for distributors when publishing their network planning

Our draft decision proposed an expansion of existing obligations on distributors when publishing their Distribution System Planning Reports, which detail network planning information for their distribution area. Our final decision incorporates these obligations with minor wording changes for clarity.

The new obligations contained in clauses 3.5.1(d) and 3.5.3B, will require distributors to include any information about the planning of REFCLs within their distribution area. CitiPower, Powercor and United Energy also suggested that it may be “simpler and clearer for the publication of the proposed information to be contained on our website”.³¹ However, the new obligations do not prevent distributors from also providing planning information related to REFCLs in other formats. The commission considers that the Distribution System Planning Report³² is a familiar document to the industry and is an appropriate place for network planning information to be included publicly.

These obligations will provide stakeholders, such as existing or new high voltage customers, with information on the location and potential effect of REFCLs in the future. The obligation also aligns with the electricity distribution price reset process of the AER for distributors. Furthermore, distributors require Energy Safety Victoria’s acceptance of their plans to use REFCLs for safety purposes.

It should also be noted that the new voltage standards are not limited to a specific geographical boundary for the 22kV distribution system. This means that distributors who are proposing to install a REFCL in their network would need to state in their Distribution System Planning Report where a REFCL condition may occur in their distribution system – whether it be under system normal or abnormal configuration. Distributors would also need to inform and discuss with all affected stakeholders the potential for a REFCL conditions on an ongoing basis, as necessary.

New information provision obligations to encourage discussions between distributors and affected high voltage customers

The changes to the code include a range of information provisions that aim for distributors to maintain discussions with affected customers when planning, commissioning or operating REFCLs. Our draft decision proposed an obligation for distributors to inform and notify customers who may be affected by the installation or operation of the network.

³¹ CitiPower, Powercor and Unity Energy, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, p. 7.

³² The Distribution System Planning Report is an annual reporting obligation on distributors set by the commission to publish their forward five year forecasting, planning and management of the distribution network.

3. Changes to the code

Saputo Dairy Australia sought further clarification on the requirements on distributors to communicate to customers who may be affected by the testing or operation of REFCLs.³³ Our final decision retains the intent of our draft decision and includes four new obligations on distributors to provide information to customers related to the potential effects of a REFCL condition on the supply of electricity to that customer. This will provide information to potentially affected customers in order to prepare for a REFCL condition.

Four distributors also expressed concerns about the time required for high voltage customers to complete the necessary works on their private assets in line with the REFCL roll out schedule, suggesting that we specify a reasonable time period for when distributors should notify customers of the installation of a REFCL.³⁴ The Minister for Energy, Environment and Climate Change also sought clarity on possible obligations on customers to provide information to distributors if they change or alter their own electrical equipment.³⁵

Our final decision does not prescribe distributors to notify customers on a once-off basis. Instead, the commission expects both distributors and customers having ongoing discussions with each other to enable the successful implementation and operation of REFCLs.

However, to support high voltage customers seeking timely information to perform their own works, distributors must provide the required information related to REFCLs upon a customer's request. Similarly, customers will be required, at the request of their distributor, to provide reasonable information to their distributor related to the operation of a REFCL. This obligation is important as the operation of REFCLs mature over time, and this obligation supports the approach of ongoing discussions and exchange of information between distributors and customers. We also recognise that Energy Safe Victoria has the ability to impose bushfire mitigation requirements on a customer as required under the Electricity Safety Act 1998.

³³ Saputo Dairy Australia, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p. 1.

³⁴ CitiPower, Powercor and United Energy, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p. 8; AusNet Services, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, pp. 5-6.

³⁵ Hon. Lily D'Ambrosio MP, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p. 2.

3. Changes to the code

Expanded obligations for distributors when operating REFCLs in modes other than the 'required capacity'

In section 3.2 of this paper, we outlined new voltage standards that will apply to REFCLs operating not only for bushfire mitigation purposes, but also for safety or reliability purposes where approved by a relevant regulator such as Energy Safe Victoria. The Department of Defence was concerned about customers having access to timely information related to these other operating modes of REFCLs, stating:

How will notification requirements for issues such as regular REFCL testing or their use for other functions such as reliability be managed and how will high voltage customers be kept informed.³⁶

Given these potential other modes of operation, we have introduced a new obligation for distributors to inform and discuss with affected customers when they intend to operate a REFCL outside of 'required capacity'. For example, under the new obligation in clause 9.1.14(c) of the code, the distributor must provide information to the customer on whether they will operate the REFCLs to meet 'required capacity' as well as for other modes throughout the year.

3.3.1. How the amendments will apply

Our final decision is to:

- Insert new clauses 3.5.1(d) and 3.5.3B to specify the inclusion of information on plans for a potential REFCL condition by a distributor in their Distribution System Planning Report.
- Amend clauses 9.1.9 and 9.1.10 to insert describing the information provision obligations for distributors to provide to customers related to REFCL requirements, at the customer's request.
- Insert new clauses 9.1.14 regarding information provision obligations by distributors to customers. These obligations include:
 - a) relevant information such as project planning, commissioning and other operational information to the assist the customer's own plans;
 - b) advice on the possible effects of the REFCL condition for the customer and steps the customer may take to eliminate or mitigate such effects;
 - c) information on the purpose for which the relevant equipment or technology is installed.

³⁶ Department of Defence, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p. 2.

- Amend clause 9.3.1(i) to require customers to provide information related to their private assets to distributors, at the request of the distributor in the context of operating REFCLs.

Many of these amendments are largely extensions of existing obligations in the code, which should not lead to material costs for distributors. It should also be noted that the intent of clauses 9.1.9, 9.1.10 and 9.1.14 were previously proposed in our draft decision as a new clause 3.5.5. It should also be noted that these obligations relate to customers as defined by the code, that is, it includes existing and new customers that may be affected by REFCL operations.

The obligations will also apply to customers who have the potential to be supplied electricity from a network under a REFCL condition due to reconfigurations of the network, such as load transfers. Distributors will be expected to engage and discuss with potentially affected customers under these scenarios.

3.4. Consequential amendments to the code

In our draft decision, we proposed a number of other consequential amendments to support the new voltage standards in the code. These consequential amendments were intended to be extensions of existing obligations in the code.

In particular, we proposed the inclusion of an obligation for distributors to use their best endeavours to minimise the frequency of voltage variations for periods of less than one minute. Several stakeholders did not support this change.³⁷

Energy Safe Victoria expressed concerns that such an obligation may reduce the bushfire risk mitigation benefits related to the operation of REFCLs.³⁸ CitiPower, Powercor and United Energy stated that the proposed obligation could prevent the use of REFCLs “to compensate for faults and to carry out annual testing of the equipment”.³⁹ Jemena and AusNet Services also stated that there are other regulations for distributors to minimise the number of interruptions caused by REFCLs,

³⁷ Energy Safe Victoria, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, pp. 1-4 and 6-8; AusNet Services, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, pp 4-5; Jemena, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, pp. 2-3; CitiPower, Powercor and United Energy, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, p. 8.

³⁸ Energy Safe Victoria, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, pp. 1-2.

³⁹ CitiPower, Powercor and United Energy, submission to the Essential Services Commission consultation paper ‘Review of Voltage Standards for Bushfire Mitigation: Draft decision’, June 2018, p. 8.

3. Changes to the code

such as the Service Target Performance Incentive Scheme and f-Factor Scheme administered by the Australian Energy Regulator, and Guaranteed Service Levels.⁴⁰

We recognise that there are a number of regulatory mechanisms intended for a certain level of reliability to be maintained. For this reason our final decision is not to include a best endeavours obligation on distributors to minimise the frequency of voltage variations as a result of REFCL conditions.

However, we recognise the concerns of the potential operational impacts on high voltage customers, as stated by Metro Trains:

REFCL asset damage leaves HV Customer services exposed to extended supply outages while damaged distribution company assets are located.⁴¹

Recognising these concerns and as described in section 3.3 of this paper, we have introduced new obligations on distributors to provide information to high voltage customers on the operation of REFCLs, and to inform and discuss with these customers when REFCLs are being used for other safety and reliability purposes.

It is also standard practice for distributors to conduct prudent asset management in monitoring and recording the performance of any type of technology they operate, including REFCLs. We have amended an existing obligation related to this standard practice.

3.4.1. How the amendments will apply

Our final decision amends clause 4.2.6 in the code that relates to monitoring and recording requirements. This will require a distributor to monitor and record voltage variations that exceed the prescribed limits of Table 1A at certain locations – at zone substations and the extremity of one feeder supplied from each substation. Monitoring of these variations will support clause 4.2.7 in the code related to the compensation of customers that applies when voltage variations exceed the prescribed limits during REFCL condition.

Clause 4.6 of the current code also requires distributors to manage negative sequence voltages at a certain level. Distributors have confirmed that these levels can be managed when REFCLs are

⁴⁰ AusNet Services, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p 4; Jemena, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p. 3

⁴¹ Metro Trains Melbourne, submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', June 2018, p. 2.

3. Changes to the code

operating and WSP in their review were not aware of this being an issue. Therefore we will not amend this clause.

3.5. When the code amendments take effect

Our final decision is for the amendments to the code take effect on 20 August 2018. This timing promotes certainty for stakeholders, and avoids a distributor or customer being in technical breach of the code prior to the commissioning of REFCL technology where prescribed by the bushfire mitigation regulations.

4. Summary of our final decision

In summary, our final decision amends the code primarily for the purposes of enabling the compliant operation of bushfire mitigation equipment, such as REFCL, on the 22kV Victorian network to support the Electricity Safety (Bushfire Mitigation) Regulations 2013. Our final decision also allows the operation of such REFCL technology for other purposes, where approved by Energy Safe Victoria.

The new code is available at our website and will take effect on 20 August 2018.

Appendix A also includes a summary of the new and amended clauses in comparison with our proposed changes in our draft decision.

Summary of our final decision

- Amend clause 1.2 to incorporate the code amendment starting date.
- Amend clause 3.5.1(d) and introducing new clauses 3.5.3B to require distributors to include information on future planning of REFCLs installations within a 5-year period in the Distribution System Planning Report.
- Amend clause 4.2.2 and introduce a new clause 4.2.2A, for voltage variation during REFCL condition. The amendment adds a new set of allowable voltage variations (Table 1A) for periods when REFCLs are operating. When REFCLs are not operating, the allowable voltage variations remain the same as per clause 4.2.2 Table 1.
- Amend clause 4.2.6 relating to monitoring and recording requirements. The amendment restructures and extends the requirement to monitor and record variations that exceed the prescribed limits during REFCL condition.
- Amend clause 4.2.7 relating to liability and compensation obligations. The amendment ensures that the compensation of customers applies when voltage variations exceed the prescribed limits during REFCL condition.
- Amend clauses 9.1.9 and 9.1.10 and introduce new clause 9.1.14. These amendments describe the information distributors must to provide customers related to REFCL installations and a REFCL condition.
- Amend clause 9.3.1(i), which describe the information provision requirements that up on request from a distributor, the high voltage customer to provide distributors with information related to their private assets and REFCL requirements.

4. Summary of our final decision

- Amend clause 16(c) relating to liability obligations. The amendment ensures that customers take reasonable measures to safeguard their own equipment during REFCL condition.
- New definitions in clause 19, which include:

Energy Safe Victoria

Rapid Earth Fault Current Limiter or REFCL

REFCL condition

relevant voltage

- Amend the existing definition of **voltage** in clause 19. This is to remove a possible conflict in the meaning of phase to phase voltage, i.e. whether this means Root Mean Square (RMS) or peak values. The definition has been clarified and made more consistent with the National Electricity Rules definition.

4. Summary of our final decision

Glossary

Term	Definition
Customer's electrical installation	Any electrical equipment at a customer's site that is connected to, but not part of, a distribution system
Code	Electricity Distribution Code
Commission	Essential Services Commission established by the Essential Services Commission Act 2001 (Vic)
Distributor	A person who holds a distribution licence under the Electricity Industry Act 2000
Nominal voltage	The voltage level that a distributor must maintain in accordance with clause 4.2.1 of the Electricity Distribution Code
Phase-to-Earth voltage	The voltage that exists between a phase conductor and ground in a three phase electrical system
Phase-to-Phase voltage	The voltage that exists between any two phases in a three phase electrical system
REFCL	Rapid Earth Fault Current Limiter
Reliability of supply	The measure of the ability of the distribution system to provide supply to customers
Voltage variation	A variation in voltage from the nominal voltage

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2009 Victorian Bushfires Royal Commission, Final Report Volume II: Fire Preparation, Response and Recovery, July 2010

Australian Energy Regulator - Submission on Electricity Distribution Code (EDC) - Review of Voltage Standards for Bushfire Mitigation - Draft decision, 7 June 2018.

AusNet Services - Submission in Response to Draft decision on the Review of Voltage Standards for Bushfire Mitigation, 22 June 2018.

CitiPower, Powercor and United Energy - Review of voltage standards in the Distribution Code, 22 June 2018.

Department of Defence - Electricity Distribution Code – Voltage standards Review 2018, 21 June 2018.

Department of Economic Development, Jobs, Transport and Resources, Regulatory Impact Statement, Bushfire Mitigation Regulations Amendments, November 2015.

Electricity Safety (Bushfire Mitigation) Regulations 2013

Energy Safe Victoria - Electricity Distribution Code - Review of Voltage Standards for Bushfire Mitigation - Draft decision, 12 June 2018.

Essential Services Commission Act 2001

Electricity Industry Act 2000

Gippsland Water – Rapid Earth Fault Current Limter (REFCL) – Impact Assessment, 22 June 2018.

Jemena - Electricity Distribution Code - Review of Voltage Standards for Bushfire - Draft decision - 22 May 2018, 22 June 2018.

The Hon. Lily D'Ambrosio MP - Essential Services Commission 2018, Electricity Distribution Code - Review of Voltage Standards for Bushfire Mitigation: Draft decision 22 May 2018 – Submissions of the Powerline Bushfire Safety Program, 21 June 2018.

Metro Trains Melbourne - Electricity Distribution Code - Review of Voltage Standards for Bushfire Mitigation 2018, 22 June 2018.

Pacific Energy Victorian Hydro - Email submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', 20 June 2018.

References

Saputo Dairy Australia - Email submission to the Essential Services Commission consultation paper 'Review of Voltage Standards for Bushfire Mitigation: Draft decision', 22 June 2018.

References

Essential Services Commission **Electricity Distribution Code – Review of voltage standards for bushfire mitigation**

Appendix A – Summary of final changes to the code compared to the draft decision

The following table outlines our changes to the Electricity Distribution Code in comparison with the changes proposed in our draft decision.

Clause	Draft decision proposed changes	Final decision changes
1.2	Version 9A amendments to this Code will take effect on [date to be the week after commission final decision] August 2018.	Version 9A amendments to this Code will take effect on 20 August 2018.
3.5.1(d)	<p>A distributor must submit to the Commission an annual report called the ‘Distribution System Planning Report’ detailing how it plans over the following five calendar years:</p> <p>...</p> <p>(d) to install REFCLs or undertake associated works and to operate part or parts of the distribution system under the REFCL condition (where applicable)</p>	<p>A distributor must submit to the Commission an annual report called the ‘Distribution System Planning Report’ detailing how it plans over the following five calendar years:</p> <p>...</p> <p>(d) to install any plant, equipment or technology that may result in a REFCL condition.</p>
3.5.3B	<p>In fulfilling the requirements of clause 3.5.1(d), the report must include an outline of the part or parts of distribution system that the distributor has or intends to;</p> <p>(a) undertake the installation of REFCLs or any associated works</p> <p>(b) operate under the REFCL condition</p>	<p>In fulfilling the requirements of clause 3.5.1(d), the report must identify:</p> <p>(a) the parts of the distribution system where the distributor has or intends to install REFCL; and</p> <p>(b) the parts of the distribution system where a REFCL condition may be experienced.</p>

Clause	Draft decision proposed changes	Final decision changes
3.5.5	Each distributor must; (a) identify and notify any existing business customer who may be affected by the installation or operation of REFCLs . The distributor must use best endeavors to provide such notification in a timeframe which allows the business customer a reasonable period to plan and implement any required works. (b) inform new or prospective business customer who are seeking to be connected to a part or parts of the distribution system potentially affected by the installation and operation of REFCLs of the voltage variation conditions set out in clause 4.2.2A.	<i>New clause not included as it has been effectively replaced by new or amended clauses 9.1.9, 9.1.10 and 9.1.14.</i>

4.2.2	Subject to clause 4.2.2A	Subject to clause 4.2.2A
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4.2.2A	The period of time during which the distributor is operating a part or parts of the 22kV distribution system under the REFCL condition the phase to earth voltage variations in clause 4.2.2 shall not apply and the phase to phase voltage variations may occur in that part or parts of the 22kV distribution system in accordance with Table 1A	During the period in which a REFCL condition is experienced on the distribution system (including when a REFCL condition arises from the commissioning and testing of a REFCL): (a) the Phase to Earth voltage variations in Table 1 of clause 4.2.2 do not apply; and (b) the Phase to Phase voltage variations in Table 1A apply to that part of the 22kV distribution system experiencing the REFCL condition .
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Table 1A

Nominal Phase to Phase Voltage Level in kV	Phase to Phase Voltage Range for Time Periods			Impulse Voltage
	Steady State	Less than 1 minute	Less than 10 seconds	
22	± 6 % (± 10 % Rural Areas)	± 10%	Phase to Phase +20%-100%	150kV

Table 1A

PHASE TO PHASE NOMINAL VOLTAGE VARIATIONS				
Voltage Level in kV	Voltage Range for Time Periods			Impulse Voltage
	Steady State	Less than 1 minute	Less than 10 seconds	
22	± 6 % (± 10 % rural areas)	± 10%	Phase to Phase +20%-100%	150kV peak

Clause	Draft decision proposed changes	Final decision changes
4.2.6	<p>A distributor must monitor and record:</p> <ul style="list-style-type: none"> • steady state voltages and voltage variations at each zone substation in its distribution system which are outside the limitations specified in Table 1; and • steady state voltages and voltage variations of a duration of more than one minute which are outside the range of steady state voltages specified in Table 1 at the extremity of one feeder supplied from each of those zone substations. • any voltage variations outside the limitations specified in Table 1A and the occurrence and the duration recorded at each zone substation where the distribution system is operating under the REFCL condition. 	<p>A distributor must monitor and record:</p> <ul style="list-style-type: none"> • steady state voltages and voltage variations at each zone substation in its distribution system which are outside the limitations specified in Table 1 and Table 1A; and • steady state voltages and voltage variations of a duration of more than one minute which are outside the range of steady state voltages specified in Table 1 and Table 1A at the extremity of one feeder supplied from each of those zone substations.
4.2.7	<p>Without limiting the liability of a distributor under any other provision of this Code, a distributor must compensate any person whose property is damaged due to voltage variations outside the limits prescribed by Table 1 and Table 1A in accordance with any relevant guideline</p>	<p>Without limiting the liability of a distributor under any other provision of this Code, a distributor must compensate any person whose property is damaged due to voltage variations outside the limits prescribed by Table 1 and Table 1A in accordance with any relevant guideline</p>
9.1.9	<p><i>This new clause effectively replaces the proposed clause 3.5.5 as per the draft decision.</i></p>	<p>On request by a customer, a person nominated by a customer, or by a retailer on behalf of a customer, a distributor must provide the customer, the customer's nominee, or retailer (as relevant) with information on the distributor's requirements in relation to any proposed new electrical installation of the customer or changes to the customer's existing electrical installation, including advice about:</p> <ol style="list-style-type: none"> supply extensions; and if the customer is or is to be connected to part of the distribution system that may experience a REFCL condition, advice on the possible effects of a REFCL condition on the customer's supply and steps the customer may take to eliminate or mitigate such effects.

Clause	Draft decision proposed changes	Final decision changes
9.1.10	<i>This new clause effectively replaces the proposed clause 3.5.5 as per the draft decision.</i>	On request by a customer , a person nominated by a customer or by a retailer on behalf of a customer , a distributor must provide the customer , the customer's nominee, or retailer (as relevant) with advice on: (a) the facilities required to protect the distributor's equipment; (b) how the customer should use the electricity supplied at the customer's supply address so that it does not interfere with the distributor's distribution system or with supply to any other electrical installation ; and (c) where the customer may obtain a copy of the standards which are given force by this Code.
9.1.14	<i>This new clause effectively replaces the proposed clause 3.5.5 as per the draft decision.</i>	A distributor must provide customers that are or may be connected to parts of the distribution system that may experience a REFCL condition : (a) relevant information such as project planning, commissioning and other operational information to assist the customer's own plans; (b) advice on the possible effects of a REFCL condition on the customer's supply and steps the customer may take to eliminate or mitigate such effects; (c) information on the purpose for which the relevant equipment or technology is installed.
9.3.1(i)	<i>Not proposed in draft decision</i>	A customer , embedded generator or retailer must, on request from a distributor , provide details of loads connected or planned to be connected to the distribution system which are required for the purpose of the distributor planning its distribution system , including: ... (i) any information the distributor may reasonably require in connection with a distributor's operation of a REFCL .

Clause	Draft decision proposed changes	Final decision changes
16(c)	<p>Liability</p> <p>...</p> <p>(c) A business customer must take reasonable precautions to minimise the risk of loss or damage to any equipment, premises or business of the business customer which may result from poor quality or reliability of electricity supply or the distribution system operating under the REFCL condition in accordance with clause 4.2.2A</p>	<p>Liability</p> <p>...</p> <p>(c) A business customer must take reasonable precautions to minimise the risk of loss or damage to any equipment, premises or business of the business customer which may result from poor quality or reliability of electricity supply or the distribution system operating under the REFCL condition in accordance with clause 4.2.2A</p>
19	<i>Not proposed in draft decision</i>	Energy Safe Victoria means the body established pursuant to section 4 of the Energy Safe Victoria Act 2005 (Vic) .
19	REFCL or REFCLs means Rapid Earth Fault Current Limiter or any other technology, which as minimum satisfies the required capacity as defined by the <i>Electricity Safety (Bushfire Mitigation) Regulations 2013</i> .	Rapid Earth Fault Current Limiter or REFCL means any plant, equipment or technology (excluding neutral earthing resistor) which is: (a) designed to reduce the effect of distribution system faults and which when operating as intended may lead to a REFCL condition ; and (b) approved by Energy Safe Victoria in an electricity safety management scheme or bushfire mitigation plan pursuant to the Electricity Safety Act 1998 (Vic) .
19	REFCL condition means operating conditions on the 22kV distribution system caused by the proper operation of REFCLs which results in the neutral reference of the three phase distribution system moving to allow the phase to earth voltage to approach a value close to the phase to phase voltage. To avoid doubt, the term operating conditions on the 22kV distribution system in this definition extends up to but not beyond any device or plant which is functionally equivalent to an isolating transformer.	REFCL condition means an operating condition on the 22kV distribution system arising from the proper operation of REFCL which results in the neutral reference of the distribution system moving to allow the un-faulted Phase to Earth voltage magnitude to approach a value close to the Phase to Phase voltage magnitude. The term 'operating condition on the 22kV distribution system ' in this term extends up to, but not beyond any device or plant which is functionally equivalent to an isolating transformer
19	relevant voltage means either phase to phase or phase to earth as applicable.	relevant voltage means either Phase to Phase or Phase to Earth as applicable.

Clause	Draft decision proposed changes	Final decision changes
19	<p>voltage means the root mean square (RMS) of the phase to phase voltage. To avoid doubt, this means the electronic force or electric potential between two points that gives rise to the flow of electricity, expressed as the root mean square (RMS) of the peak values (except in the case of impulse voltage).</p>	<p>voltage the electronic force or electric potential between two points that give rise to the flow of electricity expressed as the Root Mean Square (RMS) of the Phase to Phase voltage (except in the case of impulse voltage).</p>

Appendix B – Submissions to the draft decision

The following stakeholders provided submissions to our draft decision:

- Australian Energy Regulator
- AusNet Services
- CitiPower, Powercor and United Energy
- Department of Defence
- Energy Safe Victoria
- Gippsland Water
- Jemena
- The Hon. Lily D'Ambrosio MP
- Metro Trains Melbourne
- Pacific Energy Victorian Hydro
- Saputo Dairy Australia