ESSENTIAL SERVICES COMMISSION

Electricity Distribution Code review – Technical standards

Draft decision

3 December 2019

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Contents

Executive summary

The Essential Services Commission is the independent regulator that promotes the long-term interests of Victorians with respect to the price, quality and reliability of essential services. We regulate Victoria's energy, water and transport sectors, administer the rate-capping system for the local government sector and regulate the Victorian Energy Upgrades program.

In December 2018, we launched our review of the Electricity Distribution Code (the code). This code has an operational focus, managing the electricity network by setting minimum standards for distribution businesses. The code aims to promote system security and provide a level of service protections for Victorian customers. The code covers technical standards that govern the way electricity is supplied, and provides customer service standards such as compensation schemes and requirements for how distribution businesses are to communicate with customers.

We are undertaking our review of the code in multiple phases. After considering the feedback of stakeholders, recent policy announcements, and observed changes in the electricity industry, we prioritised our review of the code's technical standards. The second phase of the code review will focus on customer service standards. Stakeholders will be invited to engage separately on these standards in the coming months.

We also expect the code review to continue beyond the customer service standards to consider a wider range of matters and address any remaining items that may remain unresolved by 2020-21. This will also allow the commission to consider new emerging business models or technologies that might interact with the code or other regulatory instruments we administer.

Modernising our technical standards

In this draft decision, we are proposing amendments to the technical standards of the code. Technological advancement is enabling customers to take charge of their energy needs. Examples include installing solar generators or exploring new energy models such as micro-grids and the aggregation of small-scale power generators.

These changes should not be hampered by needless barriers for new energy technologies and service adoption that can provide benefits for Victorian consumers. So, the regulatory framework must support the operation of these technologies and business models in a manner that supports grid stability and customer safety.

We are proposing to adopt more flexible voltage standards for the low voltage parts of the network. But we also seek to retain existing customer protections particularly when compensating customers whose equipment are affected by excessive voltage variations. We also propose to update many technical standards of the code to align with relevant Australian Standards, industry best-practice or the National Electricity Rules. We will also update legacy standards and definitions with those that are the most current and relevant.

Our draft decision will modernise the code's technical standards and also help ensure that our code remains fit for purpose and for the long-term interest of Victorian consumers. In making our draft decision, we considered stakeholder comments and feedback to our approach paper and issues paper and public forums that we facilitated.

Our draft decisions

Draft decision 1: New voltage standards for more flexibility to the grid

We propose to implement more flexible voltage standards by adopting the equivalent Australian Standards (AS61000.3.100). This standards would enable a more dynamic approach towards the management of the electricity distribution system as the sector undergoes significant change.

We propose to only adopt the flexible standards for the low-level voltage parts of the network- below 1.0kV.

Draft decision 2: We will maintain customer protections for equipment damage by excessive voltage variation

We propose to retain a revised fixed voltage parameters in our current code guideline to enable a customer to seek compensation for damage (through the guideline process to a capped limit), without needing to demonstrate detailed cause of the damage, should they be affected by voltage variations.

These revised voltage parameters will continue their interaction code to continue their operation with our existing Guideline 11 – Voltage variation compensation.

Draft decision 3: Technical standards updated in line with industry best-practice

We propose to update legacy standards and regulations to promote industry best practice:

- Safety regulation – Clause 4.2.1, update reference to Electricity Safety (Network Assets) Regulations 1999 with the Electricity Safety (General) Regulations 2019
- Over voltage control – Clause 4.2.3, IEC 60364-4-443 to be updated with IEC 60364-4-44
- Powerline signal – Clause 4.2.5, IEC 1000-2-2 to be updated with AS/NZS 610002.2
- Current harmonics – Clause 4.4.3 and 7.6.2, update with IEEE 519-2014
- Inductive interference – Clause 4.5, update AS/NZS 2344-1997 with AS/NZS 2344-2016

Draft decision 4: Harmonise a range of technical standards with the National Electricity Rules

The technical standards and clauses we propose to harmonise with the National Electricity Rules include:

- Voltage harmonics – Clause 4.4.1 and 4.4.2 to be harmonised with the National Electricity Rules (S5.1a.6) and current Australian Standards
- Power factor – Clause 4.3, Table 2 to be amended. 100kVA power factor range to be increased from 0.75 to 0.8 (lagging)
- Negative sequence voltage – Clause 4.6 and 7.5 to be harmonised with the National Elelctricity Rules, Schedule 5.1a.7 (voltage unbalance, Table S5.1a.1).
- Disturbing load – Clause 4.8 of the code to be harmonised with the National Electricity Rules (S5.1a.5, voltage fluctuations)
- Distributed Energy Resource register - Clause 7.9 to be harmonised with the National Electricty Rules (new clause 3.7E), Part ZZZJ, clause 11.108 (register of Distributed Energy Resources - transitional arrangements). Consequential amendment to clause 9.1.3A to rectify incorrect reference to clause 7.8.
- Generating unit – Definition harmonisation with the National Electricity Rules to be technology neutral

Draft decision 5: Introduce new obligations for distribution businesses to report on how they are using smart meter technology

We will introduce new distributor reporting requirements on how smart meter technology is being used to enhance the management and operation of the distribution system. These changes aim to provide further transparency for policy makers and customers. Consequential amendments to clauses 3.5.1(e), 3.5.3C, new definition and schedule 1 are proposed to reflect.

Draft decision 6: Other technical standards to remain unchanged

Based on our review and following early stakeholder feedback, we propose not to change the standards relating to minimum technical requirements for embedded generation, supply frequency, impulse voltage, load balance and fault level.

Draft decision 7: Commencement date of code amendments

We propose to give effect to the proposed code amendments in March 2020.

Timeline for implementation

The key dates relating to this draft decision are as follows:

- 3 December 2019 – draft decision
- 16 December 2019 – stakeholder briefing on the draft decision
- 20 January 2020 – submissions to draft decision close
- March 2020 – final decision released

How to make a submission

Engage Victoria

We are seeking feedback on our draft decision **by 5pm on 20 January 2020** through Engage Victoria. To view our Engage Victoria page and information on how to make a submission, please visit Engage Victoria at:

Website: https://engage.vic.gov.au/

General enquires

If you have other general enquires or wish to discuss before submitting a written submission regarding this paper, you can contact us by:

Phone: (03) 9032 1300

Email: edc.review@esc.vic.gov.au

Website: https://www.esc.vic.gov.au/

Post: Attention: Energy division
Essential Services Commission
Level 37, 2 Lonsdale Street
Melbourne Vic 3000

Submissions will be published on the commission's website, except for any information that is commercially sensitive or confidential. Submissions should clearly identify which information is sensitive or confidential.

1. Context for this draft decision

The Electricity Distribution Code

The code is a multi-faceted regulatory instrument with an operational focus towards managing the electricity networks. It sets the minimum standards for the distribution networks, promotes system security and provides a level of service protections for Victorian customers. The code covers areas such as:

- protections for customers, such as when customers will be compensated for low reliability
- communication requirements, such as when distribution businesses are to contact customers before a planned outage
- certain process requirements, like new customer or generator connections
- technical standards that govern the way electricity is supplied

The technical standards in the code seek to promote the safe and efficient distribution of electricity through our community. Distributors must comply with these standards as a condition of their licence and have the primary responsibility to manage the network within the standards.

The code forms one part of the regulatory framework supporting the development, management and operation of Victoria's electricity network.

Appendix A provides further information on our role and the purpose of the code.

Early stakeholder feedback to our issues paper

Our August 2019 issues paper highlighted a range of emerging technical matters that we considered important to review. These included voltage standards, customer protection and technical standards that may interact with new business models. In general stakeholders agreed with us that these were the key issues facing the electricity grid. Stakeholders also expressed support for aligning and harmonising technical standards with Australian industry norms or best practice.

This draft decision proposes changes to our code to address the key technical matters identified in our issues paper. We encourage stakeholders to consider and provide submissions in response to those proposed amendments. These will further inform our final decision.

2. Voltage standards for more flexibility for the grid

We are proposing more flexible voltage standards in the code by adopting the Australian Standards. These standards better align with changes occurring in the electricity sector, recent government policy supporting small-scale generation and to further assist with managing the network.

Voltage is a characteristic of electricity and by extension the power system. A useful analogy to think of voltage is like water pressure in pipes. Pressure is necessary for water to flow through the pipes. The higher the pressure, the faster it flows. Similarly, voltage could be thought of as the electrical pressure for the power system. Too high or not enough voltage could lead to equipment malfunction across the system.

Clauses 4.2.1, 4.2.2 and 4.2.2A of the code sets out the voltage standards.

In our issues paper, we highlighted how the code sets technical standards for distributors to regulate the supply arrangements between customers and distributors. This is to achieve a safe and sustainable electricity grid.

We also highlighted how Victoria's electricity network is changing, with the increased uptake of distributed energy resources including solar generators and batteries across the networks. This change creates opportunities for the operation of the network, including the ability to better manage demand in peak periods. It also creates challenges, such as managing voltage within the levels prescribed by our code, to which a range of industry projects are researching and exploring.[1]

In our issues paper, we presented a range of approaches for the code to set voltage standards, particularly in the context of an electricity system that is changing from one that was designed for a one-way flow of electricity to a multi-directional flow system now. We proposed the following approaches to voltage standards:

- retaining the existing fixed voltage limits in the code
- adopting a 'best endeavours' approach or
- adopting the industry recognised Australian Standards 61000.3.100 (statistically based approach).

We also sought any alternative approaches proposed by stakeholders.

[1] Networks renewed, ARENA, https://arena.gov.au/projects/networks-renewed/

We propose to adopt flexible voltage standards

We propose to adopt the Australian Standard for voltage managment. This standard promotes flexbility in managing voltage for the grid.

In summary, the proposed code amendments reflect stakeholder views of adopting the Australian Standards to enable flexible voltage management, performance monitoring and maintaining customer protection.

Draft decision 1: New voltage standards for more flexibility to the grid

We propose to adopt more flexible voltage standards by adopting the equivalent Australian Standard (AS61000.3.100). The standard would enable a more dynamic approach towards the management of the distribution system as the sector undergoes significant change, for example, a greater volume of rooftop solar.

We propose to only adopt the flexible standards for the low-level voltage parts of the network (i.e. below 1.0kV). We propose changes to clause 4.2.2 of the code, which sets out the standards relating to voltage limits.

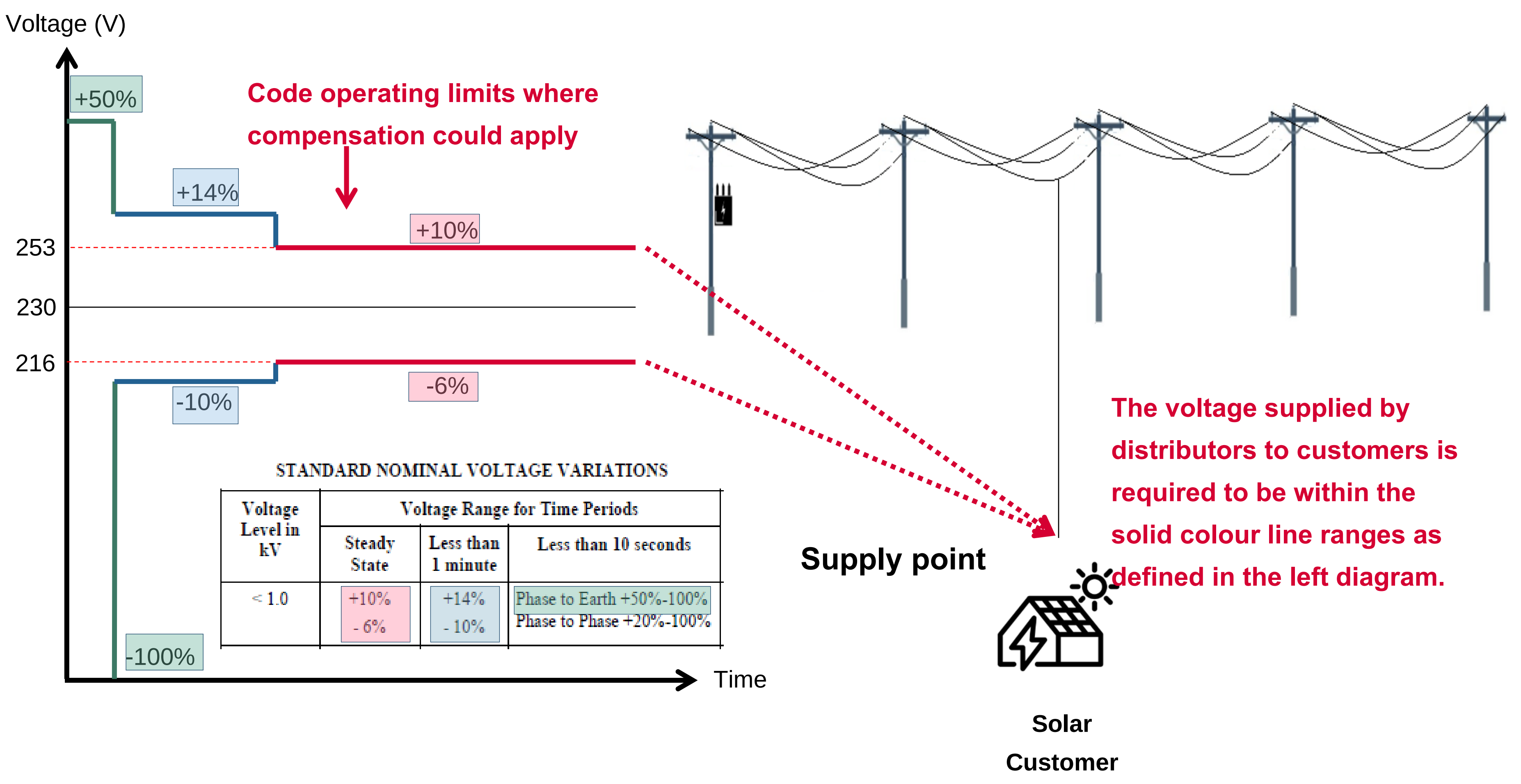
Figure 1 illustrates how the low voltage parameters of our standard currently apply to distributors for customers, set out at clause 4.2.2 of the code. Under steady state conditions (or normal, business-as-usual conditions), distributors are to manage voltage within a fixed limit. This is not the case for non-steady state conditions, such as periods of less than 1 minute or 10 seconds, where distributors are only required to use its best endeavours to manage voltage within limits – this is for abnormal conditions where voltage fluctuations may not instantly be controllable.

Figure 2 illustrates the comparison between the code's existing voltage standards and the Australian Standard. The proposed Australian Standard for voltage replaces the fixed limits of the code with a more flexible statistical based approach.

In practice, this means that distributors would not strictly manage voltage levels within the fixed limits of the code. Under the statistical approach, distributors would instead aim to manage voltage levels to be within the limits for 99 percent of time for customers on the network. This approach to flexible voltage management would allow for a more dynamic system, where distributors could adjust and optimise the network to suit more local conditions. This flexibility would also support and align with other initiatives such as the voltage response measures proposed in the Australian Energy Market Operator's Technical Integration of Distributed Energy Resources report.[2]

[2] Australian Energy Market Operator, Technical Integration of Distributed Energy Resources, p50 – 51.

Figure 1– Electricity distribution code voltage standards (existing)

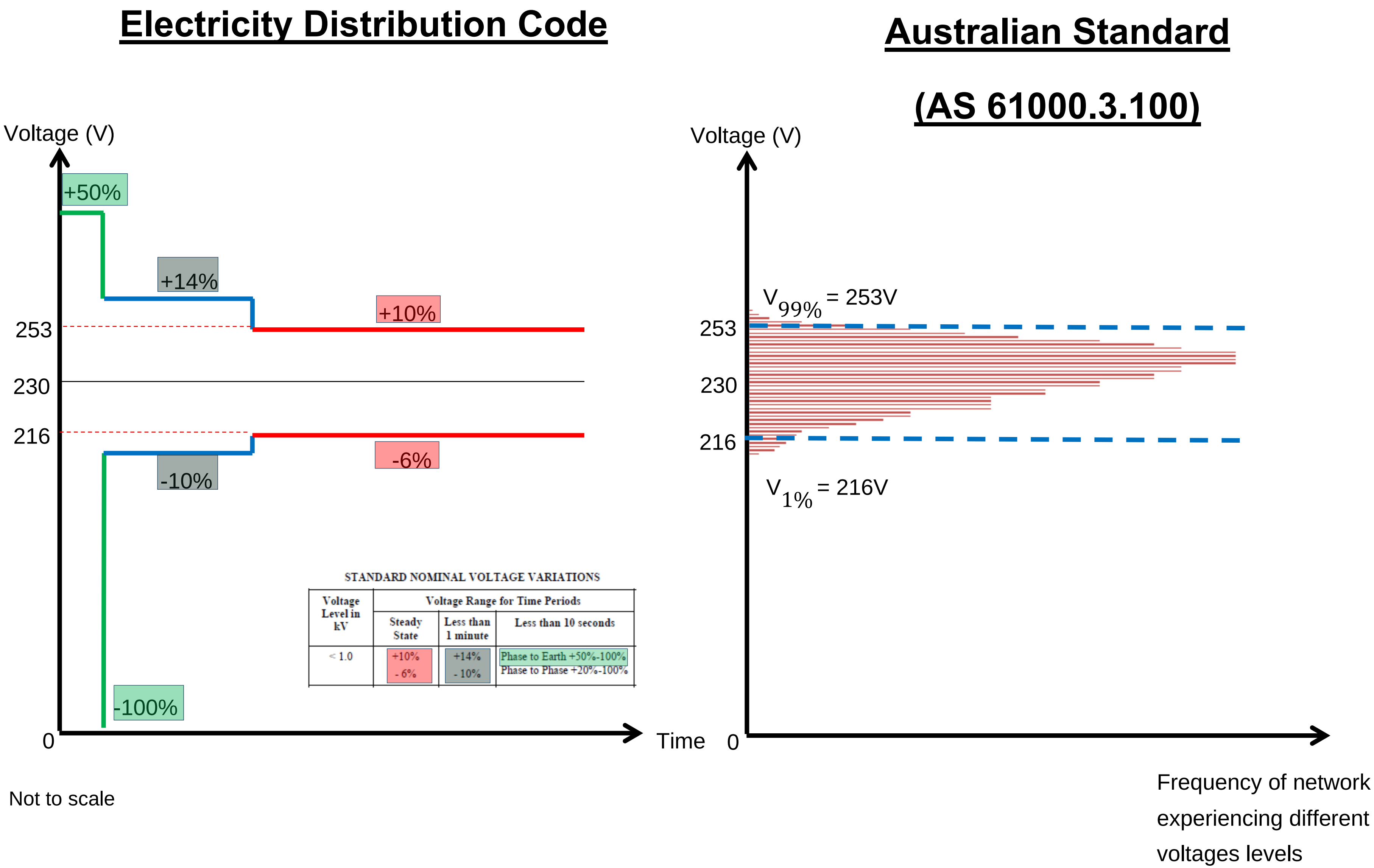


STANDARD NOMINAL VOLTAGE VARIATIONS

Voltage Level in kV	Voltage Range for Time Periods		
	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%

Not to scale

Figure 2 – Comparison of the Electricity Distribution Code and the Australian Standards (AS 61000.3.100) voltage standards



STANDARD NOMINAL VOLTAGE VARIATIONS

Voltage Level in kV	Voltage Range for Time Periods		
	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%

Updated requirements for reporting on voltage management performance

Given the flexibility provided to distributors to manage voltage, we would expect distributors to expand their monitoring of power quality to track voltage performance. With the deployment of smart meters across Victoria, we believe there are further opportunities to explore and leverage the capabilities of this technnology. Additionally, making this information more accessible and transparent to the public would promote innovation for new energy models to explore where non-network opportunities can be generated for customer benefits.

We propose new requirements on distributors to report annually and publicly on power quality information such as voltage. We will introduce a new clause 3.5.3C and also update clause 4.2.6 of the code relating to the reporting of voltage performance to reflect the requirements of Australian Standard AS 61000.3.100 of flexible voltage standards. Further reporting changes are set out in section 0 of this draft decision.

Consequential updates on standards for voltage variation frequency

In light of the proposed flexible voltage standards being adopted, we propose to make a consequential update to clause 4.2.4 (voltage variation frequency), to clarify the 1 minute to be conditional as applied in table 1 to the relevant sections of table 1.

Stakeholder feedback

Feedback at our August 2019 stakeholder forum, and stakeholder submissions to our issues paper, supported adopting the flexible approach to voltage management as set out in the Australian Standard (AS61000.3.100). This included stakeholders across consumer groups, distributors and retailers, providing the following comments:

> "Adopting the Australian Standards (AS 61000.3.100), as South Australia and New South Wales have done (with Queensland in the process) is preferable to taking a 'best endeavours' approach because it provides more certainty" [3]

> "Consumer Action supports suggestions to align standards prescribed in the code for voltage and harmonics with the Australian Standards. We trust that these standards provide a clearly defined and universally accepted specification of what performance consumers should expect from businesses" [4]

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[3] The Energy and Water Ombudsman of Victoria, submission to the Essential Services Commission issues paper, p12, 9 September 2019

[4] Consumer Action Law Centre, submission to the Essential Services Commission issues paper, p6, 9 September 2019

"Rather, we support Victoria adopting the Australian Standards (AS 61000.3.100) for voltage in the Electricity Distribution Code" [5]

"We support amending the steady state low voltage standards to align with the current Australian Standards" [6]

Our issues paper also explored a 'best endeavours' approach to managing voltage against fixed limits. Some stakeholders did not support this approach, believing the subjective nature of the obligation would make it difficult to enforce. Stakeholders provided the following comments:

"may likely cause disputation as 'best endeavours' are interpreted differently by various parties" [7]

"We also welcome these clear definitions in contrast to 'best endeavours' approach that are vague and potentially difficult for regulators to enforce" [8]

"…does not support a 'best endeavors' voltage standards……" [9]

While applying 'best endeavours' to voltage standards is one possible approach to voltage management, we agree that it may be more difficult to measure the compliance of distributors with a 'best endeavours' obligation compared to the Australian Standards. This approach would also not align with other jurisdictions and industry best practice where the Australian Standard (AS 61000.3.100) has been adopted for the low voltage system. A comparison of how other jurisdictions approach this matter is found in Appendix C.

CitiPower, Powercor and United Energy also noted that the Australian Standard (AS 61000.3.100) would be unsuitable to cover the high voltage range of the code, stating the following:

"We note the Australian Standards AS 61000.3.100 does not address phase-to-earth voltages. Further, there is no Australian Standard for high voltage (i.e. 66kV). On this basis, we do not advocate for changes to the steady-state medium and high voltages specified in clause 4.2.2 of the EDC" [10]

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[5] AGL, submission to the Essential Services Commission issues paper, p1, 13 September 2019

[6] Citipower, Powercor and United Energy, submission to the Essential Services Commission issues paper, p13 – 14, 13 September 2019

[7] The Energy and Water Ombudsman of Victoria. Submission to the Essential Services Commission issues paper, p12, 9 September 2019

[8] Consumer Action Law Centre, submission to the Essential Services Commission issues paper, p6, 9 September 2019

[9] AGL, submission to the Essential Services Commission issues paper, p1, 13 September 2019

[10] Citipower, Powercor and United Energy, submission to the Essential Services Commission issues paper, pages 14, 13 September 2019

We note that the Australian Standard AS 61000.3.100 covers both low and high voltage levels.[11] If adopted in its entirety, the Australian Standard would then replace the high voltage range of the code.[12] This is considered inappropriate due in part to how the standard (AS 61000.3.100) could interact with other state regulatory obligations, if adopted at differing voltage levels.

In 2018, we conducted a voltage review of the code to enable the introduction of advance bushfire mitigation technology called Rapid Earth Fault Current Limiter (REFCL) at the high voltage level. This took into consideration the requirements of the electricity safety legislation.[13] If the standard (AS 61000.3.100) were to be introduced to the high voltage level, a statistical cap may be unintentionally introduced as to how REFCLs may operate. This alters the approach from our 2018 review, which sought to promote flexibility for bushfire mitigation requirements and where appropriate, innovative use of the REFCL technology.

Due to the existence of REFCL technology in Victoria, we are not proposing to adopt the Australian Standard AS 61000.3.100 at the high voltage level. Instead, we are proposing to only adopt the Australian Standard AS 61000.3.100 for the low voltage level of the distribution system. Our proposed amendments to table 1 of clause 4.2.2 of the code reflects this approach.

We propose to maintain customer protections

The existing voltage standards of our code are also linked to a guideline administered by the commission, known as Guideline 11 – Voltage variation compensation.[14] This guideline complements the code by allowing a customer to seek compensation for damage (through the guideline process to a capped limit), should they be affected by voltage levels that exceed the existing fixed limits of the code. Table 1 shows that during the financial year 2018-19, there were over two thousand compensation claims made to distributors under Guideline 11.

Of these, 179 cases were raised with the Energy and Water Ombudsman (Victoria) for resolution.

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[11] Australian Standard AS 61000.3.100-2011, sections 5.1 - 5.2

[12] High voltage is defined as exceeding 1,000V (AC), Australian Standard AS 3000, clause 1.4.128, (c)

[13] Electricity Safety Act 1998

[14] Clause 4.2.7 of the code links existing voltage standards to Guideline 11, when dealing with customer compensation.

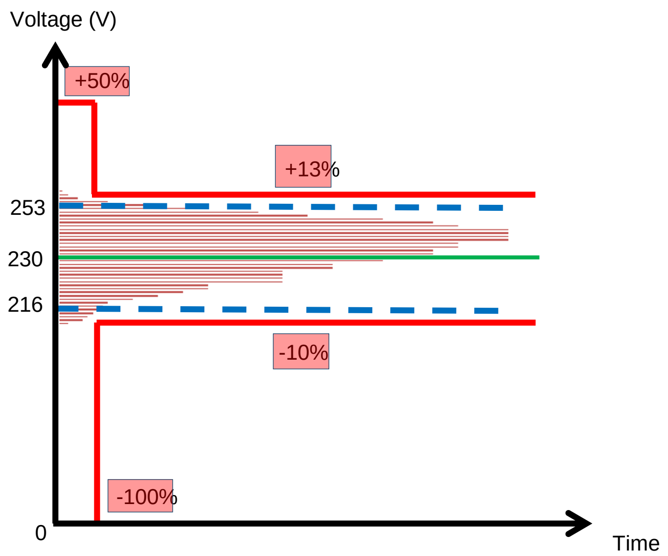
Table 1 – Guideline 11 compensation cases (FY 18/19)

<table>
<tr><th>Distributor</th><th>Distributor total customer numbers[15]</th><th>Distributor Guideline 11 compensation numbers</th><th>EWOV Guideline 11 cases[16]</th></tr>
<tr><td>Ausnet Services</td><td>666,021</td><td>398</td><td rowspan="5">179</td></tr>
<tr><td>Citipower</td><td>268,668</td><td>165</td></tr>
<tr><td>Jemena</td><td>325,214</td><td>100</td></tr>
<tr><td>Powercor</td><td>709,793</td><td>891</td></tr>
<tr><td>United Energy</td><td>623,481</td><td>45617</td></tr>
<tr><td>Total</td><td>2,589,177</td><td>2010</td><td>179</td></tr>
</table>

We understand that adopting a flexible voltage standard might create ambiguity for customers or distributors in relation to how Guideline 11 would apply or should be interpreted.

Therefore, we propose to retain a modified version of the existing fixed voltage limits of the code, for the purposes of customer compensation. This is illustrated in figure 3.

Figure 3 – Proposed flexible voltage standards (Australian Standards - AS 61000.3.100) overlaid with modified table 1 fixed limits for Guideline 11



[15] Defined as residential electricity active account owners with unique customer IDs

[16] The Energy and Water Ombudsman of Victoria submission, p2, 9 September 2019

[17] United Energy figures are only for the first half of 2019 due to migration to a new reporting platform

It is expected that distribution business would manage their network voltage in accordance with the flexible Australian Standard. This will then retain similar levels of protections for customers, while allowing flexible standards for managing voltage. Retaining the modified fixed limits will also streamline the burden of proof for customers using Guideline 11 and reduce the administrative or dispute process for customers and distributors.

Draft decision 2: We will maintain customer protections for equipment damage by excessive voltage variation

We propose to retain revised fixed voltage parameters in our code to enable a customer to seek compensation for damage (through the guideline process to a capped limit), should customers be affected by voltage variations.

These voltage parameters will be set out in table 1 of our code to continue their operation with our existing Guideline 11 – Voltage variation compensation.

Clauses 4.2.2 and 4.2.7 of the code sets the conditions that can bring about Guideline 11 – Voltage variation compensation.

The modified fixed voltage parameters are a simplified and consolidated version of the code's original fixed limit of table 1. It combines the steady state and 1-minute parameters. It should also be noted that we propose to increase the upper and lower voltage limit to +13% and -10% (from +10% and -6% respectively). This change aims to align with similar voltage parameters set out in the revised basic connection agreements proposed by distributors and approved by the Australian Energy Regulator.[18] These revised limits would also align with the voltage response measures proposed in the Australian Energy Market Operator's Technical Integration of Distributed Energy Resources report[19] and the smart inverter feature requirements being promoted as part of the solar homes program.[20]

Stakeholder feedback

The Consumer Action Law Centre and the Energy and Water Ombudsman (Victoria) suggested the importance of retaining the existing protections for customers provided for by the code and Guideline 11, noting the following:

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[18] Ausnet, Services submission to the Essential Services Commission issues paper, p11, 13 September 2019

[19] Australian Energy Market Operator, Technical Integration of Distributed Energy Resources, p50 - 51

[20] Solar Victoria Notice to Market - Solar Homes Program, p27, 27 August 2019, version 3

> “Certainly, it will be necessary to ensure customers remain compensated for damage caused by excessive voltage – even if voltage standards have been made slightly for more flexible to accommodate more complex generation mix in the grid” [21]

> “The straightforward system of compensating consumers for voltage variation should continue” [22]

These issues were also discussed in a technical workshop with stakeholders in August 2019.

[21] The Energy and Water Ombudsman of Victoria, submission to the Essential Services Commission issues paper, p12, 9 September 2019

[22] Consumer Action Law Centre, submission to the Essential Services Commission issues paper, p7, 9 September 2019

3. Modernising existing technical standards

The code has not been substantively reviewed for many years, and the industry has adopted a number of new standards (Australian Standards or internationally-recognised standards) that have not yet been updated in the code.

We propose to update several provisions and standards in the code in line with current industry standards, or the latest technical standards, jurisdictional approaches and frameworks.

Updating standards in line with industry norms and best-practice

Our proposed changes will update old standards to the latest versions or supersede old references and standards with more appropriate or modernised versions. We also propose some clarifying provisions where relevant. This chapter sets out our proposed updates to technical standards relating to over voltage control, powerline signals, inductive interference and harmonics.

Draft decision 3: Technical standards updated in line with industry best-practice

The code references legacy standards and regulations that we propose to update in line with industry best-practice, to ensure that the code remains fit for purpose. We propose to update the following standards of the code:

- Safety regulation – Clause 4.2.1, update reference to Electricity Safety (Network Assets) Regulations 1999 with the Electricity Safety (General) Regulations 2019
- Over voltage control – Clause 4.2.3, IEC 60364-4-443 to be updated with IEC 60364-4-44
- Powerline signal – Clause 4.2.5, IEC 1000-2-2 to be updated with AS/NZS 610002.2
- Current harmonics – Clause 4.4.3 and 7.6.2, update with IEEE 519-2014
- Inductive interference – Clause 4.5, update AS/NZS 2344-1997 with AS/NZS 2344-2016

Stakeholder feedback

Stakeholder feedback across consumer groups and distributors supported updating several technical standards in the code in line with Australian Standards or industry best-practice. For example, the Energy and Water Ombudsman (Victoria) and CitiPower, Powercor and United Energy stated the following:

> "As a general practice, if industry practice has out-stripped the regulatory framework then it is prudent to update the regulatory framework to reflect that practice." [23]

> "Clause 4.5 of the EDC sets out the requirement on distributors to manage inductive interference levels on the network. We consider that this clause remains relevant, and as there is no equivalent provision in the Rules, it should be updated to the current Australian Standard" [24]

Over voltage control

For many years our code has referred to older industry standards to prescribe what network controls must be in place to manage damaging large voltages (or over voltage). The older standard has been superseded from the International Electrotechnical Commission (IEC) 60364-4-443 to IEC 60364-4-44, which we propose to update (referred to in clause 4.2.3 of the code).

This standard (IEC 60364-4-44) requires distributors to manage weather-related or switching-induced overvoltage to protect the network. The new standard being an update of the old standard, its application should not materially affect the current management of the network and would reflect current industry practices.

Powerline signal

The code includes provisions that allow distribution businesses to use powerlines for communication purposes or to send signals to control equipment across the network, including at customer sites.

Some distribution businesses[25] stated that powerlines are no longer used to carry communication or control sigals. However, other distributors did not comment to support this provision no longer being required and it may be that new energy proponents may seek to explore this capability going forward. Under such circumstances retaining and updating the standard (AS/NZS 61000.2.2)

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[23] The Energy and Water Ombudsman of Victoria, submission to the Essential Services Commission issues paper, p14, 9 September 2019

[24] Citipower, Powercor and United Energy, submission to the Essential Services Commission issues paper, p18, 13 September 2019

[25] Citipower, Powercor and United Energy, submission to the Essential Services Commission issues paper, p15, 13 September 2019

to its modern equivalent would manage things such as inter-harmonics[26] as more high capacity power electronic equipment becomes connected to the distribution system.

We propose to retain and update the powerline signal provision of the code [clause 4.2.5 with the latest equivalent standard (AS/NZS 61000.2.2)]. This standard is designed to manage things like inter-harmonics emissions that are generally associated with high frequency signals, which could originate from power electronics and communication equipment.

Inductive interference

The code includes standards to manage the level of interference on communication equipment as a result of operating the electrical distribution system. This problem is known as inductive interference, and is caused by electromagnetic interference that can affect communication equipment such as radios or telephones.

We note the standards relating to inductive interference has recently been updated. We propose to update the standards referenced in clause 4.5 of the code (AS/NZS 2344-1997) to AS/NZS 2344-2016. We understand that these changes should reflect current industry norms and practices, and will not materially affect the management and operation of the grid.

Current harmonics

Harmonics is a measure of power quality (and describes the level of distortion in the pure sine wave of the power system ideal for all equipment).

High levels of harmonics can lead to the wastage of electricity, but this should be balanced against the cost to mitigate, which both distributors and customers have responsibilities to manage. For example, distributors must manage the network voltage harmonic limits and customers should be installing equipment that does not distort the harmonics outside the limits.

Clauses 4.4.3 and 7.6.2 sets the current harmonics standards of the code

The electricity distributors have suggested retaining the current harmonics provision of the code (clause 4.4.3) for various reasons. Distributors stated the following:

> "…recommends retaining existing harmonic distortion limits to avoid deterioration of REFCL performance…" [27]

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[26] Inter-harmonics are harmonic components, which are not a multiplier of an integer (i.e. whole numbers 1, 2, 3 etc.…), but a decimal number (i.e. 1.3, 2.7, 3.9 etc.) of the fundamental frequency.

[27] Ausnet Services, submission to the Essential Services Commission issues paper, p12, 13 September 2019

> "The obligation for customers to maintain current harmonics…should be maintained, as there is no direct equivalent obligations under the NER or in Australian Standards" [28]

We note that our code includes current harmonic standards that are unique to Victoria. As there is no direct equivalent Australian Standard that aligns with the Institute of Electrical and Electronics Engineers (IEEE) 519-1992, we proposed to retain an updated IEEE 519-2014 standard for clause 4.4.3 and 7.6.2.

Updated references to safety regulations in Victoria

Our code currently refers to the Electricity Safety (Network Assets) Regulations 1999 in the context of maintaining a nominal voltage level at the point of supply. The safety regulator[29] is currently reviewing their regulations, which is set to expire in December 2019. We expect the safety regulations to be remade this year and propose to update the relevant clause (4.2.1) to reflect this.

Harmonising relevant Victorian standards with the National Electricity Rules

The code contains many technical standards that have applied to the Victorian electricity distribution system for more than a decade. Some of these standards have been in place since the distribution system was managed and operated by the State Electricity Commission of Victoria until the 1990s.

Since then, new rules and standards have been introduced for the operation of distribution networks across Australia. These standards are included as part of the National Electricity Rules, which apply to the connected networks of Queensland, New South Wales, Australian Capital Territory, South Australia, Tasmania and Victoria. We propose to align relevant jurisdictional technical standards with the National Electricity Rules, particularly for standards relating to power factor, negative sequence voltage and disturbing load.

We also propose to update references and definitions to provide clarity for stakeholders and to avoid unnecessary duplication, such as linking with national requirements to maintain a register of distributed energy resources.

Draft decision 4: Harmonise a range of technical standards with the National Electricity Rules

[28] Citipower, Powercor and United Energy, submission to the Essential Services Commission issues paper, p17, 13 September 2019

[29] Energy Safe Victoria

The technical standards and clauses we propose to harmonise with the National Electricity Rules include:

- Voltage harmonics – Clause 4.4.1 and 4.4.2 to be harmonised with the National Electricity Rules (S5.1a.6) and current Australian Standards
- Power factor – Clause 4.3, Table 2 to be amended. 100kVA power factor range to be increased from 0.75 to 0.8 (lagging)
- Distributed Energy Resource register - Clause 7.9 to be harmonised with the National Electricty Rules (new clause 3.7E), Part ZZZJ, clause 11.108 (register of Distributed Energy Resources - transitional arrangements). Consequential amendment to clause 9.1.3A to rectify an incorrect reference to clause 7.8.
- Negative sequence voltage – Clause 4.6 and 7.5 to be harmonised with the National Elelctricity Rules, Schedule 5.1a.7 (voltage unbalance, Table S5.1a.1).
- Disturbing load – Clause 4.8 of the code to be harmonised with the National Electricity Rules (S5.1a.5, voltage fluctuations)
- Generating unit – Definition harmonisation with the National Electricity Rules to be technology neutral

Stakeholder feedback

Stakeholders submissions to our issues paper supported harmonising the code where appropriate. For example, Jemena, the Energy and Water Ombudsman (Victoria) and the Middleton Group (an engineering consulting organisation) providing the following comments:

> "… we seek that the harmonic voltage standard (that places obligations on distributors) to be aligned with the National Electricity Rules (NER, Rules) and Australian Standards to reduce the burden of compliance" [30]

> "Provided the register are like for like in terms of the information they require and their accessibility, then harmonization seems advisable on efficiency grounds if nothing else" [31]

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[30] Jemena Electricity, submission to the Essential Services Commission issues paper, p3, 13 September 2019

[31] The Energy and Water Ombudsman, submission to the Essential Services Commission issues paper, p13, 9 September 2019

'Harmonising the negative sequence limits of the code with the national limits seem like a good idea as it looks at different durations ensuring better resolution of data monitoring" [32]

Voltage harmonics

We propose to harmonise the voltage harmonics standard of the code with Australian Standards, which have also been adopted in the National Electricity Rules. We consider this change provides a consistent approach for stakeholders to manage harmonics on the distribution system and offer increased flexibility for the grid as it faces new types of connections.

The entire electricity system is designed to maintain total harmonic levels within prescribed limits for differing voltage levels. Total harmonics are made up of smaller harmonic components summed up to compose the total harmonics for a given point in the network. Generally this measure is called Total Harmonic Distortion (THD). When the total harmonics level becomes too high for a particular customer connection, it could affect the operation of the network and must be managed to appropriate limits.

The code currently prescribes a limit of 3% THD for the high voltage ranges. However, the Australian Standard prescribes limits between 3% to 6.5% THD for different high voltage ranges. Further information is provided in Appendix E.

Distributors provided different views on whether we should change the voltage harmonic limits of the code. AusNet Services did not advocate for change to the existing, stating the following:

"Distribution business have deployed substantial numbers of Rapid Earth Fault Current Limters (REFCLs) to prevent the ignition of bushfires … does not support adopting AS 61000.3.6 and recommend retaining existing harmonic distortion limits to avoid deterioration of REFCL performance or associated costs to resolve" [33]

Jemena, Citipower, Powercor and United Energy supported harmonising the standard with national standards:

"we support harmonising with the Rules by deleting clauses 4.4.1 and 4.4.2 of the EDC, but retaining clause 4.4.3. However, we note that the operation of REFCLs and the impact on harmonics needs to be further considered" [34]

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[32] Middleton Group, submission to the Essential Services Commission issues paper, p2, 4 September 2019

[33] Ausnet Services, submission to the Essential Services Commission issues paper, p12, 13 September 2019

[34] Citipower, Powercor and United Energy, submission to the Essential Services Commission issues paper, p26, 13 September 2019

> "…Adopting the AS in the code for harmonic voltage will not worsen the issue at REFCL substations….. We recommend the adoption of AS TR IEC 61000.3.14-2013 for harmonics for low voltage electrical installations and AS 61000.3.6-2012 at medium and high voltage installations." [35]

We note that distributor concerns relating to voltage harmonics revolve around the operation of REFCLs on the network, which is mandated by Victorian Electricity Safety Legislation.[36] The legislation has mandated the rollout of REFCLs on selected parts of the distribution system, with the expected completion of the rollout by 2023.

We note the application of REFCL technology for bushfire mitigation is new to Victoria. AusNet Services highlighted a specific condition to operate this technology under bushfire safety conditions. Managing harmonics to such a level is not found anywhere other than to achieve the condition prescribed under the bushfire mitigation regulations required capacity:

> "REFCL performance and ability to perform this task becomes compromised by harmonic voltage distortion greater than 2%" [37]

We also note the rollout and operation of REFCLs is primarily driven by requirements under the Electricity Safety Legislation. These requirements apply to specific areas of the network, particularly those areas with high bushfire risk.

In the same way, the safety legislation and supporting regulations require REFCLs to operate with conditions where harmonics need to be managed at levels below the existing standards of the code. Therefore, we understand that our existing voltage harmonics standard may not address the more stringent performance requirements of REFCLs. Put another way, where REFCLs are being deployed, the harmonic limits we set in our code would be superseded by the requirements to operate REFCLs as per the conditions of the Electricity Safety Legislation and regulations. In parts of the network where REFCLs are not being deployed, our code standards would apply.

We have then considered how voltage harmonics should be managed across most of the Victorian distribution system, particularly those areas where REFCLs are not being deployed. We recognise that our code currently sets voltage harmonic limits lower than the Australian Standards. These lower limits have been in the code for more than a decade and provides less flexibility for distributors in managing the grid compared to networks interstate.

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[35] Jemena Electricity, submission to the Essential Services Commission issues paper, p4 and p11, 13 September 2019

[36] Electricity Safety Act 1998

[37] Ausnet Services, submission to the Essential Services Commission issues paper, p12, 13 September 2019

Therefore, we propose to harmonise voltage harmonics limits with the Australian Standard. This will align with normal industry practices in Australia, which could also require less investment from distributors when managing voltage harmonics to most of the Victorian network (areas where REFCLs are not deployed). We do not propose to change the harmonic standards relating to current, which is discussed further in section 4.

Power factor

> **Power factor** is a measure of the efficient use of electricity. The closer a customer's power factor is to 1, the more efficient their usage would be. For example, a small welding machine may have relatively poor power factor compared to a washing machine or a dish washer. Unless measures are taken to improve power factor, higher electricity consumption or wastage would result.
>
> Clause 4.3 sets the power factor standards

We reviewed power factor standards that apply in other state jurisdictions and the National Electricity Rules against those in Victoria (see appendix D). We found that Victoria has the lowest minimum power factor value of 0.75 (lagging).

Power factor standards can help optimise the operation of distribution system and equipment. For example, solar inverters are generally designed to operate effectively within certain power factor ranges. However, a customer load and any locally installed generation should not be expected to behave coincidentally to mitigate power factor requirements.

To harmonise with industry best practice and for better alignment with current equipment performance, we propose to increase the lagging power factor from 0.75 to 0.8. We propose to only change the power factor for below 100kVA parts of the network (as per clause 4.3.5, table 2 of the code).

This updated standard clarifies the expected power factor range for distributors when planning upgrades to the network. The standard also provides an appropriate signal for customers to maintain or improve their power factor, given it is a 'best endeavour' provision in the code.

Negative sequence voltage and disturbing load

> **Negative sequence voltage** is part of an analytical method used in electrical engineering. It describes the voltage being in reverse rotation from the power system's normal rotation. During normal system operation, the presence of negative sequence could be a sign of some system imbalance due to a range of factors.
>
> One way to picture negative sequence is the unbalanced wobble of a spinning fan blade, if the weight or shape of one blade is different to the other blades.

Clause 4.6 of the code sets the negative sequence limits.

Disturbing loads come from equipment or plant which, by their operation, may affect supply quality at the connection point. Such equipment must be designed, installed and operated to manage this.

Clause 4.8 of the code sets the disturbing load standards.

The existing standards relating to the management of negative sequence voltage and disturbing loads in the code have been supersed by updated technical standards, which has also been adopted by the National Electricity Rules. The relevant standards of our code have been in place for over a decade, and do not necessarily represent current industry pracitce when managing these network characteristics.

We propose to harmonise our standards for negative sequence voltage with the National Electricity Rules for both distributors and embedded generators (clause 4.6 and 7.5 of the code respectively). Appendix E provides a comparision of the negative sequence voltage between our code and the National Electricity Rules.

We also propose to harmonise our standards for disturbing loads by making reference to the national framework (clause 4.8 of the code). In practical terms, this change has minimal effect on the management of the network as the same standard is referenced in the national framework and the code. Harmonising our code with the national framework will provide clarity, consistency and simplicity for customers to comply with requirements to minimise disturbing loads on the grid.

Definition of a 'generating unit'

Our code currently includes a definition of a 'generating unit' that is based on the common generation technology installed from more than a decade ago:[38]

> ***generating unit*** means an electricity generator and related equipment essential to its operation, which together function as a single unit

Since then, the electricity network has seen the increased connection of other generation technologies, such as wind power or solar farms, that may not be captured by our existing definition of a 'generating unit'. Our current definition reflects the traditional synchronous-based units as the representative definition simply because there was no other technical alternative that

[38] Electricity Distribution Code, version 9A, p41.

was practical and economical. However, modern technology such as batteries are changing this as they can both produce and absorb electricity.

We propose to update the definition of a ‘generating unit’ to be technology neutral so that it can account for generation technologies such as solar PV and battery storage. Our proposed definition aligns with the definition of a ‘generating unit’ under the National Electricity Rules. It should be noted that when this definition was recently updated in the national framework, stakeholders supported the updated definition for technology neutrality.[39] We welcome views from Victorian stakeholders on our proposed definition as it relates to the code.

Applying the use of the national register for distributed energy resources

The code currently requires distributors to maintain a register of embedded generators connecting to their network. Embedded generators include any generation facility such as small-scale solar PV generators, or larger combustion-based power generators.

However, from 1 December 2019, the Australian Energy Market Operator will launch its national register of distributed energy resources. This register aims to capture necessary information on distributed energy resources connected to help support the management of the grid. The register also requires distributors to request relevant information from qualified electrical contractors and solar installers at the time of the installation of these devices or equipment.

To avoid unnecessary duplication, we propose to align our requirements for distributors to maintain a register of embedded generators with those of the recent national requirements (under the National Electricity Rules). We propose to amend clause 7.9 to reflect the national register, and a consequential amendment to clause 9.1.3A of the code to rectify an incorrect reference to clause 7.8 (to clause 7.9).

[39] AEMC 2016, Rule determination: National Electricity Amendment (Registration of proponents of new types of generation) Rule 2016, 26 May 2016, p5.

4. Other considerations to support grid management

There are other standards and requirements for distributors in the code that support the management of Victoria's electricity distribution system, including obligations on electricity distributors to report to us on their performance.

Reporting requirements for distributors on the use of smart meter technology and data

The code currently includes requirements on distributors to report annually on planned investments and upgrades on each of its networks through a report known as a Distribution System Planning Report (also known as a Distribution Annual Planning Report as per the national regulatory framework). These reports also require distributors to publicly identify network constraints and opportunities for demand management and embedded generation.[40] We also recognise that distributors have also visualised this type of information through online map-based systems.[41]

Following the summer outage of 2017-18, the Victorian government conducted a review of the event. The review highlighted the need for distributors to improve the transparency and accessibility of information on network constraints, outage events and trends over time.[42] The review recommended that distributors make this information available on their websites in a timely manner.

We agree with the Victorian government that publication of this network information should support the operation of the network. We also recognise that this information can help customers and businesses to identify commercial opportunities when distributors are considering alternatives to investing directly in upgrading the network.[43] We are also aware that distributors have produced interactive online maps that report on the outages occurring on their networks.

To further these and other endeavours, we consider smart meters could provide more granular information. Victoria is a leading jurisdiction in the deployment of smart meter technology, and this

[40] Electricity Distribution Code, clause 3.5

[41] Australian Renewable Energy Mapping Infrastructure, ARENA, https://nationalmap.gov.au/renewables/

[42] Post event review – Power outages 28 and 29 January 2018, Department of Environment, Land, Water and Planning, https://www.energy.vic.gov.au/safety-and-emergencies/past-energy-emergencies

[43] The National Electricity Rules have specific requirements as part of the demand management incentive scheme and demand management innovation allowance mechanism (National Electricity Rules, Schedule 5.8, clauses 6.6.3 and 6.6.3A).

offers other opportunities for distributors to leverage their capabilities such as system performance monitoring.

Therefore, we propose expanding the reporting requirements of distribution businesses to report on how they are using smart meter technology. We aim to provide further transparency for policy makers and industry on how distributors utilise smart meter technology to enhance the management and operation of the distribution system.

Draft decision 5: Introduce new obligations for distribution businesses to report on how they are using smart meter technology

We will introduce new distributor reporting requirements on how smart meter technology is being used to enhance the management and operation of the distribution system. These changes aim to provide further transparency for policy makers and customers.

We propose introducing clauses 3.5.1(e), 3.5.3C, new definition and schedule 1 to set out new reporting requirements for distributors.

We are particularly interested in requiring distributors to use smart meter technology and data to report on some key operational areas. We propose that distributors include in their annual Distribution System Planning Reports, information on how smart meter technology is used to support:

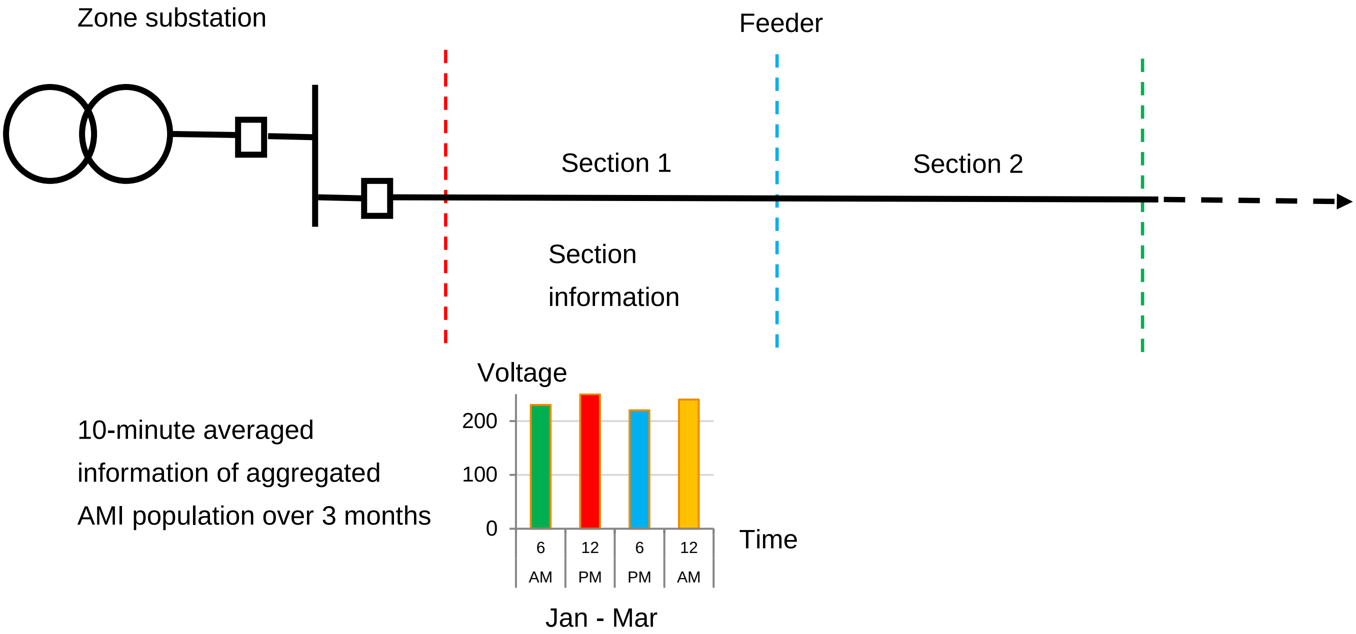
- life support customers
- demand management initiatives and
- network reliability initiatives.

We propose a general obligation for distributors to provide information in their reports regarding these topics. However, we are interested in stakeholder views on the type of public information that would be useful to stakeholders and the Victorian community.

With our proposed introduction of flexible voltage standards, we are also interested in understanding distributors performance in network power quality at an aggregated level. This will provide further transparency and accountability of distributors’ performance, given the proposed flexible voltage management standards. We are proposing additional information that distributors should make available on power quality in a new schedule 1 of the code. Figure 4 illustrates how a distributor could make information on the performance of its voltage management publicly available, based on our proposed requirements.

We welcome stakeholder views on the type of information and level of details distributors should be expected to report on performance related matters. In this context, we highlight the commission's Compliance and Reporting Guideline (CPRG) framework as a potential platform to be leveraged.

Figure 4 – Proposed voltage performance information concept illustration



Stakeholder feedback

As part of our issues paper, several stakeholders supported new requirements for distributors to report on certain operational areas. The Minister for Energy re-emphasised improving transparency in the use of smart meter technology by distributors, and Onsite Energy Solutions (a retailer) was interested in increased granularity of voltage performance across the network, as follows:

> "The ESC consider the inclusion of annual reporting obligations for distributors to report on their use of smart meter technology and options to improve transparency by publishing information online" [44]

> "…supports an increased obligation on distribution businesses to increase the granularity of voltage monitoring across their network" [45]

[44] Letter from the Minister for Energy, Environment and Climate Change, p7, 17 September 2019

[45] Onsite Energy Solutions and Energy Makeover, submissions to the Essential Services Commission issues paper, p4, 13 September 2019

We agree that increased reporting requirements for distributors will provide improved transparency on key operational areas of the grid. We also understand that distributors have begun developing capabilities to utilise smart meter technology for more dynamic management of the grid. Therefore, we do not consider these additional reporting requirements are an excessive burden for distributors.

Technical standards we propose not to change

The following matters contained in this section are not proposed to be updated. We consider these standards remain fit-for-purpose for the current operation of the network or may require further exploration to consider their affects. We note that stakeholders did not comment or raise issues relating to some specific technical standards.

Draft decision 6: Other technical standards to remain unchanged

Based on our review and following early stakeholder feedback, we propose not to change the standards relating to minimum technical requirements for embedded generation, supply frequency, impulse voltage, load balance, fault level.

Minimum technical requirements for embedded generation

Some stakeholders proposed common technical parameters to be defined in the code for embedded generation technologies. Stakeholders were particularly concerned about standards relating to generator protection and control settings such as over and under voltage and frequency setpoints, rate of change of frequency and vector shift.[46]

We considered that it was inappropriate to prescribe technical parameters for embedded generators for the following reasons:

- For a basic type residential generator connection involving inverter-based technology (such as rooftop solar PV installations), the Australian Standard AS4777 already defines these settings for the installation of the equipment 'behind-the-meter'. As the code focuses on standards for the operation of the grid rather than private customer assets, we consider that the widespread application of AS4777 for behind-the-meter embedded generators is more appropriate to be part of the standard and not the code.

[46] Energy makeover and Onsite Energy, submissions to the Essential Services Commission issues paper, p5 respectively, 13 September 2019.

- For negotiated type generator connection, irrespective of the generation technology, we recognise that customers and distributors would negotiate optimal technical requirements that are bespoke and unique to that connection.
- The technical parameters being proposed for the code would also need to consider other factors such as those involving electricity safety. Furthermore, the operational and technical requirements for specific equipment or plant makes it impractical to implement in practice. For example, synchronous and inverter-based generation technologies have differing technical characteristics. To prescribe common protection and control settings would likely lead to incompatibilities with either of these generation technologies.

Supply frequency

Our August 2019 issues paper highlighted emerging new business models such as micro-grids and stand-alone power system. Some of these models could be designed to disconnect from the wider network and operate self-sufficiently. However, this means the management of technical matters such as frequency may reside with an entity other the Australian Energy Market Operator, such as the operator of the micro-grid or stand-alone power system.

Frequency

Supply frequency is an operating characteristic of the power system, and results from the physical spinning of electricity generators. The management of frequency is necessary for the safe, stable and secure delivery of electricity to customers. If frequency becomes too high or low, equipment connected to the network may stop working. In very unusual circumstances, unstable frequency could also lead to system wide instability and malfunction.

Stakeholders had varying views on introducing new obligations in these areas. Some stakeholders proposed new requirements, while others suggested different reviews and projects as being more appropriate to consider frequency. We recognise this is a complex and emerging area, with a growing interest in these new operating models. We are also conscious of other ongoing research and pilot projects that might interact with our code requirements.

Therefore, we propose to explore these matters as part of our intended wider review of the code in 2020. This will provide time to consider new information from relevant research and the outcomes from recent trials, such as the microgrid demonstration projects currently being supported by the Victorian government.[47]

Impulse voltage

We do not propose to amend the impulse voltage levels set out in the code. We consider that retaining the current impulse voltage levels support the compliant operation of existing assets on the network. We also note the code does not prevent distributors and customers negotiating an arrangement that allows for impulse voltages to be at lower levels.

In August 2018, we made a final decision to change the voltage standards applicable for the 22kV distribution system. This was to enable the introduction and operation of bushfire mitigation technology known as REFCLs.

Since our final decision last year, some stakeholders commented on the impulse voltage rating (150kV) of our code being different from the latest equipment standards. We note that throughout the 2018 consultation process, the submissions received did not indicate this being a specific issue, also noting that Energy Safety Victoria also did not raise impulse voltage ratings as a concern.[48]

Our 2018 decision paper concluded that direct negotiation between distributors and customers allows for the most efficient solution to be agreed upon between both parties. It should also be noted that the code includes a clause that provides for negotiation between distributors and customers, allowing for conditions that are bilaterally agreed.[49] We consider this is more appropriate than network-wide standards set out in the code.

Some stakeholder submission to our August 2019 issues paper suggested we consider a tiered approach to impulse voltage levels. This proposal sought the overhead distribution system retaining the existing 150kV level, and that underground assets would adopt a new lower impulse value of 125kV.[50] Another stakeholder proposed adopting a single reduced 125kV impulse level.[51]

Based on publicly available information, such as the Regulatory Information Notices published by the Australian Energy Regulator, we understand that most distribution assets are still

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[47] Department of Environment, Land, Water and Planning, 2019, Microgrid Demonstration Initiative, available from: https://www.energy.vic.gov.au/microgrids

[48] Energy Safe Victoria submission: Electricity Distribution Code – Review of voltage standards for bushfire mitigation – draft decision, 12 June 2018, p7

[49] Electricity Distribution Code, Clause 1.6

[50] Citipower, Powercor, United Energy submission, p16, 13 September

[51] Middleton group submission, p1, 4 September 2019

predominantly of the overhead category. Furthermore, engineering solution such as surge arrestors could provide alternative mitigation measures.[52] Given this, we consider that it is appropriate to retain the existing overhead impulse value of 150kV to cover most of the assets applicable for the Victorian distribution system. We propose to retain the existing impulse levels of 150kV for the 22kV, 95kV for 11kV and 60kV for the 6.6kV systems.

It should also be noted that the code sets a maximum impulse voltage value. Where bespoke arrangements are required between customers and distributors, the code allows for both parties to negotiate appropriate solutions that may be below the 150kV impulse voltage level in the code.

Load balance

Load balance refers to those customers having a three-phase power supply that their equipment and systems should be balanced across these three phases.

The code provides for two approaches for load balance:

- negotiation to suit bespoke cases
- reasonable technical standards involving connections

We consider that these existing approaches would provide sufficient scope not to require amendment to these provisions.

Fault level

No specific matter was raised by stakeholders in this area. Therefore, we are not proposing any amendments or updates to this topic.

Other general updates

We propose other general updates for the code to reflect current legislation, regulations, referenced documents and definitions. The accompanying amendments document captures these updates. For clarity, the proposed updates to the latest references include:

- updating reference to AEMO documents to reflect the latest Single Industry Protocol for Electricity in Victoria
- updating the liability clause to reflect the Competition and Consumer Act 2010 and Australian Consumer Law (Victoria)

[52] Middleton group submission, p1, 4 September 2019

- updating the reference of ‘approved statement of charge’ to be the charge determined by the AER
- updating the definition of the ‘AER’ to reflect the Competition and Consumer Act 2010
- updating to include the five-minute interval settlement to reflect the NER rule change
- updating the definition of ‘electrician’ to reflect the latest Electricity Safety (General) Regulations 2019
- updating the definition of a ‘meter' to harmonise with the metering code
- updating the Metrology Procedure to reflect AEMO procedure
- harmonising the definition of a ‘price determination’ with reference to the AER and
- harmonising the definition of a ‘regulatory test’ with reference to the AER.

5. Next steps

How to make a submission

Engage Victoria

We will continue to consult with interested stakeholders and invite you to contribute your views by making a submission in response to this draft decision in writing **by 5pm on 20 January 2020**.

Submissions marked 'Submission to Electricity Distribution Code review: Technical standards draft decision' should be sent to Engage Victoria. To view our Engage Victoria page and information on how to make a submission, please visit Engage Victoria at:

Website: https://engage.vic.gov.au/

General enquires

If you have other general enquires or wish to discuss before submitting a written submission regarding this paper, you can contact us by:

Phone: (03) 9032 1300

Email: edc.review@esc.vic.gov.au

Website: https://www.esc.vic.gov.au/

Post: Attention: Energy division
Essential Services Commission
Level 37, 2 Lonsdale Street
Melbourne Vic 3000

To promote an open and transparent decision-making process, all submissions will be made available on the commission's website, except for any information that is commercially sensitive or confidential. Submissions should clearly identify which information is sensitive or confidential.

Our approach to consultation is set out in our updated Stakeholder Engagement Framework.[53]

[53] Essential Services Commission, Stakeholder engagement framework – Charter of Consultation and Regulatory Practice, June 2018.

Indicative timelines

Target date	Activity
3 December 2019	Draft decision released
Mid December 2019	Briefing on the draft decision
20 January 2020	Submissions close
March 2020	Final decision released and code amended
March 2020	Amendments come into effect

Commencement of new requirements

We also propose that the new technical standards are take effect from the time of our final decision.

Draft decision 7: Commencement date of code amendments

The anticipated commencement date for the code amendments is at the time of our final decision, likely to be in March 2020.

Abbreviations

Insert term	Insert definition
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AMI	Advanced Metering Infrastructure
AS	Australian Standards
ESV	Energy Safe Victoria
IEC	International Electrotechnical Committee
IEEE	Institute of Electrical and Electronics Engineers
REFCL	Rapid Earth Fault Current Limiter
THD	Total Harmonic Distortion
TR	Technical Report

Appendix A – Our role and purpose of the code

Our role

The commission is Victoria's independent economic regulator. Our key objective is to promote the long-term interest of Victorian consumers with respect to the price, quality and reliability of essential services.[54]

Among other things, we are responsible for granting licences to anyone wishing to generate, transmit, distribute or retail electricity in Victoria. We may grant licences subject to any conditions we consider appropriate having regard to our objectives under the:

- Electricity Industry Act (2000) and the
- Essential Services Commission Act (2001).[55]

Licenced electricity distributors are required to comply with energy rules that we set out for them. These rules are set out in codes and guidelines and include (but are not limited to):

- Electricity Distribution Code (the code)
- Guideline 14: Electricity Industry – Provision of services by electricity distributors
- Guideline 15: Electricity Industry – Connection of Embedded Generation

In addition to state laws and our regulations, distributors are governed under the national regulatory framework. This framework is established under the National Electricity Legislation and the National Energy Rules. It generally differs from our remit by focusing on the economic regulation of the businesses and not on the non-economic regulatory matters (for example service standards and technical standards).

Purpose of the code

The purpose of the code is to set minimum service standards for the distribution network that tries to safeguard system security and provide a level of service protections for customers.

> The purpose of this Code is to regulate the following activities so that they are undertaken in a safe, efficient and reliable manner:
>
> (a) the distribution of electricity by a distributor for supply to its customers;

[54] Essential Services Commission Act (2001), section 8, (1), (2)

[55] Electricity Industry Act (2000), sections 19–20

(b) the connection of a customer's electrical installation to the distribution system;

(c) the connection of embedded generating units to the distribution system; and

(d) the transfer of electricity between distribution systems.

The code has been in effect for many years setting out the service and technical standards distributors must deliver to customers. It was first written when the electricity distribution network was designed and operated under different circumstances. For example, the network was planned and designed for a system where a small number of large generators in specific locations supplied almost all of the electricity demand in Victoria. The network was then primarily focused on transmitting and distributing that power across the state.

The code provided technical parameters that the distributors had to meet. These were set to ensure network security, a reliable supply at a cost-effective level and set the minimum level of service the customers could expect to receive from the distributors.

Since then, the electricity industry has been rapidly changing, which has affected the way the network is maintained and operated. One such change is the introduction and uptake of technology that allows customers to have more control of their own electricity, such as solar panels and batteries. This means that the code may need to be updated to reflect what the network will need to do to ensure the code still delivers network security, customer protections and the service customers want.

What the code is not meant to do

It is also important to note that the code is not meant to be used as a means to promote or incentivise any particular technology. However, it is important that the code takes innovation into consideration and does not set any unnecessary barriers that prevent innovation while ensuring the system remains secure and customers are still afforded appropriate levels of protection.

Appendix B – Comparison of code voltage standards with Australian Standards (AS 60038)

Table 1

	Electricity Distribution Code		Australian Standards (AS 60038)	
	Voltage level (V)	Steady state operating range	Voltage level (V)	Steady state operating range
Low voltage	230	Table 1 (+10%, -6%)	230	Table 1 (+10%, -6%)
	400		400	
	460		460	
High voltage[56]	-	Table 1 (±6% urban) (±10% rural)	3,300	Table 3 (±10%)
	6,600		6,600	
	11,000		11,000	
	22,000		22,000	
	-		33,000	
	66,000	Table 1 (±10%)	66,000	Table 4 (no information)

The code and Australian Standard AS60038 nominal voltage comparison

[56] High voltage is defined as exceeding 1,000V - Australian Standard 3000, 1.4.128, (c)

Appendix C – Comparison of low voltage standards across Australian jurisdictions

Table 2

DISTRIBUTION NETWORK LOW VOLTAGE STANDARDS	
VIC	Electricity Distribution Code
NSW	AS 61000.3.100[57]
QLD	AS 61000.3.100[58]
SA	AS 61000.3.100[59]
TAS	AS 61000.3.100[60]
ACT	AS 61000.3.100[61]

Table 2 highlights the approach taken by some interstate distributors to manage their low voltage networks. In other cases, the jurisdictional regulator or Government department prescribes the standard.

[57] Services and Installation Rules of NSW, p17, Ausgrid (p167) and Essential Energy (p169), Distribution Annual Planning Reports

[58] Department of Energy and Water Supply Decision Regulatory Impact statement – Queensland's statutory voltage limits, 27 September 2017.

[59] South Australia Power Networks Distribution Annual Planning Report, p83

[60] Tasmania Electricity Code - Distribution System Operation, Chapter 8, p8-5

[61] Evo Energy, Annual Planning Report, p44

Appendix D – Comparison of power factor ranges across Australian jurisdictions

Victorian Electricity Distribution Code

Table 3

POWER FACTOR LIMITS						
Supply Voltage in kV	**Power Factor Range for Customer Maximum Demand and Voltage**					
	Up to 100 kVA		**Between 100 kVA - 2 MVA**		**Over 2 MVA**	
	Minimum Lagging	**Minimum Leading**	**Minimum Lagging**	**Minimum Leading**	**Minimum Lagging**	**Minimum Leading**
< 6.6	0.75	0.8	0.8	0.8	0.85	0.85
6.6 11 22	0.8	0.8	0.85	0.85	0.9	0.9
66	0.85	0.85	0.9	0.9	0.95	0.98

Table 3 is the extract of the power factor range from our code. A customer must use best endeavours to keep their electrical installation power factor within the table 3 range under clause 4.3 of the code.

National Electricity Rules

Table 4

Power factor range	
Supply voltage	**Power factor range**
>400kV	0.98 lagging to unity
250kV - 400kV	0.96 lagging to unity
50kV – 250kV	0.96 lagging to unity
1kV – 50kV	0.9 lagging to 0.9 leading

Table 4 is information from the National Electricity Rule (v123) power factor requirements.

New South Wales

The NSW Services and Installation Rules state a customer must maintain the power factor not to be less than 0.9 lagging up to 50kV connection services.

South Australia

Table 5

POWER FACTOR LIMITS						
Supply Voltage in kV	**Maximum Demand of electrical demand**					
	Up to 100 kVA		**Between 100 kVA - 2 MVA**		**Over 2 MVA**	
	Minimum Lagging	**Minimum Leading**	**Minimum Lagging**	**Minimum Leading**	**Minimum Lagging**	**Minimum Leading**
< 6.6	0.8	0.8	0.85	0.8	0.9	0.85
6.6 to 66	0.8	0.8	0.85	0.85	0.9	0.9

Table 5 is the power factor information available from the South Australia Power Networks Services and Installation Rules.

Queensland

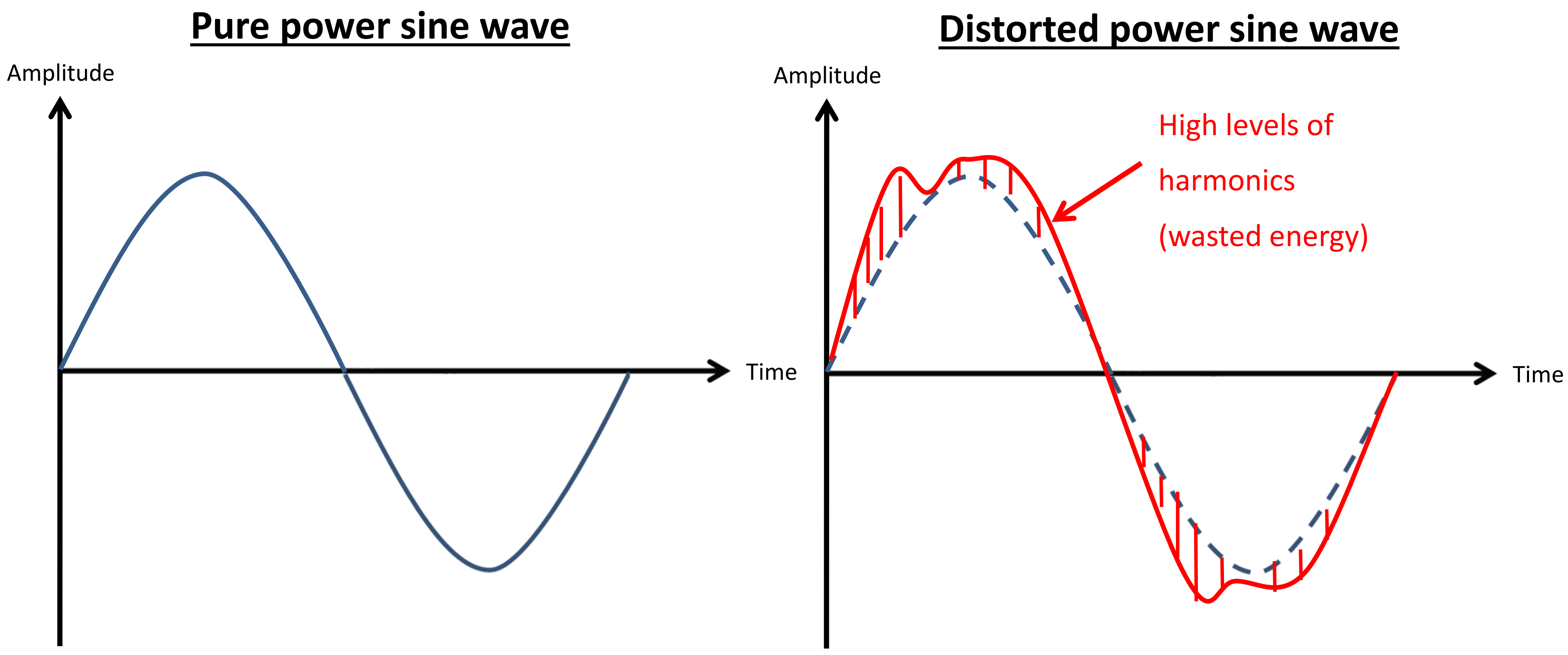
Table 6

Power factor performance	
Supply voltage	**Power factor range**
50kV – 250kV	0.95 to unity
1kV – 50kV	0.9 lagging to 0.9 leading
Less than 1kV	Above 0.8 lagging but not leading

Table 6 is the power factor information available from the Energex Services and Installation Rule

Appendix E – Comparison of harmonic limits with the National Electricity Rules

Figure A – Harmonics concept



Not to scale

Victorian Electricity Distribution Code

Table 7

VOLTAGE HARMONIC DISTORTION LIMITS			
Voltage at point of common coupling	**Total harmonic distortion**	**Individual voltage harmonics**	
		Odd	**Even**
< 1 kV	5%	4%	2%
> 1 kV and ≤ 66 kV	3%	2%	1%

Table 7 is the voltage harmonic limits Victorian distributors are required to manage under clause 4.4.1 of the code.

Table 8

CURRENT HARMONIC DISTORTION LIMITS						
	Maximum Harmonic Current Distortion in Per-cent of I_L					
	Individual Harmonic Order "h" (Odd Harmonics)					**Total Harmonic Distortion**
I_{SC}/I_L	**<11**	**11 ≤ h <17**	**17 ≤ h < 23**	**23≤ h < 35**	**35 ≤ h**	
<20*	4.0%	2.0%	1.5%	0.6%	0.3%	5.0%
20<50	7.0%	3.5%	2.5%	1.0%	0.5%	8.0%
50<100	10.0%	4.5%	4.0%	1.5%	0.7%	12.0%
100<1000	12.0%	5.5%	5.0%	2.0%	1.0%	15.0%
>1000	15.0%	7.0%	6.0%	2.5%	1.4%	20.0%

Table 8 is the current harmonic limits Victorian customers are required to manage under clause 4.4.3 of the code.

National Electricity Rules

Table 9

VOLTAGE HARMONIC DISTORTION LIMITS			
Voltage at point of common coupling	**Total harmonic distortion**	**Individual voltage harmonics**	
		Odd	**Even**
< 1kV	8%[62]	5% to 6%	2%
> 1kV and ≤ 35kV	6.5%[63]	5% to 6%	2%
> 35kV and ≤ 230kV	3%[45A]	2% to 5%	1.5%

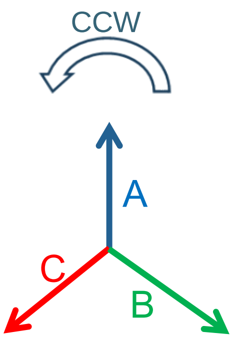
Table 9 is table 1 and 2 from AS61000.3.6-2012 under the National Electricity Rules, S5.1a.6.

[62] AS61000.3.6, Compatibility level

[63 & 45A] ibid, Planning level

Appendix F – Comparison of negative sequence standards with the National Electricity Rules

Figure B – Negative sequence concept

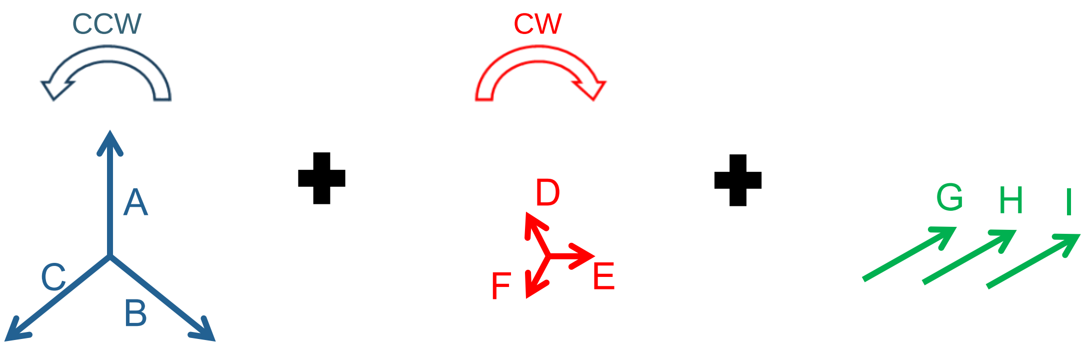


Positive sequence

Balanced

Under ideal normal operation, the three-phase power system voltage would be balanced and rotating normally with no other components being present. In the engineering analytical method, this normal rotation is called the positive sequence (rotating counter clockwise in this case).

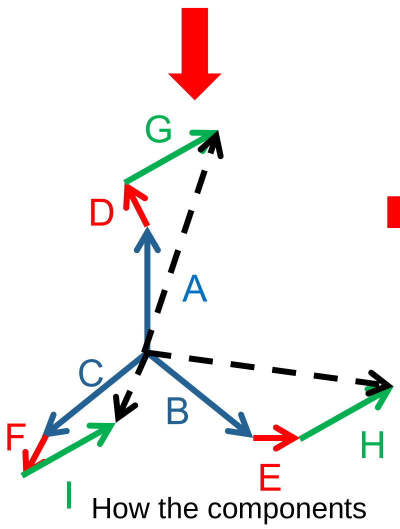
Unbalanced



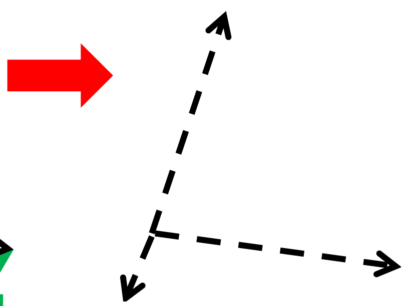
Positive sequence

Negative sequence

Zero sequence



How the components add together



The resultant unbalanced voltage

Due to a range of factors, the power system could experience a level of imbalance even during normal operation. When this occurs other components such as negative sequence can be detected in addition to positive sequence. The above diagram illustrates these components individually.

The left illustrates what the total summated unbalanced system may look like when added together (by connecting the same coloured arrows back to back). The dashed black represents the resultant unbalanced system.

Note: Accentuated diagram to illustrate concept

Electricity Distribution Code

Table 10

Negative sequence		
Voltage	**Duration**	**Maximum negative sequence (% of nominal voltage)**
All voltage levels	Steady state	1%
	5 minute every 30 minute	2%

Table 10 is a summary of the code, clause 4.6.

National Electricity Rules

Table 11

Negative sequence			
Voltage	**Duration**	**Maximum negative sequence (% of nominal voltage)**	**Note**
10kV to 100kV	30-minute average	1.3%	Non-contingent Credible contingent and protected
	10-minute average	2%	General
	1-minute average	2.5%	Once per hour
Up 10kV	30-minute average	2%	Non-contingent Credible contingent and protected
	10-minute average	2.5%	General
	1-minute average	3%	Once per hour

Table 11 is a summary of the National Electricity Rules table S5.1a.1.

Appendix G – Maximum fault level of the code

Electricity Distribution Code

Table 12

DISTRIBUTION SYSTEM FAULT LEVELS		
Voltage Level kV	**System Fault Level MVA**	**Short Circuit Level kA**
66	2500	21.9
22	500	13.1[64]
11	350	18.4
6.6	250	21.9
<1	36	50.0

Table 12 is the extract of the maximum fault level limits that embedded generators must not contribute to exceed under clause 7.8 of the code.

[64] The jurisdictional derogation of the National Electricity Rules provisions the declared shared network with different fault level for certain parts of the Victorian 22kV network.