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6 April 2018

Dr John Hamill
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Essential Services Commission Victoria
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MELBOURNE VICTORIA 3000


Dear Mr Hamill

Submission on Electricity Distribution Code – Review of voltage standards for bushfire mitigation

Please find attached the Australian Energy Regulator's (AER) submission regarding the Commission's Electricity Distribution Code – Review of voltage standards for bushfire mitigation, Project scope, February 2018.

The AER welcomes the opportunity to comment on the potential reforms to the voltage standards for bushfire mitigation.

The AER would be pleased to provide further assistance to the Commission on this important area of work. If you would like to discuss any aspect of this submission please contact Paul Dunn, Director, Network Pricing, Policy and Compliance, on (03) 9290 1426.

Yours sincerely



Chris Pattas
General Manager - Networks
Australian Energy Regulator



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

April 2018

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1 Summary

The AER welcomes the opportunity to respond to the Essential Services Commission Victoria, Project Scope for the Electricity Distribution Code – Review of voltage standards for bushfire mitigation, February 2018.

In this submission, we propose that a new clause specific to the obligations resulting from the *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016* (the Regulations) be incorporated in the Victorian Electricity Distribution Code (VEDC). We also propose that existing clause 16(c) which deals with “reasonable precautions” be amended to include a reference to the technologies deployed in response to the Regulations. In particular, we note that Rapid Earth Fault Current Limiting (REFCL) devices are being deployed in response to the Regulations and these devices operate in a manner not contemplated by the VEDC.

1.1 AER role

We are the economic regulator of electricity distribution businesses in Victoria. When the Regulations came into effect, AusNet Services and Powercor approached the AER to seek a variation to their electricity determinations to pass on the costs to them of complying with the Regulations. This was undertaken by means of tranche 1 of a contingent project allowance, which was approved by the AER in August, 2017. Details of this decision are available on our website.

A significant issue in our 2017 review was the inconsistency which exists between the Regulations and the current voltage limits contained in the VEDC. A consequence of this was the decision we made included substantial costs to address the uncertainties arising from the inconsistency.

Shortly, we anticipate the distributors will make applications in respect of tranches 2 and 3 of their contingent projects. We consider resolving this inconsistency to be an urgent matter as it will have a direct bearing on the ability of the AER to determine the most efficient allowance for these essential works. To summarise, our reasons for making this submission are:

- The operation of technology to meet the *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016* is currently inconsistent with the VEDC voltage standards;
- Operation of the new REFCL technology is mandated to commence by April 2019;
- Change is necessary to remove uncertainty about the scope of works undertaken by distributors. In particular, should the AER fund HV customer isolation or hardening works;

and

- Without amendment of the voltage limits, the cost of amendments to HV customer systems will be borne by customers of the affected distributors, which is a less equitable outcome because the benefits of bushfire mitigation affect all Victorians.

We expect the distributor submissions to be received in mid to late-April, with a final decision date in early September 2018. To facilitate our decision, we suggest the ESCV provide four weeks advance notice of the ESCV’s decision on the voltage limits to apply to REFCL installations. As was suggested by your staff in the Public Forum held on 6 April

2018, your proposed date in August 2018 for a final decision on the voltage standards would appear to be consistent with our timing if the decision can be made in early August.

1.2 REFCL compatibility problem

As is set out in the ESCV's Project Scope, Rapid Earth Fault Current Limiting (REFCL) devices are being installed in Victoria to meet the obligations contained in the *Electricity Safety (Bushfire Mitigation) Amendment Regulations, 2016* (the Regulations). We are not aware of any alternative technology which can satisfy the Regulations. Table 1 of the VEDC specifies the permitted maximum magnitude and duration of overvoltage events on a HV distribution system.

We note that a REFCL drives the HV distribution system phase-to-earth voltages to values higher than the maximum voltages and durations that Table 1 currently permits.

1.3 AER proposal

In an earlier submission to ESCV dated 22 September 2016, the Victorian electricity distributors proposed to amend the VEDC operating voltages and time limits in table 1. We refer to this submission as the Victorian Electricity Supply Industry (VESI) submission. The VESI submission proposed standards that could apply in all parts of distribution networks, (i.e. not just bushfire mitigation zones) and addressed reliability benefits by permitting continuous operation of a REFCL anywhere in a distribution network.

For the reasons discussed herein, we adopt some features of the VESI submission but do not consider it is a suitable basis for this review. In particular, we have not adopted the elements of the VESI submission which may lead to the capture of reliability benefits or which have application outside of areas mandated under the Bushfire Mitigation Regulations. We agree with ESCV there is an urgent need to review the voltage standards which must apply in areas served by REFCL devices installed to meet the obligations which now exist under the Regulations. However, we also believe those aspects of the VESI submission that relate to longer term benefits should be separately examined in the context of a broader review. We understand this approach is consistent with ESCV's intentions.

For the purposes of this review, we consider electricity customers are best served if the VEDC is modified to the minimum extent necessary to deal with overvoltage events driven by the operation of REFCLs where mandated under the Regulations. We are concerned any broader changes may lead to unintended consequences which need to be thoroughly examined before they are implemented. For example, changes to Table 1 may result in voltage limits associated with REFCLs being applied to circuits not protected by a REFCL. This could increase costs for many HV customers without an offsetting direct benefit.

To address our concern, we propose that the VEDC include a new clause 4.2.8 that is specific to the operation of a REFCL or other technology installed in response to an obligation under the Regulations. Please also note that the AER has not sought an independent technical review of the values proposed herein. We have relied on the VESI submission values as the basis for this proposal as they were generated by engineers with direct experience of the technology. The technical basis of our calculations is set out in the attachment. We recommend the ESCV seek independent technical advice before adopting these proposals.

We also think the current phrasing of clause 16(c) should be revised to include a reference to the REFCL technology. This is needed to minimise the scope for future disputation whether the technology affects the quality or reliability of supply.

We propose therefore, the following amendments should be considered to limit the changes to declared high fire danger zones as nominated in the Regulations and to give better effect to clause 16(c) of the code:

1. A new clause (which we number 4.2.8) which specifies the voltage levels and time duration which only apply to feeders served by a REFCL or other equivalent technology mandated by the Regulations; and
2. A modified approach to “reasonable precautions” that clarifies the onus on customers to modify their networks to suit REFCL operation.

The proposed new clause 4.2.8 is designed to achieve the following outcomes:

1. Limit the modification to voltage standards to situations where the Regulations have mandated a new technology solution;
2. Only replace the values detailed in Table 1 to the minimum extent necessary;
3. Not affect the operation of existing clause 4.2.7 in other areas of distribution networks outside a declared bushfire mitigation zone;
4. Recognise REFCL operating characteristics in fault detection and isolation mode and during commissioning and annual testing;
5. Make clear that clause 16(c) applies in this situation; and
6. Provide guidance on actions that would meet the obligations of clause 16(c).

EXISTING VEDC CLAUSE 4.2.7:

Clause 4.2.7 of the VEDC to remain:

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 in accordance with any relevant guideline.

SUGGESTED NEW CLAUSE 4.2.8

4.2.8 The voltage safety standards specified in the *Electricity Safety (Bushfire Mitigation) Amendment Regulations, 2016* (the Regulations) apply to all high voltage networks, including customer installations connected to a Zone Substation served by any apparatus or equipment installed to meet the Regulations, including but not limited to Rapid Earth Fault Current Limiting (REFCL) technology.

- (a) In networks which are connected to Zone Substations referred to by the *Electricity Safety (Bushfire Mitigation) Amendment Regulations, 2016*¹ and

¹ *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016* “Schedule 2-Zone Substations”. pp 8-10

identified by a *distributor* as protected by REFCLs, to the extent of any inconsistency, the voltage standards referred to in Table 1 are replaced by the voltage standards specified in clause 4.2.8 (b).

- (b) REFCL operation may cause voltage events of +90% Phase to Earth (REFCL voltage event) for up to:
 - (i) In fault detection and isolation mode, 60 seconds; and
 - (ii) In commissioning and annual testing mode, 20 minutes.
- (c) Clause 4.2.8 should be read in conjunction with clause 16(c) of this Code.
- (d) For the purposes of clause 16(c), reasonable precautions can be taken to include:
 - (i) Hardening the customer installation to tolerate a REFCL voltage event; or
 - (ii) A customer taking other measures in anticipation of a REFCL voltage event to minimise the risk of loss or damage including (but not limited to) isolating or disconnecting their installation from the HV network.

AER SUGGESTED AMENDMENT TO CLAUSE 16(c)

We note that clause 16(c) of the VEDC currently provides:

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.

Clause 16(c) is invoked by a footnote to clause 4.2.7.

When we were investigating the options for HV customer works, as part of the Contingent Project Tranche 1 review for AusNet Services and Powercor, it was argued by the distributors in their submissions to the AER that clause 16(c):

- is vague;
- did not anticipate the effect of REFCLs; and,
- could not reasonably be invoked.

We accepted these submissions had merit and were significant in the context of the AER's Bushfire Mitigation Contingent Project Tranche 1 decisions.

If the VEDC were amended to make clause 16(c) clearer, the affected customers could understand their obligations when a REFCL is installed without varying the VEDC network voltage standard outside declared bushfire safety zones. We propose the following amendment be adopted:

AER PROPOSED CLAUSE 16(c):

16. LIABILITY

- (e) 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 operation of a REFCL or other technology in accordance with clause 4.2.8. [*Emphasis added*]

Attachment 1 – Technical basis: AER proposed voltage and time limits

The REFCL operates using power electronics and real time digital analytics to store energy in an inductive coil which can be deployed in a fault event on one line of a balanced three wire system. The stored energy operates in reverse to a fault, neutralising it. It has been a theoretical concept for decades but recent advances in computer control technology have made it practical. The REFCL, if deployed effectively, can be a cheaper alternative to undergrounding HV conductors to eliminate fire starts. However, adding this stored energy drives up the voltage on the lines which have not fallen.

REFCLs work by displacing the neutral voltage from a notional value of zero to an elevated voltage and at a phase angle that reduces the fallen line to nearly zero volts. This renders the fallen line unlikely to start a fire but it dramatically increases the voltages on the other two lines. In bushfire mode, all three lines are disconnected within 1 minute.

REFCLs can also be installed in networks to improve reliability by allowing one line to remain grounded for extended periods while two lines remain energised. Reliability mode requires the REFCL to operate continuously at an elevated voltage on two lines. This mode is outside the scope of the current ESCV review. Rural customers on a REFCL system operating in reliability mode may experience no loss of supply while the fault is located by the repair crew.

The current relevant voltage standard is:

1. +80% for up to 10 seconds; and
2. for rural areas, +/-10% continuous after 10 seconds.

We calculate the effect of a REFCL increasing line voltages using standard engineering calculations. The effect on the remaining two active conductors is to increase their nominal phase-to-earth voltage of 12.7 kV to 1.732 times the nominal value, or to 22 kV.² However, the nominal voltage at a rural substation can be up to 10% higher (i.e. 14kV phase-to-earth) to offset losses on a long feeder. Therefore, the cumulative effect is 1.9 times the nominal voltage of 12.7 kV (i.e. 24.2 kV). Expressed as an increase over nominal phase-to-earth voltage this is +90%, a value consistent with the VESI submission.

The REFCL takes around 30 to 40 seconds to detect and isolate (or in technical terms, “discriminate”) a fault. Therefore, the time period allowed must be greater than the current 10 seconds. Consistent with engineering practice, the current VEDC standard and the VESI submission, this is rounded up to 1 minute (i.e. 60 seconds).

We note that a longer period is required for testing or commissioning. We base the proposed time for testing and commissioning on informal advice received from the Victorian distributors that a testing window may involve up to 20 minutes operation at +90%. We

² For non-engineers, it is easy to be confused by this calculation. Three phase power in REFCL installations in Victoria is normally 22kV from phase-to-phase. In the common 3wire or ‘delta’ HV system, the phase-to-phase voltage defines whether the system is an 11kV, 22kV...500kV system. When the delta is turned into a wye (‘Y’) it has both a phase-to-phase and a phase-to-neutral voltage. The ratio between these voltages is the square root of three, or 1.732 times. The neutral point at the centre of the ‘Y’ is often tied directly to the earth or through an impedance, which gives us phase-to-earth voltage. The REFCL acts a sophisticated impedance combined with an energy source. Through the electrical magic of vectors, the ‘Y’ is turned into a ‘V’. One line (the fallen line) becomes zero, the two remaining lines jump up from 12.7kV to 22kV and the vector between these two lines is also 22kV.

suggest this duration is a matter for the ESCV to resolve through further consultation with the distributors or an independent expert.

For the purposes of our draft submission we propose to adopt the values for impulse voltage and time duration as were proposed by VESI. These values are unchanged from current practice and are apparently unaffected by REFCL operation. We further recommend ESCV consult an independent expert familiar with REFCL operation to confirm these values.