Powerline Bushfire Safety Committee

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Advice: Changes to Electricity Distribution Code

On 22 May 2018, the Victorian Essential Services Commission (ESCV) published its draft decision[1] on changes to Victoria's *Electricity Distribution Code* (Code or EDC) following its review of voltage standards prompted by the April 2016 changes to Victoria's *Electricity Safety (Bushfire Mitigation) Regulations* (the Regulations) and the associated rollout of Rapid Earth Fault Current Limiters (REFCLs) to 45 electricity distribution networks in extreme fire risk areas of rural Victoria.

In your letter dated 30th May 2018, you formally requested the advice of the Powerline Bushfire Safety Committee (PBSC) on the implications for bushfire risk from powerlines in Victoria of the ESCV draft decision were it to be enacted as final. At its 12th June 2018 meeting, the Committee finalised its advice related to this matter as set out below.

High level issues

Three aspects of the draft decision warrant careful consideration:

1. The ESCV has focused on the need for Code-compliant REFCL operation that satisfies the Regulations. This narrow focus means important aspects of state-wide fire risk reduction may have been given less prominence in its thinking. High fire loss consequence risk exists in more areas of the state than the 45 networks nominated in the Regulations. Wider REFCL adoption in additional areas would reduce powerline bushfire risk. However, the draft decision may discourage adoption of REFCLs in areas other than those mandated by the Regulations.

2. The draft decision includes a best endeavours obligation on distributors to minimise the frequency of REFCL operation. This poses a risk of perverse outcomes (e.g. taking REFCLs out of service) and would likely impact the fire risk benefits of REFCLs when they are really needed. It also appears to have little basis in what is known about asset failure modes, where it is the cumulative duration rather than frequency of occurrence of voltage excursions that matters.

3. In its review the Committee identified a likelihood of perverse outcomes including material degradation of powerline bushfire safety, safety of powerline workers and the general public, and supply reliability. It also found that further action will be required to ensure high-voltage customers fulfil their new obligations in time to preserve the current REFCL rollout plan.

Summary of conclusions

The Committee reached the following conclusions in its review of the ESCV draft decision:

A. **Powerline bushfire safety and industry and public safety would be degraded:** The ESCV draft decision if preserved into the final version of the Code, will degrade powerline bushfire safety in Victoria and reduce the safety of powerline workers and the general public. These impacts will be both immediate and over the long term. The proposed change that would have this effect is the insertion of Clause 4.2.4(b) which establishes an obligation on all distributors to minimise the operation of REFCLs on

their networks. The quantum of the impact of this change on overall fire risk cannot be estimated with certainty, but it is likely to be material.

B. **The best option would be to omit Clause 4.2.4(b):** Ideally, the proposed Clause 4.2.4(b) should be omitted entirely, allowing normal engineering, business governance and legal liability mechanisms to manage any associated risks in the context of Victoria's other safety regulatory regimes and multiple existing energy industry economic regulatory processes.

C. **A fall-back option might be to modify Clause 4.2.4(b):** If this is not acceptable to ESCV, Clause 4.2.4(b) should as a minimum be amended to -

    a. Make the obligation to minimise cumulative duration rather than frequency of REFCL operation, recognising this will still undesirably distort decisions on REFCL settings and produce a risk of perverse outcomes; and,

    b. Recognise the precedence of obligations for safety, supply reliability and compliance with Victoria's bushfire risk management regime.

D. **Action is required to protect the REFCL rollout program:** The Code changes should be supported by effective mechanisms to ensure high-voltage customers complete the necessary work in time to avoid disruption of the REFCL rollout program to which distributors are committed under the Regulations.

E. **The Code should be aligned with legislation:** The change to Clause 4.2.2A to remove limits on phase-to-earth voltage during REFCL operation should be extended to the same range of voltages that are defined in legislation as the basis for the Regulations, i.e. 1kV to 22kV.

F. **The Code should be technology neutral:** The definitions of REFCL and REFCL condition set out in the draft decision should be changed to recognise the essential character of a REFCL, viz. resonant earthing of the distribution network.

The changes to the Code set out in the ESCV draft decision include elements that are separately supportive of powerline bushfire safety and potentially deleterious to powerline bushfire safety. The following discussion explores these changes.

Exclusions

Other proposed Code changes related to obligations to plan, monitor and report are unlikely to have any material effect on powerline bushfire safety given the rigorous powerline-associated fire reporting system in place in Victoria. Similarly, comments in the draft decision about the funding of asset changes and liability for asset failures are not covered here. Finally, the Committee has not entered into the question of legal interpretation of "best endeavours" - a highly ambiguous term not often found today give the variety of legal judgements in recent decades that have highlighted its enforceability limitations.

Change supportive of powerline bushfire safety

The main change proposed to the Code is to remove voltage-limit constraints on the operation of REFCLs. This change is centred on Clause 4.2.2A and associated definitions. In effect, it aligns the Code with global practice for resonant earthed networks by removing any regulatory specification of phase-to-earth voltage limits during REFCL operation. This allows good industry practice in accordance with recognised local and international engineering and safety standards to apply unhindered by regulation specific to Victoria. Apart from the absence of such voltage limits elsewhere in the world, the ESCV also notes

that it was simply not able to arrive at a satisfactory revised set of limits to apply during REFCL operation.

This change should be welcomed as logical, supportive of the Regulations, and consistent with international best practice. The Committee would draw your attention to some important qualifications to its support for this change:

Timing of necessary high-voltage customer works

The draft decision makes it clear the onus will be on high-voltage customers to take any necessary action required to harden or isolate their network assets to accommodate REFCL operation. This is a valuable clarification but it raises the issue of timing of the necessary work.

Distributors have committed to and are implementing a very extensive REFCL rollout program to meet a demanding seven-year timeframe set out in the Regulations. In some cases, for the new REFCLs to be placed into service, action by specific high-voltage customers will be necessary. This action must be completed in accordance with the timeframe set out in the Regulations if the rollout program is not to be disrupted. The Committee is not aware of any incentive regime or obligation on high-voltage customers that would provide confidence they will complete the necessary works in time to preserve the REFCL rollout plan.

The Committee recommends this issue be given priority consideration and effectively addressed so the current REFCL rollout can deliver full benefits in the target timeframe.

Alignment of the Code with legislation

The change to Clause 4.2.2A specifically applies only to 22kV networks. This is at odds with the legislation (Electrical Safety Act 1998) underpinning the Regulations which defines a polyphase electric line as having a nominal voltage that is not less than 1kV or greater than 22kV. Alignment of the Code change with the Act by having Clause 4.2.2A apply to all powerline that meet this definition would remove this discrepancy. It would also support the application of REFCL technology for the purposes of enhanced line worker and public safety and supply reliability in large urban areas of Melbourne supplied by 11kV high voltage networks.

Technology neutrality

The proposed definition of a REFCL (page 45 of the marked-up Code) is a ‘technology which as a minimum satisfies the required capacity’ as defined in the Regulations.

The term REFCL was coined in the Powerline Bushfire Safety Task Force in 2010 to mean any technology that acted quickly to limit the current in an earth fault. The most common technology in use world-wide for this purpose is resonant earthing.

The proposed definition in the Code is extremely specific and limiting. It is met by only one commercial product at present. If adopted, this would exclude other technologies that also require the Code change as a pre-condition of adoption. These include Arc Suppression Coils (such as the one at Sydenham zone substation) or older GFNs (such as the one at Frankston South) or new innovative technologies such as the semiconductor neutral-earth switch tested in the Kilmore South Trials. It also raises the question: Does a REFCL cease to be a REFCL if it is set to lower sensitivity since it no longer meets the definition? And does Clause 4.2.2A then cease to apply? The phrase ‘as a minimum’ is particularly ambiguous in relation to this question.

The definition of a REFCL should be entirely technology-neutral and product-neutral. It should encompass any technology that allows the neutral voltage of the network to automatically deviate from zero to reduce current in a network earth fault.

Secondly, a sentence in the definition of 'REFCL condition' (To avoid doubt, the term 'operating conditions on the 22kV distribution system' in this definition extends up to but not beyond any device or plant with is functionally equivalent to an isolating transformer.) implies a specific network topology. In particular, the phrase 'up to but not beyond' is redolent of historical unidirectional network power flow and is unlikely to serve near-future networks, or even some current ones.

Change potentially deleterious to powerline bushfire safety

One specific proposed change, the addition of Clause 4.2.4 (b) which requires network owners to use best endeavours to minimise the "frequency of which" a REFCL operates, is likely to have a chilling effect on the adoption and use of REFCLs and thereby increase powerline bushfire risk in Victoria.

The Regulatory Impact Statement (RIS[4]) and Powerline Bushfire Safety Program (PBSP) research reports[2], all point to major benefits flowing from REFCL adoption: reduced fire risk, improved public safety and improved supply reliability. Any change that may inhibit REFCL adoption or operation must be very closely scrutinised.

The wording of the draft decision does not explicitly state the reason for inclusion of Clause 4.2.4(b). In its review of the draft decision, the Committee found no rationale for the change, nor could the Committee identify any benefits that would flow from it.

Informal discussions with ESCV staff highlighted a concern for the interests of high-voltage customers whose assets will be exposed to voltage variations produced by REFCL operation. Powerline bushfire safety depends on the effective hardening or isolation of HV customer assets as faults in their assets (if not isolated) during a REFCL operation can in some circumstances cause fires anywhere on the network supplying them[3]. The changes reflected in Clause 4.2.2A make it clear the onus is on HV customers to manage this risk. Some observers have speculated the insertion of Clause 4.2.4(b) may be a form of 'quid pro quo' for the inclusion of Clause 4.2.2A, but the draft decision sheds little light on the rationale for the change.

The new clause 4.2.4(b) requires distributors to minimise the frequency of REFCL operation. The words proposed do not qualify this obligation in any way, nor is there reference to any other obligations such as those in the Regulations or any other consideration such as reliability of supply. There is a very general obligation expressed in Clause 3.1(b) (Good Asset Management) which might be seen as relevant, though the connection is somewhat tenuous.

It might reasonably be concluded that to the extent Clause 4.2.4(b) is in conflict with a distributor's other regulatory obligations, its operating strategy would be based on a comparative risk analysis of the consequences of breaching the different regulations. In this discussion paper, it is assumed that compliance with the Regulations would be preferred over compliance with Clause 4.2.4(b). The main support for this assumption is the clear and stringent financial penalty regime that applies to compliance with the Regulations.

Whenever a REFCL is in service, it will always (as designed) operate in response to network earth faults, which by definition are largely outside the control of the network operator. This means distributors can only indirectly control the frequency of REFCL operation, so a "best endeavours" obligation to minimise this frequency would create considerable uncertainty for distributors on when they should have a REFCL in service and

when they should take it out of service. This uncertainty would generate a significant risk of perverse outcomes.

There are only two ways a distributor can reduce the frequency of REFCL operation when it is in service: desensitise the REFCL so some network faults are not detected; or, take it out of service. There are only three ways a network owner can increase the frequency of REFCL operation when it is in service; increase its fault detection sensitivity so more faults are detected (possibly including some 'false positives'); apply artificial network faults to test REFCL operation; or, recalibrate the REFCL (a procedure that must be performed regularly to ensure correct operation).

Given this reality, the effects of the proposed obligation in the Clause 4.2.4(b) are not easy to predict. However, the obligation does appear to preclude REFCL operation for the purposes of electrocution safety and supply reliability when fire risk is low. Some possible outcomes would be likely to have a deleterious effect on powerline bushfire safety. These are illustrated in the following four scenarios. These scenarios are not necessarily completely realistic or comprehensive; rather, they are chosen to illustrate the factors at play in assessing the effect of the change on powerline bushfire safety.

Scenario 1: REFCLs in service on TFB days only

In this scenario, the final decision is unaltered from the draft decision. Based on a comparative business risk assessment, distributors adopt the following REFCL operating regime: REFCLs are only put into service to deliver the Regulations' required capacity on TFB days and REFCL testing and recalibration is minimised. REFCLs remain out of service at all other times. This scenario would have the following outcomes:

- Unclear compliance with the Code - REFCL operations on TFB days are not minimised.
- Compliance with the Regulations if this operating regime is in an approved BFM Plan.
- Reduced reliability and certainty of REFCL operation on TFB days.
- Increased probability of network faults under high fire risk conditions.
- Denial of supply reliability benefits included in the RIS.
- Denial of public safety (electrocution) benefits.
- Barriers to REFCL adoption in areas other than those specified in the Regulations.
- Potential liability exposure for distributors for breach of 4.2.4(b) on TFB days.

This scenario would materially increase powerline bushfire risk compared to other scenarios.

Scenario 2: REFCLs have reduced sensitivity on non-TFB days

In this scenario, REFCLs remain in service but are de-sensitised on non-TFB days. This is the scenario proposed under distributor operating strategies at present. These have been developed without foreknowledge of the proposal to add Clause 4.2.4(b). The addition of Clause 4.2.4(b) would almost certainly cause boards and insurers to rule out this scenario as involving too high a liability exposure. It would have the following outcomes compared to Scenario 1:

- Non-compliance with the Code.

- Compliance with the Regulations if this operating regime is in an approved BFM Plan.
- More reliable and certain REFCL operation on TFB days.
- Reduced probability of network faults under high fire risk conditions.
- Greater realisation of REFCL supply reliability benefits.
- Improved public and industry safety (electrocution).
- Less distortion of the business case for adoption of REFCLs in areas outside the Regulations.
- Potential liability exposure for distributors for breach of 4.2.4(b) at all times.

Scenario 3: Obligation to minimise duration not frequency

In this scenario, the ESCV reconsiders the draft decision and changes Clause 4.2.4(b) to oblige the distributors to minimise the duration of REFCL operation consistent with other objectives such as reliability and electrocution safety rather than the frequency of REFCL operation. This scenario would have the same outcomes as Scenario 2 except for the following:

- Improved alignment of the Code with international practice.
- Alignment of Clause 4.2.4(b) with other Code asset management obligations.
- Greater flexibility for distributors to decide REFCL settings to suit circumstances.
- Greater legal accountability of distributors for REFCL operation and settings.
- Lower risk of network and customer asset damage.

Scenario 4: No obligation on frequency or duration

In this scenario, the ESCV reconsiders the draft decision and omits Clause 4.2.4(b) entirely. This scenario would have similar outcomes to those in Scenario 2 except for the following:

- Settings and operating regime for REFCLs would be subject to Code asset management obligations in the same way as settings and operation of any other class of network asset.
- Full legal accountability of distributors for REFCL operation and settings.

This brief scenario exploration shows the desirability of a further change to the draft decision on Clause 4.2.4(b). The rationale for the factors used in each of the above assessments is set out in the following sections.

Reliability and certainty of REFCL operation on TFB days

It is long-standing engineering dogma that if operation of a complex system is critical to effective management of safety in emergency conditions, it should be exercised as often as possible, preferably continuously. The objective of this approach is to reveal defects under conditions where they will not produce catastrophe so they can be fixed before correct operation of the system becomes vital. Examples include hospital back-up generators, data centre UPS systems, co-primary network control centres, air traffic control fail-over systems, etc. The more complex the system, the more important this operating strategy if the system is to operate reliably when it is really needed. It is difficult to reconcile the proposed Clause 4.2.4(b) with this particular engineering best practice.

REFLCs are very complex systems comprising a diverse array of primary (high-voltage) and secondary (computer) equipment integrated into a single system that delivers a very complex repertoire of functions to meet a wide range of network circumstances. The software that drives REFCL operation is very complex and unique to REFCLs, of which there are understood to be less than 300 world-wide. For Victoria to have confidence in reliable REFCL operation to reduce fire risk in extreme fire risk conditions, REFCL owners should be encouraged to have them operate as often as possible year-round. The proposed Code change would tend to preclude this.

Experience in the REFCL rollout (approaching 12 months) and with pre-Regulations REFCLs in Victoria (approaching ten years' service in one case) shows that analysis of REFCL response to network faults throughout the year is the best way to find potential defects in this complex system, especially firmware faults. Few network owners would have confidence in reliable, as-specified REFCL operation in periods of high fire risk without this process.

Probability of 'asset-failure' network faults

All jurisdictions world-wide that have moved or are moving from solidly-earthed networks to resonant earthed networks (including Victoria) exploit the fact that the voltage displacement produced by REFCL operation in response to network faults reveals latent weaknesses in network assets. Most do this with only modest per-event voltage displacement duration (from a few seconds to a few minutes), though some with REFCLs on extensive HV cable networks with minimal or no overhead powerlines allow durations of hours. During REFCL commissioning in Victoria, extended periods of REFCL operation are artificially produced for just this purpose. However, asset weaknesses and defects will still continue to be revealed over the long term by REFCL operation in normal service – for example, as network assets age.

This is particularly important for fire risk reduction. An asset-failure fault during a REFCL operation on a high fire risk day is likely to cause a cross-country fault. Such faults almost guarantee two fire starts, one at the failed asset and one at the original fault site. Constant REFCL operation ensures weaknesses are found and remedied as early as possible (in low fire risk conditions) so that when the REFCL is critical to bushfire safety (on TFB or Code Red days) the chance of cross-country faults is minimised.

Victoria's 22kV networks are no different to similar networks in countries that use resonant earthing in normal service. Network assets are currently designed and purchased to the same international phase-to-earth voltage-withstand standards, often abbreviated to 24/50/150kV. Some older assets were not purchased to this standard and risk analysis together with testing of sample asset populations is being used in Victoria's REFCL rollout to identify susceptible older equipment for replacement. The distributors commissioning new REFCLs expect the first year or two of continuous REFCL operation to be sufficient to find most residual problems. In the longer-term, the situation will settle to one where the normal response to network faults of a continuously in service REFCL is enough to find assets that have deteriorated due to age or other factors.

The goal of distributors is to make their networks completely immune to the voltage levels produced in REFCL operation, just like networks belonging to distributors in countries that use resonant earthing. Early experience with the REFCL rollout indicates this is a realistic goal as asset weaknesses are progressively found and eliminated.

Clause 4.2.4(b) could be read to imply that local networks are somehow more susceptible to voltage excursions so they must be protected by imposing special restrictions on REFCL operation. This is simply not the case, either of distributors' networks or those belonging to HV customers (as demonstrated in ESV's recent investigation of a sample of HV

customers). However, if REFCL operation is restricted to periods of extreme fire risk then these periods will be precisely when network weaknesses will appear, manifesting themselves at the worst possible time as cross-country faults with potentially catastrophic consequences.

Supply reliability benefits of REFCLs

REFCLs improve supply reliability. In Europe, recent trialling and strategic adoption of resonant earthing by a number of countries followed the first publication of accurate comparative Eurozone supply reliability statistics that vividly showed the superiority of those countries with resonant earthing of their distribution networks over those with UK-style solid earthing. These migration programs are planned to extend over decades. Literature surveys and inter-utility discussions indicate extension of resonant earthing to Italy, France, Spain and Ireland as a minimum. Anecdotal evidence here and overseas suggests an estimated reliability benefit of 30% reduction in customer-minutes off supply with REFCLs in service and up to 90% reduction in momentary interruptions to supply.

The RIS estimated major benefits in supply reliability based on international and local experience, though these were not essential to the business case for the policy. The RIS estimates were not uniformly accepted. However, early experience of the REFCL rollout suggests they were broadly correct and Victoria's experience with REFCLs is likely to be similar to that of the rest of the world, viz. improved supply reliability. Further detail on supply reliability benefits of REFCLs can be found in Section 4.10 of the August 2014 PBSP research report *REFCL Trial: Ignition Tests* and in the RIS.

The proposed Clause 4.2.4(b) of the draft Code could constrain delivery of this benefit to Victorians. This is not a direct safety issue, but denial of this benefit will erode any business case for REFCL adoption, thereby indirectly leading to denial of substantial REFCL fire safety benefits as well.

However reliability of supply has repeatedly been identified over decades as a key issue during emergency events, especially bushfire. Both the emergency and other government services and community members have a high dependency on supply for communications and hence the understanding of risk, resource management, and the issue of and receipt of emergency warnings or evacuation calls, and post emergency to enable relief and recovery operations and the subsequent return to areas.

Hence reliability of supply is indirectly a key bushfire safety issue.

Public and industry safety (electrocution) benefits of REFCLs

REFCLs deliver public safety benefits in reducing two risks: powerline-related bushfires and high-voltage electrocution. Any barrier to REFCL adoption will have impacts in both areas. Section 4.9 of the August 2014 PBSP research report *REFCL Trial: Ignition Tests* states:

> National Coronial records reveal that about 30-40 people die from electrocution in Australia each year. Most electrocution deaths occur at low voltage levels (less than 600 volts) away from the high voltage network – generally at work or at home. Low voltage electricity often kills people by paralysis of the diaphragm or fibrillation of the heart – both of which are potentially reversible conditions that can be successfully treated by immediate first aid.
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> Electrocution from high voltage electricity is rarer and usually much more severe. It often causes irreversible damage: skin and internal tissue burns that are very difficult to treat.
> REFCLs can quickly reduce the voltage on a fallen high voltage conductor to levels

where only low voltage electrocution risk remains. In some cases, the voltage is reduced to levels where almost no electrocution risk remains. Many countries have adopted REFCLs for this reason alone regardless of other benefits.

For a network with a REFCL installed, Clause 4.2.4(b) might only allow operation of the REFCL for bushfire safety reasons. Any other use might be regarded as non-compliant. This would possibly put distributors in breach of the obligations (to eliminate or reduce the risk "so far as is reasonably practicable") in Health and Safety legislation. REFCLs not only protect the public against HV electrocution – much more frequently they protect powerline workers.

By eroding the business case for REFCL adoption, the proposed Clause 4.2.4(b) of the draft Code may constrain this public and industry safety benefit to only those networks specified in the Regulations and only when the REFCL is in service.

REFCL adoption in HBRA areas of the State other than those identified in the Regulations

In considering bushfire risk, the review of the Code appears to have taken a narrow view. It has focused on the Regulations and the obligations of network owners under them. However, the Regulations deal only with prevention of catastrophic bushfire losses to Victoria by installing REFCLs in 45 of Victoria's 200+ zone substations.

There are 63 zone substations supplying rural areas of the State that have significant levels of bushfire risk that are not covered by the required capacity section of the Regulations. Bushfires that are started by powerlines in these networks can still destroy hundreds of homes, kill many people and destroy large numbers of livestock. Ideally, powerline bushfire safety should be delivered across all Victoria's networks, not just those nominated in the Regulations. By eroding the business case for REFCL adoption, the proposed Clause 4.2.4(b) may mitigate against this outcome.

Already, the Regulations are not the only driver of REFCL installations in Victoria. There are currently two REFCL installations that have been installed without regulatory requirement: Frankston South (coming up to its tenth year of service) and Sydenham; and two more where installation is now in progress: Mornington and Dromana. The proposed obligation under Clause 4.2.4(b) is likely to constrain the operation of these and any new REFCLs in ways that must inevitably erode the benefits used to justify the associated investment. Indeed, without the countervailing pressure of the Regulations, it could be claimed the new Clause 4.2.4(b) would require that these REFCL be taken out of service.

It is relevant that major European countries (specifically France and Italy) plus China, Russia and large parts of South America are currently moving to adopt resonant earthing for public safety and supply reliability reasons. Some of these jurisdictions apply regulatory limits on per-event voltage displacement duration in REFCL-protected networks, but none are known to be applying limits to frequency of occurrence of REFCL operation.

Potential for uncertain legal liability exposure for distributors

The proposed Clause 4.2.4(b) obliges distributors to use best endeavours to minimise the frequency of REFCL operation. If this is carried through into the final decision, distributors may seek legal advice to identify an operating regime for REFCLs that will minimise their overall liability exposure. The nature of that advice cannot be predicted. However, it would be unusual and counter-productive to have REFCL settings and operations strategy set by legal interpretation (and ultimately Court decisions) of different conflicting regulations rather than clear goal-oriented engineering and business governance processes.

If the Regulations take precedence over the Code, then REFCLs might be placed into service only in heightened fire risk conditions. However, when in service, network owners must still use best endeavours to prevent the REFCL operating. This may mean no tests other than those specifically required by the regulations and no recalibration. If the Code takes precedence over the Regulations, network owners may be advised to not put REFCLs into service. Either way, the contribution of the REFCL to powerline bushfire safety will be constrained and most likely materially reduced.

The Clause 4.2.4(b) provision appears to be unique to the ESCV draft decision. Discussions with a number of overseas jurisdictions and global REFCL suppliers have revealed no other instance of a similar provision in international standards, regulations or policies related to resonant earthing.

Asset damage from REFCL operation

During REFCL operation, susceptible assets can experience internal partial discharge (PD) due to the elevated voltage levels applied to them. This phenomenon is well studied and the associated asset failure modes are well understood. In essence, PD is microscopic insulation breakdown. If it is allowed to continue for a long time, the ability of the asset to withstand higher than normal voltage decreases until in extreme cases, a flashover can occur causing a network fault.

The relevant reality is that the insulation deterioration is a progressive process that takes time. In broad terms the amount of deterioration varies as the magnitude and duration of the over-voltage condition. Some assets do not suffer from PD when voltage is increased to the levels produced by REFCL operation. Others do exhibit PD but can maintain PD for decades without noticeable loss of insulation. Yet others may deteriorate quite rapidly if the over-voltage condition is maintained for an extended period, especially if there is already an underlying defect.

Insulation deterioration from PD is largely unrelated to the number of occurrences of elevated voltage – it tends to be directly related to the cumulative duration of the over-voltage. If assets are properly rated in accordance with appropriate standards, well manufactured, maintained in good condition and not subject to overloads in service, they should suffer minimal PD damage through their normal service life on a network where REFCL operation is unconstrained by regulation.

Conclusion

On behalf of the Powerline Bushfire Safety Committee, I commend this advice for your consideration. Please do not hesitate to come back to me with any associated queries.

Yours

Signed

David Harris
Chairman
Powerline Bushfire Safety Committee

References

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