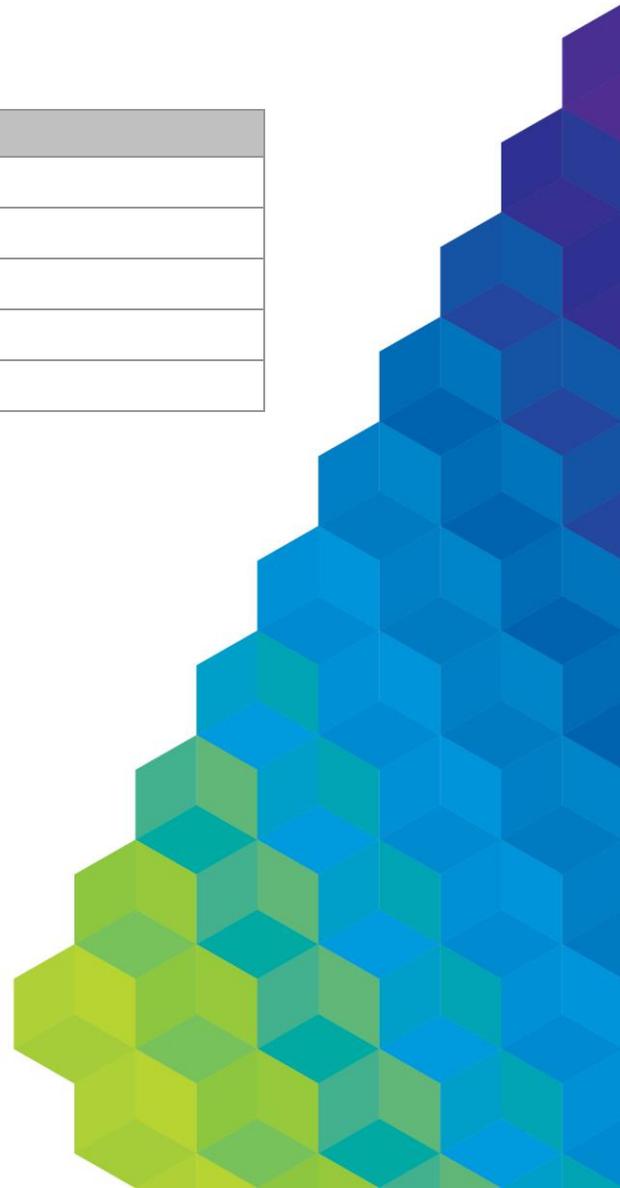

Rapid Earth Fault Current Limiter (REFCL) Program

Tranche 3 High Voltage (HV) Customer Engagement Overview

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1 Purpose and background

1.1 Purpose

The purpose of this document is to detail AusNet Services' engagement approach for High Voltage (HV) customers affected by the installation of the Rapid Earth Fault Current Limiters (REFCL) at selected zone substations in the AusNet Services electricity distribution network.

1.2 Background

AusNet Services' electricity distribution network operates in a geographical location which is exposed to extreme bushfire risk.

The 2009 Victorian Bushfire Royal Commission made several recommendations with respect to fires initiated from electricity distribution networks. Subsequently, the Victorian Government established the Powerline Bushfire Safety Program to research the optimal way to deploy REFCLs for bushfire prevention. This research led the Government to introduce *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016* which came into operation on 1 May 2016, amending the *Electricity Safety (Bushfire Mitigation) Regulations 2013 (Regulations)*.

For AusNet Services, the Regulations require each polyphase electric line originating from 22 selected zone substations to comply with mandated voltage reduction performance standards by 1 May 2023. In the timeframes specified in the Regulations, the installation of REFCLs is the only feasible technological solution.

The Regulations apply a point scoring system to establish milestones for completing the required works. Each selected zone substation is attributed a point score from 1 to 5, with the highest value attributed to those zone substations where fire mitigation measures would provide the greatest benefit.

AusNet Services is required to have REFCL compliant zone substations to accumulate:

- 30 points by 1 May 2019;
- 55 points by 1 May 2021; and
- 63 points by 1 May 2023.

1.3 Tranches overview

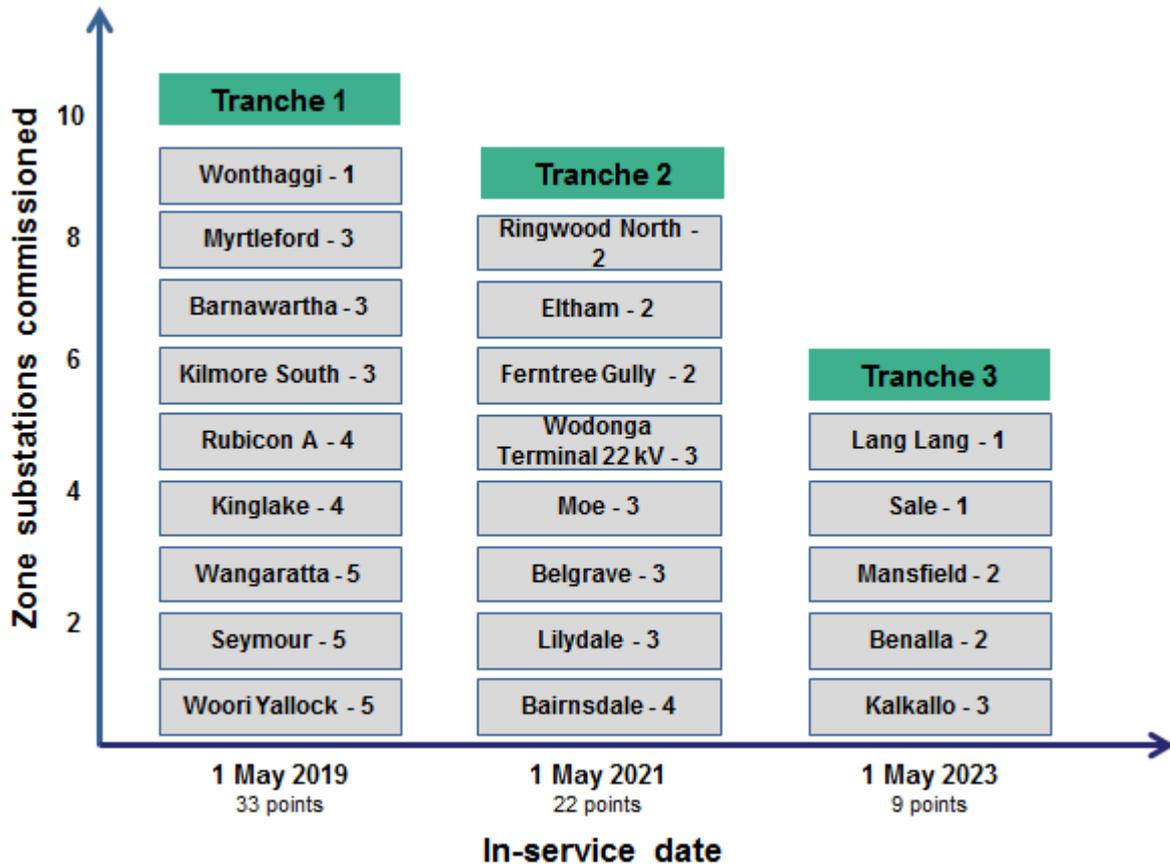
AusNet Services have allocated the 22 selected zone substations into 3 tranches:

- Tranche 1 contains 9 zone substations;
- Tranche 2 contains 8 zone substations; and
- Tranche 3 contains 5 zone substations.

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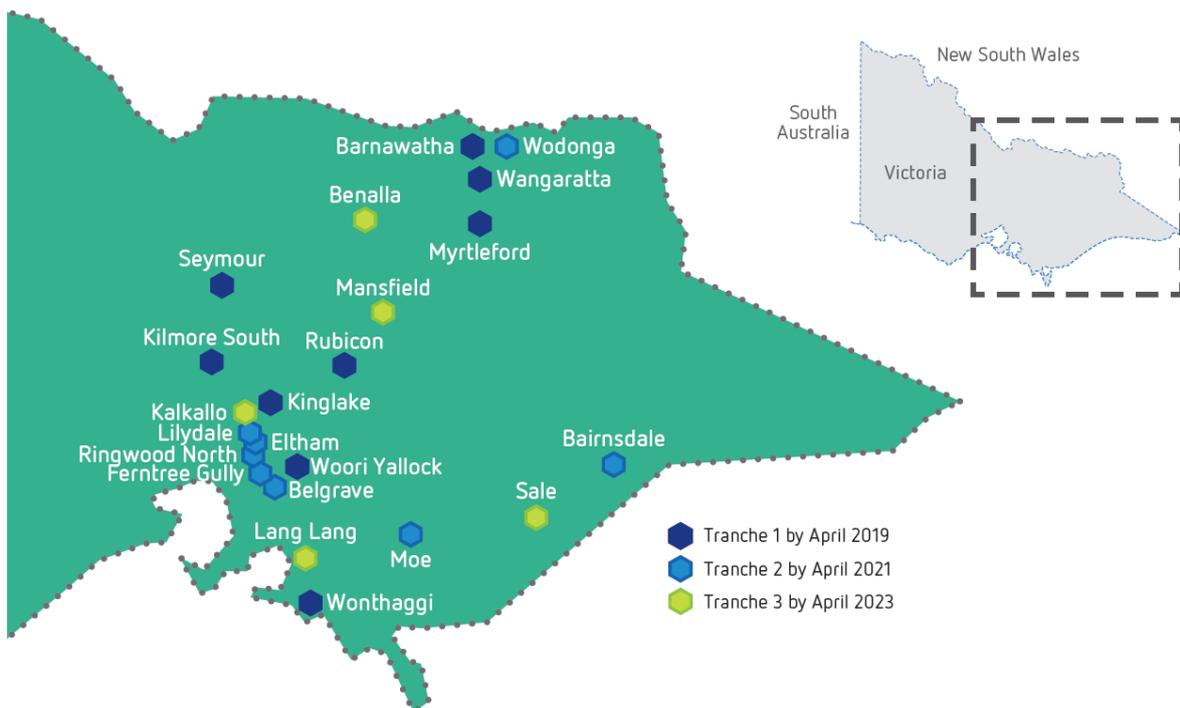
Figure 1 shows the zone substations by Tranche.

Figure 1: AusNet Services REFCL Implementation by Tranche



Source: AusNet Services

Figure 2: Map depicting the AusNet Services REFCL zone substations by Tranche



Source: AusNet Services

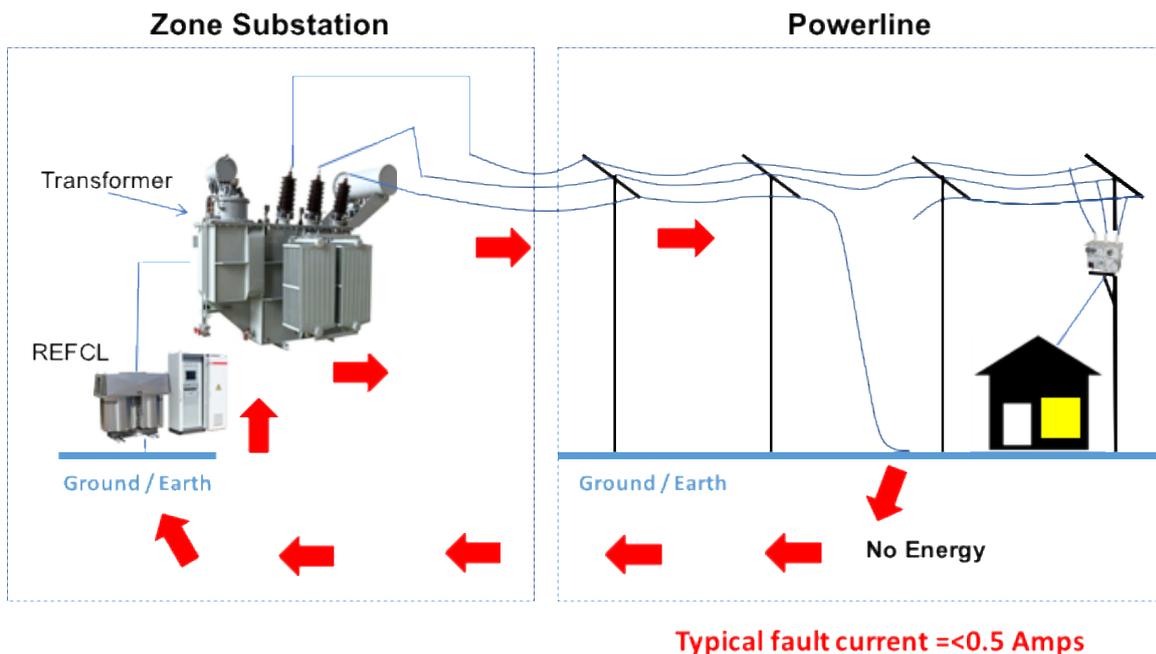
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2 REFCL implications for HV customers

2.1 REFCL technology overview

The REFCL scheme is an electricity network protection device which is designed to minimise the fault current (energy) dissipated from phase to earth (wire to ground) faults on the 22kV network in order to reduce the risk of fire ignition associated with network incidents as shown in Figure 3.

Figure 3: How does REFCL technology work?



Source: AusNet Services

The REFCL operates when a single phase-to-earth fault occurs. Its operation causes the phase voltage of the faulted phase to be reduced to near earth potential (zero volts), thereby working to eliminate the flow of fault current. To achieve this outcome, the REFCL is tuned to the inductance of the electrical network. This compensation results in phase to ground voltage on the faulted phase reducing to near 0 volts. The healthy phases could rise from 12.7kV to 24.2kV, being the nominal phase-phase voltage (22kV) plus 10 per cent.

While the REFCL is compensating for a fault, the healthy phases remain energised and customers remain on supply. However, there remains a risk that the energised phases may be in an unsafe condition depending on the nature of the network fault. Accordingly, a maximum compensating period will apply.

2.2 Implications for HV customers

With a REFCL in service during a phase to ground fault, the neutral voltage may increase up to 13.9kV consequently leading to elevated phase to ground voltages on the un-faulted two phases. These un-faulted phases are required to withstand 24.2 kV.

The REFCL also automatically adapts to network conditions while in service. This may result in individual phases voltages being increased by 20% (16.7 kV phase to ground) at a time for a total time period of 45 seconds. This may occur multiple times during a day.

The voltage changes only relate to phase-to-earth voltages. Phase-to-phase voltages are unaffected by REFCL operation. Given that only phase-to-earth voltages are changed by

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REFCL action, the only customers that can be affected are those that are supplied at high voltage. Customers supplied at 240/415V are naturally isolated from variations in the HV phase to ground voltage by the 22kV/415V transformer.

HV customer's equipment would be exposed to higher voltages than they currently are, and potentially higher than their equipment is rated for.

Any resulting failure of HV customer's equipment during REFCL operation may induce a cross country fault negating any fire mitigation effect on the phase affected by the first fault as the REFCL attempted to compensate for the second fault. This situation could result in a fire ignition at the site of the first fault or second fault.

Furthermore, there are secondary effects that will incur varying impacts on HV customers with respect to, but not limited to, the following:

- Fault levels;
- Power quality;
- Earthing arrangements;
- Protection and control;
- Operating protocols;
- Connection agreements; and
- Physical arrangements at the point of connection.

These factors should be investigated by each REFCL-impacted HV customer to understand the full impact of REFCL operations on their HV electrical assets.

For Tranche 3, AusNet Services is providing support to HV customers in the form of a suggested panel of technical advisers and, if requested, reimbursement of the associated costs.

2.3 Solutions available to HV customers

There are three (4) technically acceptable engineering solutions available to our REFCL-impacted HV customers to ensure they are not adversely impacted by REFCL operations:

- Conversion to low voltage (**LV**);
- Conversion to 66kV supply;
- Primary assets hardening; or
- Installation of isolating transformer & Automatic Circuit Reclosers (**ACRs**).

The following sections provide a high level overview of each solution.

2.3.1 Conversion to low voltage (LV) supply

The first engineering solution that prevents voltage stress on HV customer assets during REFCL operation is for the HV customer to convert their HV primary connection to LV.

AusNet Services will supply a transformer to convert 22kV voltage to 415V.

This solution is only viable if the customer's electricity load has reduced to a level where it is appropriate to be supplied at LV. This is most likely to occur where there is a change of use of the site. The maximum load that can be practically supplied at LV is 1000 KVA.

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2.3.2 Conversion to 66kV supply

Another engineering solution that prevents voltage stress on HV customer assets during REFCL operation is for the HV customer to convert their HV primary connection to 66kV supply

This solution is only viable if the customer's electricity load is sufficiently large to warrant conversion to 66kV supply.

2.3.3 Asset hardening solution

This method prevents voltage stress on HV customer assets during REFCL operation is to identify, and replace, the primary HV electrical assets that are not capable of being able to withstand an elevated voltage of 24.2kVrms for an agreed period of time. In some cases, customers' existing equipment may be capable of this performance.

2.3.4 Isolating substation solution

This method of preventing voltage stress on HV customer assets during REFCL operation is to electrically isolate the HV customer's installation from AusNet Services' distribution network by the installation of an isolating substation close to the HV customer's point of connection.

This arrangement prevents the higher phase to ground voltages being presented to the customer's equipment but also has the effect that any earth fault downstream of isolating transformer will NOT be detected or cleared by the REFCL equipment. This means that the customer's equipment does not benefit from the reduced fire ignition risk provided by REFCL's.

An ACR is installed on the supply side of the isolating transformer, for protection and control purposes.

Depending on the size of the isolating transformer, the isolating substation solution and required footprint varies.

Note: the installation of an isolating substation results in short sections of underground polyphase electric lines, between the isolating transformer and the HV connection point, not being REFCL protected. As such, the following exemption applications are required:

- Energy Safe Victoria (**ESV**) grant exemptions under regulation 13 of the *Electricity Safety (Bushfire Mitigation) Regulations 2013* from the requirements of regulations 7(1)(ha) and 7(1)(hb); and
- ESV facilitate the progression of applications for exemption under section 120W(1) of the *Electricity Safety Act 1998* from compliance with section 120M of the *Electricity Safety Act 1998*.

Refer to REF 30-10: REFCL Program HV Customer Policy for REFCL Protected Networks (Load & Generator) for further information about these engineering solutions.

2.4 Victorian Electricity Distribution Code obligations

The Essential Services Commission (**Commission**) is responsible for licensing Electricity Distributors in Victoria. As part of their licensing functions under the *Electricity Industry Act 2000 (Vic)*, they set licence conditions for distributors that include the requirement to comply with the Electricity Distribution Code (**Code**).

In August 2018, the Commission released version 9A of the Code which resulted in HV customers being responsible for taking reasonable measures to safeguard their HV electrical assets to mitigate the effects of overvoltage which are generated during REFCL operation.

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2.5 HV Customer Assistance Package

The Victorian Government has established a High Voltage Customer Assistance Program (**HCAP**) to provide funding to high voltage customers impacted by the role-out of REFCLs.

3 HV customer engagement

3.1 HV customer lead

Given the impacts of REFCL operations on HV customers supplied by REFCL-enabled feeders, AusNet Services appointed a dedicated REFCL Program HV Customer Lead in 2017.

The purpose of the role is to be the primary point of contact for the HV customers in relation to the REFCL implementation and to identify, and negotiate, the appropriate solution for each HV customer for Tranche 1. For HV customers in Tranche 2 and 3, the HV Customer Lead is responsible for providing support to HV customers as they assess the impacts of REFCL operations on the HV electrical assets and identify preferred solutions.

Each HV customer site is unique in terms of the nature and condition of the HV electrical assets, the site location and the preferred solution required to meet the required regulatory deadlines.

3.2 HV customer engagement objectives

The key objectives for the REFCL Program HV customer engagement for Tranche 3 are to:

- Proactively engage with our impacted HV customers;
- Work with the HV customers as they undertake reviews to assess their HV electrical assets and future needs;
- Provide information to impacted HV customers about the technical solutions implemented at Tranche 1 HV customer sites;
- Co-ordinate information requests and requests for quote to support the assessment, business case development and implementation of HV customer solutions; and
- Proactively monitor the HV customer readiness against the advised REFCL readiness dates, noting that HV customer solutions need to be implemented prior to the Tranche 3 compliance deadline of 1 May 2023 to enable AusNet Services to undertake the REFCL commissioning and testing activities.

3.3 HV customer engagement steps

The REFCL Program HV customer engagement steps undertaken include:

- Identifying the impacted HV customers and their HV connection points, by Tranche;
- contacting the impacted HV customers and confirm the appropriate customer contact(s) for engagement;
- establishing new, or enhancing existing, working relationships with key customer contacts;
- arranging an initial meeting to explain the implications of REFCL operations on HV customer electrical assets;
- understanding the nature of the HV customer electrical assets for each HV connection point;
- obtaining single line diagrams and other relevant information on the HV electrical assets;

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- discussing the available engineering solutions to protect their HV electrical assets from REFCL operations;
- consider the findings of independent reviews of the HV electrical assets and implications for the REFCL operations;
- for Tranche 1, working collaboratively with the HV customer to determine which engineering solution is acceptable to the HV customer, whilst meeting the mandated deadline;
- for Tranche 1, negotiating and executing the commercial arrangements to implement the agreed solution;
- for Tranche 1, managing the interaction with the customer during implementation of the solution;
- For Tranches 2 & 3, providing support to HV customers as they determine and implement their solutions to withstand REFCL operations; and
- Proactively monitoring HV customer readiness against the REFCL readiness dates.

3.4 Tranche 3 HV Customer REFCL Readiness Date

For Tranche 3 HV Customers, a REFCL readiness date of 30 June 2022 was formally advised in August 2018 following the introduction of version 9A of the Code.

By the REFCL readiness date, the HV customers must be able to withstand REFCL operations including the stress and primary earth fault testing which needs to be undertaken by AusNet Services as part of the REFCL commissioning activities.

If HV customers are not ready by this date, the HV customer will be either temporarily disconnected from electricity supply or must arrange mobile generation to maintain electricity supply, at their own cost.

4 Next Steps

AusNet Services are continuing to work closely with our REFCL-impacted HV customers to support them with their assessment and selection of appropriate REFCL technical solution for their HV connection points. Learnings from the implementation of HV customer solutions in Tranche 1 are being shared with HV customers, where possible.

HV customer readiness is a key dependency for the successful implementation of REFCLs by the mandated compliance deadlines. The status of HV customer readiness is being proactively monitored in order to identify where HV customers may not be able to meet the required deadlines and to work with the HV customer to identify ways to minimise any delays.