# Rapid Earth Fault Current Limiter (REFCL) Program

# Distribution Feeder Automation Strategy

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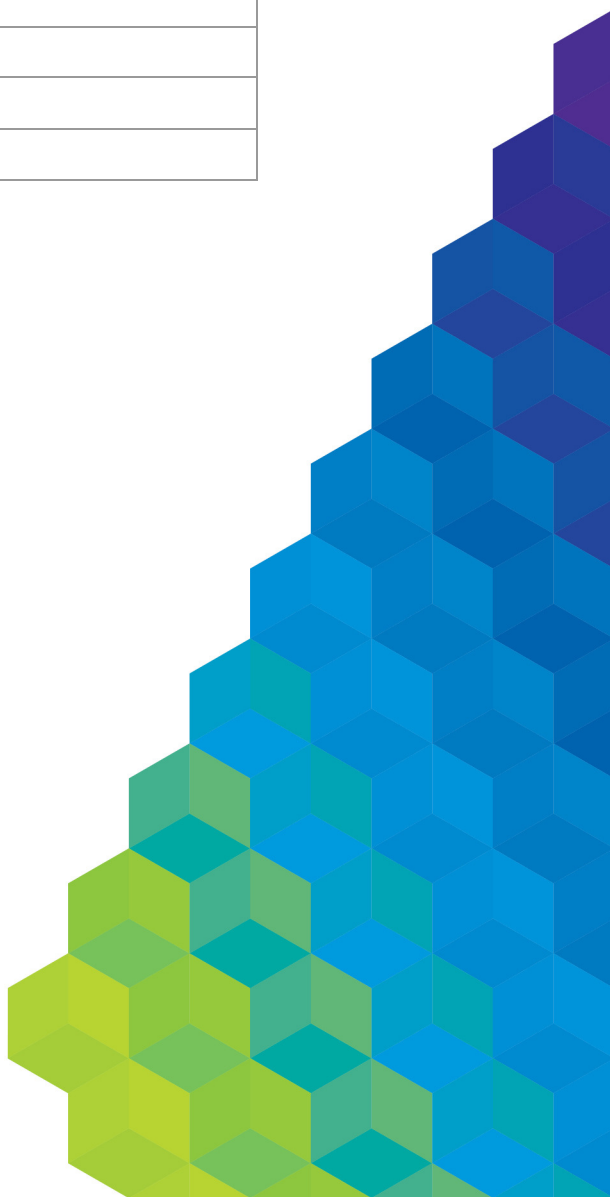

# REVISION HISTORY

| Issue Number | Date | Description | Author |
|---|---|---|---|
| 1 | 18/04/2018 | First Issue | A. Ziusudras |
| | | | |

# 1 PURPOSE AND BACKGOUND

## 1.1 Purpose

The purpose of this document is to explain AusNet Services' strategy in relation to Distribution Feeder Automation (DFA) affected by the installation of the Rapid Earth Fault Current Limiter (REFCL) installation program.

## 1.2 Background

AusNet Services' network operates in a unique geographical location, which is exposed to extreme bushfire risk. These conditions warrant significant investment to mitigate the bushfire risk.

The 2009 Victorian Bushfire Royal Commission made several recommendations with respect to fires initiated from distribution electricity 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.

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 REFCL installation program will be managed in three Tranches. This DFA strategy is expected to remain valid for all 3 Tranches however, any changes to the strategy as a result of REFCL Program deployment learnings will be captured as a revision to this document.

AusNet Services' existing 22kV feeder fault treatment scheme, DFA involves a combination of Automatic Circuit Recloser (ACRs), Remote Control Gas Switches and feeder management relay operations plus the use of adjacent feeders to supply feeder sections downstream of a faulted section and is currently used to provide network reliability.

## 1.3 Strategy objective

The objective of our DFA strategy is to minimise outage and disruption in distribution network while ensuring we successfully deliver the REFCL installation program.

# 2 Investment need

At the time when DFA was developed (circa 2006), AusNet Services distribution network was low impedance grounded (either directly or resistively earthed) therefore DFA algorithms were all based on low impedance earthed networks.

Existing DFA algorithms rely on fault targets obtained from remote control gas switches and line protection devices (ACRs and Feeder Management Relays).

ACRs that are currently installed on the AusNet Services distribution network are also not able to detect earth faults in resonant networks. In addition, they cannot provide protection coordination while the REFCL is in service and for this reason a separate stream of works and strategy has been developed to address this. Please refer to REF 20-08 REFCL Program Automatic Circuit Recloser Strategy for more information.

The installation of a REFCL which is based on resonant earthing results in a shift from the conventional low impedance earthed networks to high impedance earthed networks and a dramatic reduction in earth fault current. Consequently this change introduces some negative effects on DFA performance;

I. At present remote control gas switches are not able to detect earth faults in resonant networks; and therefore are no longer able to provide fault indications for DFA operation[1];

II. The present algorithms used for DFA are not compatible with REFCL technology;

It is therefore necessary to make some modifications to the existing DFA system in order to maintain present levels of network reliability and customer experience. Material reductions in customer supply reliability will occur when the REFCL is in service if these modifications are not made.

# 3 Options analysis and preferred approach

The installation of REFCLs on the existing network requires cost effective methods to establish and maintain network reliability and reduce the length of an outage and disruption. The DFA ensures this occurs and performs a critical role in isolating the faulted section and restoring the unfaulted sections of the REFCL protected network such that REFCL protection is maintained and available post operation of an initial fault.

The proposed approach to AusNet Services fault treatment scheme DFA involves a combination of:

- Modifying DFA algorithms;

Upgrade to existing remote control switches to new generation of remote control switches in REFCL networks including transfer feeders that form part of the DFA scheme;

Before determining our preferred approach to network reliability, we considered 2 alternative approaches:

**Option 1.** *(Preferred and desirable option)*

- Upgrade existing remote control switches to new generation of switches in REFCL protected network including transfer feeders that form part of the DFA scheme area;
- DFA algorithm to be modified to be compatible with REFCL technology;

**Option 2.**

- No upgrades to any field devices and DFA algorithm (do nothing);

[1] Field device manufacturers are currently developing new techniques to detect earth faults on resonant networks.

A summary of our analysis in relation to each of these options is shown in Table 1.

**Table 1: Options evaluated**

| Option | Advantages | Disadvantages |
|---|---|---|
| 1. Upgrade existing remote control switches to new generation of switches in REFCL protected network including transfer feeders that form part of the DFA scheme area; Distribution Feeder Automation algorithm to be modified to be compatible with REFCL technology; | Network reliability maintained with strategy consistent with pre-REFCL environment.<br>Minimises USAIDI outages and disruption in targeted feeders.<br>No significant training required. | More expensive than the alternative option. The cost depends on how many remote control switches we are upgrading. |
| 2. No upgrades to any field devices and DFA algorithm (do nothing); | No need to upgrade any field device equipment therefore no need to purchase new generation of field devices ($0 cost).<br>No need to modify DFA algorithm to be compatible with REFCL technology ($0 cost) | Material deterioration in customer experience and USAIDI.<br>Time consuming and labour intensive to locate faults. |

Option 1 is the preferred option as it is evident from the above table it has:

- Reduced public safety risk when compared to Option 2;
- Maintained a reliable supply to customers; and
- Maintains DFA ability to restore supply to customers in less than 60 seconds;

# 4 Efficient and prudent program delivery

The following high level delivery plan is to:

1. Assess current installations of remote control gas switches and determine retrofit requirements;
2. Develop hardware and software specifications with remote control gas switch manufacturers;
3. Functionally test algorithms at remote control gas switch manufacturer premises prior to wide scale deployment;

4. Install and trial remote control gas switch upgrades on a REFCL protected network prior to wide scale deployment. Completion of primary earth fault tests required to validate the remote control gas switch upgrades
5. Once proven, proceed with remote control gas switches deployment.
6. DFA code modification.

This sequence of activities ensures that the more expensive activity (modifying or replacing remote control gas switches) is only undertaken after the technology has been proven.

Ensuring delivery efficiency of the above plan relies on integration of compatible equipment works with other works on the network such as business as usual maintenance, safety programs and other REFCL line works.

## 4.1 Risk management

The risks associated with delivery of the program for DFA and remote control gas switch upgrades are shown in the table below.

| Risk | What could occur | Actions & controls |
|---|---|---|
| Interference / clashes with other project(s) and project scope creep. | Delivery delays leading to non-compliance with Bushfire Mitigation Regulations and the approved Bushfire Mitigation Plan.<br>Down time for construction crews | Continual engagement with Network Planning Teams and delivery partners.<br>Network Programs constant review of Portfolio projects.<br>Dedicated Program Sponsor Team established. |
| Delivery delays in meeting the timetable specified in the regulations. | Delivery delays leading to non-compliance with Bushfire Mitigation Regulations and the approved Bushfire Mitigation Plan.<br>Gas switch CT upgrades not completed in time.<br>DFA algorithms not working. | Monthly reporting of the progress of the project from delivery partners through to the Program Team / Steering Committee and Energy Safe Victoria.<br>Regular updates of Asset Management System enabling progress to be tracked real-time.<br>Well planned schedule of works. Early engagement with Control Energy Operations Team (CEOT), delivery partners and field personnel to ensure resourcing availability.<br>Constant engagement with gas switch manufacturer.<br>Thorough testing of gas switch hardware and software upgrades.<br>Thorough testing of DFA software upgrades. |

| Risk | What could occur | Actions & controls |
|---|---|---|
| Gas switch not available when required for fault isolation. | Gas switches out of service due to upgrade or replacement activities.<br>Gas switches not able to minimise customers affected due to an outage. | Works to be completed when gas switches are not anticipated to be required.<br>Where gas switches are to be replaced, works to be constructed alongside existing units. Cutover to new unit to be undertaken over a reduced period, decreasing outage time. |

## 4.2 Procurement

New generation remote control switches and control boxes to be installed are standard stock items. These items have been procured utilising AusNet Services' standard procurement and governance processes which include competitive tendering to ensure the cost per unit is efficient.

## 4.3 Works delivery

As stated above, the volume of non-compatible remote control switches requiring upgrade or replacement will vary per zone substation and per Tranche. A summary of the remote control switches works required for each REFCL installation will be included in the respective zone substation REFCL Planning Report.

The remote control switch works will be constructed using established external delivery partner relationships.

Modification to the DFA algorithm will be modified and deployed throughout the REFCL network by an AusNet Services consultant.

## 4.4 Program costs and benchmarking

The DFA Strategy preferred option has been costed in accordance with our standard costing methodology, as detailed in the supporting document: Cost Estimating, program delivery and unit rates.

The costs detailed below include:

- Site visits;
- Design of new generation of remote control switches  replacement or upgrades;
- Bench testing the control boxes units;
- Works and network contingency planning and governance activities;
- Construction works;
- Testing, communications and commissioning;
- DFA algorithm code modification;
- DFA scheme design & testing;
- Project management; and
- Auditing.

A summary of the capital expenditure requirements for each REFCL installation will be included in the respective zone substation REFCL Planning Report.

### 4.5 Program governance

While the Distribution Feeder Automation program will be managed using the AusNet Services' Portfolio Framework, an overarching REFCL Program Governance Framework has been established in order to provide end-to-end program oversight and accountability, to identify and manage program level risks.

The REFCL Program Governance Framework aligns to AusNet Services' values and commitment to mission zero with:

- Clear accountabilities, reporting and robust risk and issue management;
- Sustainable, long term, reliable, economical and workable whole of life designs;
- Delivery as per agreed timelines without compromising reliability and other service standards;
- Integration where possible with the rest of the AusNet Services work program;
- Compliance with required obligations;
- Strong relationships with all stakeholders in order to successfully manage change;
- Development of internal capability in order to facilitate the transition to business as usual; and
- Use of business as usual processes and resources where possible.

## 5 Concluding comments

This document has explained that:

- The proposed scope of upgrading the existing remote control switches to new generation of switches work is the lowest risk option for addressing the specific issues of customer experience and USAIDI on REFCL protected networks;
- Our network reliability commitment is consistent with our approved strategy;
- The key assumptions underpinning our network reliability and reduce the USAIDI are reasonable;
- We have identified the key risks in relation to network reliability works and taken appropriate risk mitigation measures; and
- Our projected costs (refer to relevant Planning reports) are consistent with the estimated average unit costs in the RIS

In addition, it should be noted that our forecast expenditure for replacing existing remote control switches to new generation of remote control switches on REFCL site including transfer feeders that form part of the DFA scheme has been subject to our standard business case review and approval processes. This work will also be subject to our project management and governance arrangements.

For these reasons, we regard the forecast expenditure for our network reliability approach as prudent and efficient, in accordance with the Rules requirements relating to contingent projects.