Rapid Earth Fault Current Limiter (REFCL) Program

MSD Zone Substation Functional Scope

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Contents

1 Project overview

This project scope covers all aspects involved in the conversion of the Mansfield (**MSD**) zone substation (**ZSS**) from a solidly earthed network to a resonant earthed network that can meet the performance requirements as set out in the *Electrical Safety (Bushfire Mitigation) Regulations 2013* as amended by the *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016* which came into effect on 1 May 2016.

Conversion to resonant earthing changes the electrical characteristics of the zone substation and the network it supplies. Resonant earthing significantly reduces single phase to ground fault currents. Phase to ground voltages on the faulted phase are reduced significantly whilst phase to phase voltages remain unaffected. The neutral voltage is raised to normal phase to ground voltage and the two healthy phases have their phase to ground voltages increase to phase to phase voltage levels.

Resonant earthing is only being applied to the 22 kV network. As such the resonant earthing does not affect (or protect) the following adjacent network, namely:

- 66 kV sub-transmission system;
- 12.7 kV Single Wire Earth Return System (**SWER**);
- High Voltage (**HV**) Customers with an Isolating Transformer installed; and
- Low Voltage (**LV**) supplies.

1.1 Background

AusNet Services' network operates in a geographical location which is exposed to extreme bushfire risk. These conditions warrant significant investment to mitigate the risk of bushfires as a result of earth faults on the distribution network.

The Victorian Bushfire Royal Commission, established in 2009, made several recommendations with respect to fires initiated from electricity distribution networks. Subsequently, the Victorian Government established the Powerline Bushfire Safety Taskforce (**PBST**) to investigate new cost efficient and effective technologies and operational practices to reduce catastrophic bushfire risk.

The PBST identified Rapid Earth Fault Current Limiters (**REFCLs**) installed in zone substations as an efficient and effective technology.

The *Electricity Safety (Bushfire Mitigation) Amendment Regulations 2016* (**Amended Bushfire Mitigation Regulations**) which came into operation on 1 May 2016 set out new requirements for major electricity companies including the requirement for Polyphase Electric Lines (defined as multiphase distribution between 1 kV and 22 kV) at selected zone substations to have the following abilities:

- to reduce the voltage on the faulted conductor for high impedance faults to 250 volts within 2 seconds
- to reduce the voltage on the faulted conductor for low impedance faults to
  - i. 1900 volts within 85 milliseconds; and
  - ii. 750 volts within 500 milliseconds; and
  - iii. 250 volts within 2 seconds; and
- Demonstrate during diagnostic tests for high impedance faults to limit
  - i. Fault current to 0.5 amps or less; and
  - ii. The thermal energy on the electric line to a maximum I^2t value of 0.10;

The Amended Bushfire Mitigation Regulations define the low and high impedance faults as follows:

- High impedance = a resistance value in Ohms that is twice the nominal phase-to-ground voltage. This is equal to 25.4 kOhms or a fault current of 0.5 amps on a 22 kV network.
- Low impedance = resistance value in Ohms that is the nominal phase-to-ground network voltage divided by 31.75. This is equal to 400 Ohms or a fault current of 31.75 Amps on a 22 kV network.

1.2 Selected REFCL zone substations

Schedule 2 of the Amended Bushfire Mitigation Regulations lists the selected zone substations to be REFCL enabled. For AusNet Services, 22 zone substations have been selected.

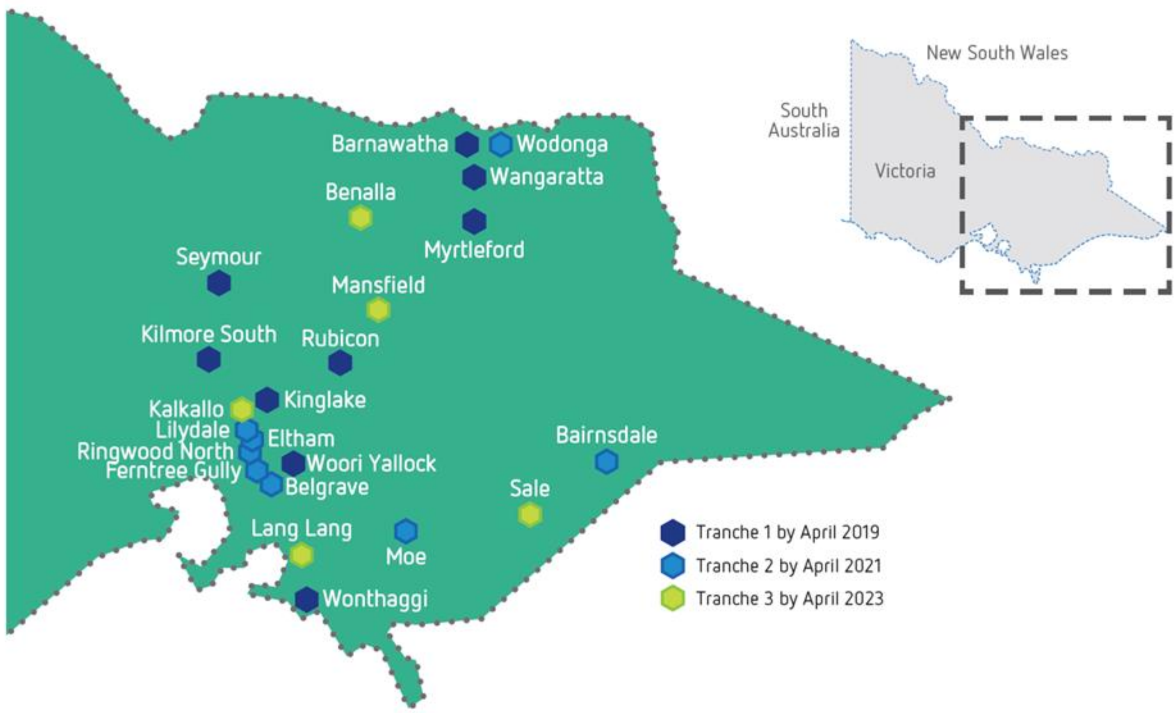
Schedule 2 assigns a number of points to each of the selected zone substations. The Amended Bushfire Mitigation Regulations require AusNet Services to ensure:

- at 1 May 2019, the points set out in Schedule 2 in relation to each zone substation upgraded, when totalled, are not less than 30;
- at 1 May 2021, the points set out in Schedule 2 in relation to each zone substation upgraded, when totalled, are not less than 55; and
- on and from 1 May 2023, each polyphase electric line originating from every AusNet Services zone substation specified in Schedule 2 has the required capacity.

AusNet Services' REFCL Program has been structured into three separate tranches in order to achieve the 'points' requirement by the mandated dates.

The following figure shows the specified zone substations by tranche.

Figure 1: AusNet Services selected REFCL Zone Substations



Source: AusNet Services

1.3 Mansfield zone substation overview

The MSD ZSS is located approximately 190km north east of Melbourne at 3,540 Maroondah Highway, Mansfield, Vic, 3722. This ZSS was established in the 1950s and supplies approximately 6,400 customers by means of two 10/13MVA transformers and three (3) 22kV distribution feeders. The MSD 22kV feeders cover a total route length of 619km.

The MSD electricity distribution area includes both residential and commercial areas around Mansfield. MSD ZSS network is mostly long overhead SWER rural feeders, with one of the feeders acting as a non-dedicated backup supply for Mount Buller.

The estimated total capacitive current of the MSD 22kV network is 59.3Amperes (**A**). As the capacitive current is below 101A, a single REFCL will be required.

1.3.1 Key issues and challenges

The MSD ZSS is an outdoor switchyard with limited area for the installation of primary equipment to support the conversion to resonant earthing.

The existing site control room contains 66kV protection and control panels and is unsuitable for the installation of REFCL technology and associated 22 kV protection equipment. Refer to section 2.2.4 of this functional scope document for an overview of the site control room options analysis.

Additionally, during the snow season (May to September), there are sections of the MSD network that have limited access for construction and maintenance works.

1.3.2 Implementation timing

Whilst the MSD ZSS is included in Tranche 3 of the REFCL Program, the implementation of the MSD REFCL has been brought forward to meet the Tranche 2 compliance deadline of 1 May 2021. This provides a two (2) compliance point contingency for Tranche 2.

1.4 MSD ZSS Assets

The following table provides an overview of the current assets located at the MSD ZSS.

Table 1: MSD Zone Substation – current assets

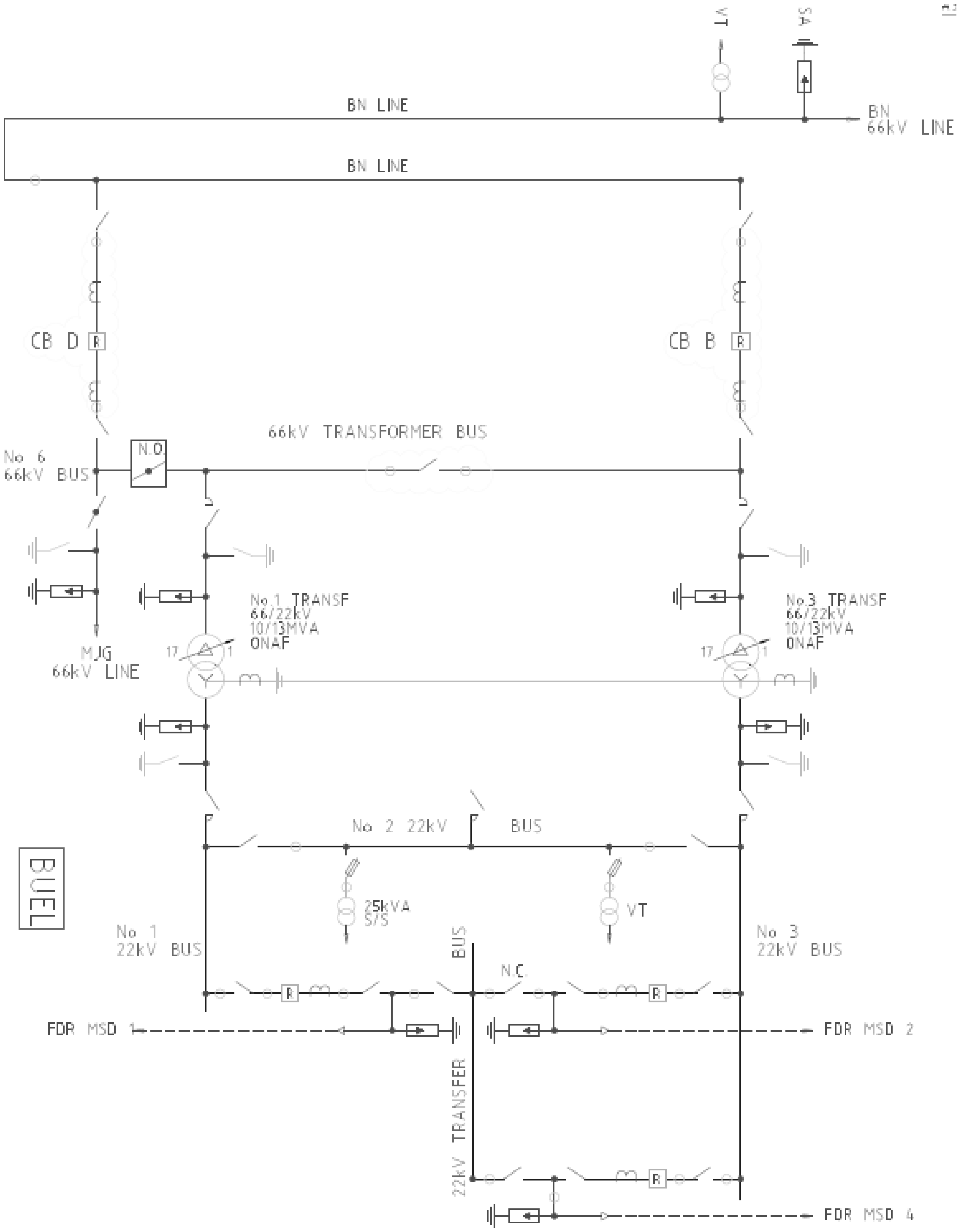
Zone Substation	Details
Location	190km north east of Melbourne
Established	1950s
Supply Area	Mansfield and surrounding areas
Customers	6,448
Zone Substation transformers	2 x 10/13 MVA
22 kV Buses	3 (plus transfer bus)
Capacitor Banks	none
Feeders	3
Station services transformers	1 x 25 kVA (22/0.415kV)
Schedule 2 points allocation	2

Source: AusNet Services

1.5 MSD ZSS single line diagram

The following figure represents the current single line diagram of the MSD ZSS.

Figure 2: MSD Current Single Line Diagram



Source: AusNet Services

1.6 MSD 22kV network

The following table provides an overview of the 22kV network originating from the MSD ZSS.

Table 2: MSD 22kV Network – current configuration[1]

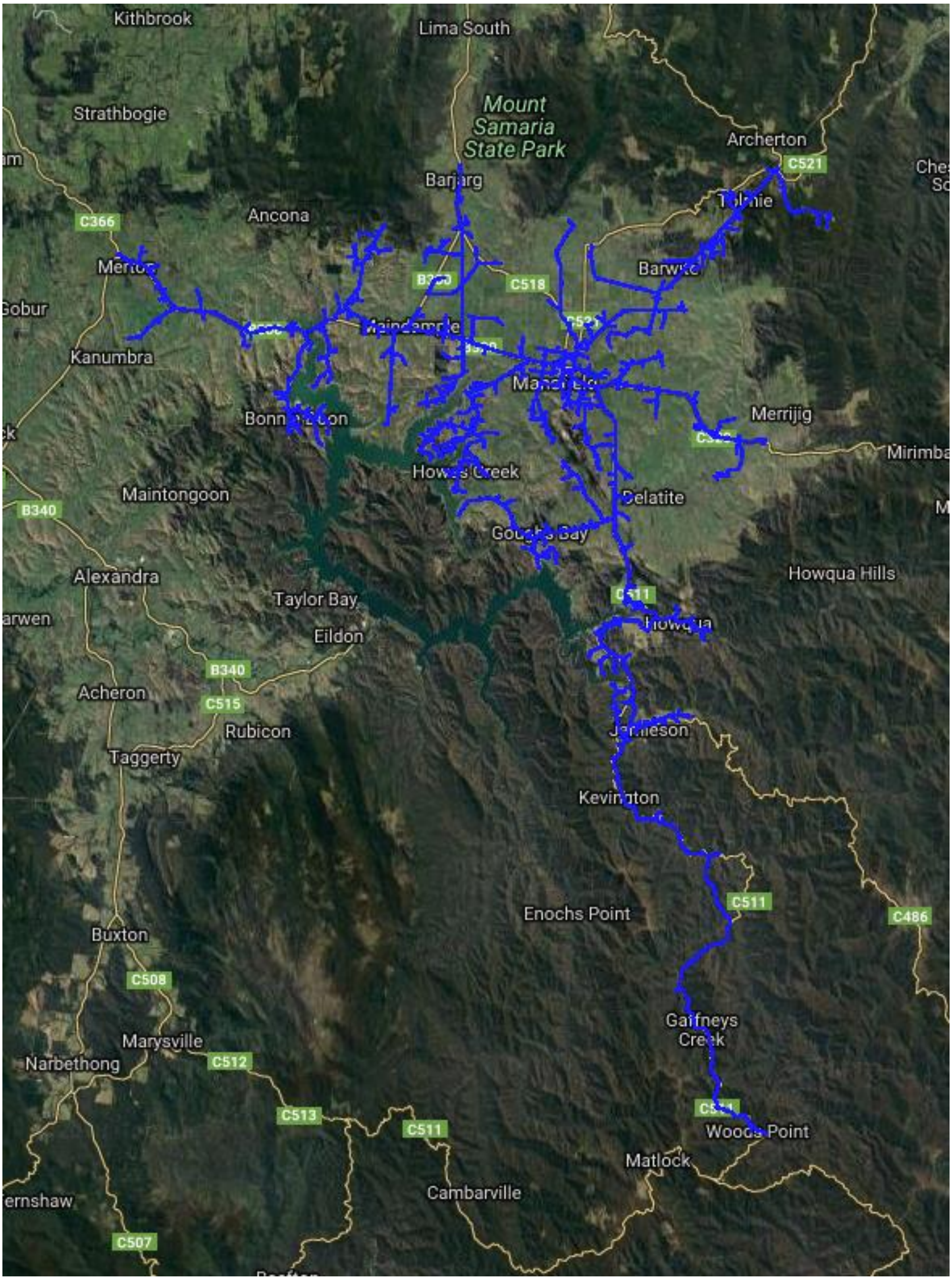
Network	Details
Total Network Length (km)	619.4
Aerial Bundled Cable (**ABC**) Length (km)	0.062
Underground (**U/G**) 3 phase (**ph**) Cable Length (km)	8.4
U/G 1ph Cable Length (km)	0.0
Overhead 3ph Line Length (km)	289.9
Overhead 1ph Line Length (km)	321.1
Estimated network capacitance (Amps (**A**))	59.3
HV Customer Connections	0
Automatic Circuit Reclosers (**ACRs**)	5
Sectionalisers	5
HV Regulator sites	2
Surge Arrestor Sites	1,591

Source: AusNet Services

[1] Not including SWER or Transfer feeders

The following figure shows an aerial view of the 22kV feeders originating from the MSD ZSS.

Figure 3: MSD 22kV feeders shown in blue



Source: AusNet Services

2 Zone substation requirements

The successful implementation of resonant earthing requires a number of changes at the zone substation including the installation of the resonant earthing equipment, installation of supporting infrastructure and replacement of equipment that cannot handle the elevated voltages introduced by the transition to resonant earthing.

The scope of works for the installation of REFCL equipment, supporting infrastructure and asset hardening at MSD ZSS is summarised in the following sections of this functional scope document.

2.1 Primary systems

2.1.1 REFCL Equipment

Taking into account the network size, dissymmetry and damping originating from the MSD ZSS, one Arc Suppression Coil (**ASC**) is required to be installed at MSD ZSS.[2]

- Installation of one (1) Ground Fault Neutraliser (**GFN**) primary equipment, including:
  - One (1) ASC;
  - One (1) Residual Current Compensator Inverter (**RCC**); and
  - One (1) Grid Balancing Unit.

2.1.2 Neutral Bus

A neutral bus system must be installed to control the neutral earthing arrangements allowing change of operational mode during fault management.[3]

- Installation of one (1) Neutral Bus kiosk.

2.1.3 Primary Cables

- Underground the existing overhead feeder (100m) MSD2 to accommodate zero sequence CTs.
- Relocate the existing 66kV line to Merrijig south to 2m from the southern boundary fence and transpose vertically – including the installation of 2 poles.
- Replacement of the two 22kV feeders (100m each); 3C 300 mm^2, AL XLPE.
- Installation of capacitor bank cables 3C 300mm^2, AL XLPE 22 kV (100m).
- Installation of the following 22kV 3C 185 mm^2, AL XLPE, from:
  - No.1 Station Service Transformer to MSD1 feeder(50m); and
  - No.2 Station Service Transformer to MSD2 feeder(80m).
- Installation of the following single core 185 mm^2, AL XLPE 22 kV neutral cables, from:
  - No. 1 Transformer neutral isolator to No. 1 Neutral Bus kiosk (50m);
  - No. 3 Transformer neutral isolator to No. 1 Neutral Bus kiosk (80m); and
  - No. 1 GFN to No. 1 Neutral Bus kiosk (20m).

2 For further information on the ASC sizing refer to REF 30-04 REFCL Program Arc Suppression Coil Sizing Policy

3 For further information refer to REF 30-16 REFCL Program Operating Modes Policy

2.1.4 Circuit Breakers and isolators

The following primary plant will need to be replaced due to poor condition and the inability to withstand REFCL operations:

- Replacement of three (3) outdoor feeder circuit breakers.
- Installation of one (1) new circuit breaker for the capacitor bank.
- Installation of two standard neutral isolator structures.
- Replacement of four isolators:
    - MSD 1 feeder isolator (CB bus side);
    - MSD 1 Feeder Transfer bus isolator;
    - MSD 1 Feeder isolator (CB feeder side);
    - 22kV Bus VT fused isolator; and
    - Installation of two (2) new U/S for the capacitor bank.
- Currently 22kv transfer capacity is insufficient to support the 22 kV Merrijig which is a radial supply from Mansfield during peak loading periods (May to September). As such, the installation of one (1) 66kV Circuit breaker is required between the incoming Benalla 66kV line and the 66kV transformer bus on the transformer side. This will enable the switching of the 66kV bus to isolate either of the two 66/22kV supply transformers at any time without extensive customer interruptions to Mount Buller. Without this switching capability, AusNet Services will not be able to complete the required REFCL zone substation works within mandated delivery timeframes. Only the installation and refurbishment costs of the circuit breaker are included in the contingent project application.

2.1.5 Station Service Transformers

The existing 25 kVA Station Service transformer (22/0.415 kV) does not have adequate rating to supply the RCC during fault compensation and must be replaced with a suitably rated transformer, therefore AusNet Services requires the following:

- Installation of two (2) 500kVA (22kV/415V) transformers;
- Removal of the existing Station Service Transformer.

2.1.6 AC Supplies

The existing AC supply boards cannot supply the current required by the RCC and handle the fault level introduced by the new Station Service transformer.

- Installation of one (1) AC 415V REFCL change over board rated for 500 kVA and suitable for the REFCL equipment.
- Installation of one (1) AC 415V station services change over board rated for 500kVA and suitable to supply the station AC supplies.

2.1.7 Surge Arrestors

The existing surge arrestor units are not suitable for operation with the voltages imposed by REFCL operations.

- Replacement of six (6) 22kV transformer surge arrestors (3 per transformer).
- Replacement of three (3) 22kV surge arrestors for the feeder exits.
- Installation of two (2) single phase surge arrestors for the neutral structures for transformers due to various scenarios leading to excessive overvoltage at the neutral point.
- Installation of one (1) new surge arrestors for the capacitor bank feeder.

2.1.8 Instrument Transformers

Voltage Transformers (VTs)

The existing 22 kV Bus VTs are not rated for the voltages imposed by REFCL operations and must be replaced.

- Replacement of one (1) No. 2 Bus Voltage Transformers on existing structure.

Current Transformers (CTs)

- Replacement of two (2) CTs (1 per transformer) due to the condition and the incompatibility with REFCL operations.

Zero Sequence CTs

Zero Sequence (Core Balance) CTs are required to measure the individual imbalance on each feeder and any change in balance due to network modification or switching.

- Installation of 6 zero sequence CTs – three (3) for the exit feeders, two (2) for the station service transformers and one (1) for the capacitor bank.

2.1.9 22 kV Cabling and Transformer Testing

22 kV transformers, capacitors and feeder exit cables are critical assets within the zone substation and failures in service may result in significant customer outages. To minimise the likelihood of failure, offline cable testing is to be undertaken and any issues identified will be addressed.

Transformer tests including partial discharge (**PD**) testing, power transformer condition monitoring test and REFCL operational test on each transformer (there are 2 x power transformers).

If testing identifies any issues, it is likely to result in full cable replacements due to the short lengths of these cables.

Offline partial discharge and high potential tests are required to be performed on the following cables:

- MSD1 Feeder exit cable;
- MSD2 Feeder exit cable;
- MSD4 Feeder exit cable;
- No. 1 Transformer 22 kV cables; and
- No. 2 Transformer 22 kV cables.

2.1.10 Capacitor Banks

- Installation of one (1) new capacitor bank (2 x 3Mvar) to address harmonic and capacitance issues for REFCL operations.

2.1.11 Earth Grid Design

- The existing earth grid design shall be reviewed to ensure the earthing system will continue to adequately protect personnel, plant and the public post the introduction of resonant earthing.

2.1.12 Neutral Earthing Resistor (NER)

MSD is a direct earthed zone substation and therefore, there is no NER.

2.2 Civil infrastructure

A number of civil infrastructure installations and modifications are required to support the REFCL installation.

2.2.1 ASC

- Installation of one (1) footing, neutral cable conduits and oil bunds.

2.2.2 Station Service Transformer

- Installation of two (2) footings, cable conduits.

2.2.3 Neutral Bus

- Installation of one (1) footing, conduits for neutral and control cables.

2.2.4 REFCL control room

The existing site control room at MSD ZSS is very compact and does not have the physical space for the required installation of REFCL technology, namely the RCC unit, REFCL control panels, protection and communications equipment, network monitoring and switchgear interface relays.

Options considered included:

- Business as usual – not viable.
- Installation of one standard REFCL control room and one modular control room;
- Same as the above option, but install one tilt slab control room to house the REFCL control units and associated 22kV protection equipment.

The preferred option is the installation of one standard REFCL control room and one modular control room to house the required 22kV protection and control equipment. Option 3 would result in a complex construction phase and increase the delivery risk. The lead times for the REFCL control room and modular control room enable the REFCL to be installed at MSD within the Tranche 2 timeframes.

The following civil items are required to deliver this option:

- Installation of one (1) modular control room and one (1) REFCL control room to house the RCC, grid balancing unit and GFN control and monitoring systems and the 22KV protection and control equipment.
- Installation of one (1) footing for the modular REFCL control room.
- Temporary security during delivery and installation.

2.2.5 Cable trench

- Installation of additional cable trenches for connection from the existing cable trench system to the following locations (allowance 50m):
  - REFCL control room;
  - CTs;
  - ASCs; and
  - Neutral Buses.

2.2.6 Capacitive Bank

- Installation of one (1) footing and structure for the capacitor bank and circuit breaker.

2.2.7 Earth Grid

- Extension of the earth grid to protect the REFCL control room, ASCs, Neutral Buses, Station Service Transformers and other installed equipment as required.

2.2.8 Switchyard Surfacing

- Restoration of the disturbed switchyard surfaces.

2.2.9 Neutral Isolator Structures

- Installation of two (2) Neutral isolator structures to facilitate GFN neutral connections to the transformers.

2.2.10 66kV Circuit Breaker

- Installation of one (1) footing.

2.2.11 Lighting

- Produce lighting design and establish outdoor switchyard lighting to relevant standard.

2.3 Secondary systems

A number of secondary systems need to be added or modified to support the installation of REFCL equipment at the station.

2.3.1 GFN Control System

The GFN vendor will install a free issued GE C30 relay RUGGEDCOM Ethernet switch and C-VT410 Voltage transformer (110V/63.5V 25VA Class1enclosed multi tapped with ratios 36V, 48V, 63.5V and 110V for the Auxiliary VT push button test circuit) to allow AusNet Services control the operational mode of the GFN system.

- Installation of one (1) GFN control system panel as part of the GFN product; and
- GE C30 relays, RUGGEDCOM RSG2488 Ethernet Switches and Auxiliary VT push button test circuit transformers (1 per GFN) shall be free issued for installation in their GFN control system panels.

2.3.2 Neutral Control System

- Installation of one (1) neutral bus interface control system panel including:
  - No. 1 Neutral Bus X ABB REF630 controller relay; and
  - No. 1 Neutral Bus Y GE30 controller relay;

2.3.3 Fault Recording and Switchgear Interface Panels

Fault location and diagnosis can be significantly more difficult with resonant earthed networks.

To assist with GFN commissioning, annual compliance testing and fault investigation activities, additional network monitoring relays must be installed to capture bus voltage, neutral voltage and bus current waveforms and harmonics.

To interface status and control signal wiring between the switchgear and the GFN system one (1) control relays are required per 22 kV bus.

- Installation of one (1) network monitoring and switchgear interface panels. Each panel includes:
  - 2 x ELSPEC Network Monitoring relays; and
  - 1 x GE C30 control relays.

2.3.4 Protection Systems

Protection review required for transformers, feeders, Master Earth Fault (**MEF**) & Back Up Earth Fault (**BUEF**), Bus and 66/22 supply transformers addressing protection sensitivity and settings.

- 66kV CB failure protection is required if the distance protection settings review comes up short;

Standard protection and control schemes may require modifications to suit specific site conditions. Any such modification should be carried out in consultation with Technical Standards and Services.

Transformer Protection

- Replacement of two (2) Transformer X and Y protection relays due to incompatibility with REFCL operations.

Feeder Protection

The existing feeder protection is not compatible with the GFN system.

- Replacement of three (3) existing GE F650 feeder protection relays with ABB REF630 relays.

Bus Protection

- The existing bus protection is compatible with the GFN system.
- Bus bar extension for the capacitor bank feeder.

Station Master Earth Fault (MEF), Backup Earth Fault (BUEF) and PQM

- The existing REF630 Master Earth Fault relay is suitable and will only need a firmware upgrade;
- The existing Back Up Earth Fault relay is new and will only need a firmware upgrade.
- Replacement of one (1) Power Quality Meter (**PQM**) as the existing is not compatible for REFCL operations.

Capacitor bank protection and control

- Installation of one (1) new capacitor bank control and protection panel.

Battery Systems

- Install X and Y 125V DC battery system in existing battery room

2.3.5 Communications

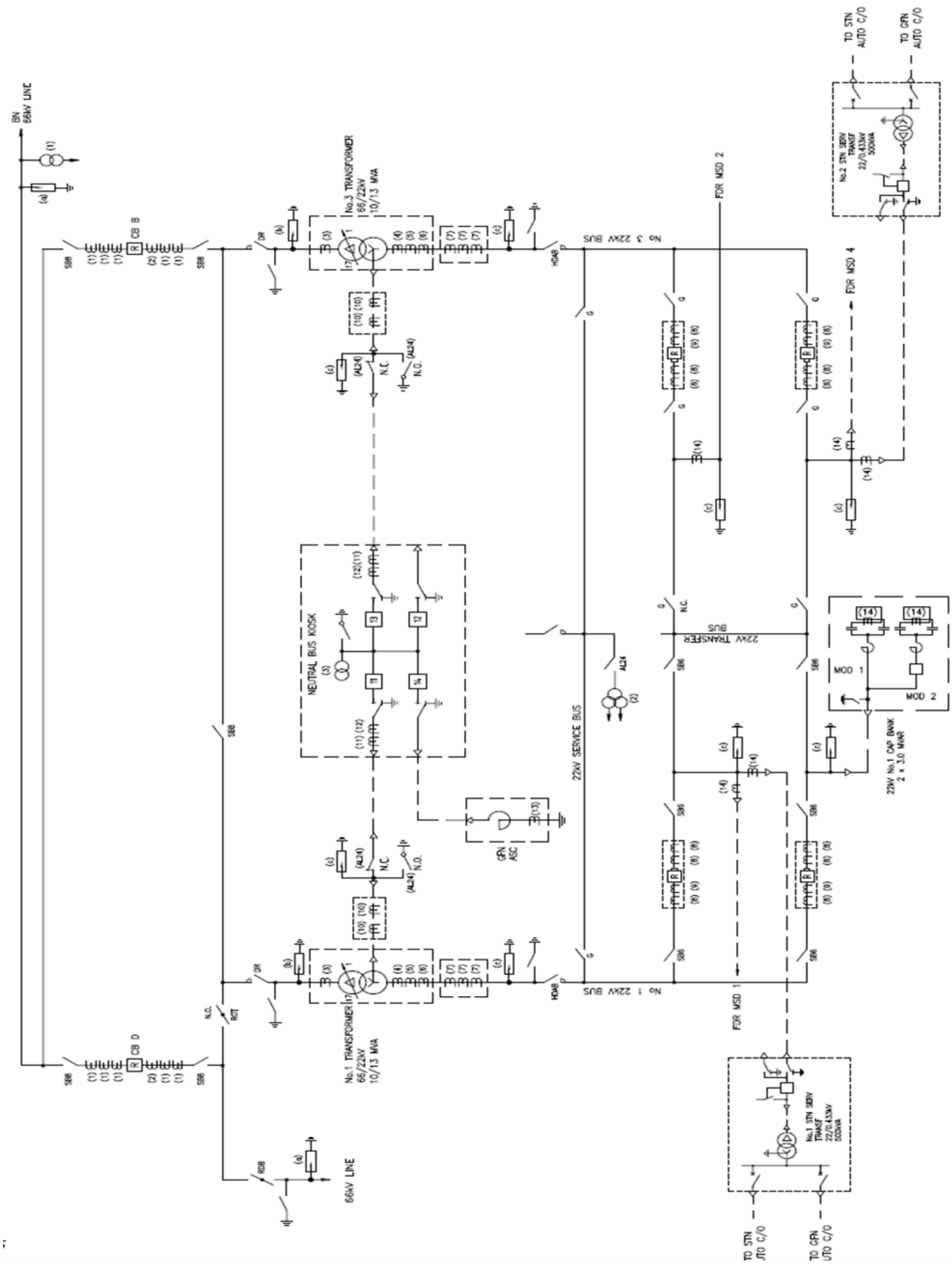
The new equipment in the REFCL control room requires connection to the existing Digital Interface Cubicle (**DIC**).

- Upgrade tele-protection equipment and communications:
- Install 1x RS2488 switch;
- Install 1x 2488 clock;
- Install one (1) HMI; and
- SCADA modifications.

2.4 MSD proposed single line diagram

The following figure represents the proposed single line diagram of the MSD ZSS following the installation of the GFN and associated compatible equipment.

Figure 4: MSD proposed single line diagram



Source: AusNet Services

3 22 kV distribution feeder requirements

The suitability of the assets on the feeders supplied by a REFCL equipped zone substation is critical to ensure successful operation of the technology without undue reliability or safety consequences.

These assets must be able to sustain the additional phase to ground voltage stress introduced by the REFCL technology, be balanced with regards to capacitance to ensure the REFCL technology works at the regulated performance levels and operate normally during REFCL fault compensation.

To achieve these outcomes, three programs address equipment that does not meet the above criteria, namely:

- Network hardening;
- Capacitive balancing; and
- Compatible equipment.

3.1 Network hardening

Operation of resonant earthing, on which the REFCL technology is based, introduces periods of increased phase to ground voltages.

This increased voltage can cause issues for existing assets specified for a solidly grounded operational profile.

AusNet Services has assessed its assets and determined that network assets most impacted by the increased voltages are:

- Surge arrestors; and
- High Voltage (**HV**) cables.

3.1.1 Surge arrestors

Surge arrestors are a voltage dependent resistor designed to begin to conduct as the voltage increases to supress very short duration overvoltage such as those associated with lightning strikes. In doing this, they absorb energy whilst the voltage is higher. If not rated suitably, surge arrestors may overheat and fail during REFCL operation, potentially obstructing the effectiveness of the REFCL in limiting the fault current.

Replacement activities are required at three 22kV line asset types: cable head poles, transformers and switches.

AusNet Services has tested each type of surge arrester installed on its networks to determine the suitability of each type for REFCL protected networks.[4] To determine the volumes for the MSD network, each surge arrestor site was inspected and the surge arrestor types installed confirmed to determine replacement requirements.

[4] For further information, refer to REF 20-07 REFCL Program Line Hardening Strategy.

At MSD, the following needs to be addressed.

Table 3: MSD surge arrestor replacement volumes

Sites	Units
429	977

Source: AusNet Services

3.1.2 HV Cables

Insulated HV cables are susceptible to failure resulting from damage that can occur during operation at higher voltages. Periods of operation at higher voltage can cause immediate failure or initiate partial discharge that can continue to damage the cable after voltages have returned to normal. Premature cable failure can occur in the subsequent hours or days after the initiating overvoltage occurred.[5]

AusNet Services utilises offline testing for critical backbone portions of the feeder to identify cables requiring repair or replacement. A review of the cables database has been undertaken and cable failure and test results from REFCL Tranche 1 and 2 investigations have been utilised to forecast the likely proportion of cables that will need to be tested and replaced for Tranche 3.

Table 4: MSD HV cable testing, repair and replacement volumes

Online tests	Offline tests	Repair Cable	Replace Cable
5	5	6	0m

Source: AusNet Services

3.1.3 Other Assets

Other asset classes may exhibit issues with the voltages introduced by operation of REFCL technology and will be replaced when they fail as it is impractical to proactively identify which ones may fail. The most common items are:

- Distribution transformers; and
- Line insulators – especially in areas on the coast where salt contamination can cause current tracking to ground failures at REFCL voltages

From previous stress testing, AusNet Services has not experienced extensive failures of other distribution assets excluding cables and HV Aerial Bundled Cable (**ABC**) addressed in section 3.1.2. AusNet Services does not anticipate failures of other assets.

3.2 Capacitive balancing

Capacitive balance is a key enabler of achieving the performance requirements of the Amended Bushfire Mitigation Regulations. Neutral voltage caused by capacitive imbalance decreases the sensitivity of the REFCL technology.[6]

A number of balancing activities are required to achieve the necessary capacitive balance level including:

- Installation of a 3rd conductor on single phase spurs where only a few spans are required;
- Conversion of single phase cable spurs to three (3) phase by connecting the 3rd phase;

5 For further information, refer to REF 20-07 REFCL Program Line Hardening Strategy

6 For further information, refer to REF 20-06 REFCL Program Network Balancing Strategy

- Phase rotations of single phase spurs;
- Installation of single phase capacitor banks at the beginning of single phase spurs;
- Installation of 3 phase capacitor banks for each automatically switchable section; and
- Removal of fuses on network segments with excessive capacitive current as single phase fuse operation will cause excessive imbalance causing the GFN to trip the feeder. Therefore, to solve the excessive imbalance, it is essential AusNet Services remove the existing fuses and replace the fuse elements with solid links and to install fuse savers where required for network protection.

The MSD network is a long network and it has a number of automatic switching sections to provide reliability in the areas it serves.

This necessitates an increased quantum of balancing activities. Network data has been analysed to identify the material sources of imbalance and the optimal mixture of balancing works to achieve the necessary level of capacitive balance for the MSD network.

Table 5: MSD network capacitive balancing volumes

Spans of 3rd phase	Unbonded 3rd phase (cable)	Single phase spur phase rotations	Single phase balancing capacitors	Three phase balancing capacitors	Solid links	Fuse Saver Site
0	1	33	3	15	13	12

Source: AusNet Services

3.3 Compatible equipment

Some existing network equipment is incompatible with the operation of REFCL technology. This equipment includes:

- Automatic Circuit Reclosers (**ACRs**);
- Sectionalisers;
- HV voltage regulators.

3.3.1 ACRs

Existing ACRs have non-directional fault detection and may 'mal' operate during REFCL operation due to the capacitive charge flowing back through healthy parts of the network to the fault. Replacement ACRs have VTs installed to determine when the REFCL is displacing the neutral voltage and supress tripping for reverse fault current direction. [7]

Existing ACRs require upgrades or replacement to operate successfully with REFCL technology. Each ACR on the MSD network has been identified from network data and its type confirmed through protection setting data to determine whether it can be upgraded or must be replaced.

The general Distribution Feeder Automation (**DFA**) and sectionaliser algorithm will require an ACR or equivalent to be present at key points on each feeder to allow the DFA/Sectionalisers to locate a fault with the GFN in service. Without these additional devices the DFA/Sectionaliser algorithm will not be able to identify which feeder is faulted. As a result, two (2) additional ACRs are required to be installed on the MSD network.

Furthermore, as part of the fuse review detailed above in section 3.2, additional ACRs are required as a least cost alternative to the replacement of many fuse sites within a network

[7] For further information, refer to REF 20-08 REFCL Program Automatic Circuit Recloser Strategy

segment and utilising the much larger protection coverage of the ACR. There is also considerable labour cost savings to be gained from adapting this method. As a result, one (1) additional ACR is required to be installed on the MSD network.

Table 6: MSD ACR upgrade, installation and replacement volumes

Additional	Upgrade	Replacement
3	1	4

3.3.2 Sectionalisers

Existing sectionalisers that are a key part of AusNet Service's DFA Scheme to provide customer reliability benefits do not have high accuracy CTs that are compatible with the low fault currents that the REFCL introduces.[8]

Existing sectionalisers require replacement to operate successfully with REFCL technology.

On the MSD network, there are a number of automatic switchable sections involving sectionalisers to ensure a reliable service for the customers served. Each sectionaliser on the MSD network has been identified from network data and individually confirmed as non-compliant with REFCL requirements.

Table 7: MSD Sectionaliser update and replacement volumes

Upgrade	Replacement
0	5

Source: AusNet Services

3.3.3 HV voltage regulators

Some HV voltage regulators have individual phase voltage tap controls. These controllers are not compatible with REFCL operation as they may try to tap voltages whilst the REFCL is compensating and introduce further imbalance reducing the effectiveness of the REFCL.[9]

The MSD network has no HV voltage regulators requiring works to be compatible with REFCL operations.

3.4 HV customers

HV customers are connected directly to the 22kV network rather than the Low Voltage (**LV**) networks and are therefore impacted by the increased voltages introduced by the REFCL technology. This can cause issues for customers including:

- requirements to harden their equipment to withstand the increased voltages;
- updates to protection equipment and settings; and
- interruption to the customer's business operation.

In some cases, it may be more economical to isolate the customer from the REFCL voltage profiles rather than address each of the issues listed above.

3.4.1 HV customers serviced by the MSD network

There are no HV customers on the MSD network.

8 For further information, refer to REF 20-13 REFCL Program Distribution Feeder Automation (DFA) Strategy

9 For further information, refer to REF 20-09 REFCL Program Line Voltage Regulator Strategy

4 Proposed Site Plan

The following figures provides an aerial view of the current MSD ZSS with the proposed sites of the new REFCL-related assets and control room.

Figure 5: Aerial view of the MSD ZSS

Source: AusNet Services

5 Referenced Documents

Supporting documents referenced in this document:

- REF 20-06 REFCL Program Network Balancing Strategy
- REF 20-07 REFCL Program Line Hardening Strategy
- REF 20-08 REFCL Program Automatic Circuit Recloser Strategy
- REF 20-09 REFCL Program Voltage Regulator Strategy
- REF 20-13 REFCL Program Distribution Feeder Automation Strategy
- REF 30-04 REFCL Program Arc Suppression Coil Sizing Policy
- REF 30-16 REFCL Program Operating Modes Policy