Rapid Earth Fault Current Limiter (REFCL) Program

LLG Zone Substation Functional Scope

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Contents

1 Project overview

This project scope covers all aspects involved in the conversion of the Lang Lang (**LLG**) zone substation (**ZSS**) from a low impedance 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.

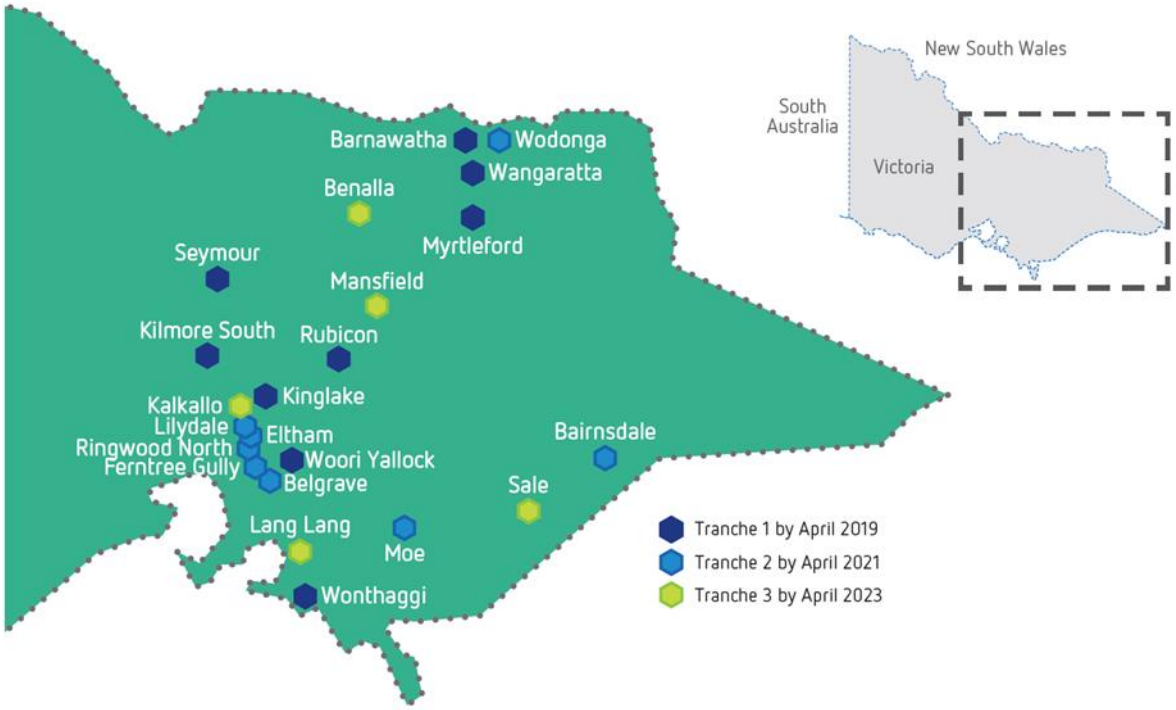
Schedule 2 assigns a number of points to each of the selected zone substations. The Amended Bushfire Mitigation Regulations require AusNet Services to ensure:

- 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 Lang Lang zone substation overview

The LLGZSS is included in Tranche 3 of the AusNet Services REFCL Program. It is situated on Westernport Road in Lang Lang and is located approximately 85 km south-east of Melbourne.

This zone substation was established in 2007 and supplies approximately 6,500 customers by means of one (1) 20/33MVA transformer and four (4) distribution feeders. The LLG 22kV feeders cover a total route length of 498km.

The estimated total capacitive current of the LLG 22kV network is 67.7Amperes (**A**). As the capacitive current is below 101A, a single REFCL will be required.

The LLG electricity distribution area consists primarily of residential areas as well as scattered industrial and commercial sites in and around Lang Lang and the nearby surrounding areas including Nyora, Koo Wee Rup and Grantville.

1.3.1 Key issues and challenges

The LLG ZSS is an indoor switchyard with ample space for the installation of primary equipment to support the conversion to resonant earthing.

The existing 22kV switch room is burdened with moisture ingress issues that need to be addressed. As a result the existing 22kV switchgear has major internal damage and needs to be replaced. The existing site control room and 22kV switch room can be made suitable (waterproof) for the housing of REFCL assets and associated 22 kV protection equipment and the new switchboard installed in a new control building.

Refer to section 2.2.4 of this functional scope document for an overview of the site control rooms options analysis.

1.4 LLG ZSS assets

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

Table 1: LLG Zone Substation – current assets

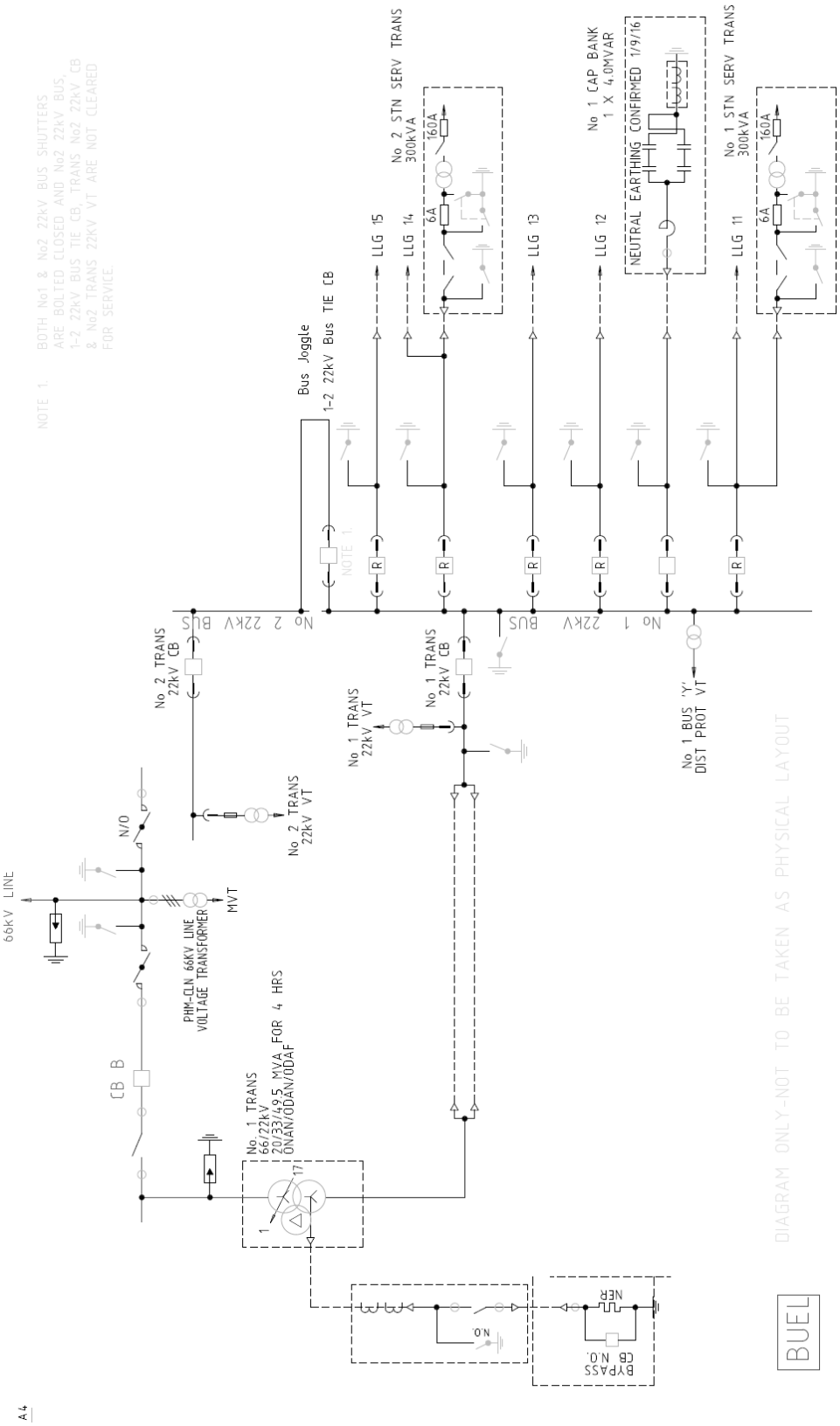
Zone Substation	Details
Location	85 km SE of Melbourne
Established	2007
Supply Area	Lang Lang and surrounding areas including Nyora, Koo Wee Rup and Grantville
Customers	6,585
Zone Substation Transformers	1 x 20/33 MVA
22 kV Buses	2
Capacitor Banks	1 x 4 MVAR
Feeders	4
Station Services Transformers	2 x 300 kVA (22/0.433kV)
Schedule 2 points allocation	1

Source: AusNet Services

1.5 LLG ZSS single line diagram

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

Figure 2: LLG Current Single Line Diagram



Source: AusNet Services

1.6 LLG 22kV network

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

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

Network	Details
Total Network Length (km)	498
Aerial Bundled Cable (**ABC**) Length (km)	0.0
Underground (**U/G**) 3 phase (**ph**) Cable Length (km)	11.7
U/G 1ph Cable Length (km)	0.0
Overhead 3ph Line Length (km)	282
Overhead 1ph Line Length (km)	204
Estimated network capacitance (Amps (**A**))	67.7
HV Customer Connections	1
Automatic Circuit Reclosers (**ACRs**)	7
Sectionalisers	20
HV Regulator sites	2
Surge Arrestor Sites	975

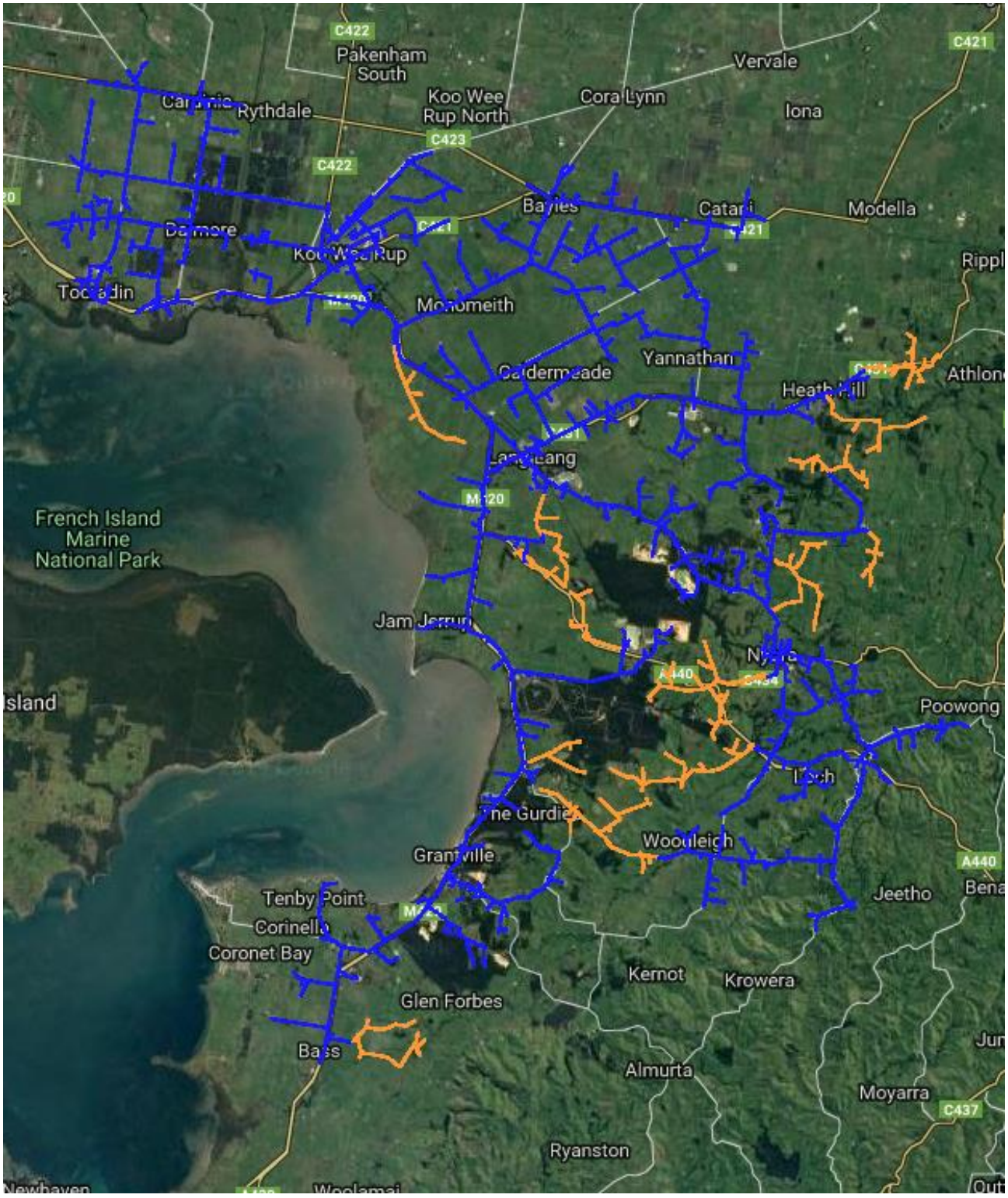
Source: AusNet Services

[1] Not including SWER or Transfer feeders

LLG Zone Substation Functional Scope

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

Figure 2: LLG 22kV feeders shown in blue (SWER lines in yellow)



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 the LLG zone substation 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 LLG ZSS, one (1) Arc Suppression Coil (**ASC**) is required to be installed at LLG ZSS. [2]

- Installation of one (1) Ground Fault Neutraliser (**GFN**) primary equipment, namely:
  - 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

- Replacement of the four (4) 22kV, 240mm^2 feeders (1,600m total) with 3C 300 mm^2, AL XLPE.
- Installation of 22kV 3C 185 mm^2, AL XLPE, for the capacitor bank to the new switch room (80m).
- Replacement of 22kV cable (6 x 500mm^2 IC CU) from:
  - No.1 Transformer to No.1 22kV Switchboard (300m);
- Installation of the following 22kV 3C 185 mm^2, AL XLPE, from:
  - No.1 Station Service Transformer to Switchboard (40m); and
  - No.2 Station Service Transformer to Switchboard (40m).
- 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. 1 NER to No. 1 Neutral Bus kiosk (80m); and
  - No. 1 GFN to No. 1 Neutral Bus kiosk (20m).

2.1.4 Circuit Breakers and isolators

Replacement of the existing 22kV switchboard and all associated equipment with a new modular urban type switchboard.

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[2] For further information on the ARC 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

Refer to section 2.2.4 of this document for an overview of the options analysis.

2.1.5 Station Service Transformers

The existing two (2) 300 kVA (22/0.433 kV) Station Service transformers do not have adequate rating to supply the RCC during fault compensation and must be replaced with suitably rated transformers.

- Installation of two (2) 500 kVA (22/0.415V) transformers;
- Removal of existing Station Service Transformers.

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 arrestors are not suitable for operation with the voltages imposed by REFCL operations.

- Replacement of one (1) 22kV surge arrestor for the neutral structure on the transformer due to various scenarios leading to excessive overvoltage at the neutral point.

2.1.8 Instrument Transformers

Current Transformers (CTs)

- Replace neutral CTs for one (1) 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 seven (7) zero sequence CT for four (4) feeders, one (1) capacitor bank and one (1) for each station service transformer.

2.1.9 22 kV Cabling and Transformer Testing

The 22 kV transformer, capacitor and feeder exit cables are critical assets within the zone substation, failures in service may result in significant customer outages. To minimise this 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. 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:

- LLG11 Feeder exit cable;
- LLG12 Feeder exit cable;
- LLG13 Feeder exit cable;
- LLG14 Feeder exit cable;
- No. 1 Capacitor Bank cable; and
- No. 1 Transformer 22 kV cables.

2.1.10 Capacitor Banks

The existing Capacitor Bank is a 4.0 MVAR grounded star arrangement. The existing Capacitor Bank will be modified to achieve an ungrounded star arrangement. Capacitor cans have been assessed for suitability with the revised voltage profile with the following works required:

- Replacement of the capacitor bank reactor insulators only.

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 EarthingResistor (NER)

The NER has been assessed against REFCL requirements and considered fit for purpose with no replacement required.

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 conduit and oil bunds.

2.2.2 Station Service Transformer

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

2.2.3 Neutral Bus

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

2.2.4 REFCL control room

The existing site control room at the LLG ZSS is congested and does not have the physical space for the required installation of REFCL technology, namely the RCC unit, REFCL control panels, protection and communications modifications along with network monitoring and switchgear interface relays.

Options considered included:

- Do nothing;
- Refurbish the existing switchboard after addressing the moisture ingress issues and then install the REFCL equipment in a new separate modular building; and
- Replace the existing 22kV switchboard at LLG ZSS with a new modular urban type switchboard (a separate new modular building). The existing building is proposed to be used for REFCL equipment after addressing the moisture ingress issues.

The do nothing option does not allow the installation of REFCL technology at LLG ZSS and therefore does not meet the requirements of the regulations. The existing 22KV switchboard cannot withstand the increased voltages induced by the REFCL equipment, this is mainly due to the age and condition of the existing 22KV switchboard.

The option to refurbish the existing 22kV switchboard and install the REFCL equipment in a new separate modular building will result in a complex construction process and high levels of customer outages.

Therefore, the preferred option is to install a new 22kV switchboard in a new modular building, retire the old 22kV switchboard and utilise the old switchboard room for the new REFCL equipment.

The following civil items are required to deliver this option:

- Design, construction, delivery and installation of a standard modular building for the new 22kV switchboard.
- Installation of one (1) footing for the 22kV switchboard (switch room).
- Engaging a building surveyor to address the current moisture ingress issues within the old 22kV Switchboard.
- Temporary security during delivery and installation.

2.2.5 Cable trench

- Installation of additional underground cable containment for connection to new primary equipment (allowance of 50m):
    - REFCL control room;
    - ASC;
    - Neutral Bus;
    - New Station Service Transformers; and
    - Feeder exit cables.

2.2.6 Capacitive Bank

- Capacitor bank foundations do not need to be replaced.

2.2.7 Earth Grid

- Extension of the earth grid to protect the REFCL control room, ASC, Neutral Bus and Station Service Transformers.

2.2.8 Switchyard Surfacing

- Restoration of the disturbed switchyard surfaces.

2.2.9 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 product includes a control panel containing the master and slave control modules, HMI computer, VT and CT inputs and trip outputs and ASC and RCC interfaces.

Tthe 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 is 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, settings and time grading between stages when NER is in service;

- 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.

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; and
- 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 with the GFN operations.

Transformer Protection

- Replacement of one (1) Transformer X and Y protection relay due to incompatibility with REFCL operations.
- Replacement of one (1) VRR controls due to incompatibility with REFCL operations.

Battery Systems

- Install X and Y 125V DC battery system.

2.3.5 Communications

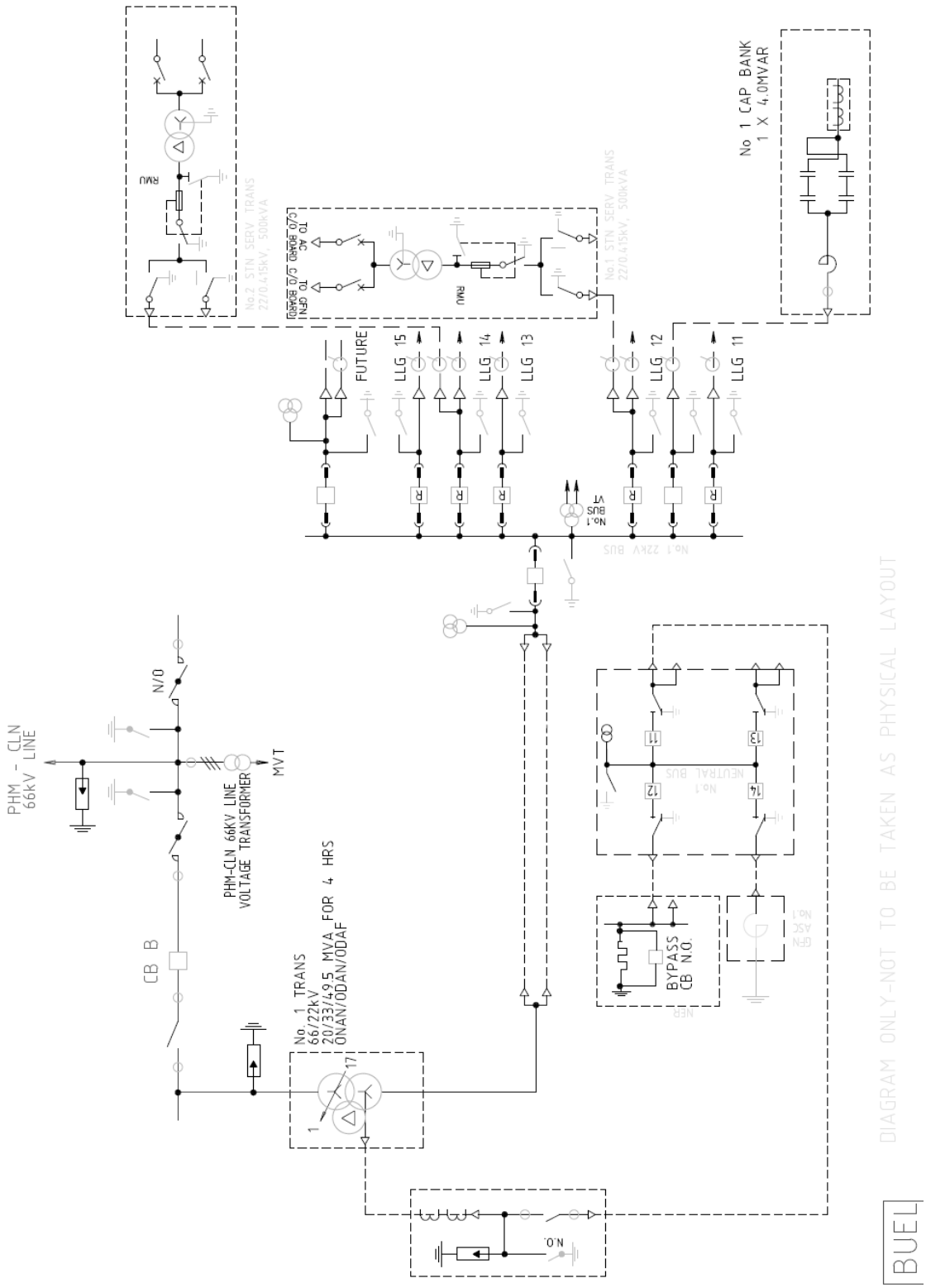
The new equipment in the REFCL control room requires connection to the existing Digital Interface Cubicle (**DIC**).

- Upgrade tele-protection equipment and communications:
- Install 1x RS2488 switch;
- Install 1x 2488 clock;
- Install one (1) HMI; and
- SCADA modifications.
- Replacement of one (1) RTU from existing MD1000 to Cooper SMP 5G-4250.

2.4 LLG proposed single line diagram

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

Figure 3: LLG 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.

Additionally, customers connected directly to the 22 kV supply network need to ensure their electricity assets can withstand REFCL voltages. If the HV customer assets are not hardened to withstand REFCL voltages, they must be isolated from the REFCL protected network.

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.

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 LLG network, each surge arrestor site was inspected and the surge arrestor types installed confirmed to determine replacement requirements.

At LLG, the following surge arrestors need to be addressed.

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

Table 3: LLG surge arrestor replacement volumes

Sites	Units
214	511

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 failures 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: LLG HV cable testing, repair and replacement volumes

Online tests	Offline tests	Repair Cable	Replace Cable
4	4	4	395m

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.

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

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;
- 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 LLG 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 LLG network.

Table 5: LLG 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 Savers Sites
0	1	43	3	11	13	20

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]

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

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

Existing ACRs require upgrades or replacement to operate successfully with REFCL technology. Each ACR on the LLG 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 LLG 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 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, no additional ACRs are required to be installed on the LLG network.

Table 6: LLG ACR upgrade, installation and replacement volumes

Additional	Upgrade	Replacement
2	1	5

Source: AusNet Services

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

Table 7: LLG Sectionaliser update and replacement volumes

Upgrade	Replacement
0	21

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

[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

3.4 HV customers

HV customers are connected directly to the 22 kV 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.

The dedicated REFCL Program HV Customer Lead has proactively engaged with impacted HV customers to share the learnings from Tranche 1 and to provide guidance on the most appropriate solution for the HV electrical assets to either be harden to withstand, or isolated from, REFCL operations.

3.4.1 HV customers serviced by the LLG network

There is one (1) HV customer on the LLG network supplied by LLG13.

The HV Customer has been requested to be ready for REFCL operations by 30 June 2022.

AusNet Services will install an ACR at each HV Customers connection point. An ACR is necessary because it will enable AusNet Services to operate our network safely:

- The ACR can help reduce the impact cross-country faults have on the 22kV network;
- The ACR provides an isolation point that stops supply into the customer site. This is a safe guard in the event that a HV customer's site fails under REFCL conditions;
- ACRs assist AusNet Services to identify fault locations promptly so that we can take the appropriate safety action; and
- Reliability – the ACR will allow the network to quickly isolate a faulted HV customer and restore power quickly to unaffected customers once the fault is resolved.

4 Proposed Site Plan

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

Figure 5: Aerial view of the LLG 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