CitiPower	ELECTRICITY NETWORKS Asset Strategy and Performance Functional Scope	Powercor Australia

Functional Scope Created	01/11/2018	**By**	Danny Jutrisa		
		Ex:	6656		
Project RO					
Project Title	Terang (**TRG**) REFCL Installation				
Network No. and F/C					
Last Update	30/06/2019	**By**	Danny Jutrisa	**Version**	1.0
Related Scopes					
Project Engineer					
System Planning Engineer	Chris McCallum				
Protection and Control Engineer	Paul Nidras				
Plant and Stations Engineer					
Asset Strategy Engineer					
Required Quote Date					
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Revision History:

Version	Date	Changes	Responsible Officer
0.1	01/11/2018	Original	D. Jutrisa
0.2	19/11/2018	Added Prot & Control Comments	P. Nidras
0.3	18/04/2019	Update with new requirements	C.McCallum
0.4	17/06/2019	Update of admittance balancing and fuse saver requirements	D.Jutrisa
1.0	30/06/2019	Scope finalised	D.Jutrisa

1 Project overview

This project scope covers the migration of the Terang zone substation (**TRG**) system to a resonant earthed network. Migration to a resonant network requires the installation and operation of a ground fault neutraliser (**GFN**). This changes the electrical operating characteristics of a zone substation and its distribution network as follows:

- full voltage displacement occurs on the system for operation of the GFN
- this significantly stresses equipment on the system and may lead to failure
- this equipment has been identified and included in this scope for replacement as part of the GFN installation
- other limitations will dictate part of the operational protocols that will be developed by Electricity Networks.

The GFN provides potential benefits to single-phase-to-ground faults on the 22kV three phase system. It provides no benefit on the following:

- the 12.7kV Single Wire Return System (**SWER**)
- the 66kV sub-transmission system
- the low voltage (**LV**) system.

1.1 Background

To meet the Victorian Government Bushfire Mitigation Regulations performance standards for detection and limiting of arc fault energy on high voltage (**HV**) overhead assets in high bushfire consequence, rapid earth fault current limiters (**REFCLs**) can be used.

A REFCL is a network protection device, normally installed in zone substations that significantly reduce the arc fault energy generated during a phase to ground fault to mitigate against fire ignition.

The Bushfire Mitigation Regulations mandate the following performance criteria (for a phase-to-ground fault on a polyphase electric line with a nominal voltage between 1 kV and 22 kV):

- to reduce the voltage on the faulted conductor in relation to the station earth when measured at the corresponding zone substation for high impedance faults to 250 volts within 2 seconds; and
- to reduce the voltage on the faulted conductor in relation to the station earth when measured at the corresponding zone substation for low impedance faults to:
  - 1900 volts within 85 milliseconds; and
  - 750 volts within 500 milliseconds; and
  - 250 volts within 2 seconds; and
- during diagnostic tests for high impedance faults, to limit:
  - fault current to 0.5 amps or less; and
  - the thermal energy on the electric line to a maximum I^2t value of 0.10.

1.2 TRG zone substation

The TRG 66/22kV zone substation is located in Terang, Victoria and consists of two transformers, five 22kV feeders, one capacitor bank and one (1) NER.

The two transformers are in a banked arrangement and a fault on any one transformer or 22kV busbar will cause a station black.

To permit the transfer of loads from adjacent zone substations with the GFN in service the 22kV feeder requirements in section D of this scope must also be applied to the portion of the feeders that can be transferred to TRG. ART033, CDN006, COB011, COB012, COB021 and HTN003 are the feeders that can be transferred to TRG. Of these only the COB021 transfer of the whole feeder is considered.

ART033 will be hardened as part of the ART REFCL scope, CDN006 and COB011 have already been hardened as part of Tranche 1 and a decision was made that a fourth feeder out of COB (COB022) would be built instead of hardening COB012 so that a transfer was available, which concludes no transfers are to take place between TRG and COB012 or the new COB022.

Table 1 TRG existing characteristics (zone substation)

Zone substation	Volume
Feeders	5
Zone substation transformers	2
22kV buses	3
Capacitor banks	2
Station service transformers	1
22kV circuit breakers (switching configuration)	6

Table 2 TRG: REFCL network to be hardened

Network	TRG	COB021	Total
Total route length (km)	1,331	39	1,370
Underground cable length (km)	5	0.3	6
Overhead line length (km)	1,326	39	1,365
Underground network (%)	0		0
Overhead single phase	377	2	379
Estimated network capacitance (A)	101	4	105
Distribution transformers	1,907	9	1,916
HV regulator sites	6	1	7
Fuses	1,953	11	1,964
ACRs	21	1	22

Network	TRG	COB021	Total
Surge arrestor sites (3ph)	505	7	512
Surge arrestor sites (1ph)	1,438	6	1,444
HV customers	2	2	4

2 TRG zone substation requirements

The functional scope sets out the TRG zone substation requirements, including the following:

- install and commission one (1) GFN system and its subcomponents
  - install one (1) 17-200A ASC
  - install one (1) 320kVA RCC Inverter
  - provision is to be made for a future second GFN system
- zone substation naming changes
  - rename the existing No.1 transformer as No.2A transformer
- modification of the 22/66kV transformer earthing arrangement
  - insulate and surge protect transformer neutral and connection assets
  - installation of one (1) Neutral Bus System (Type ‘A’ configuration per Powercor technical ZD081 standard)
    - transformer and neutral bus tie CB’s
    - ASC and direct ground connections
    - neutral VT installation
    - provision is to be made for a future second Neutral Bus System
- 22kV bus modifications
  - decommission and disestablishment of the existing outdoor 22kV bus
  - installation of 22kV switch room to facilitate the:
    - REFCL inverter room
    - eight (8) 22kV feeder CBs
    - two (2) 22kV transformer CBs
    - two (2) 22kV capacitor bank CBs
    - two (2) 22kV bus VT, and earthing switches
    - one (1) 22kV bus tie CB
  - TRG001 is to be connected to the new TRG022 indoor feeder CB
  - TRG002 is to be connected to the new TRG012 indoor feeder CB
  - TRG003 is to be connected to the new TRG023 indoor feeder CB
  - TRG004 is to be connected to the new TRG011 indoor feeder CB
  - TRG005 is to be connected to the new TRG021 indoor feeder CB
- install new control room
  - decommission and disestablishment of the existing control room
  - installation of new control room
- replace existing station service supply with two (2) new 500kVA kiosk transformers with changeover board
  - upgrade station service supplies including installing a new AC distribution board
  - station service supplies are to come of the TRG011 and TRG022 feeders, with the TRG022 station service to be normally in service.
- replace all substation surge arrestors with new station class units

- install a new capacitor bank)
  - remove HV earth from star point
  - remove earth connection from the capacitor bank neutral (star-point)
  - install new cabling to the new 22kV Switch Room and Control Room with the Capacitor Bank to be attached to the No.2 22kV Bus
  - install new CB management and current balance protection
- earth grid to be extended to cover areas where all new plant items are being installed
- site expansion is required for this scope, requiring land purchase of the surrounding property
- install weather station
- replace amenities,as required
- install new feeder tie between the new TRG011 (TRG004) and TRG023 (TRG003), to compensate for the removal of the transfer bus
- liaise with four (4) HV customers relating to the installation of the REFCL

Secondary requirements

- Install the following cubicles within the new control room
  - uplink communication and substation LAN cubicle
  - Station Remote Terminal Unit (RTU) cubicle
  - X Protection ethernet communication cubicle
  - Y Protection ethernet communication cubicle
  - No1 REFCL cubicle
  - Earth Fault Management cubicle
  - HMI cubicle
  - No1 Transformer Differential cubicle
  - No2 Transformer Differential cubicle
  - Backup Earth Fault and Digital Fault Recorder cubicle
  - No 1 Bus Protection cubicle
  - No 2 Bus Protection cubicle
  - 22kV X CB Management and CB Fail cubicle
  - No1 Bus Feeder Protection cubicle
  - No2 Bus Feeder Protection cubicle
  - Capacitor Bank Protection cubicle
  - PQM, VRR and VAR Control cubicle
- Within the existing control room
  - retire and declare out of service
    - feeder protection relays

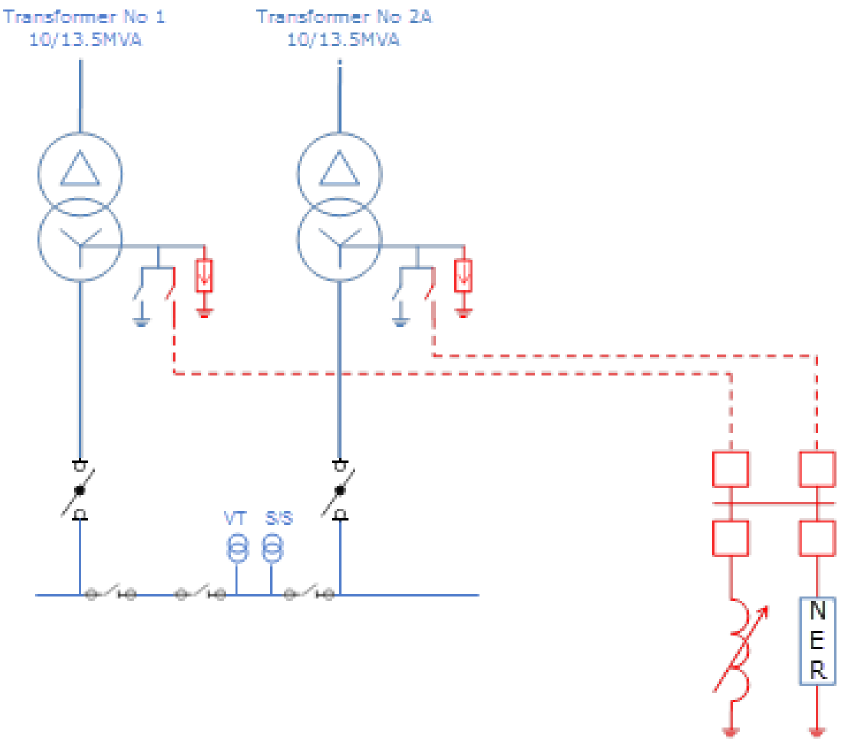
  - transformer differential
  - capacitor bank protection relays
  - Master and Backup Earth Fault relays

- install interface equipment to concentrate and display operator alarms

2.1 Primary plant requirements

The works associated with the installation of the TRG ASC arrangement is summarised in the following single line diagrams.

Figure 1 TRG single line diagram



2.1.1 Arc Suppression Coil

Install one (1) 17-200A Swedish Neutral – Ground Fault Neutraliser Arc Suppression Coil (ASC) component. The arc suppression coil is a paper wound copper coil wrapped around a solid iron core and immersed in oil. This arc suppression coil is of fixed reluctance but contains an array of capacitors in parallel that are switch as part of the tuning process of the coil. The coil also features an LV winding for coupling of these capacitors and the Residual Current Compensator.

Primary neutral and earth connections are via elbows.

As this is an oil filled device, it shall be installed in a bunded area in accordance with current standards (AS2067). The total volume of oil is approximately 1320 litres.

The proposed location for the GFN ASC installation is adjacent to the NER on the south side (refer to the proposed general arrangement drawing in the appendix). Suitability shall be evaluated within the Detailed Design Scope (DDS) and confirmed prior to the first Construct, Operate and Maintain (COM1) on site.

- install Ground Fault Neutraliser comprising of one (1) 17-200A ASC and residual current compensation modules with maximum available tuning steps onto the provided pad mount within a newly established bunded area
- the footing of the ASC shall reside on the installed 150mm steel beams fixed to the concrete pad
- install cable connections to and from the neutral system as shown in Figure 1.

2.1.2 Zone substation surge arrestors

In a non-effectively earthed system, the voltage displacement caused under earth fault conditions results in the healthy phases experiences full line-to-line voltage on a line-to-ground basis. Surge arrestors used in Powercor substations do not have the Temporary Overvoltage Capability required for these conditions.

To accommodate transition to a resonant network:

- replace all sub-standard zone substation surge arresters with a station class (class 2) 22kV continuous voltage arrestor
  - ABB MWK22 or equivalent

2.1.3 Zone substation capacitor bank

TRG ZSS has one (1) 22kV Capacitor Bank. The existing No.3 22kV Capacitor Bank is connected in grounded star.

To facilitate migration to a resonant network, the earth must be removed from the No.3 Capacitor Bank and the neutral (star-point) must have sufficient insulation to allow for continuous neutral displacement (12.7kV + 10%) under system earth fault conditions. Note:

- the primary designer shall review the existing design to ensure the neutral point is fit for continuous operation at 13.97kV
  - the star point shall be reconfigured as a floating neutral, and the neutral structure re-designed if necessary
- install new surge arrestors at the Capacitor Bank 22kV connection point
  - ABB POLIM-H25N Line Discharge Class 4 or equivalent
- remove the ground connection CTs and disconnect from master and backup earth fault protection circuits.

New cabling for both the new 22kV switch room and to the control room is required. Underground cable to the switch room is to be 3 x 630mm^2 1/c 22.a.x.hc.h. The capacitor bank is required on the No.2 bus.

As it is a more cost effective solution retire the existing No.3 22kV Capacitor Bank, then to provide reactive support, one (1) new capacitor bank is required on the No.2 bus:

- install new two (2) x 3.0 MVAR ABB Abbacus modular capacitor banks and associated CBs and protection
  - new No.2 Capacitor Bank

The Capacitor Bank is to be an ungrounded star with an insulation rating of not less than 13kV at the neutral point. Refer to ABB Abbacus Capacitor Bank at CDN ZSS.

2.1.4 Station service transformer

Retire the existing 63kVA 22kV Station Service Transformer from the No.2-3 22kV tie bus:

- install two (2) new 500kVA 22kV Station Service Kiosk Transformers.
  - the general arrangement drawing in the appendix shows suggested locations for these kiosks
  - connect one (1) new station service transformer to the new TRG011 feeder, and connect one (1) new station service transformer to the new TRG022 feeder, with both protected by HV fuses. The design shall consider the risk of ferro-resonance when switching the station service transformer, and install an appropriate three (3) phase switching device if necessary. The TRG022 feeder station service transformer is to be normally in service.

2.1.5 Neutral system arrangement

A neutral bus system comprised of:

- one (1) new kiosk type ground mounted modules as per Powercor technical standard ZD081

  - type A comprising of four (4) circuit breakers
- transformer neutral connection assets
  - HV neutral cable
  - neutral bus connection isolator
- system earth connection

The neutral bus system facilitates simple use of the different earthing methodologies and permits isolation of the transformer neutral in case of access or internal fault.:

- the neutral bus system and all connection assets shall be continuously rated to 13.97kV
- the type A neutral bus module has CTs on two (2) of the CBs. Connection to each of the two (2) transformer neutrals is to be via a CB with CT at the neutral bus module end.

Note that provision is to be made for a future second neutral bus system.

2.1.6 Neutral bus

The connection to the neutral bus module shall be via elbow connections. Four (4) elbows are required at one module for:

- transformer neutral connection (2 transformers)
- neutral bus tie
- ASC connection
- NER and solid ground connection

Neutral voltage transformer

A neutral VT shall be included in each of the neutral bus modules, connected directly to the bus.

- $\frac{22000/\sqrt{3}}{110/\sqrt{3}}$
- Class 0.5M1P
- Output: 15VA
- Frequency: 50 Hz
- Voltage Factor: 1.9 for eight (8) hours
- Dielectric Insulation Level: 24/50/150kV.
- Australian Standard: AS 60044.2.

2.1.7 Transformer earthing and ground bypass isolators

The two (2) 66/22kV transformers in service at TRG are delta/star connected with the neutral of the 22kV star winding solidly earthed via an 8Ω NER.

The neutral earthing arrangement for each transformer shall be modified to permit connection to the neutral bus system. For each transformer neutral connection point:

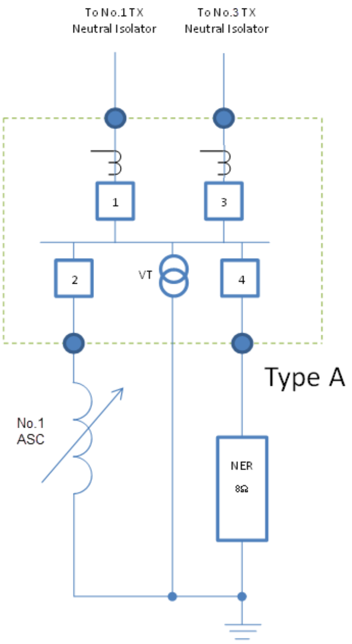
- insulate the neutral conductor and install independent Neutral Bus/Direct Ground isolators
  - this is required so that if the neutral bus is to be taken out of service the transformer neutrals can be earthed by closing these ground by-pass isolators

- install single phase HV cable and cable terminations between the new Transformer Neutral Bus Isolators and the relevant Neutral Bus CB via elbow connections on the Neutral Bus RMU

2.1.8 Neutral Surge Diverter

Install a Station Class (Class 2) 19kV surge diverter between the transformer neutral bus and the substation earth grid, as close to the transformer neutrals as possible, using ABB MWK19 or equivalent.

Figure 2 Proposed TRG neutral system single line diagram



2.1.9 Surrounding property land purchase

Due to space restrictions around constructability of the REFCL system at TRG zone substation, additional land is required at the TRG zone substation site to be able to construct the ultimate arrangement.

Purchase of the adjacent property is required to be able to construct and install the REFCL. This includes the 66kV Bus CB, REFCL system, control room and 22kV switch room.

2.1.10 New control room

Due to space restrictions within the existing control room leading to safety concerns with constructability a new control room is required.

- retire the existing control room, note that it is likely asbestos will be encountered through the building
- install a control room that is able to fit the requirements of the ultimate arrangement as per the System Design Sheet.

2.1.11 22kV feeder rearrangement /new 22kV switch room

Due to space restrictions within the zone substation (in particular installing a second 22kV transformer CB on the existing outdoor 22kV bus) a new 22kV switch room and switchboard is required.

- retire the existing 22kV outdoor yard including all bus work, switchgear, VTs, CTs, etc.
- install a new 22kV switch board including:
  - REFCL inverter room

- eight (8) 22kV feeder CBs
- two (2) 22kV transformer CBs
- two (2) 22kV capacitor bank CBs
- two (2) 22kV bus VT, and earthing switches
- one (1) 22kV bus tie CB

- The existing TRG001 feeder is to be connected to the new TRG022 indoor feeder CB
- The existing TRG002 feeder is to be connected to the new TRG012 indoor feeder CB
- The existing TRG003 feeder is to be connected to the new TRG023 indoor feeder CB
- The existing TRG004 feeder is to be connected to the new TRG011 indoor feeder CB
- The existing TRG005 feeder is to be connected to the new TRG021 indoor feeder CB

Design to confirm suitable poles for the new cable heads to each feeder with all cable heads being switched.

- 240mm2 3/c 22.a.x.hc.h. underground cable is to be used for all feeder exit cables at TRG, unless the cable is de-rated by more than 10%, in that case 300mm2 3/c 22.c.epr.hc.v. underground cable is to be used.

2.1.12 22kV Bus VT

Replace the existing No. 2 22kV bus VT with two (2) new VTs on the new 22kV switchboard, similar to the WIN design.

2.1.13 Feeder protection current transformers

New feeder protection current transformers as to be installed as part of the new 22kV switch room.

2.1.14 General arrangement

The existing and proposed general arrangement of TRG zone substation is shown in the appendix.

Consideration is required for all elements of the TRG ZSS possible ultimate plan as per its System Design Sheet.

TRG zone substation transformer naming

Ensure that the existing 10/13.5MVA 66kV/22kV No.1 transformer is renamed to No.2A transformer once the new 25/33MVA No.1 transformer is installed as part of the No.3 TRG transformer replacement project in 2019.

TRG zone substation site amenities

The amenities (including the building) at the TRG zone substation site are to be replaced where they are inadequate or unsafe.

22kV bus naming

Any large scale changes to the 22kV yard require that consideration is given to the naming of plant in the substation from an operational perspective. This is critical from a healthy and safety perspective as well as operational.

All primary and secondary drawings must be reviewed and any that do not conform with the new naming of primary plant must be updated.

- Review all drawings with references to 22kV Circuit Breakers, Buses, Isolators, Disconnect Switches, Earth Points and Cables.

Particular attention shall be given to the naming of primary plant items in the operational systems to ensure that any naming changes in the field are updated in the operational software such that switching instructions are correct when printed. This requires coordination between the field works, the SCADA group and network operations.

2.2 Civil works requirement

- For neutral systems
  - install concrete foundation pad for neutral system modules
  - install neutral cable conduit, control cable conduit and provision for solid earth grid connections
  - install neutral cable conduits from transformers to neutral system modules
  - install conduits to ASCs, NER and earth grid connection
  - install conduits for secondary circuits
- For ASCs:
  - install neutral cable conduit, control cable conduits and solid earth grid connections
  - pour concrete foundation
  - install steel beam, 150mm high at a width designed to accommodate the placement of the GFN Arc Suppression coil
  - install bunding to EPA requirements and AS2067 requirements
- For station service supplies:
  - install concrete foundation for new station service 500kVA kiosk transformers
  - install HV cable conduit to new switch room
- For 22kV indoor switchgear / switch room:
  - install indoor switch room and switchgear, allowing sufficient space for future station requirements
  - install HV cable conduits from existing feeders to new indoor switch room
- For control room
  - assess the load bearing capability of the floor to accommodate the new GFN control cubicle
- For new capacitor bank
  - install concrete footings for new modular capacitor bank
  - install control cable conduits for new modular capacitor bank
  - install HV cable conduits from to new indoor switch room
  - ensure sufficient space for future capacitor bank requirements.

2.3 Secondary Works

The following outlines the protection and control requirements.

2.3.1 Cubicle works

Uplink Communication & SubLAN Control Loop Cubicle

- Install standard 23" protection cubicle
- Install two (2) Fortigate 60E firewalls
- Install one (1) MDS SD9 radio device
- Install one (1) 4G modem
- Install one (1) EKI-2525 Ethernet switch
- Install two (2) RST-2228 SubLAN switches
- Design Notes:
  - refer appendix B for proposed Ethernet connectivity
  - MDS radio unit device type and part no. is to be confirmed by the comms group
  - the SubLAN switches in this cubicle are to be ordered with 4x RJ45 ports

Station RTU Cubicle

- Install standard 23" protection cubicle
- Install two (3) SEL-3505-4 RTACs for RTAC A, B & NVD
- Install one (1) Tekron GPS Clock
- Install station I/O Controllers for HW connections to non-DNP devices
- Design Notes:
  - Refer appendix B for proposed Ethernet connectivity
  - RTAC A to be used for establishing DNP session to 66kV relays
  - RTAC B to be used for establishing DNP session to 22kV relays
  - RTAC NVD to be used for new neutral displacement blocking scheme for 22kV connected generators

SubLAN X & Y Protection A Loop Cubicle

- Install standard 23" protection cubicle
- Install three (3) RST-2228 Ethernet Switches for
  - X RST-2228-21 SubLAN
  - X RST-2228-22 SubLAN
  - Y RST-2288-31 SubLAN

SubLAN X & Y Protection B Loop Cubicle

- Install standard 23" protection cubicle
- Install three (3) RST-2228 Ethernet Switches for
  - X RST-2228-41 SubLAN

  - X RST-2228-42 SubLAN
  - Y RST-2228-32 SubLAN

REFCL Cubicle

- Install Standard Swedish Neutral GFN cubicle with associated devices for GFN control

HMI Inverter Cubicle

- Install one (1) SEL-3505-4 RTAC with HMI for dedicated station HMI
- Install one (1) DC-AC inverter for supply to station HMI PC
- Install one (1) DC-DC converter for 24V DC distribution
- Emergency lighting controls
- Install Audible Controls
- Design Notes:
  - Establish red GPO on operator desk for connection of station HMI

66kV TGTS No1 Line X & Y Protection Cubicle

- Install standard 23" protection cubicle
- Install one (1) SEL-311L Relay for TGTS No1 Line Y Differential protection
- Install one (1) RS400 for DNP communication and engineering access to SEL-311L & 7SD522
- Install one (1) SEL2411 for TGTS No1 Line Management
- Relocate one (1) 7SD522 Relay for TGTS No1 Line X Differential protection
- Design Notes:
  - Refer appendix B for proposed Ethernet connectivity
  - 2 serial connections are to be established to the SEL311L & 7SD522 from the RS400 (one for DNP3 and the other for engineering access)
  - Existing 7SD522 relay to be relocated from old control room and is utilised to prevent works at TGTS
  - Existing SEL-311L relay has no fibre ports and will therefore need to be replaced to incorporate IEC-61850

66kV WBL No1 Line X & Y Protection Cubicle

- Install standard 23" protection cubicle
  - One (1) SEL-311C-1 Relay for WBL No1 Line X Differential protection
- Install one (1) GE-D30 Relay for WBL No1 Line Y Differential protection

66kV TGTS No1 Line X & Y Protection Cubicle

- Install standard 23" protection cubicle
- Install one (1) SEL-311L Relay for TGTS No1 Line Y Differential protection
- Install one (1) RS400 for DNP communication and engineering access to SEL-311L & 7SD522
- Install one (1) SEL2411 for TGTS No1 Line Management
- Relocate one (1) 7SD522 Relay for TGTS No1 Line X Differential protection

- Design Notes:
  - Refer appendix B for proposed Ethernet connectivity
  - 2 serial connections are to be established to the SEL311L & 7SD522 from the RS400
  - (One for DNP3 and the other for Engineering access)
  - Existing 7SD522 relay to be relocated from old control room and is utilised to prevent works at TGTS
  - Existing SEL-311L relay has no fibre ports and will therefore need to be replaced to incorporate IEC-61850

66kV WBL No2 Line X & Y Protection Cubicle

- Install standard 23” protection cubicle
- Install one (1) SEL-311C-1 Relay forWBL No2 Line X Differential protection
- Install one (1) GE-D30 Relay for WBL No2 Line Y Differential protection

66kV X CB Management Cubicle

- Install standard 23” protection cubicle
- Install four (4) SEL-351S X CB Management and X CB Fail relays for
  - 66kV CB A
  - 66kV CB B
  - 66kV CB C
  - 66kV CB D

66kV Y CB Management Cubicle

- Install standard 23” protection cubicle
- Install four (4) GE-C60 Y CB Management and Y CB Fail relays for
  - 66kV CB A
  - 66kV CB B
  - 66kV CB C
  - 66kV CB D

66kV No1 Low Impedance Bus Protection & X CB Management Cubicle

- Install standard 23” protection cubicle
- Install one (1) GE-B90 Relay for 66kV No1 X Low Impedance Bus Protection (LIBP) & No1 Bus Reclose
- Install one (1) SEL-351S X CB Management and X CB Fail relays for 66kV CB F

66kV No2 Low Impedance Bus Protection (Future) & Y CB Management Cubicle

- Install standard 23” protection cubicle
- Install one (1) GE-C60 Y CB Management and X CB Fail relays for 66kV CB F
- Note : 66kV No2 LIBP relay to be installed under future Transformer No2 Replacement project

66kV No1 Trans Protection Cubicle

- Install standard 23” protection cubicle

- Install one (1) SEL-787 relay for No1 Trans X Differential and X REF Protection
- Install one (1) GE-T60 relay for No1 Trans Y Differential and Y REF Protection
- Install one (1) SEL-2414 relay for No1 Transformer Mechanical Protection and monitoring

66kV No2A Trans Protection Cubicle

- Install standard 23" protection cubicle
- Install one (1) SEL-787 relay for No2A Trans X Differential and X REF Protection
- Install one (1) GE-T60 relay for No2A Trans Y Differential Protection
- Install one (1) SEL-2414 relay for No2A Transformer Mechanical Protection and monitoring
- Note: REF CT to be installed to create transformer 2A station zone, second REF CT will be installed as part of a future No2A transformer replacement project

22kV No1 Bus Protection Cubicle

- Install standard 23" protection cubicle
- Install one (1) GE-B90 relay for No1 22kV X Low Impedance Bus Protection (LIBP)
- Install one (1) SEL-311C-1 relay for No1 22kV Y Bus Distance protection

22kV No2 Bus Protection Cubicle

- Install standard 23" protection cubicle
- Install one (1) GE-B90 relay for No2 22kV X Low Impedance Bus Protection (LIBP)
- Install one (1) SEL-311C-1 relay for No2 22kV Y Bus Distance protection

22kV X CB Management & X CB Fail Cubicle

- Install standard 23" protection cubicle
- Install three (3) SEL-351S relays for
  - No1 Transformer X CB Management & X CB Fail
  - No1-2 Bus Tie X CB Management & X CB Fail
  - No2A Transformer X CB Management & X CB Fail
- Note: Serial to Fibre converters to be installed for Mirrored Bits communication to switch-room

Station Earth Fault and Neutral Bus Management Cubicle

- Install standard 23" protection cubicle
- Install one (1) SEL-451 relay for Station Earth Fault Management (SEFM)
- Install one (1) GE-F35 relay for Neutral Bus Management & X MEF

Backup Earth Fault and Disturbance Fault Recorder Cubicle

- Install standard 23" protection cubicle
- Install one (1) GE-F35 relay for Backup Earth Fault (BUEF) protection
- Install one (1) Elspec G5 Black Box for 22kV Disturbance Fault Recorder (DFR)

No1 Bus 22kV Feeder Protection Cubicle

- Install standard 23" protection cubicle
- Install two (2) SEL-351S relays for:
  - TRG11 Feeder protection
  - TRG12 Feeder protection
- Note:
  - Space to be reserved for future TRG13 & TRG14 feeder protection relays
  - Neutral CT ratio to be considered in relay setting
  - Serial to Fibre converters to be installed for Mirrored Bits communication to switch-room

No2 Bus 22kV Feeder Cubicle

- Install standard 23" protection cubicle
- Install three (3) SEL-351S relays for:
  - TRG21 Feeder protection & management
  - TRG22 Feeder Protection & management
  - TRG23 Feeder Protection & management
- Notes:
  - Space to be reserved for future TRG24 feeder protection relay
  - Neutral CT ratio to be considered in relay setting
  - Serial to Fibre converters to be installed for Mirrored Bits communication to switch-room

PQM, VRR & VAR Control Cubicle

- Install Standard 23" protection cubicle
- Install one (1) ION-9000 relay for No1 Transformer PQM
- Install one (1) ION-7400 relay for No2 Transformer PQM
- Install one (1) SEL-451 relay for Station 22kV voltage regulation
- Install one (1) SEL-2411 relay for No2 Cap Bank VAR Control

Capacitor Bank Protection Cubicle

- Install standard 23" protection cubicle
- Install one (1) SEL-351S relay for No2 Capacitor Bank OC, EF & Management
- Note:
  - Space to be reserved for future No1 Cap Bank OC, EF & Management relay
  - Neutral CT ratio to be considered in relay setting
  - Serial to Fibre converters to be installed for Mirrored Bits communication to switch-room

2.3.2 IEC61850 Configuration

- IEC61850 Design Integration Spreadsheet

  - Prepare new IEC-61850 design integration spreadsheet
  - Add and configure all new relays performing functions through IEC-61850
  - Map and re-configure signals to new and existing relays as per relevant Scheme Documents
- IEC61850 Architect & GE UR Setup
  - Configure CID files for all new relays performing functions through IEC-61850 as per Design Integration Spreadsheet
  - Prepare station 'SCD' file as per Design Integration Spreadsheet
- IEC61850 TRG Scheme document drawings
  - Produce TRG scheme document drawings to match configured Design Integration Spreadsheet

2.3.3 GPS Clock

- Establish time synchronisation to new relays

2.3.4 SCADA works

- Prepare RTU configuration and master station configuration for new equipment
- Update TRG Single Line Diagram to accommodate new station arrangement
- Update Powercor System Control Centre Alarm Pages to include new relays and retire old relays
- New configurations required for SEL RTACs
- Develop Human Machine Interface configuration

2.3.5 Fibre Optic works

- Establish new Fibre connections from new feeder relays to existing CB Remote I/O SEL2506 relays in switch-room
- X & Y Fibre paths are to be diverse

2.3.6 DC Distribution

- Install X & Y DC Distribution Wall boxes as per current standard

2.3.7 AC Station service supplies

- Install AC station service, AC changeover & AC distribution as per current standard

2.3.8 Building access control system

- Install building access control system and intrusion detection as per current standard

2.3.9 Fire System & Indication

- Install fire system as per current standard

2.3.10 AC Charger & DC System

- Install X & Y Battery Charger as per current standard
- Install X & Y DC Systems as per current standard
- Load calculation for DC System to be attached in RESIS

2.3.11 Fibre Patch Panel

- Install X fibre patch panel/wall box

- Y fibre patch box to be installed at rear of any Y protection cubicle
- Fibre paths are to be diverse and Multimode OM3 (Aqua) fibre to be utilised

2.3.12 Operator Desk

- Install Station HMI PC, mouse, keyboard, monitor on operators desk
- Refer Protection & Control group for procurement and setup of these device

2.3.13 Station HMI works

- Create SLD and control pages
- Create IEC61850 status pages

2.3.14 Ground Fault Neutraliser

Control Unit

The GFN control unit is a single cubicle comprising of:

- GFN Master Control module
- GFN Slave Control Module
- Windows Based PC utilising proprietary NM Term software
- All VT & feeder I_0 CT terminations
- All trip link outputs
- RCC Inverter and ASC Interface
- Panel Meters

The control unit is to be constructed within a swing frame cubicle. The cubicle will contain an interface controller in the form of a SEL-2440 DPAC control unit in the top 2U of this cabinet. This control unit will be used to interface controls to the Station Earth Fault Management relay.

VT Supplies (R,W,B & V_N) are required from bus into the GFN controller along with Feeder and Transformer neutral summation (I_N) circuits. Refer proposed DPS in appendix B for detail.

Inverter

The Residual Current Compensation technique used by the GFN requires an Inverter to inject current into the ASC via an auxiliary winding. The inverter must be sized to displace the full capacitive current drawn by the system and as a result requires significant power.

The performance specification discussed earlier calls for a 0.5A fault current sensitivity. GFN sensitivity is determined by two main factors;

- System Damping
- Capacitive Dissymmetry

The size and future growth of TRG does not suggest any issues in meeting this threshold with one ASC.

The inverter requirement is also quite large as it must have the power to counter balance the system damping and capacitance when in operation. Inverters in the order of 300-400kVA is expected.

The inverters shall be installed in a separate air conditioned hut in the switchyard. Inverter AC Supplies to be supplied of the new station service transformer.

2.3.15 VT Supplies

Auxiliary transformer for GFN

Establish VT supplies from the new 22kV Bus VT to the GFN control unit.

For earth fault detection, an open delta (U_N) input is required from the 22kV bus VT at 110V secondary. Swedish Neutral will supply an auxiliary transformer within the GFN control cubicle which is to be used to create the open delta connection.

2.3.16 CT Performance

Existing CTs used in the GFN scheme are to be tested to confirm sensitivity of neutral current measurement and overall CT performance is acceptable for GFN application. If performance does not meet GFN criteria, service provider must allow for replacement/installation of new CTs.

2.3.17 Protection Settings

A protection review shall be undertaken by Network Protection & Control of all schemes within TRG zone substation with particular reference to earth fault schemes on the 22kV network.

2.3.18 Protection Relay Configurations

Powercor Network Protection and Control will provide standard relay configuration files available to the Service Provider where appropriate. Given the nature of this project, the service provider must expect that this project may have non-standard requirements.

2.3.19 TSIU Wall Box

Once corporate phone is established the TSIU wall box should no longer be required and is to be retired. Designer shall confirm with Progility that all services have been disconnected prior to removal.

2.3.20 ELSPEC Power Quality Meter and Disturbance Recorder

The ELSPEC shall be installed to capture bus voltage, neutral voltage and bus incomer currents (ie transformer currents). The purpose of this recorder is to aid with GFN commissioning and long term monitoring.

2.3.21 Time Synchronisation

SNTP/NTP capable equipment is to be configured to synchronise to the existing GPS clock. All non SNTP/NTP capable equipment is to be connected via IRIG-B.

2.3.22 Station HMI and HMI RTU

Existing HMI to be updated to reflect new SLD (status, controls, metering) with the addition of a 61850 overview page

2.3.23 415/240 AC Supplies

Since the new 500kVA station service kiosk will be supplied off the 22kV bus, there is no need for a second station service transformer or an AC changeover scheme.

The AC Supplies must ensure capacity and reliability requirements are fulfilled for a single ARC Suppression Coil.

Current limiting fuses are to be installed on distribution AC board supplies.

The existing station AC board is to be reviewed and upgraded as required to meet AS3000 standards.

2.3.24 DC Supplies

The battery capacities shall be verified as being of adequate capacity to supply the station standing load and any CB operations that could occur within a 10 hour period following loss of AC Station Service supplies.

Documentation must be provided that demonstrates the battery amp-hour rating chosen has been sized for the load and the duty of the load. Calculations and appropriate documentation must be provided to demonstrate compliance with IEEE – 485 “IEEE Recommended Practices for Sizing Lead Acid Batteries for Stationary Applications”.

2.3.25 Station Design

As a minimum the secondary design documentation shall include:

- 22kV Station Schematic Diagram
- 61850 Site configuration file and integration document
- Protection, Control, Instrumentation and Alarm data schedules
- Control room layout and elevation of cubicles
- Cubicle Layouts

- Wiring schematics/diagrams for individual protection, control and metering schemes
- DC supply schematics
- Remote control equipment and associated data schedules
- Labelling for cubicles and all slide link terminals
- Manufacturer and interface drawings for the Ground Fault Neutraliser equipment

2.3.26 Powercor Control Centre SCADA Works

A new series of Control System Pages shall be created for the GFN interface and any new equipment as required.

Create additional sections in the Alarm and Additional analogue pages to accommodate points& controls from new relays

Consultation between SCADA, Operations and Network Protection & Control is required to establish these pages.

2.3.27 Fibre Optic Cable

Fibre optic patch leads are required for Zone Substation Sub-LAN Ethernet communications.

These optic fibres shall be of OM1 62.5/125um type.

2.3.28 Building & Property considerations

Yard Lighting

Switch yard lighting shall be reviewed to ensure adequate coverage of the ASCs and the Neutral cubicle.

Fire Suppression

The ASC winding is immersed in oil. A review of its design and the amount of contained oil is required to determine if any fire suppression assets are required.

2.3.29 Recoveries

The following items are to be fully recovered and returned to stores for consideration:

- 63kVA station service transformer
- Existing No.1 22kV bus VT
- RMS 2C137 X MEF relay
- 5 x SEL351S Feeder management relays on TRG 1, 2, 3, 4 & 5
- SEL-311B 2 Zone bus distance relay

2.3.30 Health and Safety

- The asbestos register shall be consulted and any occurrences validated on-site
- The register should be updated following completion of the project.

3 22 kV distribution feeder requirements

The 22kV distribution works is to include all TRG feeders, the part of HTN003 that can be transferred to TRG and the COB021 feeder.

3.1 Surge diverters and insulation limitations

The operating principle of the GFN uses a tuned reactance to choke fault current in the event of a single-phase-to-ground fault. As a result, displacement of the line-to-ground voltage occurs in the healthy phases. Whilst line-to-line voltages remain at 22kV, the line-to-ground voltage rises to 22kV, phase-to-ground, on the two healthy phase's subsequently stressing substation and distribution equipment. In the case of surge diverters, this displacement cannot be tolerated and as such the diverters require replacement.

To accommodate the GFN installation:

- Replace surge diverters across the 22kV three phase and single phase system.
- This includes all TRG feeders and COB021 feeder which can be temporarily supplied from TRG
- Surge arrestors beyond inter-station open points shall be upgraded in addition to those on all TRG feeders to permit the transfer of loads with the GFN in service
- All surge arrestors except 'Type A' Bowthorpes, will need to be replaced with the new ABB polim D 22kV arrestor
- The replacement diverters should be of 22kV continuous rating with a 10 hour 24kV TOV rating.

Table 3 Surge arrestor replacement volumes

Surge arrestors	Volume (sites)	Volume (arrestors)
Surge arrestor sites (single phase)	556	1112
Surge arrestor sites (three phase)	517	1551

3.2 Distribution transformers

Operation of the GFN displaces the neutral voltage of the entire 22kV system from the bus to the outer extremities of the feeders. This is different from an NER arrangement, when displacement is at its highest for a fault on the 22kV bus, and decreases for faults occurring down the feeders.

During GFN commissioning, voltage offset testing will simulate the voltage displacement that will occur for a single-phase-to-ground fault (22kV phase-to-ground).

- Some distribution transformers may not be in a condition to withstand the overvoltage and will subsequently fail during the voltage offset testing
- Some distribution transformers may fail following repeated subjection to sustained over-voltages caused post commissioning due to normal operation of the GFN.

Experience from network resilience (voltage stress) testing at GSB and WND has suggested that there is a low likelihood of distribution transformer failure, and any that fail are likely to fail due to poor condition rather than as a result of inappropriate rating. This project scope does not include the proactive replacement of any distribution transformers.

3.3 Line insulators

As is the case above for distribution transformers, line insulators are also susceptible to premature failure caused by the repetitive over-voltage stresses.

Similar to Distribution Transformers, experience from the network resilience testing has suggested that there is a low likelihood of line insulator failure. This project scope does not include the replacement of any line insulators.

3.4 Line regulators

Single phase open-delta-connected Cooper regulators displace the system neutral voltage by regulating line-line voltages on two phases as opposed to three.

Closed-delta independent regulator control schemes tap each regulator independently causing a similar displacement to the neutral voltage occurs as for the open-delta mode.

All regulator works shall be compliant with current CitiPower and Powercor standards for 22kV regulators. For all single phase Cooper regulators on the TRG network the controls shall be upgraded to 3 single phase units with a CL7 control unit such that:

- All units regulate & tap together in a master follower style scheme
  - For ground mount option, a three phase CL7 module shall be employed
  - For “adjacent pole option”, single phase CL7 running communicating over fibre optic can be used
- Each tank tap position is monitored and fed back into an out-of-step control circuit
  - Out-of-step logic shall lock out automatic control within 90 seconds of detection
- All alarms and controls shall be integrated into SCADA

The TRG 22kV distribution network contains six (6) 22kV regulating systems.

Table 4 TRG regulating systems

Fdr	Name	Regulator Make	Phasing	Control Box	Issue/Work Required
TRG002	TGTS-HTN P59A REG	Cooper – 3 x 300A	RWB	CL 6B	Independent controls / new CL7 controller.
TRG002	WOORNDOO P80 REG	Cooper – 3 x 200A	RWB	CL 6B	Independent controls / new CL7 controller.
TRG003	COBDEN P131 REG	Wilson Elec Tran Ferranti – 1 x 5MVA	RWB	CL 5C	No issue
TRG003	COB-WSD P128L REG	Wilson Elec Tran Ferranti – 1 x 3.75MVA	RWB	CL 5C	No issue
TRG005	TERANG STH P76 REG	Wilson Elec Tran Ferranti – 1 x 7.5MVA	RWB	CL 5C	No issue
TRG005	TIMBOON P226 REG	Wilson Elec Tran Ferranti – 1 x 7.5MVA	RWB	CL 5C	No issue

The COB021 22kV distribution network contains one (1) 22kV regulating systems.

Table 5 Cobden feeder regulating systems

Fdr	Name	Regulator Make	Phasing	Control Box	Issue/Work Required
COB021	COB-WSD P184W REG	Cooper – 3 x 300A	RWB	CL 5E	Independent controls / new CL7 controller.

The table below summarises the replacements.

Table 6 Regulator works

HV regulators	Volumes (sites)
Regulator sites	7
Regulator replacement	0
Control box upgrade	3

3.5 Capacitive balancing

The ground fault neutraliser uses a tuned inductance (Petersen Coil / Arc Suppression Coil) matched to the capacitance of the distribution system. The 3 phase 22kV distribution system supplied from ART zone substation contains a significant amount of single phase lines. Whilst planning philosophies have always attempted to balance the single phase system, inevitably this is difficult to achieve and the objective has been load balancing rather than capacitive balancing. In order to balance the capacitance of the three phase system such that the ASC can be correctly tuned, balancing substations that utilise low voltage capacitors to inject the missing capacitance onto the system are to be placed at selected locations on the 22kV distribution system in addition to courser balancing by altering phase connections of single phase lines.

Note: Balance does not refer to the balancing of load. System balance is required from a capacitance-to-ground perspective and affected by route length and single phase connected distribution equipment.

As the existing phase connections of single phase lines and single phase transformers is largely unknown a detailed scope of works cannot be produced without visual inspection on site. This scope thus includes estimated quantities of the required balancing works with a subsequent detailed scope of works to be produced following a field audit to be conducted as described below.

A reconciliation of all 22kV overhead and underground lines routes (including the portion of HTN005 and STL005 covered by this scope) shall be conducted to enable a more detailed balancing design scope of the network balancing requirements to be produced.

The following steps shall be outworked prior to GFN installation;

1. Consolidate all “Single Phase” and “unknown” conductor into the “BR”, “RW” or “WB” categories
    a. Perform field audits to validate “Single Phase” and “unknown” conductor where required
    b. Perform field audit to spot check the validity of current phasing information
2. Consolidate all single phase transformers on the 22kV system and assign to one of the “BR”, “RW” or “WB” categories
3. Ascertain the construction types for all sections
    a. Indicate whether LV subsidiary exists
4. Consolidate all “1 Phase” and “unknown phase” 22kV cable and assign phase information
5. If single phase circuits are used underground, ascertain the design principles behind the single phase underground sections
    a. Conductor type, two or three core?
    b. Treatment of the unused core (earthed or phase bonded)
        i. If bonded, to what phase
6. Provide this data so that the network can be modelled with correct balancing study and a detailed balancing scope can be produced.

The data will be assessed and an action plan for a “course balance” will be developed as part of the separate detailed balancing design scope. The course balance will look at sections of the system in “switchable blocks” and for any re-phasing opportunities in order to balance out the single phase route lengths.

A finite balancing approach will then look at the system again in “switchable blocks” for the application of admittance balancing substations.

Prior to completion of this additional scope the estimated quantities are provided in the table below.

The number of rephasing sites, single phase balancing units and 3 phase balancing units are based on the experience of Tranche 1 and Tranche 2.

Table 7 Balancing requirements summary

Balancing Concept	Number of sites
Re-phasing Sites	70
Single Phase Balancing Units	16
3 Phase Balancing Units	25
Remote Control Gas Switches*	6

*Remote control gas switches are required on HTN003 for Mt Napier Rd spur (from existing fuse switch 14946) and Mortons Lane Spur (from existing switch 12460) due to series fusing down stream of where the original 1 phase CBU and fuse saver combo would be.

3.6 Automatic Circuit Reclosers (ACRs)

The TRG 22kV Distribution Network currently has 26 in service Automatic Circuit Reclosers (ACR’s). Of these 5 are RVE or VWVE models, 10 are Nulec N24 models and 2 are Schneider N27 model ACRs. There are also 3 unknown ACR models. The portion of HTN003 covered by this scope has 1 further in service ACR and the COB021 feeder also has 1 further in service ACR. The HTN003 ACR is an unknown model, whilst the COB021 ACR is a Schneider N24 model.

Each RVE or VWVE ACR on the TRG, COB021 or portion of HTN003 network should be replaced with the current standard Schneider N27 ACR which has inbuilt voltage measurement.

Table 8 TRG ACR sites

Name	Operating voltage	Phase code	Control Box Model	ACR model
BAYNES-GARVOC TIE P35 ACR	22kV	RWB	ADVC	N24
BRUMBYS RD P33 ACR	22kV	RWB	ADVC	unknown
ECKLIN P179 ACR	22kV	RWB	ADVC	N24
GLENFYNE EAST P42 ACR	22kV	RWB	ADVC	VWVE27
LAKE BOLAC P 279	22kV	RWB	ADVC	N27
NOORAT P51R ACR	22kV	RWB	ADVC	VWVE27
OCONNORS LN P1229 ACR	22kV	RWB	CAPM5	N24

Name	Operating voltage	Phase code	Control Box Model	ACR model
PENSHURST P1 ACR	22kV	RWB	CAPM5	N24
PENSHURST P290 ACR	22kV	RWB	ADVC	unknown
PETERBOROUGH P1 ACR	22kV	RWB	CAPM5	N24
PETERBOROUGH P96 ACR	22kV	RWB	ADVC	N24
TERANG STH P1 ACR	22kV	RWB	ADVC	N24
TGTS-COB P141 ACR	22kV	RWB	ADVC	N24
THE SISTERS P2 ACR	22kV	RWB	ADVC	VWVE27
TIMBOON LINE P284 ACR	22kV	RWB	ADVC	N24
TIMBOON P326 ACR	22kV	RWB	ADVC	VWVE27
TIMBOON P446 ACR	22kV	RWB	ADVC	unknown
TIMBOON WINDFARM P1 ACR	22kV	RWB	ADVC3	W27
WOORNDOO P27 ACR	22kV	RWB	ADVC	VWVE27
WOORNDOO P84 ACR	22kV	RWB	CAPM5	N24

Table 9 HTN003 feeder ACR replacements

Name	Operating voltage	Phase code	Control Box Model	ACR model
HAWKESDALE P148 ACR	22kV	RWB	ADVC	unknown

Note the above ACR is an open point with KRT013.

Table 10 COB021 feeder ACR replacements

Name	Operating voltage	Phase code	Control Box Model	ACR model
COB-WSD P333 ACR	22kV	RWB	CAPM5	N24

Each ACR or remote controlled gas switch requires a modern control box which has required programmable functions and up to date firmware. ACR and gas switch control box replacements are required (for CAPM5 or GCR300 control boxes) in order to:

- automatically detect REFCL operation and prevent incorrect operations de-energising customers
- provide advanced fault locating algorithms capable of detecting REFCL fault confirmation tests

- continue to operate in the traditional manner automatically when REFCL is not in operation.

Table 11 Control box replacements

Name/Location	Control box model
OCONNORS LN P1229 ACR CTRL	PTCC (CAPM5)
PENSHURST P1 ACR CTRL	PTCC (CAPM5)
PETERBOROUGH P1 ACR CTRL	PTCC (CAPM5)
WOORNDOO P84 ACR CTRL	PTCC (CAPM5)
COB-WSD P333 ACR	PTCC (CAPM5)

Table 12 Total replacements

Units	Number of sites
ACR replacements	5
Control box replacements	5

3.7 HV fusesavers

HV fuses pose a difficulty in operating a network with a REFCL. Maintaining capacitive balance is critical in the network, and scenarios that result in 1 or 2 out of 3 fuses blowing in a 3 phase section, such as phase-phase faults can result in large capacitive imbalances. This depends on the size of the downstream network. These imbalances can result in loss of REFCL sensitivity, REFCL maloperations resulting in widespread outages or REFCL backup schemes operating to remove the REFCL from service.

Fusesavers are to be installed as a 3 phase ganged unit such that when any individual phase operates for a fault, all 3 phases open in unison de-energising a balanced section of the network regardless of the fault type.

Fusesavers are required to operate for any fused section with a minimum downstream network capacitive charging current of 150mA for the 40A model, 500 mA for the 100A model and 1A for the 200A model. If fault levels are too high, then alternative solutions are required (e.g. augmentation works, network rearrangement, etc).

The table below shows the number of sites where fusesavers will be required.

Table 13 Fusesavers

Units	Number of Sites
Fusesavers	39

3.8 Distribution switchgear

Overhead distribution switchgear has been shown to be largely resilient to the phase to earth over-voltages experienced in a resonant network. There is no planned replacement of these assets.

Based on our tranche one experience, we will replace 100% of the ABB and F&G switchgear as well as 6 per cent of all other distribution switchgear.

Table 14 Switchgear replacements

Unit	Volume
Distribution switchgear	8

3.9 HV underground cable

Experience from REFCL testing has shown that HV underground cable can fail due to a number of flaws. Manufacturing techniques in the past have relied on steam curing of XLPE cables which can in the presence of higher voltages, result in extensive water treeing and subsequent failure. Additionally, joints and other terminations produce higher stress and can be a point of failure. The following lengths of cable are required to be replaced.

Table 15 HV underground cable requirements

Location	Length (m)
Cable failure length	290

3.10 New feeder tie

Due to the removal of the transfer bus as part of the new 22kV Switch Room, a review of the distribution feeder ties was conducted to ensure that there are still appropriate transfers available for operational switchability of the TRG network.

A new feeder tie is to be created between the new TRG011 (TRG004) and TRG023 (TRG003), to compensate for the removal of the transfer bus as the TRG023 feeder has no distribution ties with the TRG No.1 bus feeders and only other distribution transfers are to the non-REFCL zone substation feeders COB012 and COB021.

The feeder tie is to be new 240mm2 3/c 22.a.x.hc.h. underground cable run between the two feeders on two new switched cable heads between High Street and Peterborough Rd in the vicinity of the TRG zone substation.

3.11 HV customers

The Electricity Distribution Code stipulates that at the point of connection to a customer on the 22kV network, the phase to earth voltage variations in the distribution code (section 4.2.2) no longer applies during a REFCL condition.

For HV customers, this means that they need to ensure that their network can tolerate these conditions. Given this, all HV customers will now have an ACR installed at their supply point. HV Customers which generate and export onto the 22kV system require additional signalling to coordinate with the REFCL operation.

Table 16 HV customer

Units	Volume
HV customer sites with generation	1
HV customer sites without generation	3
Total HV customer sites	4

4 Appendix

4.1 Proposed Site General Arrangement

Figure 3 Existing TRG zone substation general arrangement (drawing VX11/6791/151)

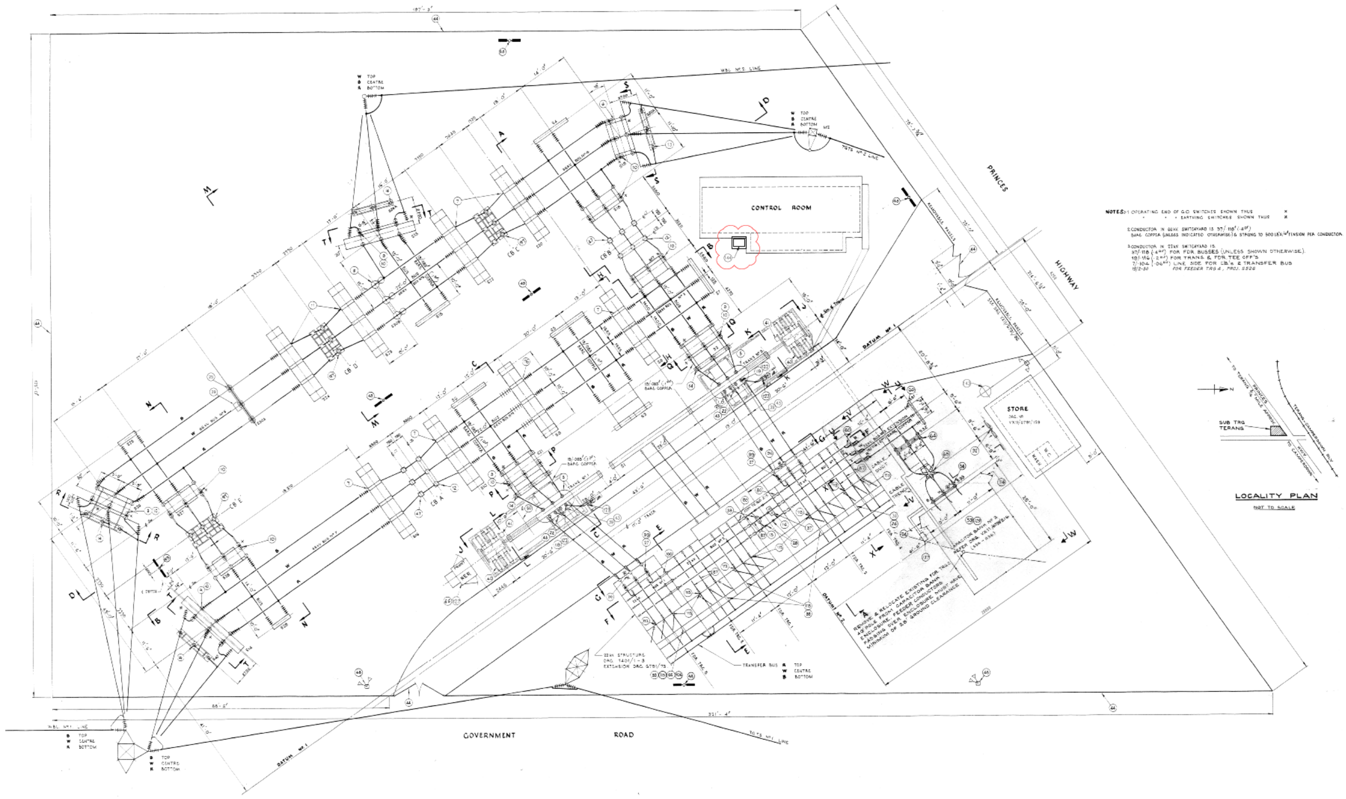
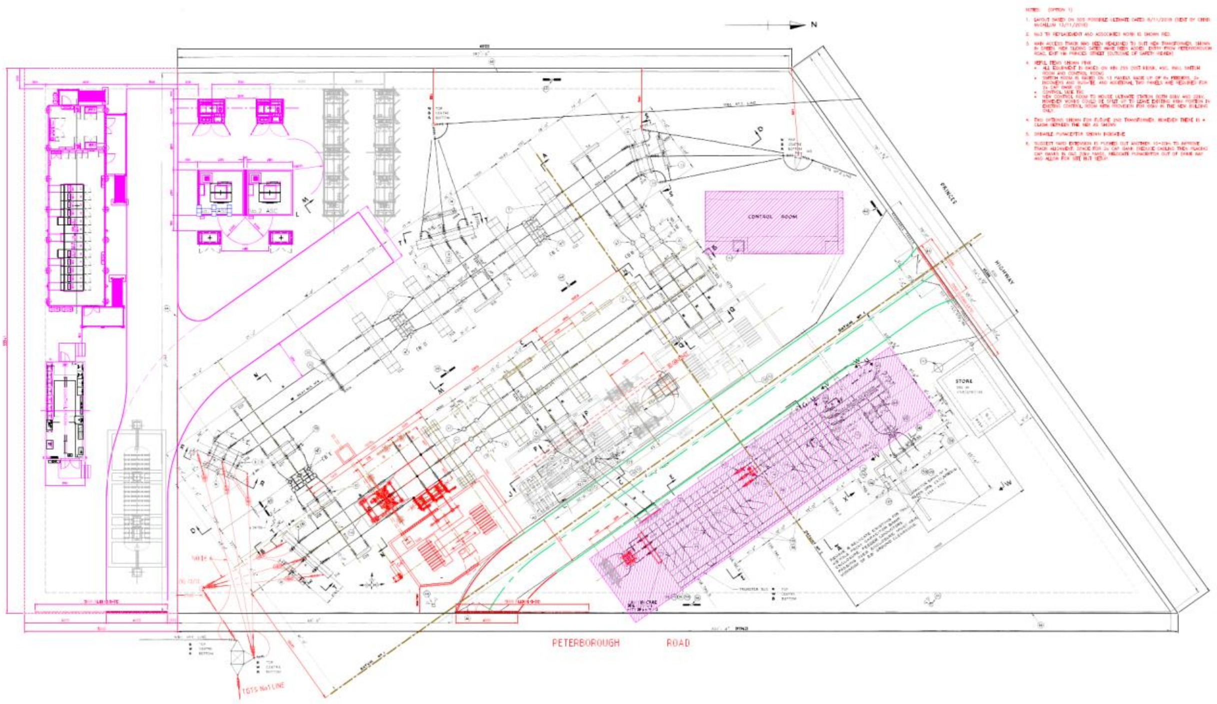

CONTROL ROOM
STORE
PRINCES
HIGHWAY
GOVERNMENT
ROAD
LOCALITY PLAN

Figure 4 Proposed TRG zone substation general arrangement (updated drawing VX11/6791/151)



N
CONTROL ROOM
STORE
PETERBOROUGH ROAD