CITIPOWER	**ELECTRICITY NETWORKS** **Network Planning & Development** **Functional Scope**	Powercor AUSTRALIA

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<tr><td rowspan="2">Functional Scope Created</td><td rowspan="2">06/01/2020</td><td>By</td><td colspan="3">Danny Jutrisa</td></tr>
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Revision History:

Version	Date	Changes	Responsible Officer
0.1	06/01/2020	Initial Scope	D.Jutrisa
0.2	16/04/2020	Added P&C requirements	R.Lim
0.3	21/04/2020	Added fibre comms link requirements	N.Godellewatte
0.4	05/05/2020	Updated 66kV cut in from FDN to CRO	D.Jutrisa
0.5	14/05/2020	Updated the length and the drawing of the new sub-transmission lines	S.Li
0.6	12/06/2020	Minor update and added proposed General Arrangement	D.Jutrisa
1.0	16/06/2020	Final review	N. Watt

1 Project overview

This project scope covers the installation of a new zone substation at Gheringhap (GHP). The GHP zone substation is to be built with two (2) 25/33MVA transformers, a 66kV outdoor bus with four (4) 66kV circuit breakers, two (2) 66kV lines (GTS-GHP and GHP-CRO), a 22kV switch room with thirteen (13) 22kV circuit breakers, one (1) 2 x 3.0MVar capacitor banks and two (2) ground fault neutralisers (GHP).

As part of these works, fibre optic cables are to be constructed between GTS terminal station and GHP zone substation, and GHP zone substation and CRO zone substation.

The GFNs are required as the new GHP system will be a resonant earthed network. The GFNs change 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; and
- 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; and
- the low voltage (**LV**) system.

1.1 Background

The Victorian Government Bushfire Mitigation Regulations require that Corio (CRO) zone substation and Geelong (GL) zone substation are both migrated across to a resonant network. However, building GHP zone substation will mitigate the associate bushfire risks on both CRO and GL zone substation networks more cost effectively. GHP zone substation will thus be required to meet the Victorian Government Bushfire Mitigation Regulations performance standards.

2 ZSS requirements

This functional scope sets out the GHP zone substation requirements, including the following:

- Purchase of land in Gheringhap
- Install two (2) 66/22 kV, 25/33 MVA zone substation transformers.
- Install foundations and steel support structures for the Primary plant in the 66kV switch yard
- Install new 66kV outdoor looped bus comprising of four (4) 66 kV circuit breakers (CB) and two (2) 66kV line exits.
- Install eight (8) sets of 66kV under slung isolators (2 sets for each 66kV CB)
- Install two (2) 66kV Surge Diverter/Line VT; including structures
- Install two (2) 66kV rotary double break switch/earth switch; including structures (66kV line entry and Exit)
- Install new indoor 22kV switch room containing the GFN inverters and associated equipment, and a switchboard with two (2) 22 kV buses, with thirteen (13) 22kV circuit breakers (two (2) 22kV bus tie CBs, two (2) transformer CBs, eight (8) 22kV feeder CBs, one (1) capacitor bank CBs), two (2) bus risers, two (2) bus earth switches, two (2) bus VTs and two (2) transformer VTs.
- Install one (1) 6 MVAr capacitor bank with 2 x 3 MVAr module steps and VAR control.
- Install new control room.
- Install two (2) new station service supply 500kVA kiosk transformers and associated 415V distribution system.
- Install amenities facilities.
- Install new zone substation earth grid.
- Installation of two (2) Arc Suppression Coils (ASC) in an appropriately bunded enclosure.
- Modification of the 66/22kV transformer earthing arrangement
  - Installation of Transformer Neutral Isolators, Sure Arrestors and Direct Earth Switches
  - Installation of Neutral Bus Systems
- Install weather station.

<u>Secondary Requirements</u>

This functional scope sets out the GHP zone substation requirements, including the following:

- New Comms equipment including station RTUs, firewalls, modem, Ethernet switches and SubLAN switches.
- New REFCL equipment.
- New 66kV GTS Line X & Y Protection.
- New 66kV CRO Line X & Y Protection.
- New 66kV X & Y CB Management.
- New 66kV No.1 Bus Y Protection & Reclose.
- New 66kV No.2 Bus Y Protection & Reclose.
- New 66kV No.1 Trans X & Y Protection.
- New 66kV No.2 Trans X & Y Protection.
- New 22kV No.1 Bus X & Y Protection.

- New 22kV No.2 Bus X & Y Protection.
- New 22kV X CB Management & X CB Fail.
- New Station Earth Fault and Neutral Bus Management.
- New Backup Earth Fault.
- New Disturbance Fault Recorder.
- New 22kV Feeder Protection.
- New PQM.
- New VRR.
- New VAR control.
- New Capacitor Bank Protection.
- New GPS Clock.
- New Station HMI.

This functional scope sets out the GTS terminal station requirements, including the following:

- Update 66kV CRO Line X & Y Protection settings.
- Install a new Fibre Optic Cable between the GTS terminal station and the GHP zone substation.

This functional scope sets out the CRO zone substation requirements, including the following:

- Update 66kV GTS Line X & Y Protection settings.
- Install a new Fibre Optic Cable between the CRO zone substation and the GHP zone substation.

2.1 GHP ZSS land purchase requirement

Land is required to be purchased before the GHP ZSS build can proceed. The standard sized parcel of land required is 100m x 100m (or 1.0 Hectare), to enable enough space for future requirements. This will need to be suitable from a council zoning, environmental, civil and structural build of the zone substation.

2.2 Primary plant requirements at GHP

2.2.1 Zone substation transformers

Install and commission two (2) 66/22 kV, 25/33MVA transformers (Dyn1, 25% boost, 5% buck) as per Powercor Transformer Specification ZD101. The transformer shall be installed complete with 66 kV station class 10kA surge arresters and 22kV continuous station class (LDC class 2) voltage arrestors (SAP ID: 35470 [ABB MWK22 or equivalent]).

The current transformers required are as follows (as per Tech Standard ZD101):

- 66 kV Side –
  - Four (4) three phase sets 900/500/300/5A; Class 0.35PX100 R0.15 Ohm on 300/5A.
- 22 kV Side –
  - One (1) three phase set 1200/700/5 Class 1.0M 20 VA on 700/5 (Metering).
  - One (1) single phase (w ph) 1200/700/5 Class 1.0M 20 VA on 700/5 (Control).
  - One (1) single phase (w ph) 1200/700/5 Class by Supplier (WTI).

- Neutral CT in each transformer 22 kV Star-point earth connection -
  – Two (2) dual winding 300/5 0.25PX50 R0.15 Ohm.
- REF Neutral CT in each transformer 22 kV Star-point earth connection.
  – One (1) single winding 1600/1500/1200/900/5 0.2PX75 R0.40 Ohm on 900/5.

2.2.2 Zone substation 66kV circuit breakers

Install four (4) 66 kV Circuit Breaker with isolators to Tech Standard ZD011. Dead-tank CB's with integral CT's are required. The CB's and CT's shall be rated 72.5kV, with a minimum continuous current rating of 1600A and fault rating of 25kA. 66kV Circuit Breaker module as per Tech Standard SJ221.

The 66 kV circuit breaker current transformers required are as follows:

- Four (4) three phase sets 1600-1200-900-600/5A; 0.25PX100R0.15 Ohm on 300/5A
- (Preferably 2 sets on each side of CB).

2.2.3 Zone substation 66kV bus

Install two (2) 66 kV line entry structures (Tech Standards SJ 201 & SJ 361) including:

- Two (2) 66 kV rotary double break switches (Min rating 1250 A) complete with earthing switch for the new GTS-GHP and GHP-CRO 66 kV Line mounted at the line entry isolator structures.
- Two (2) sets of three (3) 66 kV station class surge arresters directly connected at the line entry structure.
- Two (2) sets of three (3) 66 kV/110V single phase Magnetic Voltage Transformers (72.5kV) as line voltage transformers. (66 kV/√ 3: 110V/√ 3: 110V/√ 3 Class 0.5M/1.0P 100VA).

Install appropriate bus work in the same footprint as equipment for the possible ultimate design. Refer To Section 14 Appendix – GHP SDS attached.

- Five (5) 66kV Bus Crossovers Modules (2 for transformers and 3 for termination bus as per SJ231 Tech Standard).
- Ultimate twenty four (24) 66 kV single blade underslung isolators (min. rating 1250A) to enable proposed and future CB isolation. Designer to consider methods to install minimum isolators for 66 kV CB works as per Section 12 Appendix - Proposed GHP General Arrangement

Install two (2) Transformer modules (Tech Standard SJ 361 Disconnect Switch and Tech Standard SJ 933A 22 kV cable support Structure modified for 66 kV tube bus support overhead) including:

- Two (2) 66 kV gang operated disconnect switches (Min rating 1250A) complete with earthing switch. The purpose of each switch is to earth the 66 kV windings of each transformer.

Install new 32mm Cu tube Bus sections with tubular bus expansion joints to Standard SJ541 for 66 kV Disconnect Switch and 22 kV U/G cable connections to the new Transformers.

Construct outdoor 66 kV Yard with Strung 66 kV bus – 37/3.75 AAC (Min rating 1250 A).

2.2.4 Zone substation capacitor bank

Install one (1) 2 x 3 MVAr capacitor bank and VAR control on the No.1 22kV Bus.

The new capacitor banks are to be un-earthed and is to have the following specifications to make this new capacitor bank meet resonant network requirements:

- Neutral (star-point) structure must provide sufficient insulation to allow for continuous neutral displacement (12.7kV + 10%) under system earth fault conditions.
- Neutral point is fit for continuous operation at 13.97kV.

- CTs on capacitor bank are REFCL compliant CTs.

2.2.5 Zone substation 22kV switch board

Install a new 22 kV indoor switchboard with CB's that shall preferably have 150kV LIWL rating (or 125kV by approval) and shall be suitable for resonantly earthed network and shall comprise a minimum:

- Two (2) 22kV buses with two (2) bus risers.
- Eight (8) 22 kV feeder circuit breakers (800A, 25kA) with four (4) 22 kV feeder circuit breakers on each bus. Feeder CB's shall have the capability for terminating single core/phase of up to 630 sq mm Al XLPE cable and a station service cable using 3/c 95m2 22 kV XLPE.
- One (1) 22 kV circuit breaker (800A, 25kA) for the capacitor bank on the No.1 22kV Bus. The breaker must be capable of switching of 12MVAr capacitor banks. (4 x 3 MVAR modules).
- Two (2) 22 kV circuit breakers (2000A, 25kA) for the bus-ties.
- Two (2) 22 kV circuit breaker (2000A, 25kA) for the transformers. The transformer CBs shall have the capability for terminating 2 x single core/phase 630 sq mm Al single core XLPE cables.
- All 800A CBs shall be interchangeable.
- All 2000A CBs shall be interchangeable.
- The switchboard shall include separate lockable bus & cable shutters, voltage indicators and separate earthing facilities.
- The bus fault rating shall be a minimum 25kA.
- The current rating of the bus is to be a minimum 2000A at system highest voltage of 24kV.
- The 22kV switchboard shall have 25kA for 1 second Arc Fault Containment with AFC cladding through building flashed aperture. AFC cladding to be terminated by an approved pressure relief vent cover. AFC bus segregation to be between the joggle and BT CB. Aperture openings will be confirmed (ZD103 Powercor Tech Standard).

Two (2) of three (3) x 630mm^2 1/c 22 kV Cu XLPE underground cables are to be installed between the zone substation transformer 22 kV bushings and the transformer CBs on the 22 kV Buses, and one (1) of three (3) x 630mm^2 1/c 22.a.x.hc.h. underground cable between the 22 kV bus (No.1) and the Cap Bank CB.

2.2.6 22kV bus VTs

Integrate two (2) new three phase bus VTs (on Bus No.1 and Bus No.2) within the new switchboard with the following specification:

- Frequency: 50Hz
- Ratio: 22,000/110/110V
- Connection: Star/Star/Star
- Vector Group: YNyn0yn0
- Neutral for HV and 2 LV Windings: Solidly Earthed
- Output: 100VA Per Phase Per Secondary Winding
- Accuracy: Class 0.5M1P per secondary winding at the specified voltage factor
- Voltage Factor: 1.9 for 8 Hours
- Category B

Integrate two (2) new single phase VTs (with CTs) on the transformer side of the transformer CB (per ZD103). That is, one VT (with CTs) per transformer 22kV leg with the following specification:

- Frequency: 50Hz
- Ratio: 22,000/√3:110/√3V
- Connection: Single Phase (White phase)
- Neutral for HV and LV Windings: Solidly Earthed
- Output: 100VA
- Accuracy: Class 0.5M1P at the specified voltage factor
- Voltage Factor: 1.9 for 8 Hours
- Category B

2.2.7 22kV bus CTs

Install the following 22 kV current transformers in the switch board for the feeders and transformers circuit breakers:

Each Feeder CB CT's shall have;

- One (1) Three Phase set 600/5A, 0.2PX100 R0.3 Ohm (Bus side).
- One (1) Three Phase set 1500/5A, 0.2PX100 R0.5 Ohm (Feeder side).
- One (1) Three Phase set of core balance CTs 600-300/5A 40-20VA class 0.1 (Feeder side, preferably in the switchboard).

Note: CT's on feeder CBs may all be on the feeder side of the CBs.

Transformer incomer CB CT's shall have:

- Two (2) Three Phase sets 1200/5A, 0.2PX100 R0.3 Ohm (Bus side).
- Two (2) Three Phase sets 1500/5A, 0.2PX100 R0.5 Ohm (Transformer side).
- Note: CT's on transformer CB may all be on the transformer side of CB.

Bus-Tie CB CT's shall have:

- Two (2) Three Phase sets 1500/5A, 0.2PX100 R0.5 Ohm (Bus No 2 side).
- Two (2) Three Phase sets 1500/5A, 0.2PX100 R0.5 Ohm (Bus No 1 side).

Capacitor Bank CB CT's shall have:

- One (1) Three Phase set 600/5A, 0.2PX100 R0.3 Ohm (Bus side).
- One (1) Three Phase set 1500/5A, 0.2PX100 R0.5 Ohm (Capacitor Bank side).

Note: CT's on capacitor back CB may all be on the capacitor bank side of the CB.

2.2.8 Station service transformers

Install two (2) new 500kVA 22kV/415V Station Service Kiosk Transformers

- The new kiosk substations are to be connected to 22 kV Feeder CBs (one on 22kV Bus No.1 and one on Bus No.3) using 95mm^2 3/c 22.a.x.hc.h. underground cable. The transformer and fusing is to be fault rated to a minimum of 13.1kA.
- Connect the new station service transformers to the No.1 and No.2 22kV buses, connected to spare 22kV CBs.

2.2.9 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 non-REFCL Powercor substations do not have the Temporary Overvoltage Capability required for these conditions.

- Install only zone substation surge arresters with a station class (LDC class 2) 22kV continuous voltage arrestor (SAP ID: 35470 [ABB MWK22 or equivalent]).

2.2.10 Amenities shed

Install one (1) new amenities shed, including appropriate toilet and washing facilities.

2.2.11 GHP design for future works

The design of the station is to allow for the ultimate configuration with twelve HV feeders.

2.2.12 Zone substation earth works and earthing

New zone substation earth works as per Tech Standard SJ041:

- Complete earth fill works as required on the site to create a compacted, raised level area on the site for construction of the HV enclosure and access roadway required for establishment of the new GHP ZSS. Install site drainage and a triple interceptor pit.

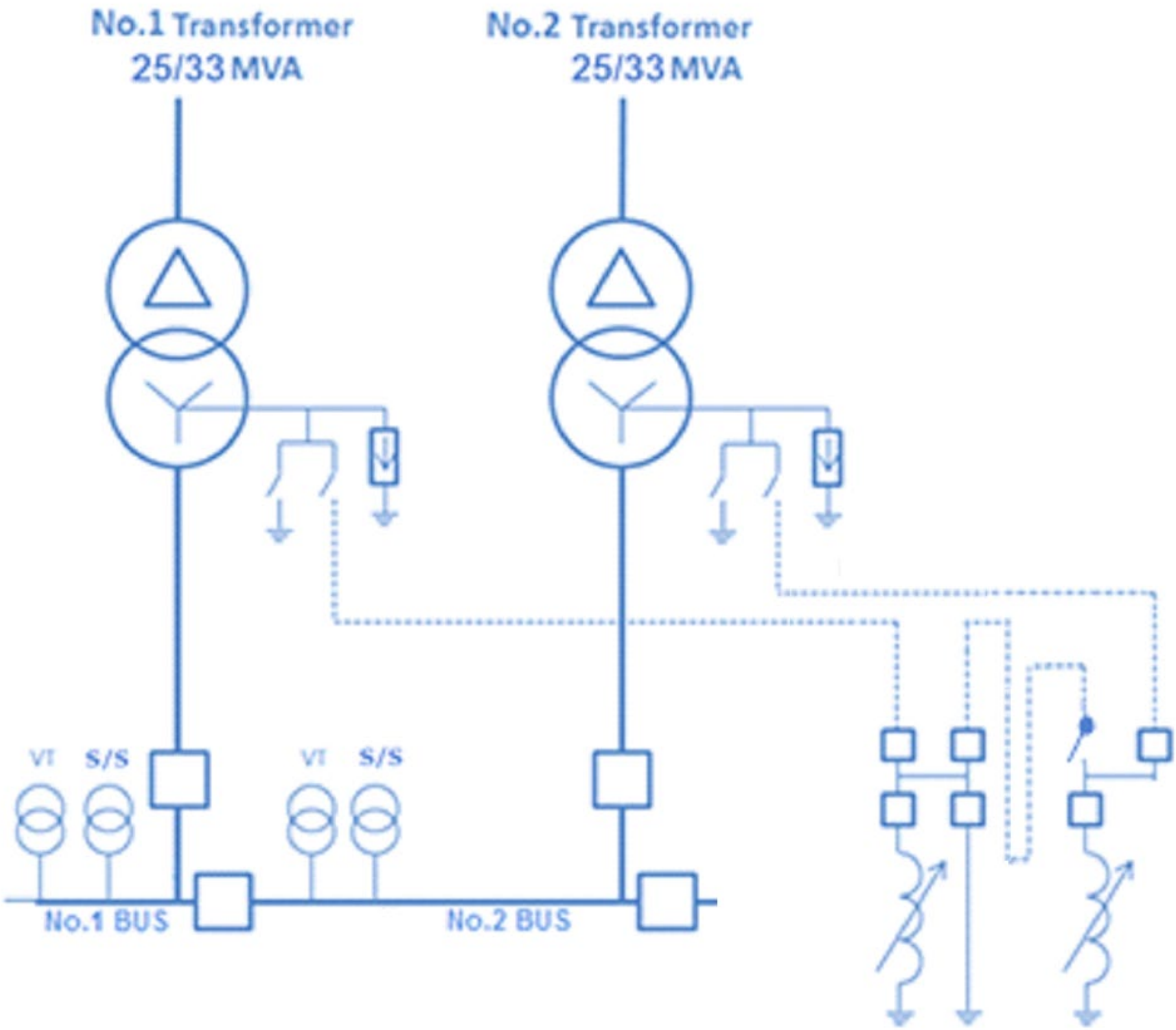
Install a HV earth grid within the substation to Powercor Tech Standards with an earth grid impedance as low as possible, as the earth grid impedance impacts negatively on REFCL operation. The following should be carried out:

- Site survey, earth grid and soil resistivity testing
- Detailed analysis and modelling of earth grid and soil conditions

2.2.13 GHP REFCL installation

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

Figure 1 GHP Proposed Neutral Diagram



2.2.14 Arc suppression coil

Install two (2) arc suppression coils in accordance with the ZD026 series technical standards.

The ASCs shall be installed in an appropriate bunded area in accordance with AS2067 and applicable Powercor technical standards.

The ASC primary network connection to the neutral bus shall be cabled via an Elbow (Interface – C) connection to the neutral bus system.

The ASC network earth connection shall be connected to an earth grid rising into the bunded area at two (2) diagonally opposed locations. The network earth shall connect to both points via solid 40 x 4mm copper conductor. Protected earths shall be bonded together and connect separately to the earth grid at the connection point.

The footings of the ASCs shall reside on the factory installed 150mm steel beams and fixed to the concrete pad.

2.2.15 GFN inverters

Install one (1) modular building built to Powercor standard ZD090 to house REFCL power electronic and interface equipment. The building shall be located as close to as possible to the ASC. This is a technical requirement to ensure voltage drop between the inverter and ASC is minimised.

2.2.16 Neutral system arrangement

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 12.7kV + 10%.

Install a Neutral Bus system comprised of:

- Two (2) new kiosk type ground mounted modules as per Powercor technical standard ZD081
  - One (1) module is to be Type A comprising of four (4) circuit breakers.
  - One (1) module is to be Type B2 comprising of two (2) circuit breakers and one (1) switch.
- Transformer neutral connection assets
  - HV neutral cable.
    - Neutral bus connection isolator.
- Direct earth connection.

Note:

- The Type A neutral bus module has CTs on two (2) of the CBs. Connection to one (1) transformer neutral and to the Type B2 neutral bus module is to be via a CB with CT at the neutral bus module end.
- The Type B2 neutral bus module has CTs on one (1) of the CBs. Connection to one (1) transformer neutral is to be via a CB with CT at the neutral bus module end.

Neutral Bus

The connection to the neutral bus module shall be via elbow connections. A typical neutral bus uses three phase metal clad switchgear connected for single phase use. For this single phase application, the centre phase connections shall be used.

Elbow connections are required for cable connection to each module.

Type A neutral bus:

- No.1 Transformer neutral CB.
- No.1-2 Neutral bus tie CB.
- No.1 ASC connection CB.
- Solid ground connection.

Type B2 neutral bus:

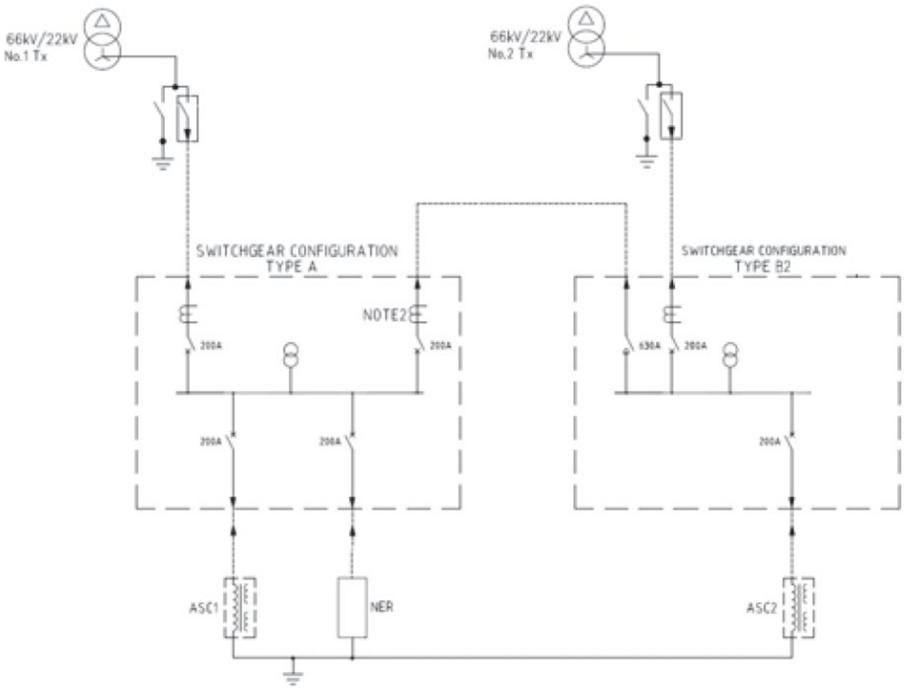
- No.2 Transformer neutral CB.
- No.1-2 Neutral bus tie switch.
- No.2 ASC connection CB.

Neutral Voltage Transformer

A single phase (neutral) VT shall be included in each of the Neutral Bus modules, connected directly to the bus on the centre (white) phase (as shown in ZD081).

- 22000 √3 ⁄ 110 √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.

Figure 2 Proposed GHP neutral system single line diagram



2.2.17 Transformer Earthing and Ground Bypass Isolators

The neutral earthing arrangement for each transformer shall 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 Transformer Neutral Bus Isolators and the relevant Neutral Bus CB via elbow connections on the Neutral Bus RMU.

2.2.18 Neutral surge diverter

Install a Station Class (LDC Class 2) 19kV surge arrestor between the transformer neutral bus and the substation earth grid, as close to the transformer neutral connection point as practicable (SAP ID: 354764 [ABB MWK19 or equivalent]).

2.3 Civil works requirement at GHP

Civil works should include what's required for the installation of two transformers initially and for the ultimate configuration of three transformers and three GFNs. Furthermore, the civil works include the following:

- The GHP site to be graded from the security fence to exclude the ingress of any offsite stormwater, and internally from the security fence to channel stormwater on site via concrete spoon drains through an internal stormwater system. This system would include a sump pit, station isolation valve, and triple interceptor pit.
- Primary oil spill containment, in the form of a bund wall to is to be installed around the main transformers (including radiators) to accommodate 110% of the total oil volume of the plant. The floor of the bund area should be impermeable and be graded to one corner to enable stormwater to be drained via a valve (normally closed) installed in the bund and shall be incorporated into the existing station drainage system.
- Secondary oil spill containment, in the form of a Separation Pit/ Triple Interceptor Pit (TIP) system shall be incorporated into the design with drainage from the transformer bunded area. Inclusion of a station isolation valve is required in the drainage system before the TIP, located near an access gate (for emergency services access). The design should have the ability to allow for future transformer equipment requirements.
- TIP and drainage design is required for the metal enclosed outdoor Capacitor Bank. Must provide appropriate oil containment for failure of capacitor can/s. Any oil containment used shall be incorporated in the station stormwater management system & TIP.
- The switch room and control room and foundations shall be to local council building requirements.
- Supply and install station outdoor nameplates on primary equipment in accordance with "Powercor Zone Substation Equipment Labelling Standard".
- An enclosed control cable system comprising cable trenches and PVC cable conduits to be laid between major plant items and the control room so that entry by vermin is prevented. The cable trenches shall be of concrete construction, cast on site, be fitted with galvanised steel checker-plate covers and shall be as shown on drawing VX10/44/8.
- Cable brackets to be provided to support cables above ground for maintenance staff safety.

For Neutral System:

- Install concrete foundation pad for neutral system module.
- Install neutral cable conduit, control cable conduit and provision for solid earth grid connections.
- Install neutral cable conduits from transformers to neutral system module.
- Install conduits to ASC and solid earth grid connection.
- Install conduits for secondary circuits.

For ASC:

- 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.
- Ensure appropriate bunding to requisite standards.

For Station Service Supplies:

- Install concrete foundation for new station service transformers.

2.4 Switchyard lighting at GHP

Install 240 V AC Yard Lighting to achieve a minimum level of 10 Lux at electrical equipment and operating locations within the HV enclosure.

2.5 Building & property considerations at GHP

Include the following considerations for the switch room:

- Construction of the 22kV switching room may include solid brick, brick veneer, tilt concrete slab, colour-bond clad low profile with a concrete floor with cast cable ducts and cable conduits or be an elevated type with adequate space beneath to run cables [Such construction will require an aesthetically pleasing, removable plinth between switch-room base and ground level]. The switching room is to enable the ultimate 3 x 22kV busses and possibly the station service transformers (Design to consider similar to TNA ZSS on cost & practicality basis). Refer to Powercor specification ZD091.
- If elevated the building must be secured to the concrete foundations as per the appropriated regulations. The building will have suitable access ways to enable equipment installation. A flat roof or pitched roof construction is acceptable provided that eaves are provided and the building and all doors are sealed to prevent ingress of water.
- The switch room shall be designed and constructed with tunnel vents such that it shall be capable of withstanding the pressure wave resulting from an arcing switchgear fault without suffering any damage and such that any operational personnel in the switch room at the time of the fault are not injured. This design feature is to be reviewed if arc fault cladding and venting is installed on the 22kV switchboard as per section 2.1.5 Zone substation 22kV switch board.
- The building shall be designed for a life span of more than 50 years, be aesthetically pleasing and blend naturally with the surrounding environment.

Include the following considerations for the control room:

- The requirements for the control room building are as for the switch room building; however the control room will be a separate building. The control room shall have a thermostatically controlled air-conditioner / heating system.
- The control room dimensions shall be such that all secondary protection, control, monitoring and remote control equipment required for the ultimate development of GHP substation shall be able to be readily accommodated without the need for any further control room expansion.
- The protection/control panels and switchgear are to be located within the control room building to allow ready access for the installation of additional equipment to future possible ultimate – at a later stage. Refer to Section 13 Appendix – GHP SDS attached.
- The building shall be designed for a life span of more than 50 years, be aesthetically pleasing and blend naturally with the surrounding environment.

The building designs for the switch room and control room shall be submitted to PCN for approval.

Include the following considerations for the zone substation site:

- All operational requirements from Operations group to be provided e.g. desk/phones, earthing equipment, first aid kit, fire extinguishers etc. The intention is to provide a fully functioning ZSS to PCA Network for immediate operation during commissioning.
- A vehicle access track adequate for heavy moving equipment such as crane and low loaders etc. shall be provided. The track must allow for the turning circles of cranes, load loaders etc.

- An adequate security fence will be required to encompass the HV equipment and the 'possible ultimate' 66 kV switchyard. Appropriate entry points (minimum of 1 gate) shall be provided for access by personnel, cranes and low loaders etc. The entry point(s) will need to enable the final positioning of possible ultimate equipment without station outages. Yard surface within the security fence shall be 100 mm F.C.R.
- No vegetation is to remain within the security fence. A landscape plan for plantings/screening is required to be submitted to PCN for approval.
- Fire fighting compliance to the relevant authorities requirements will be provided by PCS (this will include consideration of any water tanks or hydrants etc).

2.6 Secondary works at GHP

The following outlines the Protection and Control requirements at GHP.

- Latest version of application manuals are to be confirmed with EN Protection & Control at design commencement.
- Ensure DC battery capacity is appropriate for any new equipment. Calculations to be conducted.
- A protection review shall be carried out, new settings to be applied to all relevant relays and tested into service.
- All protection settings, calculations, setting files, coordination plots are to be attached in RESIS.
- A site visit with the RO and a tester is required to determine possible panel location for the new relays prior to DDS development.

2.6.1 Uplink Communication & SubLAN Control Loop Cubicle

Install:

- Standard 23" protection cubicle
- Two (2) RST-2228 main Ethernet switches
- Two (2) Fortigate 60E firewalls
- Two (2) RST-2228 SubLAN switches

Design Notes:

- Refer to Section 17 Appendix - for proposed Ethernet connectivity.
- The SubLAN switches in this cubicle are to be ordered with 4x RJ45 ports.

2.6.2 Station RTU Cubicle

Install:

- Standard 23" protection cubicle
- Three (3) SEL-3505-4 RTACs for RTAC A, B & NVD
- One (1) Tekron GPS Clock
- Station I/O Controllers for HW connections to non-DNP devices

Design Notes:

- Refer to Section 17 Appendix - 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.

2.6.3 SubLAN X & Y Protection A Loop Cubicle

Install:

- Standard 23” protection cubicle
- Three (3) RST-2228 Ethernet Switches for
  - X RST-2228-21 SubLAN
  - X RST-2228-22 SubLAN
  - Y RST-2288-31 SubLAN

Design Notes:

- Refer to Section 17 Appendix - for proposed Ethernet connectivity.

2.6.4 SubLAN X & Y Protection B Loop Cubicle

Install:

- Standard 23” protection cubicle
- Three (3) RST-2228 Ethernet Switches for
  - X RST-2228-41 SubLAN
  - X RST-2228-42 SubLAN
  - Y RST-2228-51 SubLAN

Design Notes:

- Refer to Section 17 Appendix - for proposed Ethernet connectivity.

2.6.5 REFCL Cubicles

Install:

- Two (2) Standard Swedish Neutral GFN cubicles with associated devices for GFN control

Design Notes:

- Refer to Section 17 Appendix - for proposed Ethernet connectivity.

2.6.6 HMI Inverter Cubicle

Install:

- One (1) SEL-3505-4 RTAC with HMI for dedicated station HMI
- One (1) DC-AC inverter for supply to station HMI PC
- One (1) DC-DC converter for 24V DC distribution
- Emergency lighting controls
- Audible Controls

Design Notes:

- Establish red GPO on operator desk for connection of station HMI.

2.6.7 PQM, VRR & VAR Control Cubicle

Install:

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

Design Notes:

- Refer to Section 17 Appendix - for proposed Ethernet connectivity.

2.6.8 66kV GTS Line X & Y Protection Cubicle

Install:

- Standard 23” protection cubicle
- One (1) SEL-311L Relay for GTS Line X Differential protection
- One (1) SEL2411 for GTS Line Management
- One (1) 7SD522 Relay for GTS Line Y Differential protection
- One (1) SEL2440 for GTS Line 61850 Interface
- One (1) RS400 for DNP communication and engineering access to SEL-311L & 7SD522

Design Notes:

- Refer to Section 17 Appendix - for proposed Ethernet connectivity.
- Firmware R502 to be used with SEL311L relay
- Parameter set of 7SD522 relay to be confirmed
- 2 serial connections are to be established to the SEL311L & 7SD522 from the RS400.
    - (One for DNP3 and the other for Engineering access).

2.6.9 66kV CRO Line X & Y Protection Cubicle

Install:

- Standard 23” protection cubicle
- One (1) SEL-311L Relay for CRO Line X Differential protection
- One (1) SEL2411 for CRO Line Management
- One (1) 7SD522 Relay for CRO Line Y Differential protection
- One (1) SEL2440 for CRO Line 61850 Interface
- One (1) RS400 for DNP communication and engineering access to SEL-311L & 7SD522

Design Notes:

- Refer to Section 17 Appendix - for proposed Ethernet connectivity.
- Firmware R502 to be used with SEL311L relay
- Parameter set of 7SD522 relay to be confirmed
- 2 serial connections are to be established to the SEL311L & 7SD522 from the RS400.

   – (One for DNP3 and the other for Engineering access).

2.6.10 66kV X CB Management Cubicle

Install:

- Standard 23" protection cubicle
- Three (3) SEL-351S X CB Management and X CB Fail relays for
  - 66kV CB A
  - 66kV CB B
  - 66kV CB E

Design Notes:

- Refer to Section 17 Appendix - for proposed Ethernet connectivity.

2.6.11 66kV Y CB Management Cubicle

Install:

- Standard 23" protection cubicle
- Three (3) GE-C60 Y CB Management and Y CB Fail relays for
  - 66kV CB A
  - 66kV CB B
  - 66kV CB E

Design Notes:

- Refer to Section 17 Appendix - for proposed Ethernet connectivity.

2.6.12 66kV No1 Trans X & Y Protection and Y 66kV Bus Protection & Reclose Cubicle

Install:

- Standard 23" protection cubicle
- One (1) SEL-787 relay for No1 Trans X Differential and X REF Protection
- One (1) GE-T60 relay for No1 Trans Y Differential and Y REF Protection
- One (1) SEL-2414 relay for No1 Transformer Mechanical Protection and monitoring
- One (1) GE-B90 relay for No1 66kV Bus Y Protection & Reclose

Design Notes:

- Refer to Section 17 Appendix - for proposed Ethernet connectivity.
- SEL-2440 I/O and SEL-2600 relays should already be in the Zone Substation 66kV/22kV Transformer specification.

2.6.13 66kV No2 Trans Protection Cubicle

Install:

- Standard 23" protection cubicle
- One (1) SEL-787 relay for No2 Trans X Differential and X REF Protection
- One (1) GE-T60 relay for No2 Trans Y Differential Protection

- One (1) SEL-2414 relay for No2 Transformer Mechanical Protection and monitoring
- One (1) GE-B90 relay for No2 66kV Bus Y Protection & Reclose

Design Notes:

- Refer appendix B for proposed Ethernet connectivity to Section 17 Appendix - for proposed Ethernet connectivity.
- SEL-2440 I/O and SEL-2600 relays should already be in the Zone Substation 66kV/22kV Transformer specification.

2.6.14 22kV No1 Bus Protection Cubicle

Install:

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

Design Notes:

- Refer to Section 17 Appendix - for proposed Ethernet connectivity.
- A GE-60 relay for Switchboard Management and Incomer CB Fail should already be in the 22kV Switchboard specification.

2.6.15 22kV No2 Bus Protection Cubicle

Install:

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

Design Notes:

- Refer to Section 17 Appendix - for proposed Ethernet connectivity.
- A GE-60 relay for Switchboard Management and Incomer CB Fail should already be in the 22kV Switchboard specification.

2.6.16 22kV X CB Management & X CB Fail Cubicle

Install:

- Standard 23" protection cubicle
- Four (4) SEL-351S relays for
    - No1 Transformer X CB Management & X CB Fail
    - No1-2 Bus Tie X CB Management & X CB Fail
    - No2 Transformer X CB Management & X CB Fail
    - No2-3 Bus Tie X CB Management & X CB Fail

Design Notes:

- Refer to Section 17 Appendix - for proposed Ethernet connectivity.
- Serial to Fibre converters to be installed for Mirrored Bits communication to switch-room.
- An appropriate number of SEL-2506 I/O relays should already be in the 22kV Switchboard specification.

2.6.17 Station Earth Fault and Neutral Bus Management Cubicle

Install:

- Standard 23” protection cubicle
- One (1) SEL-451 relay for Station Earth Fault Management (SEFM)
- One (1) GE-F35 relay for Neutral Bus Management & X MEF

2.6.18 Backup Earth Fault and Disturbance Fault Recorder Cubicle

Install:

- Standard 23” protection cubicle
- One (1) GE-F35 relay for Backup Earth Fault (BUEF) protection
- One (1) Elspec G5 Black Box for 22kV Disturbance Fault Recorder (DFR)

2.6.19 No1 Bus 22kV Feeder Protection Cubicle

Install:

- Standard 23” protection cubicle
- Two (2) SEL-351S relays for:
  - GHP11 Feeder protection & management
  - GHP12 Feeder protection & management

Design Notes:

- Refer to Section 17 Appendix - for proposed Ethernet connectivity.
- Space to be reserved for future GHP13 & GHP14 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.
- An appropriate number of SEL-2506 I/O relays should already be in the 22kV Switchboard specification.

2.6.20 No2 Bus 22kV Feeder Protection Cubicle

Install:

- Standard 23” protection cubicle
- Three (3) SEL-351S relays for:
  - GHP21 Feeder protection & management
  - GHP22 Feeder Protection & management
  - GHP23 Feeder Protection & management

Design Notes:

- Refer to Section 17 Appendix - for proposed Ethernet connectivity.
- Space to be reserved for future GHP24 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.

- An appropriate number of SEL-2506 I/O relays should already be in the 22kV Switchboard specification.

2.6.21 Capacitor Bank Protection Cubicle

Install:

- Standard 23" protection cubicle
- One (1) SEL-351S relay for No1 Capacitor Bank OC, EF & Management

Design Notes:

- Refer to Section 17 Appendix - for proposed Ethernet connectivity.
- Space to be reserved for future No3 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.
- An appropriate number of SEL-2506 I/O relays should already be in the 22kV Switchboard specification.

2.6.22 IEC61850 Configuration

- IEC61850 Design Integration Spreadsheet
  - Add new relays as per Section 14 Appendix – GHP SDS.
  - Map and Re-configure signals to new relays as per relevant Scheme Documents.
- IEC61850 Architect & GE UR Setup
  - Configure CID files as per Design Integration Spreadsheet.
- IEC61850 GHP Scheme document drawings
  - Produce GHP scheme document drawings to match configured Design Integration Spreadsheet.

2.6.23 GPS Clock

- Establish time synchronisation to new relays.

2.6.24 SCADA works

- Create GHP Single Line Diagram to accommodate new SLD.
- Create Alarm Pages to include new relays.
- New configurations required for SEL RTACs.

2.6.25 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.

2.6.26 DC Distribution

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

2.6.27 AC Station service supplies

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

2.6.28 Building access control system

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

2.6.29 Fire System & Indication

- Install fire system as per current standard.

2.6.30 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.

2.6.31 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.

2.6.32 Operator Desk

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

2.6.33 Station HMI works

- Create SLD and control pages.
- Create IEC61850 status pages.

2.7 Secondary works at GTS

The following outlines the Protection and Control requirements at GHP.

- A protection review shall be carried out, new settings to be applied to all relevant relays and tested into service.
- All protection settings, calculations, setting files, coordination plots are to be attached in RESIS.

2.7.1 66kV CRO (future GHP) Line X & Y Protection

- Update the existing CRO Line X & Y differential protection settings

Design Notes:

- Existing SEL311L to be upgraded to firmware R502 depending on compatibility. Otherwise, replaced with firmware R502.
- 7SD522 parameter set to be confirmed
- A new fibre optic cable is to be installed between the existing GTS terminal station and the new GHP zone substation. Refer section 2.9

2.8 Secondary works at CRO

The following outlines the Protection and Control requirements at GHP.

- Latest version of application manuals are to be confirmed with EN Protection & Control at design commencement.
- Ensure DC battery capacity is appropriate for any new equipment. Calculations to be conducted.

- A protection review shall be carried out, new settings to be applied to all relevant relays and tested into service.
- All protection settings, calculations, setting files, coordination plots are to be attached in RESIS.
- A site visit with the RO and a tester is required to determine possible panel location for the new relays prior to DDS development.

2.8.1 66kV GTS (future GHP) Line X & Y Protection

- Update the existing GTS Line X & Y differential protection settings

Design Notes:

- Existing SEL311L to be upgraded to firmware R502 depending on compatibility. Otherwise, replaced with firmware R502.
- 7SD522 parameter set to be confirmed

A new fibre optic cable is to be installed between the existing CRO zone substation and the new GHP zone substation Note that new overhead fibre optic cables are to be designed so that a subsidiary 22kV circuit can be installed on the 66kV pole line, if there is not one already.

2.9 Fibre works at GHP, CRO & GTS

Proposed fibre build between GHP & GTS and GHP and CRO following new 66KV pole route to support Current differential protection schemes. This fibre builds will create a fibre ring GHP-GTS-SRC-FNS-CRO- GHP to support Diverse X&Y prot fibre paths.

Figure 3 Fibre arrangement for GHP

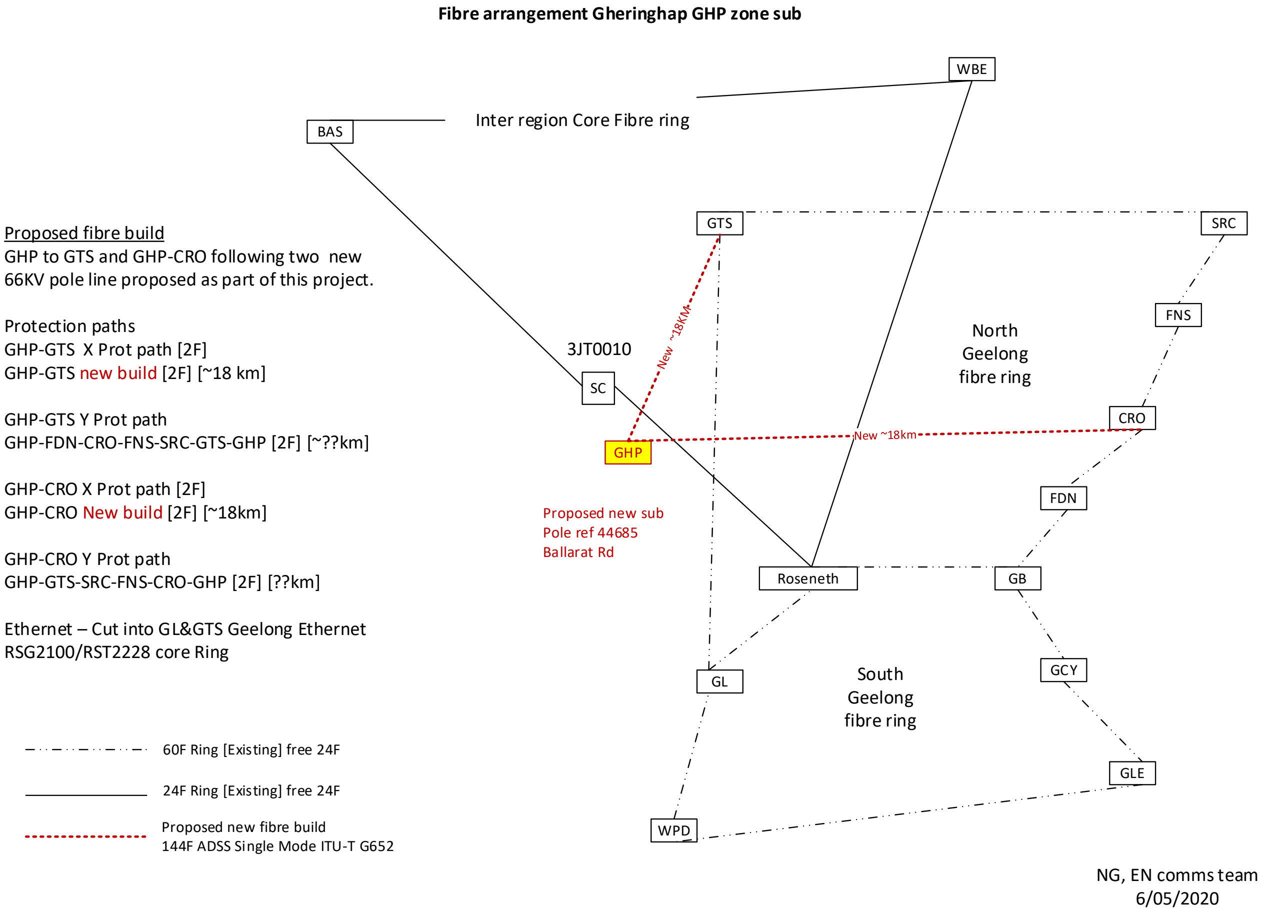
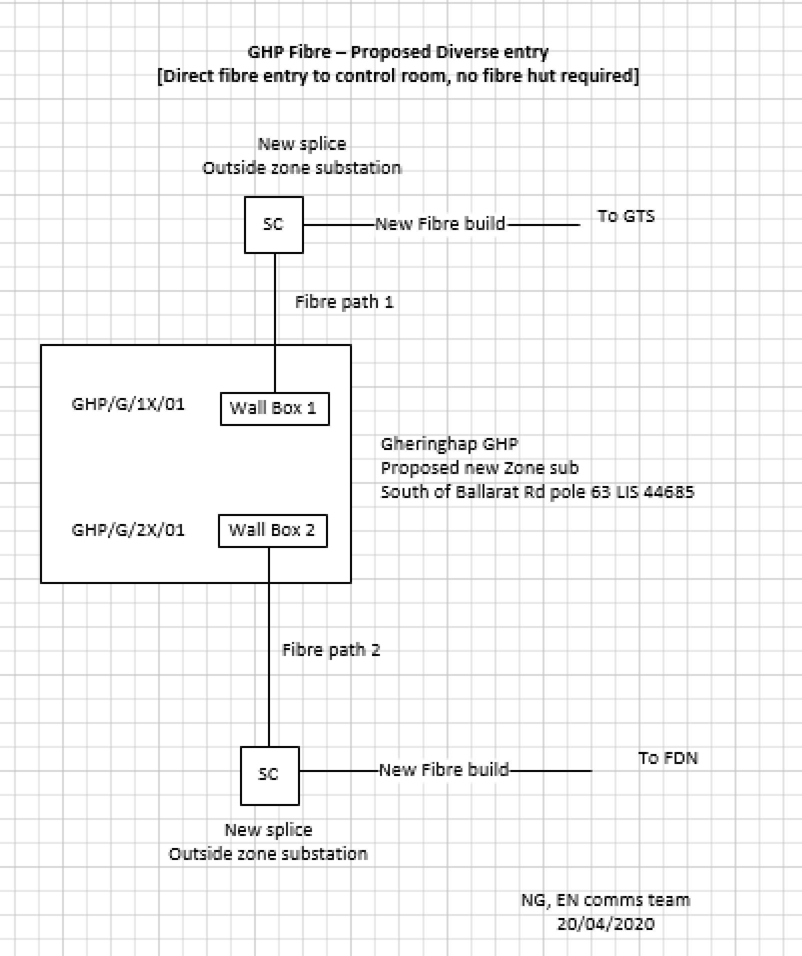


Figure 4 Fibre connectivity around GHP zone sub



Diverse fibre entry at GHP

3 LV line requirements

Not applicable.

4 66kV sub-transmission requirements

4.1 GTS terminal station site requirements (AusNet works)

- Upgrade the exit rating of the GTS-FDN line from 900A to minimum 1185A
- Changes to labelling, as required, at the GTS line exits for the new GTS-GHP 66kV circuits;
- Revision of SCADA mapping tables, if required;
- Review and update the 66kV line protection and control settings;
- Update all primary equipment labelling and update of design drawings

4.2 GHP zone substation site requirements

Two new 66kV Sub-Transmission Lines (GTS-GHP and GHP-CRO) are required to be built to connect GHP zone substation to the existing GTS terminal substation and CRO zone substation. This will form a new 66kV loop between the existing GTS terminal station, new GHP zone substation, CRO zone substation and the FDN zone substation. In the event of the loss of one of the 66kV lines, the other 66kV lines will be able to supply the entire GHP, CRO and FDN station load. There is also enough capability to transfer part of the load from GHP station with the 22kV ties to GL zone substation; this eliminates the load at risk under this contingency.

Possible routes for the two 66kV lines from GHP zone substation will require design input.

4.2.1 GTS-GHP works

The following works are required to establish the GTS-GHP line:

- Install new 3-37/3.75 AAC overhead conductor (100°C/+75°C design temperature) from GHP zone substation to the existing GTS-CRO 66kV line pole No.7 (GIS 17035846) (approx. 11.4km).
- If underground cable is required 3 x 1c 1600mm Al 66kV cable should be used.
- The minimum line rating should not be less than 1185A.

All new sections of overhead 66kV sub-transmission construction are to be designed to accommodate a new optical fibre (Refer to section 2.9 Fibre works).

4.2.2 GHP-CRO works

The following works are required to establish the GHP-CRO line:

- Install new 3-37/3.75 AAC overhead conductor (100°C/+75°C design temperature) from GHP zone substation to the existing GTS-CRO 66kV line pole No.13 (GIS 17035822) (approx. 17.6km). Remove the existing 66kV overhead conductor between pole No.7 and pole No.13.
- If underground cable is required 3 x 1c 1600mm Al 66kV cable should be used.
- The minimum line rating should not be less than 1185A.

All new sections of overhead 66kV sub-transmission construction are to be designed to accommodate a new optical fibre (Refer to section 2.9 Fibre works).

4.3 FDN zone substation site requirements

Uprate the existing GTS-FDN line exit at FDN zone substation from 960A to minimum 1185A

5 22 kV distribution feeder requirements

5.1 REFCL 22 kV distribution feeder requirements

5.2 HV feeder rearrangements

Five (5) new feeders are to be initially established from the new GHP zone substation, GHP011, GHP012, GHP021 GHP022 and GHP023. Works will also occur on existing CRO and GL 22kV feeders as follows:

5.2.1 New GHP011 works

New GHP011 feeder to supply the north part of the GHP network, taking over sections of GL012 and GL015 feeders, works as follows:

- From the new GHP011 circuit breaker in the new GHP 22kV switch room extend new 300mm^2 3/c 22.c.epr.hc.v. HV underground cable in a 150mm Ø conduit to a new switched cable head (Tech Standard GE106) and tie in at pole 73 Ballarat Rd (LIS 44561). Note: depending on how far the ZSS exit is please use new 3-19/3.25 AAC (65°C/+30°C design temperature) overhead line or 240mm2 Al 3/c HV 22kV cable to connect the feeder exit cable to pole 73 Ballarat Rd (LIS 44561).
- Create new open point between new GHP011 feeder and new GHP022 feeder by opening the existing Ballarat Rd P72 Ballarat Switch (SW 12370).
- Create new open point between new GHP011 feeder and new GHP012 feeder by opening the existing Moreillion-Shekkleton Kiosk Switch (SW 35196).
- Create new open point between new GHP011 feeder and new GHP012 feeder by opening the existing Shelford Bannockburn Rd P13 Gas Switch (SW 27522).
- Close existing normally opened switch between new GHP011 feeder and new GHP012 feeder Kelly Rd P2A Gas Switch (SW 70174).

5.2.2 New GHP012 works

New GHP012 feeder to supply Bannockburn and he west part of the GHP network, taking over sections of GL012 feeders, works as follows:

- Install new 19/3.25 AAC (65°C/+30°C design temperature) overhead line along Midland Hwy to pick up Ryan Rd Spur from Pole 64 Ballarat Rd (LIS 44686). Then continue to install the new 19/3.25 AAC (65°C/+30°C design temperature) overhead line for approximately 4km along Fyansford-Gheringhap Rd to pick up the Johns Stonehaven Spur from Pole 9 Johns Stonehaven Spur (LIS 15758).
- Augment approximately 2km of existing 3/12 ST from Pole 9 Johns Stonehaven Spur (LIS 15758) to Pole 62 Hamilton Hwy (LIS 15948) with new 19/3.25 AAC (65°C/+30°C design temperature) overhead line.
- From the new GHP012 circuit breaker in the new GHP 22kV switch room extend new 300mm^2 3/c 22.c.epr.hc.v. HV underground cable in a 150mm Ø conduit to a new switched cable head (Tech Standard GE106) and tie into the new overhead line along Midland Hwy. Note: depending on how far the ZSS exit is please use new 3-19/3.25 AAC (65°C/+30°C design temperature) overhead line or 240mm2 Al 3/c HV 22kV cable to connect the feeder exit cable to the new overhead line along Midland Hwy.
- Create new open point between new GHP012 feeder and new GHP023 feeder by opening the existing Hamilton Hwy P79 ACR (SW 45168).
- Create new open point between new GHP012 feeder and new GHP011 feeder by opening the existing Moreillion-Shekkleton Kiosk Switch (SW 35196).
- Create new open point between new GHP012 feeder and new GHP011 feeder by opening the existing Shelford Bannockburn Rd P13 Gas Switch (SW 27522).

5.2.3 New GHP021 works

New GHP021 feeder to supply the eastern part of the GHP network, taking over sections of CRO022 and GL015, works as follows:

- From the new GHP021 circuit breaker in the new GHP 22kV switch room extend new 300mm^2 3/c 22.c.epr.hc.v. HV underground cable in a 150mm Ø conduit to a new switched cable head (Tech Standard GE106) and tie in at any pole between Pole 70A Ballarat Rd (LIS 783525) and Pole 60 Ballarat Rd (LIS 44682). Note: depending on how far the ZSS exit is please use new 3-19/3.25 AAC (65°C/+30°C design temperature) overhead line or 240mm2 Al 3/c HV 22kV cable to connect the feeder exit cable to any pole between Pole 70A Ballarat Rd (LIS 783525) and Pole 60 Ballarat Rd (LIS 44682).
- Install new ACR on pole 58 Ernest St (LIS 46499) to be used as a new open point between GHP021 and GL015.
- Replace existing HV fuses (SW 69794) on Pole 1 Coates G/hap Spur (LIS 847424) with a new 630A RC Gas to be used as a new open point between new GHP021 feeders and new GHP023 feeder.
- Close existing Gas Switch (SW 38712) to become normally closed.
- Create new open point between new GHP021 feeder and CRO022 feeder by opening the existing Reserve Rd P4 ACR (SW 17607).
- Create new open point between new GHP021 feeder and new GHP022 feeder by opening the existing Midland Hwy P70A ACR (SW 56751).

5.2.4 New GHP022 works

New GHP022 feeder to supply the north east part of the GHP network, taking over sections of GL015 and CRO013, works as follows:

- From the new GHP022 circuit breaker in the new GHP 22kV switch room extend new 300mm^2 3/c 22.c.epr.hc.v. HV underground cable in a 150mm Ø conduit to a new switched cable head (Tech Standard GE106) and tie in at any pole between Pole 70A Ballarat Rd (LIS 783525) and Pole 72 Ballarat Rd (LIS 44560). Note: depending on how far the ZSS exit is please use new 3-19/3.25 AAC (65°C/+30°C design temperature) overhead line or 240mm2 Al 3/c HV 22kV cable to connect the feeder exit cable to any pole between Pole 70A Ballarat Rd (LIS 783525) and Pole 72 Ballarat Rd (LIS 44560).
- Retire existing HV Fuses (SW 16901) on Pole 71 Ballarat Rd (LIS 59813).
- Install new HV Fuses (type and size TBD) on Pole 1A Bakers Bridge Rd.
- Augment approximately 6km of existing 3/2.75 ST from 71 Ballarat Rd (LIS 59813) to Pole 26 Bakers Bridge Rd (LIS 45633) with new 3-19/3.25 AAC (65°C/+30°C design temperature) overhead line.
- Install approximately 1.7km of new HV from Pole 26 Bakers Bridge Rd (LIS 45633) to Pole 20 Robbs Rd (LIS 50923) with new 3-19/3.25 AAC (65°C/+30°C design temperature) overhead line.
- Augment approximately 5km of existing 3/12 ST from Pole 20 Robbs Rd (LIS 50923) to Pole 98E Anakie Rd (LIS 51181) with new 3-19/3.25 AAC (65°C/+30°C design temperature) overhead line.
- Retire existing HV Fuses (SW 24400) on Pole 98 Anakie Rd (LIS 50920).
- Install new RC HV Gas Switch on Pole 1 Robbs Rd (LIS 731581). Switch to be normally closed.
- Create new open point between new GHP022 feeder and new GHP021 feeder by opening the existing Midland Hwy P70A ACR (SW 56751).
- Create new open point between new GHP022 feeder and new GHP011 feeder by opening the existing Ballarat Rd P72 Ballarat Switch (SW 12370).

5.2.5 New GHP023 works

New GHP023 feeder to supply the north east part of the GHP network, taking over sections of GL012 and GL015, works as follows:

- From the new GHP023 circuit breaker in the new GHP 22kV switch room extend new 300mm^2 3/c 22.c.epr.hc.v. HV underground cable in a 150mm Ø conduit to a new switched cable head (Tech Standard GE106) and tie in at Pole 2 Coast G/hap Spur (LIS 984594). Note: depending on how far the ZSS exit is please use new 3-19/3.25 AAC (65°C/+30°C design temperature) overhead line or 240mm2 Al 3/c HV 22kV cable to connect the feeder exit cable to Pole 2 Coast G/hap Spur (LIS 984594).
- Augment approximately 3km of existing 3/12 ST from Pole 1 Coast G/hap Spur (LIS 847424) to Pole 11 Coast G/hap Spur (LIS 45912) with new 3-19/3.25 AAC (65°C/+30°C design temperature) overhead line.
- Install approximately 700m of new HV from Pole 11 Coast G/hap Spur (LIS 45912) to Pole 3 Old Ballarat Rd (LIS 4379) with new 3-19/3.25 AAC (65°C/+30°C design temperature) overhead line.
- Augment approximately 700m of existing 3/12 ST from Pole 3 Old Ballarat Rd (LIS 4379) to Pole 10 Johns Stonehaven Spur (LIS 974389) with new 3-19/3.25 AAC (65°C/+30°C design temperature) overhead line.
- Augment approximately 30m of existing 3/12 ST from Pole 10 Johns Stonehaven Spur (LIS 974389) to a new Single Phase Fused (Fusing Size and Type TBD) pole before Pole 11 Johns Stonehaven Spur (LIS 15764) with new 3-19/3.25 AAC (50°C/+25°C design temperature) overhead line.
- Install approximately 4km of new HV from Pole 10 Johns Stonehaven Spur (LIS 974389) to Pole 65 Hamilton Hwy (LIS 4959) with new 3-19/3.25 AAC (65°C/+30°C design temperature) overhead line.
- Install approximately 1km of new HV from Pole 25 Hamilton Hwy (LIS 46280) to Pole 27B Queens Park Rd (LIS 24528) with new 3-19/3.25 AAC (65°C/+30°C design temperature) overhead line. Note please consider using the existing GTS-WPD and GTS-GLE2 66kV pole line.
- Install one new 6MVA Isolation Transformer between Pole 7 Highett Rd (LIS 24709) and Old Flour Mill Rivergum Kiosk. Note that the REFCL team will need to coordinate an ESV exemption.
- Create new open point between new GHP023 feeder and new GHP012 feeder by opening the existing Hamilton Hwy P79 ACR (SW 45168).
- Close existing Beacon-Salisbury Kiosk Switch (SW 50188) to become normally closed.
- Create new open point between new GHP023 feeder and existing GL012 feeder by opening the existing Aberdeen St P22 Switch (SW 11957).
- Create new open point between new GHP023 feeder and existing GL021 feeder by opening the existing Noble St P17 AS (SW 46674).

5.2.6 GHP feeder exit spare conduits

- Install eight (8) 150mm Ø spare conduits from the GHP 22kV switch room, towards Midland Highway for future GHP 22kV feeders.

5.2.7 New GHP feeder arrangements

The Network Solutions group will confirm switching for the new GHP 22kV feeders closer to the construction period.

5.2.8 HV fuse changes

A number of HV fuses will be required to be changed due to the increased fault level in the vicinity of the new GHP zone substation. EDO HV fuses will need to be replaced with new Fault Tamer fuse types for sizes up to 20A and new Boric Acid types for fuses over 20A. Figure 5 shows the area impacted where EDO fuses will need to replaced.

High level estimate is that there will be approximately 500 fuse replacements at 200 sites. Exact number TBC.

5.2.9 Surge diverters and insulation limitation

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 approximately 3,409 surge diverters across the 22kV three phase and single phase system. This is made up of 2,781 three phase surge diverters and 628 single phase surge diverters.

This covers all feeders ex GHP ZSS as well as surge arrestors on the CRO013, CRO022, FNS011, GL012, GL014, GL015 and GL021 transfers.

The replacement diverters should be of 22kV continuous rating with a 10 hour 24kV TOV rating such as the ABB POLIM D 22kV arresters.

CitiPower and Powercor previous standard surge diverters were the ABB MWK 20 and POLIM D 20 arresters.

These, and all previous types except Bowthorpe 'Type A' arresters do not meet the overvoltage requirement needed for use with a GFN and therefore the higher rated arresters are required.

These surge diverters will be a new standard, applicable to distribution systems with a GFN installed.

5.2.10 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).

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

At this time, experience from network resilience (voltage stress) testing does not support a proactive replacement of any distribution transformers.

5.2.11 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, a similar displacement to the neutral voltage occurs, as per the open-delta mode.

All regulator works shall be compliant with current CitiPower and Powercor standards for 22kV regulators.

The GHP distribution network will contain seven (7) 22kV regulating systems:

Table 1 GHP regulating systems

Feeder	Name	Manufacturer	Phasing	Scope of works
GHP011	ROBERTSONS RD P6 REG	Cooper – 2 x 100A pole mounted	BR	Requires new 3 x 100A reg and CL7 control box.

Feeder	Name	Manufacturer	Phasing	Scope of works
GHP011	BALLARAT RD P219 REG	Cooper - 2 x 200A pole mounted	RW	Requires new 3 x 200A reg and CL7 control box.
GHP011	MOORABOOL VALLEY REG	Wilson – 5MVA ground mounted	RWB	Nil
GHP022	ANAKIE P155 REG	Cooper – 2 x 100A pole mounted	RW	Requires new 3 x 100A reg and CL7 control box.
GHP012	SHELFORD B/BURN RD P24 REG	Cooper – 2 x 100A pole mounted	RW	Requires new 3 x 100A reg and CL7 control box.
GHP012	SHELFORD P98 REG	Cooper - 1 x 50A pole mounted	RWB	Nil
GHP012	HAMILTON HWY P142 REG	Cooper - 1 x 300A ground mounted	RWB	Nil

Table 2 Regulator works

HV regulators	Volume (sites)
Regulator sites	7
Regulator replacement	4
Control box (only) upgrade	0

5.2.12 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 the future GHP 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 coarser 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 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.
7. Update GIS with this phase information.

The data will be assessed and an action plan for a "coarse balance" will be developed as part of the separate detailed balancing design scope. The coarse 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 3 Balancing requirements summary

Balancing concept	EstimatedNumber of sites (GHP Feeders ONLY)	EstimatedNumber of sites (Transfers ONLY)	EstimatedNumber of sites (Combined)
Re-phasing Sites	66	7	73
Single Phase Balancing Units	11	0	11
3 Phase Balancing Units	20	9	29
RC Gas Switches	4	0	1
ACRs	1	0	1

5.2.13 Automatic Circuit Reclosers (ACRs) and remotely controlled gas switches

Each RVE or VWVE ACR on the GHP network should be replaced with the current standard Schneider N27 ACR which has inbuilt voltage measurement.

Table 4 ACR sites

Feeder	Name	Operating voltage	Phase code	Control Box	ACR model

Feeder	Name	Operating voltage	Phase code	Control Box	ACR model
CRO022	THOMPSON RD P62 ACR	22kV	RWB	CAPM5	N24
FNS011	BACCHUS MARSH RD P50 ACR	22kV	RWB	ADVC	N24
GL021	SHANNON AVE P54 ACR	22kV	RWB	CAPM5	N24
	LETHBRIDGE P179 ACR	22kV	RWB	ADVC	VWVE27
	MIDLAND HWY LETHB P226 ACR	22kV	RWB	ADVC	N27
	ANAKIE RD P47 ACR	22kV	RWB	ADVC	RVE
	PALEY-GOLDSWORTHY P1 ACR	22kV	RWB	ADVC	N24
	BANNOCKBURN P25 ACR	22kV	RWB	ADVC	VWVE27
	LEVY-BURNSIDE P70 ACR	22kV	RWB	ADVC	N24
	MIDLAND HWY P70A ACR	22kV	RWB	ADVC	N24
	RESERVE RD P4 ACR	22kV	RWB	CAPM5	N24
	COX-ANAKIE P7 ACR	22kV	RWB	ADVC	N24
	MERRAWARP RD P2 ACR	22kV	RWB	CAPM5	N24
	HAMILTON HWY P79 ACR	22kV	RWB	CAPM5	N24
	LEVY-BURNSIDE P70 ACR	22kV	RWB	ADVC	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 5 Control box replacements

Name	Control box model
THOMPSON RD P62 ACR	CAPM5
SHANNON AVE P54 ACR	CAPM5

Name	Control box model
RESERVE RD P4 ACR	CAPM5
MERRAWARP RD P2 ACR	CAPM5
HAMILTON HWY P79 ACR	CAPM5

Table 6 ACR and control box requirements summary

Units	Number of sites
ACR replacements	3
Control box replacements	5

5.2.14 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. Detailed requirements will be provided in a separate scope along with the admittance balancing requirements following completion of the field audit.

Table 7 Fusesaver requirements

Units	Number of sites
Fusesavers	34

5.2.15 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 8 Switchgear replacements

Unit	Volume

Unit	Volume
Distribution switchgear	11

5.2.16 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 9 HV underground cable requirements

Location	Length (m)
Cable failure length	1,957

5.2.17 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 10 HV customer

Units	Volume
HV customer sites with generation	0
HV customer sites without generation	0
Total HV customer sites	0

6 Other work external to the zone substation

All works at GHP zone substations as well as works external of the zone substations to establish GHP have been included in this scope in Sections 3, 4 and 5.

7 Environmental considerations

Preliminary Environmental Impact Assessment (EIA) to be completed at least a year before GHP scheduled construction.

Flora & Fauna as well as Cultural Heritage issues to be identified and all permits obtained.

Identify all requirements regarding the following:

- Effect of work location (Rural, CBD, Urban, Residential etc.),
- Visual, noise, EMF considerations.
- Access, traffic, pedestrians, obstructions and working hours.
- Pollutants, dust, debris and water run-off, oil containment.
- Contaminated soil area. Soil testing and management required.
- Standard work practices to apply regarding traffic, noise, pollutants, dust, debris and water run off.
- Trees, roots & pruning.

All works and installations are to comply with current EPA requirements.

8 Liaison and coordination of works

The PCS PM will provide the Responsible Officer with a work plan outlining the key steps and associated target dates needed to achieve the overall project completion target date. This will be used as an aid in determining how the project is progressing.

The PCS PM will submit a detailed commissioning plan, (addressing both sub-transmission and distribution issues as appropriate) to the Responsible Officer for discussion and identification of any system operational problems at least 5 weeks prior to commissioning. The PCS PM will be responsible for obtaining acceptance of the commissioning plan from Powercor's Operations Group (as appropriate).

If a major project (greater than $300,000), the PCS PM and RO will communicate on a fortnightly basis with a minimum reporting on:

- Work done – survey, design, drafting, construction, and closeout.
- Forecast target dates.
- Materials ordering & delivery progress
- Current project expenditure to-date vs. budget, and forecast cost to complete.

The PCS PM will submit a project Quality Plan to the Responsible Officer for approval.

<u>Construction:</u>

- At least one week before construction starts the PCS PM will submit to the Responsible Officer:
- A project specific Health and Safety Plan satisfying guidelines set out in Powercor document 08-F161 Guidelines for Review of H&S Plans.

- Plan drawings showing the locations of all new or modified structures, span lengths, angular changes in route, pole types, structure types, locations of stays, conductors, isolators, fuses, transformers, switches and any other equipment relevant to the work;
- General arrangement or erection drawings for each structure type used in the design, details of material components, locations of all components, major dimensions, electrical clearances, etc.

Commissioning:

- Plans provided will include a detailed Commissioning Plan, Contingency Plans, Pre-Commissioning Meeting Agendas, H & S plans, Inspections and Test Plans.

Close-out:

- As part of the "Close Out" process the Project Manager is to provide hard copy drawings and any ZSS Test & Inspection Reports to the Network RO.

Note: Final drawings to be submitted in A3 folder format to Powercor Network. Drawings shall include as a minimum as described in Section "9"

Any possible variations shall be processed in accordance with the "Powercor Network Engineering Project Variation Guidelines."

9 Known issues specific to this location or project

Would depend on where the land is purchased. That said, liaison may be required, as construction works might impact customers.

10 Health and safety concerns

Appropriate access permits and clearances shall be maintained throughout the works.

Appropriate traffic management shall be carried out where necessary.

All health & safety precautions are to be taken.

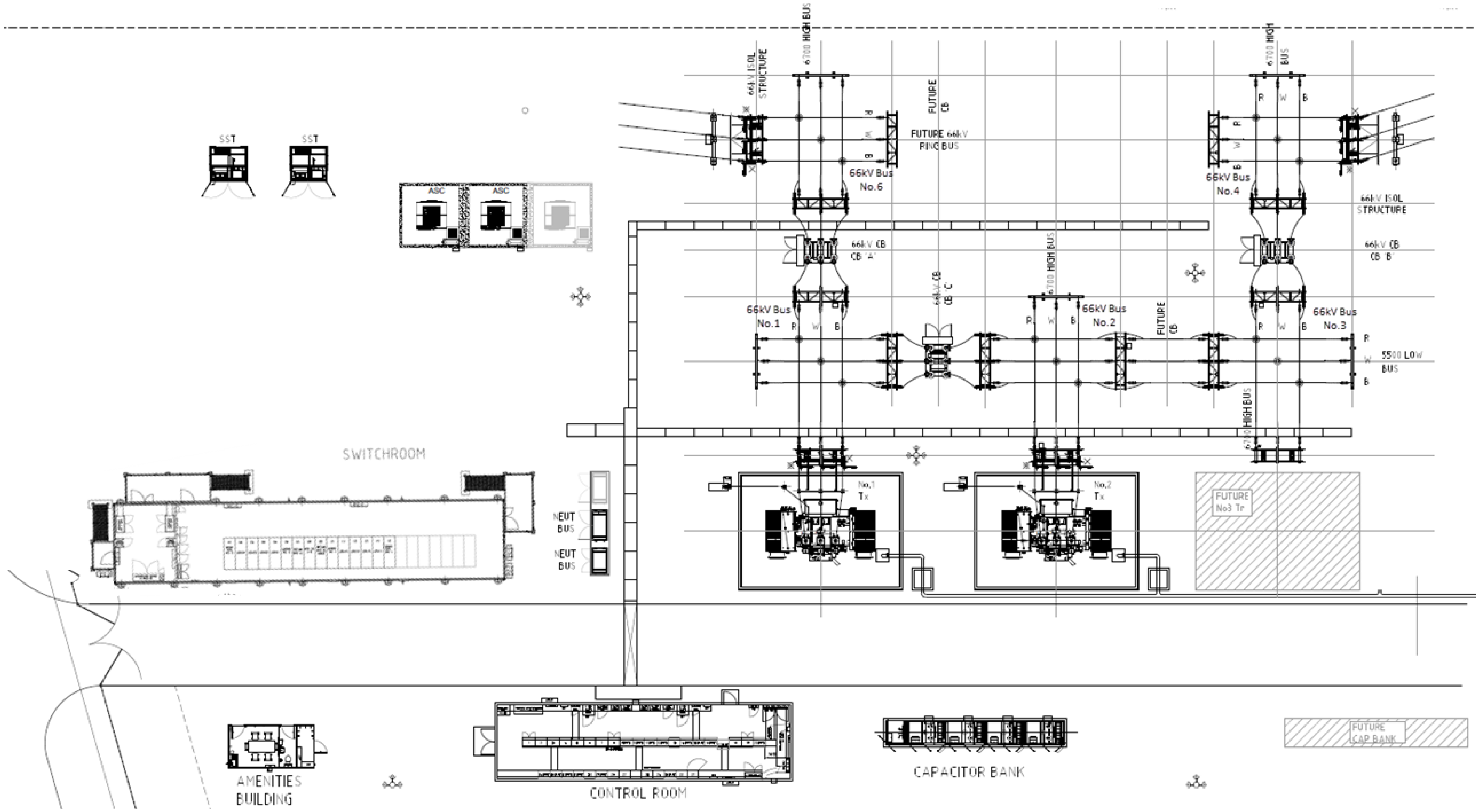
Retirement village residents entering the site.

11 Test and commissioning plans

Network Services to prepare Test and Commissioning Plans:

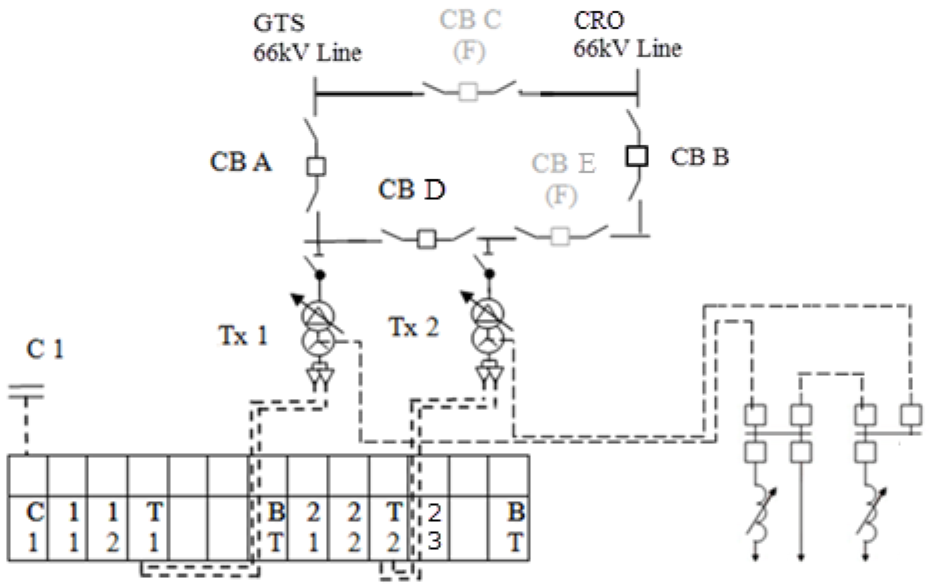
- Inspection and Test Plans
- Contingency Plans
- Pre-Commissioning Meeting Agendas
- Commissioning Plan
- Any other drawings or plans required by the business

12 APPENDIX - Proposed GHP Site General Arrangement



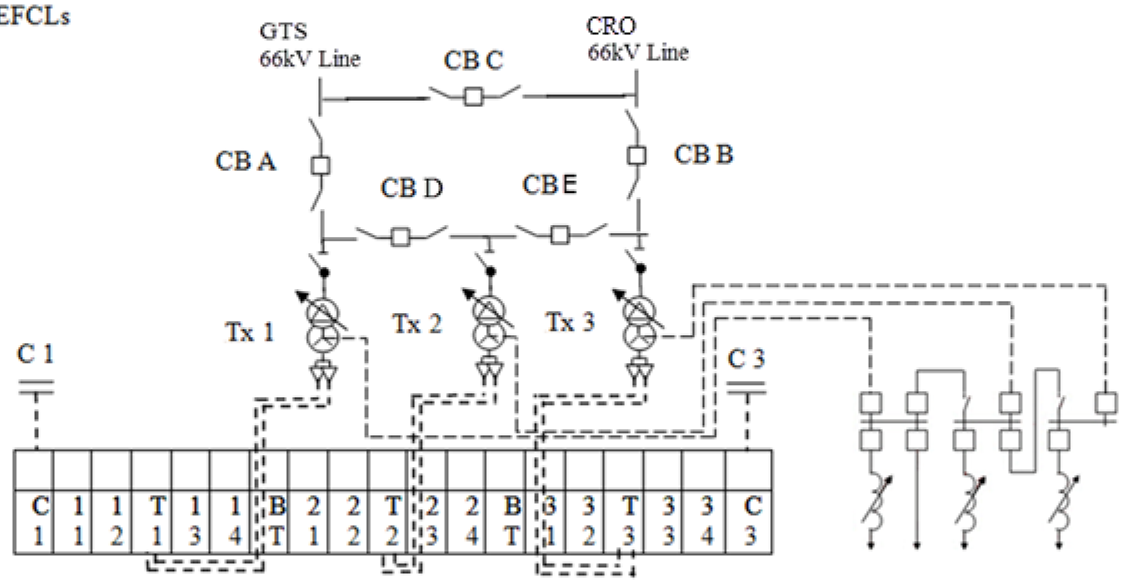
13 APPENDIX - GHP System Design Sheets

Proposed - 2022 REFCL
2 - 25MVA TXs
2 - 66kV lines
3 - 66kV CBs
5 - 22kV feeders
1 - 2 x 3MVA cap bank
2 - REFCL



Possible - Ultimate

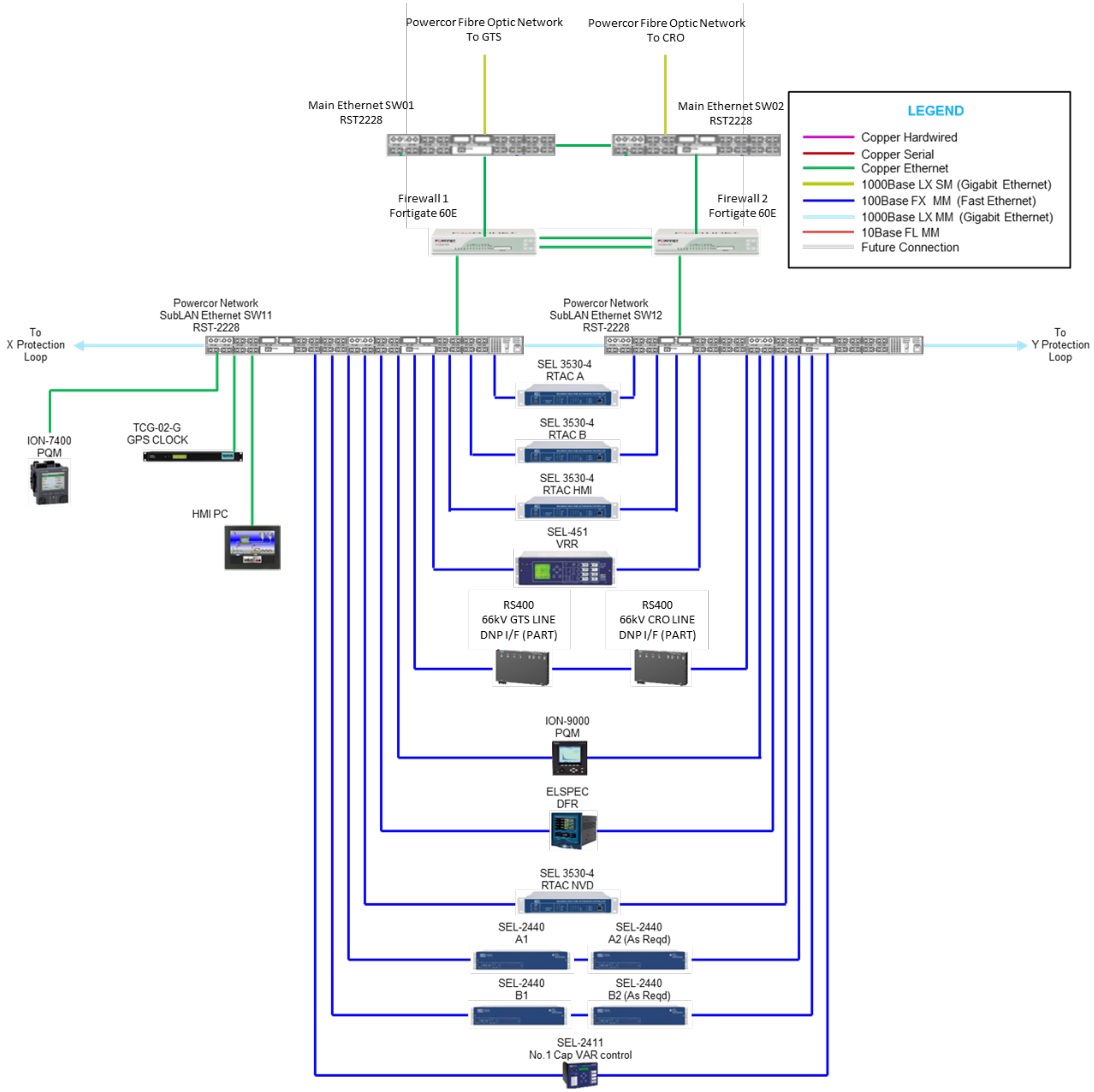
- 3 – 25/33 MVA Transformers
- 2 – 66kV lines
- 5 – 66kV CBs
- 12 – 22kV feeders (3 * Bus Indoor Switchboard)
- 2 – Capacitor banks
- 3 – REFCLs



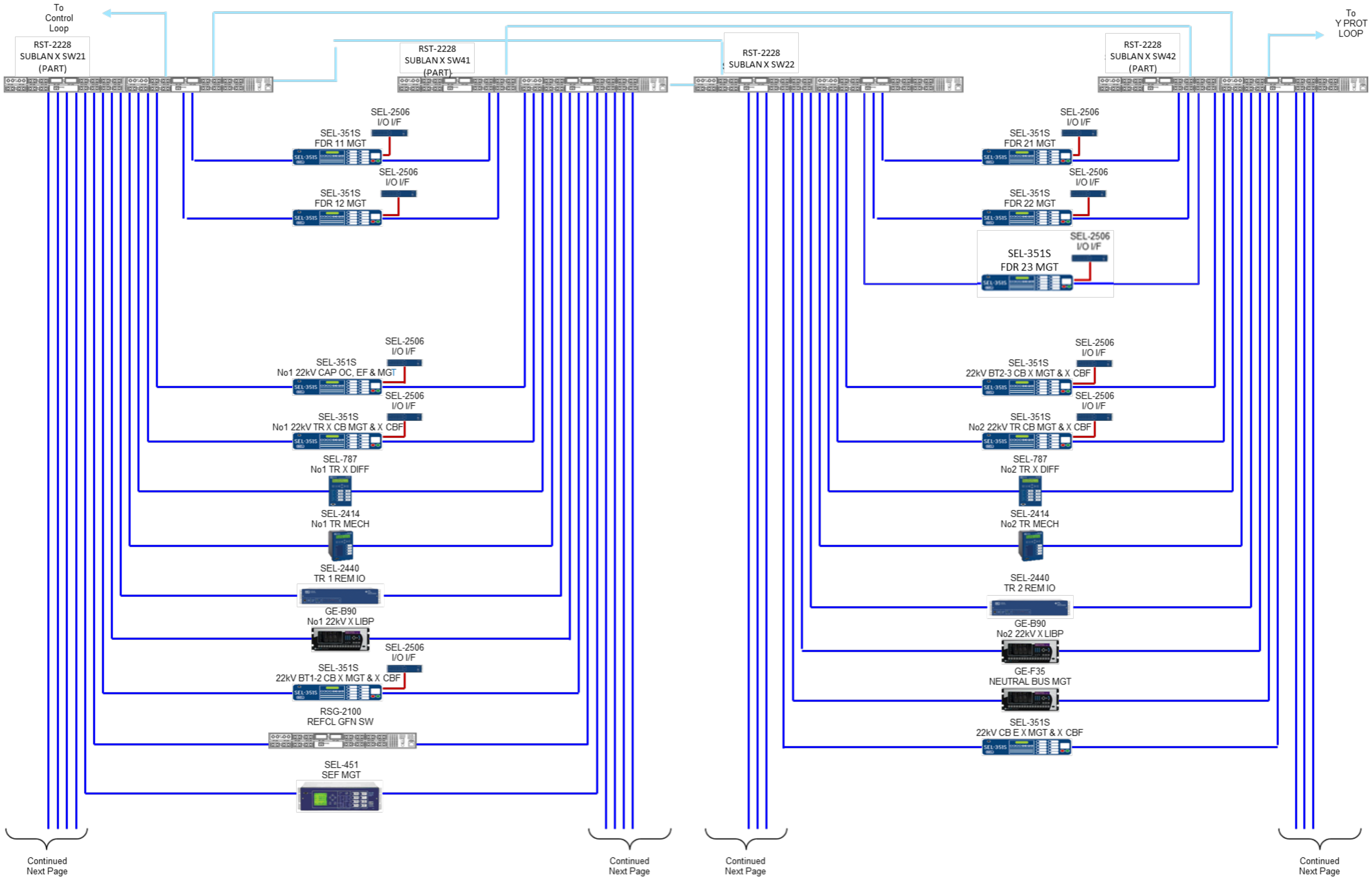
14 APPENDIX – Proposed Control Room Arrangement at GHP

CUB 1	CUB 2	CUB 3	CUB 4	CUB 5	CUB 6	CUB 7	CUB 8	CUB 9	CUB 10	CUB 11	CUB 12	CUB 13	CUB 14	CUB 15	CUB 16	CUB 17	CUB 18
WAN & CONTROL LOOP COMMS	COMMS X & Y A LOOP	RTAC A & B GPS, RTAC NVD STATION I/O	REFCL PC & HMI	REFCL PC & HMI	HMI RTAC, PC INVERTER, ALARMS	PQMs VRR CAP CONTROL	66kV GTS LINE X & Y PROT	66kV CRO LINE X & Y PROT	FUTURE	FUTURE	CB A, B, E X CB MGMT & CB FAIL	CB A, B, E Y CB MGMT & CB FAIL	FUTURE	FUTURE	TRANS No1 & 66kV No1 Bus X & Y PROT	TRANS No2 & 66kV No2 Bus X & Y PROT	TRANS No3 & 66kV No3 Bus X & Y PROT
CUB 36	CUB 35	CUB 34	CUB 33	CUB 32	CUB 31	CUB 30	CUB 29	CUB 28	CUB 27	CUB 26	CUB 25	CUB 24	CUB 23	CUB 22	CUB 21	CUB 20	CUB 19
FUTURE	FUTURE	FUTURE	FUTURE	FUTURE	FUTURE	No1 CAP PROT No3 CAP PROT	GHP31, GHP32, GHP33, GHP34 FDR MGMT	GHP21, GHP22, GHP23, GHP24 FDR MGMT	GHP11, GHP12, GHP13, GHP14 FDR MGMT	BUEF & Y MEF ELSPEC DFR	SEF MGMT NEUT BUS MGMT & X MEF	BT 1-2, 2-3 X CB MGMT & X CB FAIL PROT	TR No1, No2, No3 X CB MGMT & X	22kV No3 BUS X & Y PROT	22kV No2 BUS X & Y PROT	22kV No1 BUS X & Y PROT	COMMS X & Y B LOOP

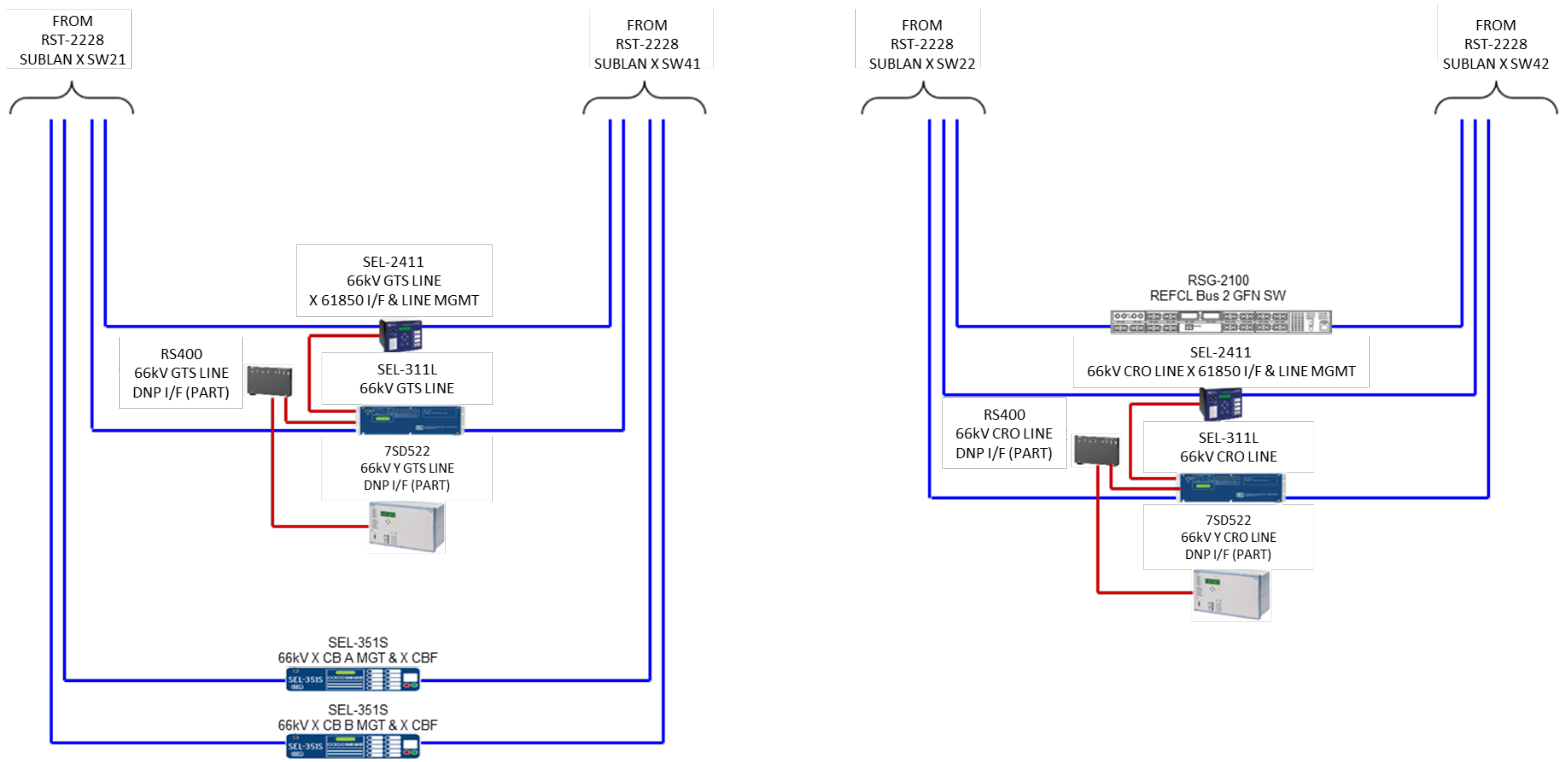
15 APPENDIX – Proposed Ethernet Connectivity – Uplink & SubLAN Control Loop at GHP



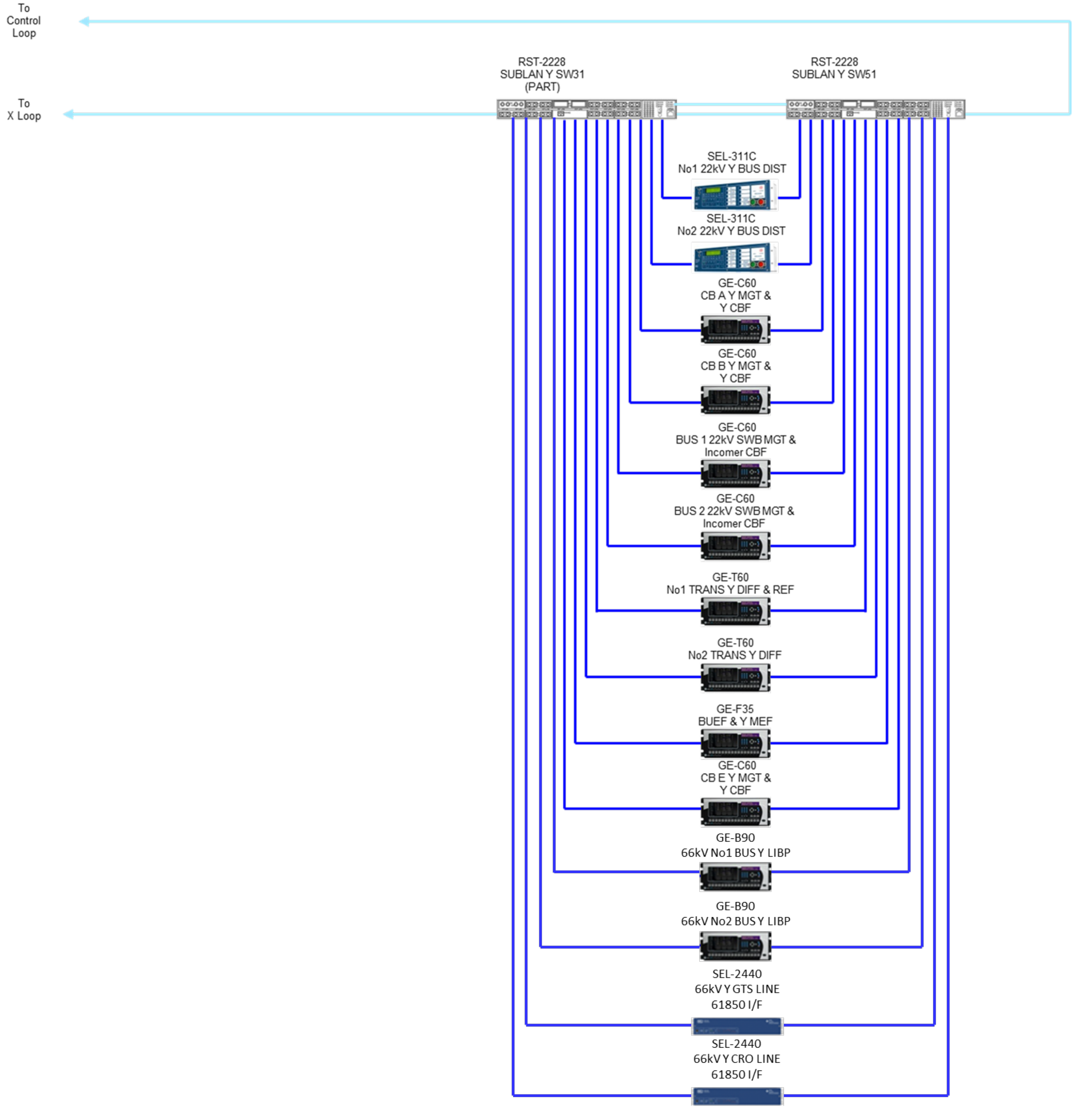
16 APPENDIX – Proposed Ethernet Connectivity – SubLAN X Protection Loop at GHP



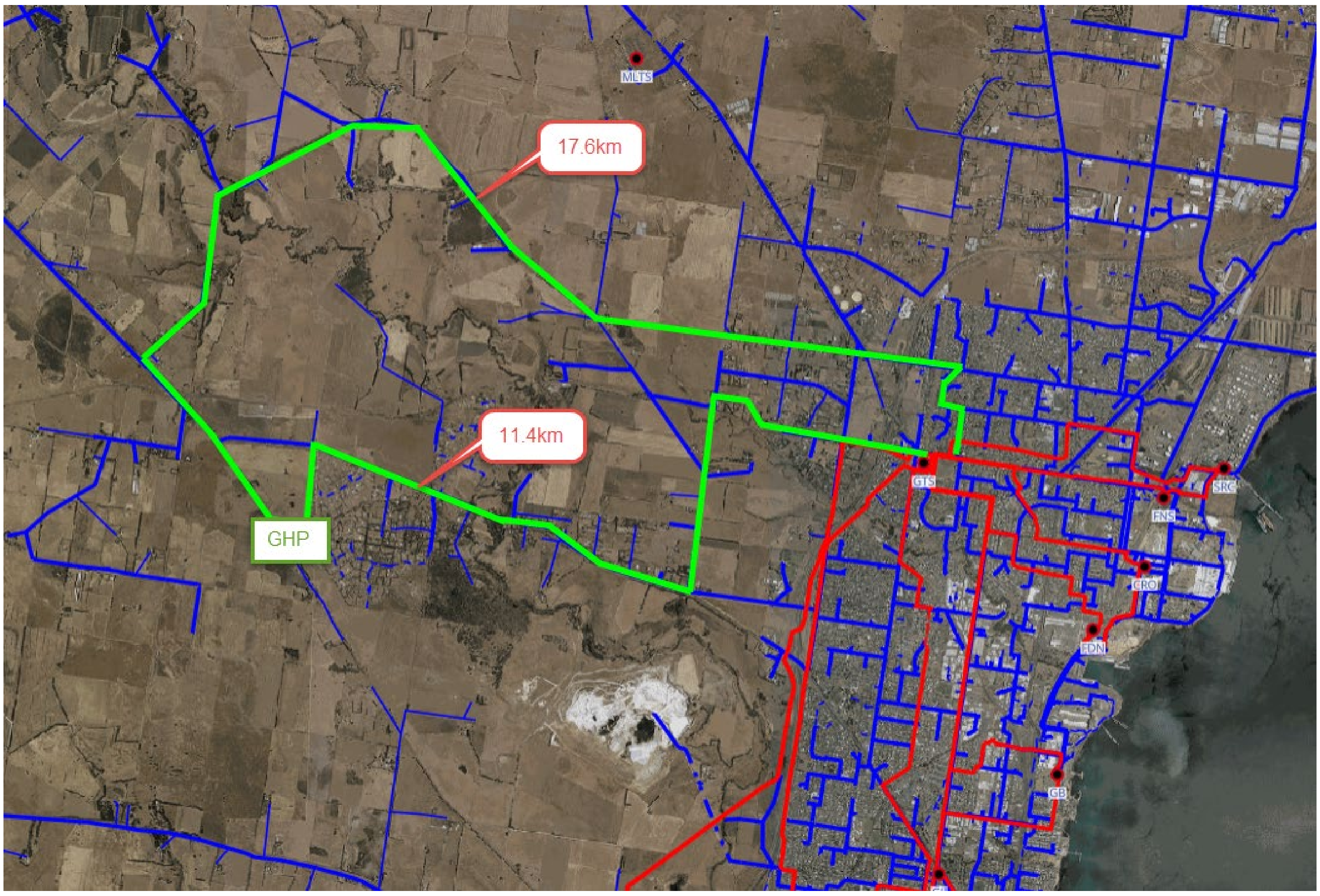
17 APPENDIX – Proposed Ethernet Connectivity – SubLAN X Protection Loop at GHP (continued)



18 APPENDIX – Proposed Ethernet Connectivity – SubLAN Y Protection Loop at GHP



19 APPENDIX – Proposed 66kV line for GHP



20 APPENDIX – Proposed GHP feeder layout

20.1.1 GHP feeder layout