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Auckland City Rail Link

In association with:

MOTT MACDONALD

Jasmax

ARUP

CONSTRUCTION CONTRACT 1
BRITOMART STATION
Electrical, Communications, Security & CCTV Specification

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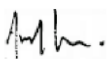
Author signature		Approver signature	
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Title	Electrical Engineer	Title	C1 Package Manager

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1 Preliminaries

1.1 GENERALLY

This part of the specification shall be read in conjunction with the general conditions of contract, preliminary clauses and technical clauses included in the main specification.

The Contractor when entering into the conditions of this contract shall be fully aware and in acceptance of the full responsibility for the planning design development, coordination, workshop documentation, supply, installation, testing, commissioning, quality assurance, certification and maintenance during defects liability period for the provision of the complete new mechanical, fire and hydraulic services systems required in the station.

The specification is indicative and a guideline for the scope of works required. It shall be the full responsibility of the Contractor to allow for full compliance of all required electrical, comms and security systems in the station, inclusive of all necessary and required system components, equipment, plant, accessories and interface with other building services systems in accordance with all relevant New Zealand Standards and Authority requirements.

1.2 DEFINITIONS

The following terms shall represent the relevant parties in this specification.

“Client/Principal”	City Rail Link (CRL)/Auckland Transport (AT)
“Engineers Rep”	herein after referred to, as the ER shall be the person as nominated by the Client or as nominated in the main building contract.
“PTA”	Principal Technical Adviser to AT. Includes a number of integrated companies that provide design and advice to AT. Companies include: Aurecon, Mott MacDonald, Jasmax, Grimshaw and Arup
“PTA Architect”	Jasmax
“PTA MEP Engineer”	Mott MacDonald New Zealand
“Building Contractor”	Downer NZ
“MFH Contractor”	Contractor carrying out the Mechanical, Fire and Hydraulic services installation under this specification. Referred to as the MFH Contractor or Contractor.
“ESC Contractor”	Contractor carrying out the Electrical, Communications and Security services installation under this specification.
"Approved"	shall mean approved in writing by the ER or by Regulation or Ruling by Local Authority.
"Or equal"	shall mean a material, product of component nominated by the Contractor, which is equivalent in performance and quality to and of cost not exceeding that specified. The reference ‘or equal’ shall be taken in all cases to be the same as the reference ‘or equal in all respects to”. The acceptance of what constitutes as being of equal type and quality shall be at the sole discretion of the ER or Client.

2 General

2.1 INTRODUCTION

This specification has been prepared based on the instructions from Auckland Transport (AT) as part of the design for Britomart Station works associated with the City Rail Link (CRL) project. Mott MacDonald was commissioned as part the Principal Technical Advisor (PTA) team to produce the design for the Building Services aspects of the design.

This specification covers the work encompassing the following 'ECS' Services:

- Electrical Services (Power, Lighting, Emergency Lighting, UPS);
- Communications and CCTV services
- Security Services (Access Control and Intruder Detection)

All works shall be in accordance with P&G sections of the main contract – refer to all other relevant documents.

This document details the requirements for the detailed design (where required), construction design, supply, delivery, shop drawings, installation, testing, commissioning (staged as required to suit the overall works), maintenance and guarantee of the new engineering services for the overall project.

2.2 PROJECT OVERVIEW

This specification includes the Construction Contact 1 works for the upgrade and integration of the existing Britomart Station and CPO building for the proposed new CRL passenger rail link.

This specification covers works required for the demolition, temporary and permanent works at Britomart Station, CPO building, and associated ancillary buildings. Staging of works and works required for staging purposes shall be the responsibility of the Contractor.

Works include:

- Demolition of existing services
- Diversions and relocation of services
- Temporary services
- Permanent services
- Provision for base build retail services

The enabling works at Britomart Station will require extensive civil works within the CPO building. The most northerly line (Platform 1) and the most southerly line (Platform 5) will be extended West under the CPO and then southward under Albert Street. During the construction period the station will need to remain operational with minimal adverse impacts on rail customers.

The extent of works generally covers the following areas at the western end of the station (excluding the alighting platforms):

- B2 platform level (typical up to the existing gate lines)
- B1 Station Level
- B1 Concourse level
- CPO Underpass

- CPO ground and upper floors
- CPO glass house
- Station Plaza West
- Integration into existing east end systems

2.2.1 Preliminary and Generals

Refer to the Main Contract documentation for Preliminaries and General.

2.2.2 Britomart Station – Continuous Operation

Britomart station shall remain operational throughout the demolition, temporary and permanent works. The Contractor shall allow for all staging and phasing of the works to ensure continuous operation of the station is maintained.

The temporary phasing of the project is described in more detail in the following document (CRL-SYW-ENG-000-RPT-0008). Refer to Section 6.2 Passenger and Pedestrian Analysis, in particular table 6-2.

The hours of operation for normal working hours and Engineering hours shall be as described in the main contract.

2.2.3 CRL Design Documents

The contactor shall make reference to the following CRL documents, specifications and reports as part of these works;

Report/Specification No.	Description
Mechanical, Fire and Hydraulics Specification	CRL-BTM-MEP-000-SPE-0001
Electrical and Communication Specification	CRL-BTM-MEP-000-SPE-0002
Vertical Transportation Specification	CRL-BTM-VER-000-SPE-0001
SCADA Specification	CRL-BTM-BMS-000-SPE-0001
Station Building Management System (BMS) SCADA Specification	CRL-BTM-BMS-000-SPE-0002
Architectural	
Structural	
Civils	
FIRE ENGINEERING BRIEF AND REPORTS	
Fire Engineering Brief	CRL-SYW-FIR-000-MAN-0007
Fire Engineering Report	CRL-BTM-FIR-000-RPT-0011
DETAILED DESIGN REPORTS – Temporary Works	
Overview and Assurance – Vol 1	CRL-BTM-ENG-000-RPT-0010
Structural – Vol 2	CRL-BTM-STR-000-RPT-0051
Architectural – Vol 3	CRL-BTM-ARC-000-RPT-0019
MEP and Rail Services – Vol 4	CRL-BTM-MEP-000-RPT-0024
DETAILED DESIGN REPORTS – Permanent Works	
Overview and Assurance – Vol 1	CRL-BTM-ENG-000-RPT-0011

Civil and Structural – Vol 2	CRL-BTM-CIV-000-RPT-0022
Architectural – Vol 3	CRL-BTM-ARC-000-RPT-0020
MEP and Rail Services – Vol 4	CRL-BTM-MEP-000-RPT-0025
DESIGN MANUALS	
Draft Design Manual Volume 1, Part 1 - General	CRL-SYW-ENG-000-MAN-0001
Draft Design Manual Volume 1, Part 2 – Civil Infrastructure and Structures	CRL-SYW-CIV-000-MAN-0002
Draft Design Manual Volume 1, Part 3 – Mechanical and Electrical Systems	CRL-SYW-MEP-000-MAN-0003
Draft Design Manual Volume 1, Part 4 – Rail Systems	CRL-SYW-ARC-000-MAN-0005
Draft Design Manual Volume 1, Part 5 - Architecture and Planning	
Draft Design Manual Volume 1, Part 6 - Passenger Analysis	CRL-SYW-TPP-000-MAN-0006
Draft Design Manual Volume 1, Part 7 – Fire Engineering Brief	CRL-SYW-FIR-000-MAN-0007
HUMAN FACTORS, RAMS AND PED ANALYSIS	
Passenger and Pedestrian Analysis (Temporary)	CRL-BTM-TPP-000-RPT-0008
Passenger and Pedestrian Analysis (Permanent)	CRL-BTM-TPP-000-RPT-0009
Human Factors Technical Note	CRL-BTM-HMF-000-ENN-0001
C1 RAM Report	CRL-BTM-SSA-000-RPT-0006

2.3 WORKS REQUIRED BY THIS SPECIFICATION

This specification has been drafted as a combined document that covers the following services;

- Electrical
- Communications
- Security
- CCTV

Should this specification be spilt into independent specifications for separate Contractors to carry out the works then the following sections must be provided in conjunction.

2.3.1 Electrical

Section 1, 2, 3 and 4 including, the SCADA Controls Specification (CRL-BTM-BMS-000-SPE-0001) and Building Management Systems Specification (CRL-BTM-BMS-000-SPE-0002)

2.3.2 Communications

Section 1, 2, 3 and 4 including, the SCADA Controls Specification (CRL-BTM-BMS-000-SPE-0001) and Building Management Systems Specification (CRL-BTM-BMS-000-SPE-0002)

2.3.3 Security

Section 1, 2, 3 and 4 including, the SCADA Controls Specification (CRL-BTM-BMS-000-SPE-0001) and Building Management Systems Specification (CRL-BTM-BMS-000-SPE-0002)

2.3.4 CCTV

Section 1, 2, 3 and 4 including, the SCADA Controls Specification (CRL-BTM-BMS-000-SPE-0001) and Building Management Systems Specification (CRL-BTM-BMS-000-SPE-0002)

2.3.5 Future Rail Systems works

At the completion the Construction Contract 1 works various rail systems rooms are not required to be operational. The running tunnels will be isolated from the station and the fitout of the rail systems rooms will take place at a 'future' date. This is due to the 'future' CRL project connecting Britomart with Mt Eden via Aotea and Karangahape Road Stations. These stations and running tunnels will form 'future' works.

These rooms include;

- Overhead Line Room (OHLE)
- Tunnel LV Room
- Tunnel Splice Rooms (x2)
- Signalling Equipment Room (SER)
- Platform Screen Doors Room (PSD)
- Main Sump at B2 Level (Fire water pumps only)

The Construction Contact 1 design allows for the provision of services to these rooms. However ECS services are not required to be installed at the completion of the Construction Contact 1 works. This is described in more detail in section 3.0.

The Rail System rooms will have no MEP services installed in these spaces and it is assumed that these rooms will be isolated and sealed off from the operational station until such time as the 'future' fit out is carried out.

All rail systems and 3rd party equipment associated with the Rail Systems rooms is not included in this specification and is by others.

2.4 SCOPE OF WORK

2.4.1 General Scope for ECS Systems

The services work covered by these documents includes, but not be limited to, the final design co-ordination, manufacture, supply, installation, testing, commissioning and subsequent maintenance for the stipulated period of the work specified herein and shown on the accompanying drawings.

Provide all manufactured items, materials, labour, cartage, tools, plant, appliances and fixings necessary for the proper execution of the works, together with all minor and incidental works.

The whole of the works shall comply with all the latest relevant Regulations and to all Local Authority requirements. The cost of any materials or equipment required to meet such regulations and requirements shall be included in the Tender whether specially shown or described in the documents or not.

All materials and equipment shall be the best of their respective kinds, complying with the relevant Standards and Local Codes of Practice. All materials and equipment shall be new and shall be delivered to the site with the maker's label intact.

The general scope of the Electrical Specification includes for all Electrical, Communications, Security/CCTV systems, including;

- Demolition of existing services not required for station operation

- Diversion of services during temporary and permanent works
- Services diversions required to enable the CPO building to be safely isolated and reinstatement at the end of the works;
- Staging of all works necessary for enabling, temporary and permanent works
- Provision of all services for permanent works
- Provision of base build retail services (described below)
- Provision of enclosures, fixings and all supports;
- Design and installation of all seismic restraints to comply with NZS 4219
- Isolation and decommissioning of services to the temporary accommodation facilities;
- Isolation and decommissioning of services not required to remain or be provided for the permanent works;
- Integration of temporary and permanent systems into the station east end (i.e. BMS/SCADA, Fire etc)
- Co-ordination of services with other trades
- Reinstatement of the station fire integrity where identified and impacted by the Construction Contract 1 works
- Submission of shop drawings and samples for approval
- Spare parts
- Testing & Commissioning of all installed services to provide fully functioning systems
- Training
- Operating & maintenance manuals
- Warranties on all works and materials
- As built drawings and documentation

2.4.2 Electrical

The scope of the contract Electrical works as detailed within this specification and associated drawings shall include, but not be limited to, the design, supply, installation, testing and commissioning of the following:

2.4.2.1 Demolition Works

- Isolate and make safe of electrical wiring and cabling
- Removal of existing electrical installation including lighting and small power
- Resupplying of operational circuits from alternative sources
- The diversion of electrical cabling and wiring for operational station equipment during the demolition and temporary phase
- The decommissioning of existing electrical switchgear and equipment not required during the temporary phase

- Test and commission electrical wiring and cabling modified during the demolition works

2.4.2.2 Permanent Works

- Incoming power supply
- Switchboards
- Cabling and cable containment
- Enclosures, fixing and supports
- Seismic bracing
- Small power
- Power supplies for other services
- Power supplies for operational, staff and passenger services
- Power supply and lighting for retail
- Uninterruptible power supplies (UPS's) and batteries
- Power conditioning and surge suppression
- Fire-rated services
- Earthing and bonding
- Lightning protection
- Penetrations and fire stopping
- Interfacing between electrical systems
- Interfacing to other systems and the wider network
- Coordination between trades
- Lighting and lighting controls
- Emergency lighting and exit signage
- Testing, commissioning, training
- O & M manuals
- Warranties and as-built documentation

2.4.3 Communications

The scope of the contract Communications works as detailed within this specification and associated drawings shall include, but not be limited to, the design, supply, installation, testing and commissioning of the following:

2.4.3.1 Temporary Works

Omitted for clarity. Refer Rev 7 of this specification.

2.4.3.2 Permanent Works

- Incoming Telecommunications
- Local Area Network (LAN)

- Wide Area Network (WAN)
- Passenger Information Displays (PIDS)
- Public Help Points (PHP)
- PA/EWIS
- Emergency Telephone (ET)
- Visual Alarm Beacons
- Warden Intercommunications Points (WIP)
- Leaky Feeder Radio Network.
- Comms racks, fibre trays, patch panels, patching
- Cabling and cable containment
- Enclosures, fixing and supports
- Seismic bracing
- Fire-rated services
- Earthing and bonding
- Interfacing between communications systems
- Interfacing to other systems and the wider network
- Coordination between trades
- Testing, commissioning, training
- O & M manuals
- Warranties and as-built documentation

2.4.4 Security and CCTV

The scope of the contract Security/CCTV works as detailed within this specification and associated drawings shall include, but not be limited to, the design, supply, installation, testing and commissioning of the following:

2.4.4.1 Temporary Works

Omitted for clarity. Refer Rev 7 of this specification.

2.4.4.2 Permanent Works

- CCTV
- Access Control
- Intruder Detection
- CCTV, Access Control and Intruder Detection equipment
- Cabling and cable containment
- Enclosures, fixing and supports
- Seismic bracing
- Fire-rated services

- Earthing and bonding
- Interfacing between CCTV, Access Control and Intruder Detection equipment
- Interfacing to other systems and the wider network
- Coordination between trades
- Testing, commissioning, training
- O & M manuals
- Warranties and as-built documentation

2.5 SUSTAINABILITY

The project's sustainability objectives are set out in the main contract. The Contractor shall be aware of their requirements to contribute to the achievement of these objectives.

The project is targeting an 'Excellent' rating against the Infrastructure Sustainability rating tool from the Infrastructure Sustainability Council of Australia. The Contractor shall be aware of their requirements to contribute to the achievement of this rating.

- Energy efficiency: any substitutions proposed by the Contractor will need to achieve equivalent or better performance in terms of energy demand.
- Water efficiency any substitutions proposed by the Contractor will need to achieve equivalent or better performance in terms of water use.
- Zero waste to landfill: The Contractor shall be cognisant of this target when procuring goods and services in relation to the project.

The Contractor shall refer to the following information as part of these works:

Report/Specification No.	Description
CRL Infrastructure Sustainability Management Plan	CRL-EWG-SUS-AT-PLN-003680

2.6 WORK BY OTHER TRADES

Refer to the Technical General section for the following specific works by other trades;

- Electrical (section 4)
- Comms (section 4)
- Security CCTV (section 4)

2.7 BUILDERS WORKS IN CONJUNCTION (BWIC)

The Main Contractor shall provide all the BWIC with this specification. This shall include, but not limited to;

- Cutting, forming or drilling through walls, floors or ceilings to allow services to pass.
- Ensuring structural integrity is not compromised.

- Chasing block and brickwork for conduits or pipes.
- Lifting and replacing floors.
- Asbestos removal.
- Plant moving services.
- Sealing holes.
- Reinstating fire, thermal or acoustic separation.
- Constructing plinths.
- Making good plaster and other finishes

2.7.1 BWIC for Electrical, Comms, CCTV and Security

- All electrical, communications, security and CCTV main switch rooms, distribution board cupboards, risers and plant rooms
- Cutting and provision of trimmed openings to all ceilings and walls for luminaires and cables as required.
- Liaise with Electrical Contractor with respect to bonding to the building structure/reinforcing
- Supply and installation of door hold open devices.
- Temporary electrical supply for use during construction;
- Provision of building and structure penetrations including provision and removal of formwork, or provision of framing, and making good at locations as required by Electrical Sub-Contractor, with under-flashing for ducts, cable trays, conduit and the like through external walls and roofs.
- Cut all holes in finished surfaces, timber, cupboards, false ceilings, vanity units, shelves, etc, as required by the Contractor.
- Concrete plinths and metal forms to the dimensions supplied by the Contractor.
- Bollards and mechanical protection to ducts, cable trays, conduit and equipment.
- All roof work, roof flashing and roof penetrations being made watertight.
- Set out of building grids to allow set out of core holes
- Correct positioning and fixing of all conduits and draw pits.
- All enclosures, recesses and/or cupboards for installation of equipment and submains.
- Fire resisting shafts for ducts, cable trays and conduit.
- Platforms stairs, ladders and walkways providing permanent access to plant and complying with AS1657 Fixed platforms, walkways, stairways and ladders unless otherwise noted
- Trip protection in the form of stairs or ramps and head protection where services cross walkways.
- Building in circular sleeves for penetrations, cast in fixings, conduit and similar items at locations shown on the Electrical Contractor's drawings.
- Concrete up-stands, pits, bunds and kerbs.
- Cutting and making good of chases for wiring, conduits, wall boxes and the like. Where chases exceed 80mm wide, provide expanded mesh over the full width and length of the chase.
- Boxing in of exposed services.

- Painting of exposed conduit, metal ducting and other metalwork.
- Access panels in the ceilings, shafts, walls and bulkheads for access to Electrical services.
- Removal, relocation and replacement of ceiling tiles and grids for access for the installation and commissioning of Electrical services.
- Trenching for services installations including cutting, excavation, shoring, backfilling and making good of surface, but excluding services, bedding and initial cover.
- Provide all penetrations as shown on structural drawings only. All other penetrations by Contractor.
- Temporary drainage and water supply for use during construction.
- Access panels to all ducts and ceilings, inspection openings and fire hose reel/hydrant housings, including fire hydrant booster valve cabinet.
- Bollards and mechanical protection to pipework, stacks and equipment.
- Supply and installation of waterproof membranes associated with the works.
- Set out of building grids to allow set out of core holes.
- Supply and installation of all roof under flashing to external penetrations.
- Supply and installation of waterproof membranes.

2.8 TENDER REQUIREMENTS

2.8.1 Tender Quantities

The information detailed in the Schedules and drawings are to be used for Tender purposes only.

2.8.2 Tender Submissions/Returns

Where equipment or components have been specified as part of this specification the Tenderer shall include these as part of their submission or provide an equal equivalent for consideration by the ER.

The project is targeting an 'Excellent' rating against the Infrastructure Sustainability rating tool from the Infrastructure Sustainability Council of Australia. The Tenderer shall be aware of their requirements to contribute to the achievement of this rating.

The Tenderer shall provide manufactures/ products that satisfy the performance requirements indicated in the Technical sections of the specification and also provide at least 3 alternative product selections that 'exceed' the energy performance benchmarks indicated below and indicated in the Technical sections of this specification. The Tenderer shall also provide a cost comparison between the alternative products for the ER and client to review.

Where no manufacture/ product has been indicated or specified then the Tenderer shall include a proposed manufacture/ product for approval by the ER.

The tenderer shall:

- Return with his Tender a completed schedule of system details;
- Specify the make and model of all equipment being proposed;
- Include for 3 alternative product selections indicating energy benchmarks and costs for comparison by the ER

- Include within the Tender a description of any discrepancies between the Tenderer's standard system and the technical and performance requirements of this Specification. If the Tenderer does not highlight these discrepancies then it shall be deemed that the Tender complies fully with the Specification;
- Include in the tender for all electrical and electronic equipment proposed to have Electro Magnetic Compatibility (EMC) CE certification and approval.
- Include in the Tender all costs associated with the warranty requirements of attending any call by the end of the next working day;
- Include in the Tender all costs associated with warranty visits to maintain particular items that are more frequent than monthly;
- Include what the Tenderer sees as the main Health and Safety issues associated with this specific aspect of the project and their proposals for managing them.

2.8.3 Energy Benchmarks and Product Selections

The project is targeting an 'Excellent' rating against the Infrastructure Sustainability rating tool from the Infrastructure Sustainability Council of Australia. The Tenderer shall be aware of their requirements to contribute to the achievement of this rating.

The Tenderer shall provide products/equipment that satisfies the minimum energy performance requirements indicated in the tables below and in the Technical sections of the specification.

These are based on the Government 'Guidelines for energy efficient HVAC plant' that is issued as guidance under section 175 of the Building Act 2004.

2.8.3.1 ISCA Energy and Carbon Monitoring and Reduction

As part of contributing to achieving an 'Excellent' IS rating a reduction of Greenhouse Gas emissions by 10-20% below a business as usual footprint is required. An improved energy efficiency performance will contribute to a reduction in greenhouse gas emissions and hence contribute to achieving an "Excellent" IS rating.

Electrical Systems

- General and functional lighting

For all new lighting specified within the design documentation and luminaire schedules (Appendix A) are high energy efficient type fittings, which are currently available on the market at the time of this tender. The lighting design was benchmarked with NZS 4242: Part 2.

Purpose	Lighting power density limit (W/m2)
Communal non-residential - Assembly	11
Office space	12
Service Establishment (e.g. bank, booking hall)	14

Where there is alternative fitting/s of similar quality and offers higher efficacies shall be submitted as a possible alternative for the tender submission. Where alternative fittings are proposed the contractor shall also be required to provide an updated lighting design to demonstrate that the design 'betters' the current lighting design.

- Minimum energy efficiency ratio for UPS Systems.

For the online UPS systems, these shall be selected to provide the efficiency during full and part loads listed below. Standby/eco modes shall not be considered for this selection.

AC/AC efficiency in normal mode, linear load %	% (minimum)
100	92
75	92
50	92
25	92

- UPS Batteries

In order to minimise the environmental impact with the disposal of batteries, as a minimum, the design life expectancy is as per below. The contractor shall also consider other alternatives battery types which offer further longer life as part of their submission.

Battery Requirements (refer to technical section for further performance requirements)
Life expectancy of 10 years(minimum)
Warranty of 3 years with 7 years pro-rata

- Reducing voltage drop to 5%

The maximum permissible voltage drop across the electrical installation for the new works shall be designed up to 5%. This is below the required AS/NZ3000 Electrical wiring regulations, which allows a voltage drop of up to 7% for HV private networks.

With an increased cable conductor size this provides better energy efficiency across the installation by reducing the power losses within the cable. A lower voltage drop also improves the power transmission to electrical equipment, which will run at designed optimum efficiencies.

Studies have shown that excessive voltage drops due to undersized conductors can waste between 2-4% overall power due to resistance heat losses through cables.

- Power factor correction

PFC equipment shall be provided to correct the power factor to the target value of at least 0.95. Monitoring of the permanent installation shall be carried out for a set period to determine the if PFC equipment is required. PFC equipment shall be utilised to provide the following:

- Reduce energy cost
- Lower distribution losses
- Improve voltage regulation
- Reduce non-productive load on system
- Reduce supply current

2.8.3.2 Product Selections

The contractor shall submit at least 1 alternative products/equipment that 'better' the minimum energy performance requirements. This shall be included as part of the tender returns.

The equipment selections shall indicate the following;

- Energy efficiency rating (EER/SFP/%)
- Product/Equipment Cost ($)

Equipment selections and cost comparisons shall be provided for mainly major pieces of equipment.

2.9 PREFERRED MANUFACTURES

The following product manufactures are considered acceptable for use for the project. Alternative manufactures not included on the list must be submitted by the Tenderer/Contractor to the ER for approval at the tender stage.

2.9.1.1 Electrical

Equipment	Manufacture
Electrical Switchgear/Breakers	ABB Schneider/Merlin Gerin Eaton NHP Jean Mueller (LV Tap off)
UPS (UPS supplier to recommend recognised battery manufacturer - SLA)	ABB Schneider Electric Chloride Emerson or an equivalent approved alternative
Automatic Transfer Switches and Static Switches	Socamec ASCO ABB
Lighting Control Systems (DALI Protocol)	Schneider Electric (C-Bus) Dynalite or an equivalent approved alternative
EMS/Station Controls	Honeywell Siemens Schneider Electric Rockwell Trend Johnston Controls
Cable Containment Management Systems (CMS)	Interserv Legrand ModemPak
Lighting	Refer to Luminaire Schedule or equivalent approved alternative
LV Cables (Suppliers)	General Cable Olex NZ Prysmian Power Cables

Equipment	Manufacture
Earthing and Lightning/surge protection systems	Enertec Erico Schneider Electrical (Furse) ABB
Electrical Panel Builders	Lynn Electrical Gael Switchboards Jean Mueller (LV Feeder Tap off) or equivalent approved alternative
Electrical switches and accessories	PDL HPM or equivalent approved alternative
Cable draw pits/Chambers	SIKA HUMES or equivalent approved alternative

2.10 QUALITY ASSURANCE

The Sub Contractor shall establish Quality Management procedures in conjunction with the Building Contractor to ensure that the installations, equipment, materials and workmanship conform to the standards required in the Main Contract Documents.

2.11 SPECIALIST TO THE PROJECT

The Contractor is required to retain the following Specialist for the duration of the project. This shall include the Demolition, Temporary and Permanent works stages through to practical completion.

2.11.1 Building Services Coordination Engineer

The Building Services Coordination Engineer shall be responsible for the overall coordination of all trade works (main and sub). The Coordination Engineer shall have a minimum of 5years experience in similar roles preferably within the rail environment working on large complex rail projects. The MEP Coordination Engineers responsibilities shall include the coordination of the following disciplines (but not limited to):

- Mechanical (HVAC)
- Electrical
- Fire (wet and dry)
- Hydraulics (drainage and potable)
- Communications (PA/CCTV/PHP/PIDs etc.)
- IT/DATA
- Security

Overall responsibilities include:

- Manage the overall coordination of Sub Contractor’s equipment submissions
- RFI (services) tracking

- Shop drawings submissions
- Sub-Contractor coordination
- Revit “construction design”
- Work programming (including continuously updating)
- Methodology (including updates once reviewed)
- Shutdowns/cut ins into existing systems
- Staged “sectional handovers”
- Staged commissioning
- Final as-built / O&M manual production

2.11.2 Structural Engineer (Seismic Restraints)

A Chartered Engineer (Structural) experienced in seismic fixings of plant to complete the design and observation of all equipment installations. The Contractor is to make allowance for the Chartered Engineer to provide a Producer Statement PS1 (Design) and PS4 (Construction Review) prior to Practical Completion.

2.11.3 Commissioning Engineer

The Contractor shall appoint specialist Commissioning Engineers for the project to carry out all aspects of testing and commissioning. This shall include sectional testing and commissioning and final testing and commissioning stages. The Commissioning Engineer (s) shall have a minimum of 15years experience.

- Review of Design Drawings at construction issue to check for dampers, valves, sensors etc.
- Review of Contractors shop drawings for access, commissioning etc.
- Inspection on site of first fix for access.
- Static completion works
- Proving operation from static completion to fully functioning works
- Pre-commissioning review of sectional and completed systems and review of results.

2.12 SITE CONDITIONS/VISIT THE SITE

Contractors should visit the site to gain knowledge of the accessibility and of conditions affecting labour, carriage, unloading and storage of materials.

Contractors shall satisfy themselves as to the staging, scaffolding, tools, storage, accommodation etc., required for the proper execution of the Contract, with respect to the Main Contract and site conditions.

2.13 TAG AND TRACE WORKS & AS-BUILT INFORMATION

Tag and trace (T&T) works were carried out at the West end of station during July – August 2015. The information provided to the design team was based on as-built information (dating back to 2003) which was updated as far as practicable to reflect the current installation.

The T&T works generally covered the Western end of the station and where practicable identified existing services and service routes. Due to the complexities and extent of services the T&T works

were unable to fully identify all services. This was due to inaccessible spaces, services cast in slab and untidy installations.

The accuracy and validity of any T&T information shall be verified by the Contractor prior to the commencement of any works on site.

In conjunction with the T&T works the design has been based on available as-built information dating from 2003 and a REVIT model produced from point cloud data and as-built structural data. There will be areas in the station that are not accurately modelled and the Contractor shall carry out his own due diligence surveys to verify the accuracy of this information.

Any claims by the Contractor arising from lack of knowledge of the above mentioned conditions, will be disallowed.

The Contractor shall refer to the following T&T information as part of these works;

Report/Specification No.	Description
Mechanical Services Tag and Trace Information	CRL-BTM-MEP-000-DOC-0001
Electrical Services Tag and Trace Information	CRL-BTM-MEP-000-DOC-0002
Plumbing Services Tag and Trace Information	CRL-BTM-MEP-000-DOC-0003
Fire Services Tag and Trace Information	CRL-BTM-FIR-000-DOC-0001
CCTV and Security Services Tag and Trace Information	CRL-BTM-COM-000-DOC-0001
PA and Public Help Point Tag and Trace Information	CRL-BTM-COM-000-DOC-0002
Incoming Telecommunications Services Tag and Trace Information	CRL-BTM-COM-000-DOC-0003
Drainage Services Tag and Trace Information	CRL-BTM-DRN-000-DOC-0001
SCADA Services Tag and Trace Information	CRL-BTM-BMS-000-DOC-0001
IT/DATA Systems Tag and Trace Information	CRL-BTM-ITM-000-DOC-0001

2.14 CO-ORDINATION

The Contractor shall co-ordinate his work with other trades on the buildings in such a manner as not to interfere with other work being carried out on the building.

In locations where equipment must be installed along with other work being installed under other contracts, the Contractor shall co-operate with the other Contractor's concerned and see that all equipment is installed to the best advantage.

Any cutting etc, required to the building structure as a result of this Contractor's failing to co-ordinate with the program shall be arranged at this Contractor's expense.

The Building Contractor shall employ a specific “Building Services” Coordination Engineer to undertake overall responsibility of the building services coordination process. The coordinator shall have a minimum of 5years experience in similar roles preferably within the rail environment. They will need to undertake;

- Manage the overall coordination of Sub Contractor’s equipment submissions
- RFI (services) tracking
- Shop drawings submissions

- Sub-Contractor coordination
- Revit “construction design”
- Work programming (including continuously updating)
- Methodology (including updates once reviewed)
- Shutdowns/cut ins into existing systems
- Staged “sectional handovers”
- Staged commissioning
- Final as-built / O&M manual production

2.15 EXISTING SERVICES

The Contractor shall be completely satisfied that all existing services required to be connected to are those to which the documents indicate, and that they are of the size and level shown on the drawings. If there is any uncertainty the Contractor shall check on site prior to the tendering and allow a provisional sum if there are any discrepancies identified. No additional claims will be accepted for rectifying works that have been incorrectly connected as a result of failing to confirm the documented information at site prior to commencing this work.

All existing services to be connected to, other than Authority Services, shall be cleaned, traced, labelled and tested to an equivalent standard of all new works, and to the satisfaction of the ER prior to their connection.

The Contractor shall not isolate any existing services without giving at least 48 hours notification to the ER or without written approval to do so. After notification to the ER that the service is redundant, the Contractor may proceed isolate and remove in the correct manner, as is required by the Authorities and the ER.

The Contractor will be responsible for checking with all Authorities and the ER concerning the location of any existing services on the site.

The Contractor shall allow to seal off all existing services that may become redundant during the progress of the Project. All such services shall be sealed off at the relevant Authority supply main, and removed where practicable.

Include a detailed maintenance schedule in the equipment manuals for the servicing of each system.

2.15.1 Redundant Services

The contractor shall arrange for the full isolation, disconnection and removal of any ECS services that are;

- Identified as existing redundant station services not required as part of these works
- Existing redundant services left in place from previous installations
- Isolate and make safe of any exposed cabling/wiring no longer required

The contractor shall ensure all redundant wiring, pipework, ductwork etc. is fully isolated and stripped back to its source and made safe. Any reusable/recyclable materials i.e. switchgear, DB copper cabling shall be offered back to the client for the disposal of.

2.15.2 Site Hazards and Past Installation Works

The Tag and Trace works carried out during July – August 2015 identified various hazards in certain locations at the west end of the station.

The below report highlights some of the hazards and past installation practices carried out at the station. This is not an exhaustive list but an overview of the typical standard of installation that has been undertaken in the past.

The contractor shall make themselves familiar with the report contents, site hazards and past installation works.

Report/Specification No.	Description
MEPF/Comms Hazard Identification Report	CRL-BTM-HSE-000-RPT-0001

2.16 ASBESTOS

Prior to the commencement of any works, the contractor must request and read any available information on asbestos and any other relevant documentation relating to all areas where work is being carried out or used for access.

Test results from 2002 and also records of reports and tests through to 2005 are available through the main contract. In general these reports were carried out by Nikau and Dowdell & Associates;

- Summary Sheet of the reports (Test results and report comments)
- Visual representation of reports and results for CPO

Reports of CPO – records from Dowdell & Associates

2.17 CERTIFICATION OF WORKS

At the completion of the works and prior to the submission for final payment the Contractor shall make all necessary applications, pay all fees, obtain and issue to the ER Certificates indicating that the works comply with the current regulations and requirements of the relevant Authority.

Wherever applicable the relevant Authority shall issue the Certificate. Where this is not standard practice the Contractor shall provide a Certificate or Letter of Certification which will guarantee that the works comply with the relevant Authorities regulations, requirements and conditions.

2.18 CODES AND STANDARDS

The Contractor shall comply with relevant standards / codes associated within the project.

Where some doubts exist as to the appropriate standard, the decision shall be made by the ER before commencement of any work on or off the site. If a doubt exists as to whether a section of the design is able to comply with the relevant authorities regulations the ER shall be notified prior to the commencement of any work. No consideration of claim for redundant work shall be given if the ER is not notified.

The Contractor must take full responsibility for the safety and appoint his/her own authorised competent persons.

The Contractor shall comply with relevant standards / codes associated within the project these include;

- New Zealand Building Act
- Health and Safety Act
- New Zealand Electricity (Safety) Regulations
- New Zealand Building Code G9- Electricity
- New Zealand Code of Practice 2010
- AS/NZS:3000 Wiring Rules

Refer to Section 4 – Technical Requirements for additional codes and regulations that are applicable to specific equipment and services installation.

2.19 AUTHORITIES

The whole of the work shall be carried out by or under the full supervision of a fully licensed Contractor in accordance with the drawings and specification, and to the satisfaction of the ER and to the current Standards and Regulations of any authority having jurisdiction over the works.

The Contractor shall submit evidence that:

- Requirements of authorities relating to the work under the contract have been ascertained prior to the commencement of the services installation.
- Fees to authorities, if any, have been paid and all types of approvals obtained.
- Certificates of compliance with regard to the extent of the installation. Such certificates have to be obtained on completion of the installation.
- Test certificates for all essential service fittings. Be provided prior to completion.

2.20 DRAWINGS

Drawings show the approximate route of the various services in setting out; they shall be read in conjunction with all construction drawings for this Project. Make sure allowance for all necessary transitions from vertical, horizontal, rise and fall; necessary adjustments and positions of equipment as required for the execution of the works. No additional money shall be payable to the Contractor for any of these diversions.

It shall be understood that the drawings accompanying this specification are intended to show the general arrangement and the intent of the work to be done and that it is the tenderer's responsibility to provide a complete and fully functioning system complying in all respects to those codes (as amended) and Authorities. All materials and items shall be installed in accordance with the manufacturer’s recommendations unless noted otherwise in this specification or tender drawings.

The Contractor shall be responsible for checking all dimensions and levels indicated against site restrictions and ensure that the proposed layout is practical before commencing work. The drawings shall not be used for scaling of dimensions.

The Contractor shall refer to the architectural dimensioned drawings for set out of fixtures.

The Contractor is to ensure that all the plant offered can be accommodated within the available spaces and is to include for taking all necessary dimensions on site and prepare;

- Working/Workshop drawings for approval prior to installation commencing
- Manufactures drawings

- Builders works drawings
- Record Drawings
- Work As Executed Drawings

No variation will be accepted for any such items not included in the tender.

2.20.1 Discrepancies in Drawings

In the event of discrepancies appearing on the drawings, or between the Drawings, Specification, Preliminaries, and Tender Documents, the Contractor shall refer the matter to the ER for interpretation. No variation in the Tender price will be considered due to the Contractor's failure to remark such errors, or to having incorrectly interpreted any part of the Specification or Drawings.

2.20.2 REVIT

The MEP REVIT model (LOD300) was issued to the contractor to develop LOD400).

2.20.3 Working/Workshop Drawings

Produce and submit to the ER for inspection, comprehensive working/workshop drawings, with notes and/or specifications for such parts of the works as are necessary, or specified in the Contract, or as set out below.

These drawings shall be submitted following detailed co-ordination with other trades.

Submission of the drawings shall be both as CAD files and PDF files and shall be submitted electronically either via the project document management system or by CD Disk or USB stick.

Such drawings shall be submitted as described to the Building Contractor to allow sufficient time for examination, production and supply so as not to delay progress of the works.

Shop drawings shall take account of site dimensions, actual dimensions and access requirements for installation and servicing of the particular brands and models of equipment supplied, and shall co-ordinate with the building structure, finishes and other services in accordance with the design details and general arrangements shown on the design drawings and shall comply with Statutory Authorities and shall show sufficient information to enable the Building Contractor and the ER to check that the equipment can be installed, operated adjusted and maintained in the manner for which the system was designed.

The Contractor shall prepare shop drawings from the latest available information. Wherever possible consultation with the Building Contractor and ER should continue during shop drawing preparation. This will ensure the quickest possible handling when shop drawings are formally submitted to the Building Contractor and generally reduce the incidence of re-submitted drawings.

The Sub-Contract works shall include:

- The execution of the Sub-Contract works inclusive of full design and co-ordination with the intent of the Sub-Contract.
- Provision of shop drawings which take account of full design of required systems, site dimensions, actual dimensions and access requirements for installation and maintenance of the particular brands and models of equipment supplied, and which co-ordinate the locations of all pipes, conduits, equipment etc. with other trades.
- Provision of detailed drawings to the Building Contractor showing work associated with the Sub-Contract to be carried out by other trades.

Shop drawings shall have all building details such as columns, stairways, floors, lifts, etc. numbered in accordance with the Architectural drawings. Services and plant shall be identified by numbering in a manner approved by the Building Contractor and ER.

Shop drawings shall:

- Be drawn to the following scales - 1:1, 1:5, 1:10, 1:20 for components and 1:50, 1:100 for locations, except for wiring diagrams which need not be to scale.
- Be drawn on preferred metric sized drawing sheets.
- Be dimensioned in metric measurements.
- Be prepared by competent draftsperson (freehand drawings will NOT be accepted).
- Be amended as necessary and incorporated within the as-installed drawing set.
- Be co-ordinated with the building construction and all other services, so that the position of sprinkler heads, EWIS speakers and smoke detectors etc are coordinated with other services to achieve a consistent and symmetrical pattern to the ceiling.
- Include but not be limited to all necessary plant, equipment, accessories and construction details.
- Plans, sections and details shall be provided.
- Be submitted to the relevant inspecting authority where required prior to submission to the Engineer.
- Be submitted to comply with the construction programme within sufficient time to permit modifications to be made without delaying the works if such are deemed necessary by the Engineer and to provide the Engineer with not less than seven (7) working days to make his comments.

Shop drawings for electrical, communications, security and CCTV shall include, but not be limited to the following:

- Calculations, assumptions, drawings, design basis and performance parameters, Certificates of compliance, installation and maintenance requirements, manufacturer's data, risk assessment, flowcharts, technical data corresponding to the equipment schedule.
- Main switchboard and DB shop drawings and installation elevations, including general arrangements, schematics, single line diagrams, equipment schedules and fixing/mounting details for each switchboard.
- Dimensioned floor plans of MSB rooms, UPS rooms, CER and comms nodes showing equipment locations and cable tray locations.
- Full DB schedules for each main, sub-main and sub-circuit including info described in the electrical scope sections of this specification.
- Earth loop impedance and volt drop calculations for each circuit.
- Earthing/bonding plan and earthing schematic
- Lightning protection schematic
- Protective device discrimination calculations and selections for each circuit from MSB downstream to last protective device in each circuit to show correct operational co-ordination between circuit breakers
- Lighting layouts and small power layouts
- A full luminaire schedule of all light fittings and mounting method/fixing for each type of luminaire.
- Lighting control system and emergency lighting monitoring system schematics and equipment location plans, including interfacing between systems and 3rd party interfacing.
- EMS control schematic

- Communications rooms layout plan and individual rack equipment layouts including cable tray (CER and comms nodes)
- Communications schematic
- PA and EWIS speaker layouts and schematics
- Security system and CCTV system schematics and equipment location layouts
- All cable ladder, cable tray, trunking, conduit and cable basket reticulation routes including tray and containment sizessizes
- All penetration locations and penetration type/size, including all fire rated membrane penetrations (walls, floors, ceilings)
- Certify that plant and equipment meets all the requirements and capacities of the contract documents, except for stated changes. Substantiate the changes.
- Label locations, type and text. Include samples of types.
- Provide details of methods to be used where items penetrating or are fixed to structure, fire rated and/or acoustic elements. Maintain the integrity of the construction.
- Provide details of methods to be used where items penetrating or are fixed to the skin of the building, including membranes, roofing and tanking elements. Maintain the integrity of the construction.
- Related builders work required including, access doors, cast in elements, fire proofing requirements, waterproofing, pipe sleeves, penetrations and openings, plinths and kerbs etc.
- Co-ordinate with other building and services elements, adjust positions on shop drawings to suit.

2.20.4 Examination of Shop Drawings

Provide the shop drawings in CAD file and Specifications in time to allow inspection, manufacture, supply and installation so as not to delay the works.

The Building Contractor, ER and Engineer shall examine and return such drawings, indicating approval or otherwise of the work shown for use on or in connection with the Sub-Contract. Where amendments are required to such drawings, the amendments shall be made and re-submitted promptly, without variation.

If the drawings are "Accepted" or "Accepted with Notes" then the Building Contractor, ER and Engineer are satisfied that the arrangement and requirements are generally in accordance with those specified under this Contract and shown on the drawings, subject to any amendments shown thereon. However, dimensions, co-ordination with associated plant and site conditions, compliance with statutory regulations and compliance with specified requirements whether or not shown on the drawings remain the responsibility of the Contractor under this Contract work. Examination of the shop drawings shall not diminish the Contractor's responsibility for ensuring that they provide fully coordinated and functioning services.

Pay for all alterations of the work due to any discrepancies, errors or omissions in the prints of drawings or other information supplied, whether such prints of drawings or information have been inspected or not provided that such discrepancies, errors or omissions are not due to inaccurate or incomplete information given by the Building Contractor or ER.

Arrange the work in co-operation with other trades so that all work is installed to the best advantage. Where equipment is installed without due regard to other trades, the work of relocation of such equipment shall be performed by the Contractor at no extra cost to the contract.

2.20.5 Builder's Work Drawings

As soon as practicable, and in any event to allow adequate time for Engineer's comments and to comply with the requirements of the Contract programme, the Contractor shall provide to the Engineer for comment duplicate copies of fully dimensioned drawings to an approved scale, of builders work requirements in connection with this Contract. Drawings shall show details of;

- Access doors and panels.
- Conduits to be cast in slabs.
- All penetrations and associated sleeves
- Holding down bolts and other anchorage and/or fixings required complete with loads to be imposed on the structure during installation and operation.
- Openings, penetrations and block-outs.
- Plinths, kerbs and bases.
- Required external openings.

The Contractor shall provide to the Engineer full particulars of loadings including moments, and dimensions and positions of foundations and plinths, and/or fixings necessary for the support and accommodation of all equipment to be supplied under this Contract, so that adequate provision may be made. Builders work drawings shall be fully dimensioned showing location of holding down bolts, details of anti-vibration mountings, etc.

All dimensions affecting accommodation and installation of the plant, and equipment supplied under this Contract, and points at which services other than those covered under this Contract are required shall be clearly indicated on drawings to be submitted to the Engineer by the Contractor.

The Contractor shall be responsible for any discrepancies, errors or omissions in the above mentioned drawings whether these drawings have been comment on by the Engineer or not. Comments given by the Engineer to any drawing shall in no way relieve the Contractor from his liability to complete the works in accordance with this document or exonerate him from any of his guarantee.

The Engineer reserves the right to amend, or add to the Drawings as may be necessary or expedient.

2.20.6 Progress Drawings

The Contractor shall keep on site one full set of white prints of the Working Drawings showing the progress of all work in connection with this Contract.

These drawings, which shall be maintained in clean condition, shall be kept up to date on a weekly basis, and all pipe lines, duct runs, positions of equipment and apparatus, including all modifications and/or variations, shall be clearly recorded by the Contractor on the drawings as they are installed.

The Contractor shall make the above drawings available at any time for inspection by the Architect/Engineer.

The Contractor shall provide to the Engineer, for the Employers use, duplicate copies of the Progress Drawings no later than two weeks prior to the Date of Practical Completion.

2.20.7 Record Drawings

The Contractor shall keep available at all times on site, a copy of design drawings marked up in colour and dated to indicate the extent and chronological order of all work tested and approved by local authorities. The Contractor shall also keep available at all times on site a copy of all Local Authority test certificates.

2.20.8 Work as Executed Drawings

One month prior to practical completion of the works provide a complete and accurate set of CAD drawings showing the installed position of all services, equipment, valves and sundry pipework included in this specification. Drawings shall be prepared by a competent draftsman on approved reproducible material.

The minimum size scale shall be at least equivalent to those used on the contract document. The invert depths and location of all pipes and valves shall be accurately plotted and indicated by measurements and be signed off by a registered surveyor

Preliminary copies of the documents shall be submitted for inspection by the Engineer, who will indicate that they are suitable or alternatively mark where they require modification.
After approval, provide three (3) A3 size hard copy sets of CAD drawings for inclusion into the Operations and Maintenance Manuals and one (1) set of CAD drawings in AutoCAD release 2014 or later format on CD or USB stick.Flighting

All changes in between practical completion and the initial issue of the “Approved for Construction” drawings are to be allowed by the Contractor.

The WAE Drawings shall be prepared by a competent draftsman on approved reproducible material. The minimum size scale shall be at least equivalent to those used on the contract document. The invert depths and location of all pipes and valves shall be accurately plotted and indicated by measurements that are to be provided by a registered surveyor. A copy of the plans marked up and signed off by a registered surveyor shall be submitted prior to the commencement of the preparation of the work as executed drawings.

2.21 SAMPLES

Samples shall be:

- Submitted to the Engineer a minimum of four (4) weeks prior to the placement of the order of the product in question and within sufficient time for procurement, manufacturer and delivery to site so as not delay installation program.
- Submitted of all equipment/accessories whose appearance will be visible and any other items as requested.
- Approved by the Engineer in writing prior to placement of orders and installation.
- Be labelled to identify their intended use.
- Be held on site after approval and used as a standard for acceptance or rejection of subsequent production units. The Contractor shall be responsible for the security of all samples that they have provided and shall replace any samples found to be missing during the construction. Samples may or may not be returned on completion of the project.

As a minimum, the following samples shall be submitted for approval:

- All luminaires including emergency lights and exit signs
- Light switches, pushbuttons, light sensors (PE cells and movement sensors)
- Lighting control hardware including programmable controllers, hand-held devices, gateway devices, power supplies, control cabling
- Cable tray, cable ladder, trunking, conduit and cable basket
- Socket outlets, isolators, permanent connection units
- CCTV cameras

- Security access control card readers and movement detection sensors
- Intruder detection sensor devices and audible alarm devices
- Comms racks, patch panels, fibre trays, comms cables
- PA and EWIS speakers

2.22 SEISMIC DESIGN AND INSTALLATION

2.22.1 General

This section covers the general seismic restraint requirements for suspended engineering systems, both vibration and non-vibration isolated and/or related suspended equipment.

Equipment shall be provided with restraints to resist seismic forces in addition to the normal fixing and supports as provided by the Contractor. Equipment includes:

- Switchboards
- UPS's
- Batteries
- Power conditioning equipment
- Cable ladder, cable tray
- Luminaires
- Suspension systems
- Comms racks

The contractor shall retain the services of a Chartered Engineer (Structural) experienced in seismic fixings of plant to complete the design and observation of all equipment installations. The Contractor is to make allowance for the Chartered Engineer to provide a Producer Statement PS1 (Design) and PS4 (Construction Review) prior to Practical Completion.

Further Seismic design requirements are indicated in the relevant Technical Sections of this specification.

All hangers' supports, equipment etc. for the electrical, communications, security and CCTV installation are required to be designed and installed to safely resist earthquake forces without compromising the continuing operation of the installation.

All equipment, cable tray etc. shall be provided with restraints to resist seismic forces in addition to the normal fixing and supports as provided by the Contractor.

The Contractor shall allow for the costs of complying with this section of the specification. Special attention shall be given to the design of flexibly mounted equipment restraints, which shall allow freedom for vibration control, together with the appropriate earthquake protection.

This clause shall apply to complete assemblies, and subassemblies. All installed plant and equipment (including proprietary plant, containment and other components) shall be designed by the Contractor to withstand, without exceeding working stresses:

- A horizontal earthquake-induced force acting through the centre of gravity equal to its weight multiplied by a seismic factor as stated in the "Seismic Requirements for Mechanical and Electrical Services".
- Maximum gravity loads under expected operating conditions (including allowances for temperature movement, fluid pressure surges and the like).

- Wind loads induced by the application of the maximum 3-second gust expected every 50 years, multiplied by the appropriate factors as detailed in NZS 4203

Co-ordinate with the main Building Contractor and all their Contractors, the Architect and Structural Engineer in respect of the design and installation of seismic restraints to NZS4219

Considering the nature of the building, where services are exposed, seismic restraints and supports will be required that complement rather than dominate the architecture of the building.

Prior to fabrication of seismic restraints and supports the shop drawings are to be submitted to the Chartered Structural Engineer for their review and final approval.

2.22.2 Standards

To comply with this clause the installation is to be analysed and the detail design done in accordance with the provisions in the following Standards:

- NZS 4219:2009 'Seismic Performance of Engineering Systems in Buildings'.
- AS/NZS 1170 'Loadings Code' and be detailed in accordance with the appropriate material codes.

2.22.3 Seismic Requirements

The following table provides the design parameters for the temporary accommodation works and permanent works.

Britomart - Seismic design for non-structural components

Design Parameters	SLS	ULS
Design working life	100 year	100 year
Importance Level	**3**	**3**
Return Period	1/25	1/2500
Return Period Factor	0.25	1.8
Soil	Type E	Type E
Z	0.13	0.13

2.22.4 Quality Assurance

The Contractor is required to retain a Chartered Engineer (Structural) experienced in seismic fixings of plant to complete the design and observation of all equipment installations. The Contractor is to make allowance for the Chartered Engineer to provide a Producer Statement PS1 (Design) and PS4 (Construction Review) prior to Practical Completion.

Seismic restraint designer shall layout and identify seismic restraint locations. The layout and identification of seismic locations shall comply with New Zealand Standard NZS 4219:2009, Seismic Performance of Engineering Systems in Buildings. Engineered seismic restraint submittal and shop drawings shall be (signed & sealed) by a chartered New Zealand Structural Engineer and shall be submitted to the designer of record for review and acceptance prior to installation.

Seismic design submittal shall include Quality Assurance guidelines for use by reviewing authorities during inspection.

The project specific seismic restraint submittal shall include the design of both the seismic restraints and vertical (gravity) supports of the system(s) at seismic restraint locations.

Seismic restraint and vertical support design information shall dictate the following:

- Seismic restraints: Brace arm material/size/type and load rating, anchorage, allowable spacing (transverse/longitudinal), brace installation angles and allowable tolerances, means for positive attachment to utilities at longitudinal/transverse locations, means for reinforcing vertical support rods (as required) at restraint locations.
- Vertical (Gravity) Supports: Vertical support spacing, type, size, and anchorage.
- After installation of the seismic restraints, but prior to inspection by local territory authorities, Contractor shall submit to the designer of record for review and acceptance As Built Record Drawings accurately identifying all actual installed system layouts and seismic restraint locations.

2.22.5 Products

All seismic restraint bracketry and seismic anchorage connections to be those furnished by ISAT (International Seismic Application Technology) or approved equivalent.

2.23 PAINTING AND FINISHES

2.23.1 General

- Finishes for all products shall be as detailed on the Architect's drawings.
- If exposed to view (including in plant rooms) paint new services and equipment.
- Surfaces painted or finished off-site: Conform to Metals and pre-finishes.
- Exceptions: Do not paint chromium or nickel plating, anodised aluminium, GRP, stainless steel, non-metallic flexible materials and normally lubricated machined surfaces. Surfaces with finishes applied off-site need not be re-painted on-site provided the corrosion resistance of the finish is not less than that of the respective finish in the On-site paint systems table.
- All paint finishes on steel work including switchboards, UPS modules, MCC and DB shall be no thicker than 0.4mm and the sheet metal shall be equal to or greater than 0.4mm.
- Material Group Numbers shall be in accordance with Appendix A of C/VM2 and tested to either ISO 5660 part 1 and part 2 or ISO 9705, Or in lieu of testing as defined in Table A1 of Appendix A of C/VM2.

2.23.2 Standard

General: Conform to the recommendations of AS/NZS 2311 Sections 3, 6 and 7 or AS/NZS 2312 Sections 5, 8 and 10, as applicable.

Specifications: Conform to the On-site paint systems table.

ON-SITE PAINT SYSTEMS TABLE:

- Substrate 1st coat 2nd and 3rd coat
- Aluminium APAS-0035/3 APAS-0015/1
- Concrete APAS-0280/1 APAS-0015/1
- Copper APAS-2921 APAS-0024/1

- GRP APAS-2971 APAS-0015/1
- Iron and steelAPAS-0032 APAS-0015/1
- Organic or inorganic zinc primed metal APAS-0016/1 APAS-0015/1
- Timber APAS-0181 APAS-0015/1
- Metallic-coated steel APAS-0134 APAS-0015/1

2.23.3 Oil and petrol resistant finishes

- General: If the finished surface may be subject to oil and/or petrol provide APAS-0024/1 for the 2nd and 3rd coats in the On-site paint systems table.

2.23.4 Paint application

- Coats: Apply the first coat immediately after substrate preparation and before contamination of the substrate can occur. Ensure each coat of paint or clear finish is uniform in colour, gloss, thickness and texture and free of runs, sags, blisters or other discontinuities.

2.23.5 Combinations

- Do not combine paints from different manufacturers in a paint system.
- Protection
- Remove fixtures before starting to paint and re-fix in position undamaged on completion.

2.24 MARKING AND LABELLING

2.24.1 General

Mark services and equipment to provide a ready means of identification. Further marking and labelling is indicated in the relevant Technical Sections of this specification.

Locations exposed to weather: Provide durable materials.

- Consistency: Label and mark equipment using a consistent scheme across all services elements of the project.
- Operating and maintenance manuals: Provide marking and labelling text identical to the text and terminology used in operating and maintenance manuals.
- Accessories: Label isolating switches and outlets to identify circuit origin.
- Label text: To correspond to terminology and identifying number of the respective item as shown on the record drawings and documents.

Operable devices: Mark to provide a ready means of identification. Include the following:

- Controls.
- Indicators, gauges, meters and the like.
- Isolating switches.
- Outlets.

2.24.2 Labels and notices

All labelling shall be to the following requirements:

- For indoor applications only, engraved two-colour laminated plastic (Traffolyte)
- Proprietary pre-printed self-adhesive flexible plastic labels: Black lettering on white background except as follows:
- Danger, warning labels: White lettering on red background.
- Main switch and caution labels: Red lettering on white background.
- Colours in conformance with AS 1345
- For external applications: Stainless steel or brass ≥ 1 mm thick with black filled engraved lettering.
- Emergency functions: To AS 1319
- Signs for electrical hazards to NZBC F8/AS1
- If labels exceed 1.5mm thickness, radius or bevel the edges.
- Fix labels securely using screws, rivets or proprietary self-adhesive labels.
- Locate labels so that they are easily seen and are either attached to, below or next to the item being marked.
- To correspond to terminology and identifying number of the respective item as shown on the record drawings and documents.
- If labels are mounted in extruded aluminium sections, use rivets or countersunk screws to fix the extrusions.
- Use aluminium or monel rivets for aluminium labels.

2.24.3 Label locations

Locate labels so that they are easily seen and are either attached to, below or next to the item being marked.

2.24.4 Lettering heights

- Danger, warning and caution notices: ≥ 10 mm for main heading, ≥ 5 mm for remainder.
- Equipment labels within cabinets: ≥ 3.5 mm.
- Identifying labels on outside of cabinets: ≥ 5 mm.
- Isolating switches: ≥ 5 mm.
- Switchboards, main assembly designation: ≥ 25 mm.
- Switchboards, outgoing functional units: ≥ 8 mm.
- Switchboards, sub assembly designations: ≥ 15 mm.
- Other locations: ≥ 3 mm.

2.25 CONTRACTORS RESPONSIBILITY IN RESPECT TO SPECIALIST EQUIPMENT

Where specialist equipment forms part of the works the Project Manager may have had earlier contact with manufacturers in order to obtain information. The Contractor must not assume that manufacturers

are aware of the requirements as set out in this Specification and it is the Contractor's responsibility to ensure that manufacturers are given full details of Tender Requirements when seeking quotations.

2.25.1 SETTING OUT

The set out of all equipment shall be so arranged in conjunction with the ER and other trades concerned. All electrical containment including secondary containment i.e. conduits shall be made and positioned in a neat, workmanlike manner and a first class finish obtained.

2.25.2 PLACING OF ORDERS

The Contractor shall ensure that orders for materials shall be placed with the manufacturer and/or supplier as soon as possible to ensure delivery of the items specified and to obviate any delay or change of specified articles due to this neglect.

2.25.3 PROVISION OF MATERIALS

Except where otherwise noted, the Contractor shall provide all necessary fixtures and appliances, fittings, tools and all other incidental materials and accessories necessary for the satisfactory installation, testing and completion of the works, all to the satisfaction of the client.

All materials shall be new and the best of their respective kinds and generally the whole of the work shall be carried out in a neat and tidy manner and a first class finish obtained.

Allow for building in such other fittings and accessories as required or supplied with the fixtures.
The Contractor is to allow for submitting a materials and sample schedule to the ER a minimum of four (4) weeks prior to the placement of the order of the sample in question.

2.25.4 OBVIOUS WORK

The nature and spirit of the Specification and Drawings is to provide for the work herein enumerated and shown on the tender documents to be fully understood that the Contractor, on accepting the contract, agreed to furnish everything necessary for such construction notwithstanding any omission in the Specification and Drawings.

2.25.5 TRADE NAME REFERENCES:

Any reference in this Specification to trade names or to a particular manufactured product should not be interpreted to mean that the particular article or product is the only one to be supplied or used. The reference is given as an indication of the quality, class, type and finish of the items to be used and as information to Tenderers on the amount to be allowed for the items concerned.

Alternative offers will receive serious consideration but only on that basis. A conforming offer must be made with alternatives and the price variation applicable included as an option to the conforming tender. Where alternatives are offered, full details of the variation must be set out. This must include both benefits and disadvantages to enable a fair assessment to be made.

If tenderers are in doubt as to the suitability of any alternative, it is recommended that they discuss the matter with the Engineer prior to the expenditure of time and effort.

Articles or products of equal type and quality produced by the other manufacturers **must** be submitted by the Contractor to the ER for approval at the tender stage. Failure to submit alternatives at the tender stage of the project may result in any subsequent submission being rejected simply on a 'time bar' decision.

The reference 'equal to' shall be taken in all cases to be the same as the reference 'equal in all respects to". The acceptance of what constitutes as being of equal type and quality shall be at the sole discretion of the ER or Client.

2.25.6 BUILDING PENETRATIONS

Set out core holes and sleeves in floors, walls, beams and columns and obtain approval of the set out prior to placing concrete.

Where electrical services pass through walls, floors, beams or columns, provide purpose-made metal with 12mm clearance, packed with gunned silicone rubber joint sealer (self-extinguishing grade). Any penetrations that penetrate through walls/floors and ceiling shall be checked with the structural drawings and engineer before works. Additional structural supports and lintels may be necessary to maintain structural integrity.

Electrical cable ducts passing through walls below ground level shall be provided with a water stop puddle flange.

Approved fire collars shall be provided wherever a fire rated wall, ceiling or floor is penetrated by a pipe or fitting. The rating of the fire collar is to be the same fire rating of the wall, ceiling or floor penetrated, to comply to AS 1530 Part 4.

Contractor to provide fire rating certification for all installed electrical containment and wiring, sealants, materials and the like, to maintain the integrity of the fire compartments. Certification shall be provided by an independent party.

2.25.7 PLANT AND EQUIPMENT ACCESS

Services and equipment: Locate and arrange all services and equipment so that:

- Failure of plant and equipment (including leaks) does not create a hazard for the building occupants.
- Failure of plant and equipment (including leaks) cause a minimum or no damage to the building, its finishes and contents.
- Inspection and maintenance operations can be arranged to minimise inconvenience and disruption to building occupants or damage to the building structure or finishes.
- Locate and arrange all services and equipment so that:
- Inspection and maintenance operations can be arranged to minimise inconvenience and disruption to building occupants or damage to the building structure or finishes.
- Services and equipment are readily accessible for inspection and maintenance and arranged so that inspection and maintenance can be carried out in a safe and efficient manner. Include the following:
- Conform to AS/NZS 2865 and OSH Guidelines for the provision of facilities and general safety in the construction industry.
- If parts of the plant require regular inspection and maintenance either locate plant so it is safely accessible from floor level or provide permanent access platforms and ladders.
- In false ceilings locate items of equipment that require inspection and maintenance above tiled ceilings where possible. If this is not possible (for example if above set plaster or other inaccessible ceilings) provide access panels. Arrange services and plant locations to reduce the number of access panels. Coordinate with other trades to use common access panels where feasible.
- Modify manufacturer's standard equipment when necessary to provide the plant access in the contract documents.

2.25.8 PROTECTION

The Contractor shall be entirely responsible for all apparatus, equipment and appurtenances furnished by him or his Contractors in connection with this work and special care shall be taken to protect all

parts thereof in such a manner as may be necessary or as directed. This protection shall include covers, crating, sheds, stores or other means to protect the apparatus, equipment and materials from the weather and to prevent dirt, grit, plaster or other foreign substances from entering the working parts of machinery or equipment.

Special care shall be taken to keep all open ends of pipes, ducts, flues, etc. closed while in storage or during course of installation.

The Contractor shall protect all parts of the building and the work of other Contractors from damage which may be caused by the Contractor's workmen. The Contractor shall be responsible for making good any such damage.

2.26 ELECTRICAL WORK

All equipment supplied and work carried out under the contract shall comply with the requirements of the latest appropriate AS/NZS3000 Electrical Installations.

The electrical installation shall be carried out in accordance with the requirements of the Local Supply Authority.

All items of equipment shall be of first grade with regard to design and manufacture and shall be completely satisfactory for operation, control, safety and maintenance under all conditions of service.

Uniformity of type and manufacture of switch gear, control gear, fittings and accessories shall be preserved throughout the whole of the installation, refer to the Electrical for the type of fittings, wiring, conduits, control gear, etc.

2.27 STATION CONTROL REQUIREMENTS

2.27.1 General

Refer to the separate SCADA Controls Specification (CRL-BTM-BMS-000-SPE-0001) and Building Management Systems Specification (CRL-BTM-BMS-000-SPE-0002) for details of;

- Building Management Systems (BMS)
- Electrical Management Systems (EMS)
- SCADA Systems
- Control Integration and Interfacing

2.27.2 MANUFACTURER'S DIRECTIONS

Manufactured articles, materials and equipment are to be supplied, installed, connected, erected, used, cleaned and commissioned in strict conformity with manufacturer's printed directions unless otherwise specified. In any case, the Contractor is to obtain from the Supplier agreement that the product as used or specified is being used or specified in accordance with the manufacturer's requirements and practice. Retain manufacturer's directions for such articles on site for the Proprietor's reference.

2.28 SPARE PARTS AND SPECIAL TOOLS

2.28.1 Tools

At least 8 weeks before the date for practical completion, submit a schedule of tools, portable instruments and spare parts necessary for maintenance of the installation. For each item state the recommended quantity and the manufacturer's current price. Include the following in the prices:

- Checking receipt, marking and numbering in accordance with the spare parts schedule.
- Packaging and delivery to site.
- Referencing equipment schedules in the operation and maintenance manuals.
- Suitable means of identifying, storing and securing the tools and instruments. Include instructions for use.
- Painting, greasing and packing to prevent deterioration during storage.

Referencing equipment schedules in the operation and maintenance manuals.

Provide suitable means of identifying, storing and securing the tools and instruments. Include instructions for use.

2.28.2 SPARES

General: Provide spare parts listed in the appropriate work sections.

Replacement: Replace spare parts consumed during the maintenance period.

2.29 CAPPING OFF

During the construction, leave all unfinished work in safe condition and protect the works against damage or loss through any cause whatsoever, and seal off open ends of electrical cable ducts and equipment in such a manner as to prevent the entry of foreign matter into the lines until the works have been handed over on completion.

2.30 WORKMANSHIP

All equipment to be installed in a neat and tidy manner and comply with the latest relevant regulations, all local requirements and this specification.

2.31 CLEANING OF SERVICES

After installation and prior to testing all services shall be thoroughly cleaned and flushed out. All systems shall be checked for any foreign matter and cleaned.

On completion of all work, all tools, supplies, unused materials and waste materials shall be removed and the work left in a clean and tidy condition.

2.32 FIRE STOPPING / FIRE STOP COLLARS

All electrical containment, communications, security and CCTV services passing through any fire rated element shall be treated to achieve a fire rating of not less than the fire rating of the element that the service is passing through. Where any non-metallic services (eg HDPE, XPE, PE, etc) pass through any fire rated element they shall be surrounded by a sealant of intumescent material capable of completely sealing the pipe penetration under fire conditions.

Seal penetrations with a system conforming to AS 4072.1. Refer to the fire engineer's report for details of methods for penetrations through fire rated building elements.

Fire rated pillow systems shall not be used on the project.

The following methods may be used:

- Fire Resisting Gap Filler or acrylic sealant
- Foaming Sealants
- Flexible Fire Barrier Materials
- Fire Stop Collars
- Fire resistant cement, mortar
- Fire resistant bulkhead sealer

The Contractor shall provide an independently approved certification of all systems and/or methods of treatment proposed provided prior to the ordering of any materials. Certification must be for the situation that is proposed to be used. Generic certifications will not be accepted.

It is noted that where an independently approved certification of the proposed fire rating of the penetration cannot be provided for a proposed material, the Contractor shall be required to use an alternative material at no additional cost.

At the end of the project, a detailed schedule shall be provided giving the penetration number, location, services details, methods of treatment, the fire test report numbers and the fire resistance levels expected to be achieved. Provide detailed work as executed drawings showing the location of all penetrations treated. The schedule and drawings are to be included in the Operating and Maintenance Manual.

These inspecting authorities shall include but not limited to:

- Building Certifier; and
- An independent fire integrity consultant. The Contractor shall submit the name of their proposed fire integrity consultant to the Managing Contractor for approval at the time of their tender submission. The costs associated with the fire integrity consultant shall be included as part of the Electrical Contractor's tender price.

A copy of each of every inspection report of each Authority and the fire integrity consultant shall be forwarded to the Managing Contractor immediately it is available and no later than 5 working days after the inspection.

The Contractor shall arrange for all inspections required by the relevant authorities at suitable stages of the contract to enable the inspecting authority to ascertain that the treatment methods are being installed to their requirements and complies with the test reports.

2.32.1 Labelling Of Fire Rated Services Penetrations

All service penetrations to fire cells and fire separation systems are required to comply with all the designed fire integrity of the specified systems. Label all fire rated service penetrations to AS 4072.1 using the Certified Identification System provided by CID International Ltd.

Each fire stopping installation to have a permanently fixed tag or Label containing the following information:

- Manufacturer's name
- Name and address of installer
- Date of installation

Refer to CID International Ltd at www.cidcert.com to record all service penetrations.

2.32.2 Non-fire rated building elements

Seal penetrations around conduits and sleeves. Seal around cables within sleeves. If the building element is acoustically rated, maintain the rating. Pillow systems shall not be used on the project.

2.32.2.1 Sleeves

If piping or conduit penetrates building elements, provide metal sleeves formed from pipe sections. Refer to the 'Cable support and duct systems' section for further details.

2.32.2.2 Sleeves for cables

For penetrations of cables not enclosed in conduit through ground floor slabs, beams and external walls provide sleeves formed from metal pipe sections. Refer to the 'Cable support and duct systems' section for further details.

2.33 PVC MATERIALS

Typically no PVC based products shall be used for pipe work or conduits which may be exposed to fire for both public and BoH areas. PVC pipe work and conduits may be used if they are casted directly into concrete where they pose a low risk of fire spread or producing toxic fumes.

All cabling for LV and ELV systems including temporary works shall be Low Smoke Zero Halogen (LSOH) type. No PVC cabling shall be used.

2.34 TESTING AND COMMISSIONING

The Contractor shall test and commission the works in accordance with all relevant standards and general good practice and provide completion and test certificates.

The Contractor shall not connect the works to the utility supplies until all inspections and approvals, which the relevant supply authorities deem necessary, have been carried out and certified.

Discipline specific testing and commissioning is referred to in the relevant Technical Sections of this specification

2.34.1 General

The Contractor shall include for the complete testing and commissioning of the installations which must be to the complete satisfaction of the Engineer.

Britomart station shall remain operational throughout the demolition, temporary and permanent works. The Contractor shall allow for all staging and phasing of the works to ensure continuous operation of the station is maintained.

Sectional testing and commissioning shall be carried out during all phases of the works and include any systems that are 'taken out of service' that then require reinstating to ensure the safe operation and continuity of the station is not compromised.

The Contractor shall arrange for the commissioning of the installations to be carried out by a Specialist Firm of Commissioning Engineers.

All testing and commissioning shall be in accordance with the recommendations as detailed in the relevant standards and codes.

The Engineer or his appointed representative shall have access at all reasonable times to such parts of the Contractor's works as may be necessary for the purpose of inspection, examining and testing of materials, workmanship and performance of plant.

Except where stated in the specification or in the contract documents the Contractor shall provide all labour, materials, power, fuel and test equipment for carrying out the tests specified. Tests shall be on the site and/or off site as applicable to the test specified.

The Contractor shall ensure that all test equipment utilised by himself or his representatives for carrying out the tests is adequately maintained and calibrated, and carefully handled and transported.

The Contractor shall give the Engineer a minimum of seven days' notice of his intention to carry out tests. All tests will be witnessed by the Engineer or his representative.

The Contractor shall allow for carrying out the testing and commissioning of the installation in sub-sections as may be necessary for technical purpose or to suit the construction programme.

The Contractor shall arrange for a full demonstration of the installation in the presence of the Engineer and the Principal's nominated representative.

All plant, including standby equipment, shall be tested to ensure that it is operating in accordance with the specified conditions, and also that it is functioning in accordance with the control and interlocking sequences specified.

The adjusting and balancing of the systems shall as far as possible be done without the building being occupied or the systems being subjected to a full climatic cycle. Final adjustment and balancing to meet a full climatic cycle shall take place during the Defects Liability Period.

The Contractor shall commission the plant in accordance with NZ and CIBSE commissioning codes and leave the installation ready for full service.

2.34.2 Shutting Down/Linking into Existing Services

The Contractor shall follow this procedure when the work involves "shutting down" or "linking into" any existing building services at the site.

1. The Contractor shall advise the Client (through the Project Manager) of the required date, start time and duration for the shutdown. This advice shall be a minimum of 14 days before the required shutdown time.
2. Client (through the Project Manager) shall confirm to the Contractor if the required date, start time
   and duration for the shutdown is acceptable or advise an alternative.

- Steps 1 & 2 (as listed above) to be repeated until agreement is reached.

The Contractor shall then confirm in writing, the agreed date, start time and duration for the shutdown.

2.34.3 Commissioning Engineer

The Contractor shall appoint Commissioning Engineers for the project including;

- Review of Design Drawings at construction issue to check for dampers, valves, sensors etc.
- Review of Contractors shop drawings for access, commissioning etc.
- Inspection on site of first fix for access.
- Static completion works
- Proving operation from static completion to fully functioning

- Pre-commissioning review of sectional and completed systems and review of results.

2.34.4 Commissioning Plan and Staging of Works

The testing and commissioning of the works shall be carried out at various 'sectional' stages during the Demolition, Temporary and Permanent works with final system commissioning carried out prior to building handover.

2.34.5 Commissioning Dossier and Commissioning

Within an agreed time frame with the client the Contractor shall provide for the agreement and approval of the Engineer, a comprehensive commissioning dossier giving full details of all tests (sectional and final) to be carried out and the proposed method of recording of test information in respect of the plant and installations to be installed in the Contract.

2.34.5.1 Sectional Commissioning

Sectional testing and commissioning shall be carried out on any systems that are 'taken out of service' that then require 'bringing back into use' to ensure the safe operation and continuity of the station is not compromised. This includes any systems that;

- Impacts the day to day operation of the station
- Impacts any Critical Life Safety systems (xxx, xxx)
- Impacts any Critical Systems
- Impacts any Essential Life Safety Systems
- Impacts any Essential Systems

The Contractor shall review the Pedestrian and Analysis Report and use this document as a baseline to understanding the various staging and phasing of the temporary and permanent works.

Report	Description
Passenger and Pedestrian Analysis	CRL-SYW-ENG-000-RPT-0008

Testing

The Engineer or his representative will witness in conjunction with the Contractor all tests which are necessary to bring particular section of works up to a standard of "static" completion.

The Engineer or his representative will sign and obtain the signature of the Contractor on a test clearance certificate, which shall clearly indicate the test carried out, the date of the test and the result.

Sectional testing shall be carried out on any systems that are 'taken out of service' that then require 'bringing back into use' to ensure the safe operation and continuity of the station is not compromised.

Sectional testing shall be carried out on the following systems but not limited to;

Communications

- Any works to existing fibre network and existing comms racks
- Any works to existing PIDS, Help points, emergency telephones, EWIS/PA

Security and CCTV

- Any works to existing fibre network and access control systems
- Any works to existing fibre network and CCTV systems/cameras

2.34.5.2 Commissioning

Immediately prior to handover of the completed building the Employer's representative shall attend site, and together with the Engineer or his representative and the Contractor, he shall witness final acceptance testing of all engineering services.

It is intended that spot checks be taken on the installation being proposed for handover, and compared with the test data obtained under Commissioning. In the event that the spot checks are inconsistent with the test data, the element in question shall be checked in its entirety.

2.35 PRACTICAL COMPLETION

A notice of Practical completion will only be granted when the following minimum requirements are completed:

- All testing and commissioning has been carried out and accepted
- Producer Statements PS3 (Construction including all seismic support installation works).
- Producer Statement PS1 and PS4 from the seismic specialist in relation to all the design and inspection of the seismic supports for all works covered by this specification.
- Electrical Certificate of Completion
- Electrical Certificate of Compliance/Safety
- Communications Certificate of Completion
- Security Certificate of Completion
- CCTV Certificate of Completion
- Local Territorial Authority certificates of acceptance and sign off
- Setting to work and test results completed
- Draft A3 As-Built drawings inserted in the Operating & Maintenance Instruction manual
- Guarantees
- Draft Maintenance Log book

This date shall be the date from which the guarantee, warranty and defects liability periods shall operate.

This notice will not be issued until the systems have been property commissioned and until the Contractor has supplied operating and maintenance instructions.

2.36 GUARANTEES

The Contractor shall obtain all guarantees, certificates, etc for the work specified to be guaranteed or certified satisfactorily completed and lodge same with the ER on completion of the Agreement. Guarantees shall apply to all existing equipment, that is to remain in the completed development and all new equipment etc., for the full guarantee period.

2.37 OPERATION AND MAINTENANCE MANUALS

Britomart Station has an existing set of Operating and Maintenance Manuals (O&M). The intention is to maintain in operation the existing set of O&M’s and provide a new set of O&M’s for the temporary and permanent works.

The Contractor shall allow for the following;

2.37.1 Existing Station Operating & Maintenance Manuals

The Contractor shall review and update all relevant sections in the existing O&M manuals that have been affected by the works at the west end of the station and integration into the east end. This shall apply to the following disciplines;

- Electrical
- Communications (Including EWIS, PHP's, PID's, PA, WIP's etc.)
- Security
- CCTV
- SCADA

This shall include any systems that have been isolated, diverted, modified, removed, made good or new provided. Cross referencing shall be provided between the existing O&M and new O&M.

The existing O&M manuals shall be updated for both temporary and permanent works.

2.37.2 New Station Operating & Maintenance Manuals

All new works carried out at the west end of the station shall include for new Operating and Maintenance manuals.

New O&M manuals shall be provided for both temporary and permanent works.

The format of all Operation and Maintenance Manuals shall:

- Facilitate the rapid detection of the cause of all faults and the recommended course of action for repairs,
- Provide a simple and clear system for the safe and efficient operation and maintenance of the system throughout its design life.

Equipment manuals shall comprise a plastic covered ring binder(s) with the project title, Client's name, Contractors name, Architect's name and Engineer's name embossed on the cover. The manuals are to contain all necessary information required for the safe and economic operation of the services, and shall include:

- Index
- General description of the installation, and a technical description and mode of operation of the systems installed. Identify function, normal operating characteristics and limiting conditions.
- Technical description of the systems installed, written to ensure that the principal's staff fully understand the scope and facilities provided. Identify function, normal operating characteristics, and limiting conditions
- Operation procedures for; safe starting up, running in, operating and shutting down - Include logical step-by-step sequence of instructions for each procedure.
- Control sequences and flow diagrams for systems. Schedules of fixed and variable equipment settings
- Preventive Maintenance Procedures (with illustrations)
- Corrective Maintenance Procedures (with illustrations)
- Repair Procedures (with illustrations)
- Test Procedures

- Illustrated Parts List (including a list of recommended spares holding)
- Special Tools and Test Equipment
- Final shop drawings/as-built drawings, and other final shop drawing documents. Include site and underground services. For alterations include existing services.
- Statutory Certificates as appropriate
- Manufacturers' technical literature for equipment installed, assembled specifically for the project, excluding irrelevant matter. Mark each product data sheet to clearly identify specific products and component parts used in the installation, and data applicable to the installation.
- Commissioning Data.

2.38 TRAINING

2.38.1 General

Provide training and instruction to the appropriate staff on;

- Maintenance of the installation
- Operation of the installation
- Seasonal requirements
- Use of the Maintenance and Operations Manual

Conduct training, in an agreed format, by agreed persons, at agreed locations and time and to agreed owner's representatives.

Duration: Instruction to be available for the whole of the commissioning and running-in periods.
Format: Conduct training at agreed times, at system or equipment location. Also provide seminar instruction to cover all major components.

Operation and maintenance manuals: Use items and procedures listed in the final draft operation and maintenance manuals as the basis for instruction. Review contents in detail with the principal's staff.

2.38.2 Demonstrators

Use only qualified manufacturer's representatives who are knowledgeable about the installations. Explain and demonstrate to the principal's staff the purpose, function, operation and maintenance of the installations.

2.39 PREVENTIVE MAINTENANCE AND DEFECTS LIABILITY

The Preventative Maintenance and Defects Liability Period shall extend for a period of twelve (12) calendar months from the date of Practical Completion. During the maintenance and defects liability period the Contract Plant shall be under the possession and control of the Owner but the Contractor may be in attendance for maintenance.

During the Maintenance Period the Contractor shall:

- Carry out all maintenance and reporting as required by the New Zealand Building Code Handbook Compliance Schedules.
- Carry out all routine maintenance work necessitated by statutory regulations and as required by normal good trade practice.
- Comprehensively inspect, test and adjust where necessary all controls, indications and alarms for at weekly intervals, or as necessary.

- Correct any defects which may occur promptly and on a twenty four (24) hours a day, seven (7) days a week basis.

The Contractor shall provide an approved logbook kept by the Project Manager in which are recorded details of the inspection functions and all defects found and remedial actions taken. Each time an inspection is made, it shall be recorded with the name of the Building Services Contractor's inspector and details of inspections carried out and shall be signed by the Owner's representative on completion of the inspection.

All new works to be maintained by the contractor during the defects liability period. All existing equipment to be maintained by the maintenance contractor.

2.39.1 Call Out Services

A necessary element of services to be provided by the Contractor is the provision of a 24 hour, 7-day Call Out service to attend in the event of specific alarm notifications and unexpected situations or events where Contractor expertise is necessary.

There are three priority levels and associated response expectations for Call Out services and the Contractor is expected to constantly maintain a current 'Call Out' Response Plan for each:

2.39.1.1 Critical

Alarm notifications or events which are either life threatening or causing significant distress to AT. These require an immediate and absolute priority action response by the Contractor using authorised Contractor representative(s) and their attendance within 30 minutes at the scene or origin of the notification or event, subject to accessibility and normal personal safety procedures.

2.39.1.2 Emergency

Alarm notifications or events which potentially may escalate to become life threatening or cause significant distress to AT. These require an immediate response by the Contractor such that appropriate authorised Contractor representative(s) are in attendance within 240 minutes at the scene or origin of the notification or event, subject to access and normal personal safety procedures.

2.39.1.3 Routine

Alarm notifications or events which will not escalate within a 24-hour time frame to become life threatening or cause significant distress to AT. These require an initial response by the appropriate authorised Contractor representative(s) within 12 hours and their attendance at the scene or origin of the notification or event as promptly as is necessary to verify that the alarm cause or event cannot escalate to Emergency status, or implement immediate actions to ensure that this cannot occur.

Every Call Out shall be initially be treated as Critical until it is confirmed that it can be downgraded to Emergency or, in turn downgraded to Routine.

2.39.2 Defects Liability

The Contractor shall be responsible for the rectification of all defects in the work due to faulty materials and/or workmanship for the duration of the twelve (12) month defects liability period commencing from

the date of practical completion. Such defects shall be made good immediately on receipt by the Contractor on advice from the ER.

Any defects discovered during the defects liability period which are due to default or negligence by the Contractor in the performance or observance of any of his obligations, shall extend the period to enable such defects to be made good by the Contractor and to allow the whole work after being made good in every way, to be proved satisfactory.

2.39.3 Expiration of Defects Liability Period

On expiration of defects liability period the Contractor is to produce certification for all services essential services installed by the Contractor as required by the BCA.

2.40 WARRANTIES

All plant, equipment and materials supplied under this contract shall be covered by twelve (12) months warranty against faulty manufacture, workmanship and/or materials. The Contractor shall be responsible for the rectification and/or replacement of any portion of the installation which fails during the warranty period.

The Contractor shall be responsible for the rectification and/or replacement of any portion of the installation which fails during the warranty period.

The warranty period shall commence as from the date of practical completion or replacement, as applicable but extension of the period shall be made in respect of replaced portions only.

3 Scope - Electrical

3.1 PROJECT OVERVIEW

For Britomart Station Construction Contract 1, the extent of the works includes the construction of the through tunnels which continue west of the station below the CPO (Chief Post Office building) . The proposed permanent works includes the reconfiguration of station west, where existing plant and BoH rooms on levels B1 and B2 are to be demolished and removed.

Part of these works requires the existing main electrical switch rooms on platform B2 level to be relocated. This is due to the current access no longer being available due to construction of the 'down line' running tunnel. The proposed location of the new main electrical panels will be on level B1 located under Queen Street. These panels will be connected from the existing Plaza HV/Transformers on ground level.

The main construction works and the CPO building will be closed off from the public, to allow for the excavation works for the running tunnels. The CPO building is currently supplied from a local sub-switch panel on level B1, which will need to be removed during the construction works. These panels currently serves an number of areas, including the glasshouse and tenancies on level 1-3 and other BoH areas.

During the closure of the main CPO station entrance, a temporary station entrance will be built to allow the continuity of station operation. A temporary ticket office will be located east of the existing glasshouse structure currently referred as the temporary plaza works, to allow public access to the platforms via escalators and new temporary stairs. During this temporary phase, new electrical supplies will be required for the station accommodation facilities, ticket office/fares, retail and public spaces.

Part of the permanent station works is the refurbishment of the ground floor CPO including new ticket/fare offices, customer services and retail units. A new evacuation stair from platform level, exiting on to street level will also be built beside the existing north riser of the CPO. Other areas that have been impacted by the main construction including the public toilets and glass bridge will also be refurbished.

The permanent works will be designed to meet the CRL Functional Design Requirements this includes new dedicated equipment rooms to be provided for electrical, UPS' Comms, mechanical and hydraulic plantrooms. In addition to this, new diverse route across 'A and B' services shall be provided to achieve a higher level of redundancy across systems. New service corridors with high and low level trenches shall be provided. Separate service rises within the CPO building shall also be designed provided to maintain separation across systems.

3.2 GENERAL

The Electrical Contractor shall allow for;

- Provision of coordinated installation/working drawings, fabrication drawings and record drawings – the Contractor's installation/working drawings shall be developed from the design drawings and include for any post tender changes to the layout that do not alter the design intent of the engineering services. Multi service coordination details shall be provided where necessary to demonstrate the installation intent for main services distribution and congested areas, clearly indicating access for maintenance.
- Detailed design and locations for all brackets and supports. The arrangement and locations of each type, including structural loadings must be issued to the Engineer prior to installation for review and comment.
- Condition survey, testing and re-commissioning of the Britomart Station Fans in accordance with the Fire Engineering report
- Equipment component design and selection to comply with the engineering specification and performance.
- Containment fixing supports, access covers and gratings, ladders and additional structural steelwork where required and detailed in the sub-contract documentation.
- Provision of fire stopping and fire rating of selected fittings and equipment, to maintain the building's fire compartmentation at all services penetrations.
- Supply and install the electrical connections for socket outlets, lighting, fixed equipment for comms security, fire, station controls and mechanical/hydraulic MCC's;
- Provision for electrical containment including power, comms, fire SCADA and third party cabling.
- Anti-vibration and seismic mountings to suit the particular application of the mounting arrangement.
- Seismic design including installation works to meet the requirements of NZS4219.
- Details of electrical wiring diagrams of all equipment supplied by the Contractor showing all interconnections between equipment to enable the necessary wiring to be undertaken.
- Specify electrical equipment that includes EMC compatibility and compliance with CE approval of electronic equipment specified.
- Size and installation arrangement of automatic control panels to suit the detailed requirement of the particular agreed manufacturers controls equipment and cable entry/exit accommodation such that cable entry is possible in the selected location, doors are not fouled by other plant equipment, services or the building structure and safe operating and maintenance clearances are provided in all access positions when installed on site.
- Provision of all builders work including production of drawings and installation details.
- The coordination of services with the building fabric and structure, including but not limited to structures, civil works, mechanical, plumbing/drainage, fire protection/emergency egress, finishes and coordination with all other Contractors and the provision and production of manufacturer's details, fabrication details and drawings and coordinated installation drawings. All of the above information shall be submitted for review and comment prior to plant being ordered or works carried out. The Contractor's installation/working drawings shall be developed from the design drawings and include for any post tender changes to the layout that do not alter the design intent of the engineering services.
- Seismic restraint and certification of ECS equipment – provide PS1 and PS4 from their CPEng structural engineer / seismic specialist.

- Submission of required construction drawings and information on materials and equipment for the project manager's review.

Preparation of detailed method statements and programmes for the execution of the works, including refurbishment works. This programme shall include testing and commissioning which is coordinated with other Contractors and allow adequate time and notice for observation by the project manager.

3.2.1 Station LV Distribution systems

The scope of the contract electrical works as detailed within this specification and associated drawings shall include, but not be limited to, the design, supply, installation, testing and commissioning of the following:

- Detailed survey of all existing electrical systems internal and external to Britomart Station and the CPO building
- Demolition and removal of existing electrical services not required for station operation
- Electrical services required for the temporary and permanent station including all power, critical power, lighting, lighting control, emergency lighting and exit signage, interfacing to other systems, earthing and bonding
- Continuity of station operation during temporary and permanent works programmes
- Diversion of power supplies during temporary and permanent works programmes
- Staging of all works necessary for enabling, temporary and permanent works
- Rearrangement of the existing 'A' and 'B' transformer room LV infrastructure to accommodate additional new power supplies for the temporary accommodation and new permanent works
- Provision of an 'A' and 'B' low voltage power supply to the new CPO main switchrooms;
- Provision of an 'A' and 'B' low voltage power supply to the new temporary station entrance and main switchroom;
- Provision of low voltage switchgear, main switchboards and distribution boards includes for temporary and permanent works;
- Provision of ancillary switchgear such as change-over switches, automatic transfer switches, bus-ties, T-off boxes, etc ;
- Provision of circuit breakers and equipment for power factor correction and harmonics mitigation;
- Provision of low voltage metering;
- Provision of an Electrical Management System (EMS) and integration with station electrical systems, i.e. lighting controls, LV panels/switchgear, load shedding and UPS'.
- Provision of load shedding facility (permanent works);
- Provision of 'A and B' battery back-up systems for critical and essential services including on-line Uninterruptable Power Supply (UPS) systems, DC battery and charger systems;
- Provision of sub-main cabling to electrical, mechanical, hydraulic and fire switchboards, distribution boards and control panels;
- Provision of sub-main cabling to individual station equipment loads such as ventilation fans, smoke exhaust fans, lifts, fire pumps, escalators etc.;
- Provision of electrical small power and lighting sub-circuit cabling and outlets for all works including fittings, fixtures and equipment;

- Provision of minor power supplies to mechanical, hydraulic and fire services equipment such as isolators, pumps, fans, Hot Water Cylinders (HWC's) etc.
- Provision of internal and external luminaires, switching devices, occupancy sensing devices and daylight control devices
- Provision of point of supply for tunnel LV services and signalling equipment room (SER)
- Provision of earthing and bonding systems for all works and provision for interfacing to traction earthing systems
- Surge protection on all main switchboards and distribution boards
- Provision of interfaces of electrical systems to other systems such as fire, mechanical, hydraulic;
- Provision and integration for new electrical supplies to existing services i.e. platform lighting and power
- Provision for a metered power supply and DB to retail units;
- Isolation and decommissioning of services to the temporary accommodation facilities;
- Isolation and decommissioning of services not required to remain or be provided for the permanent works which may include the CPO main switchboard and the existing station main switchboards

3.2.2 Containment Management Systems and Supports

- Provision of primary and secondary containment for all electrical services which may include cable ladder, cable tray, cable basket, ducting, conduits and catenary wire throughout the entire facility, incoming services and tunnels (where required for station services reticulated in tunnels e.g LV cabling);
- Provision of primary and secondary containment for communications, security, CCTV, station controls (SCADA) Fire and Third party which may include cable ladder, cable tray, cable basket throughout the entire facility, incoming services and tunnels (where required for station services reticulated in tunnels e.g. comms backbone cabling);
- Provision of enclosures, fixings and supports including floor boxes, ducting, in-slab conduits, equipment supports and bracing;
- Design and installation of all seismic restraints for electrical and communications services to comply with NZS 4219 including cable tray/ladder, switchboards, cable basket, comms racks, UPS's, suspended light fittings etc.

3.2.3 Station Control and Extra Low Voltage Systems

- Design, supply, install and commissioning of intelligent lighting control systems and integration with EMS and interfacing to station control system I/O terminals.
- Design, supply, install and commissioning of passenger services equipment such as Passenger Information Displays (PIDs), help points, Public Address (PA) systems, vending machines, ticketing machines, public phones and clocks
- Provision of power supplies to staff services equipment such as radio systems, voice recorder systems, cash accounting systems and communications network systems
- Design, install, supply and the commissioning of Comms IT, security/CCTV systems including, structured cabling, and cable terminations and equipment racks.
- Provision for power supply for fire alarm and mimic panels
- Provision for power supply for station control systems (SCADA)
- Provision of a distributed lighting control system and software for the permanent works

- Provision of interfacing between electrical systems including lighting control, emergency lighting, LV switchgear, security, CCTV;
- Integration of any new, relocated or diverted services into the existing station east systems e.g. interfacing to station control and comms systems;
- The design and installation of the Britomart and CPO electrical systems, plant rooms and emergency rooms shall incorporate the Fire Engineering requirements.

3.3 ASSOCIATED WORK AND INTERFACES

This section outlines the work associated with the contract which is to be provided by the Contractor and other interfacing trade contractors. The Contactor shall co-ordinate and interface the services works with the associated works contractors.

This applies to the Construction Contract 1 enabling works (Temporary and Permanent).

3.3.1 Electrical for Hydraulics Works

The Contractor shall be responsible for contacting the Hydraulic Contractor to coordinate the location that the electrical power is required to be run to and for coordinating the time that the electrical power is to be connected to the hydraulics components. The power is required to be supplied, installed and terminated including isolators, switches, permanent connection units shown on electrical drawings and for the following unless specified otherwise:

- Electrical supply to hot water cylinders
- Electrical supply to boiling water/chilled water units.
- Electrical supply to hydraulics control panels/DB's (final termination by Hydraulics Contractor).
- Earthing and bonding of metallic hydraulic services components
- Liaise with the Hydraulics Contractor with respect to final equipment loads and supply locations for all relevant systems and ensure that electrical power supply and submains are adequately sized to serve the hydraulic MCC/distributed equipment as appropriate. Adjust the Hydraulic MCC circuit breaker settings on the DB's and MSBs.

Note the Hydraulic/Mechanical Contractor shall be responsible for the supplying their respective MCC/control panels and supply the power and control cabling from the control panels to the field equipment where required this includes the cable containment system. The Hydraulic/Mechanical Contractor is to allow for all costs for all wiring from the MCC's and control panels to the individual items of equipment, pumps, etc. and including all termination of the power to the items of equipment.

3.3.2 Electrical for Mechanical Works

The Contractor shall be responsible for contacting the Mechanical Contractor to coordinate the location that the electrical power is required to be run to and for coordinating the time that the electrical power is to be connected to the mechanical components. The power is required to be supplied, installed and terminated including isolators, switches, permanent connection units shown on electrical drawings and for the following unless specified otherwise:

- Electrical supply to mechanical services control panels/DB's (final termination by Mechanical Contractor).
- Range hoods with fans and lights
- Earthing and bonding of metallic mechanical services components
- Liaise with the Mechanical Contractor with respect to final equipment loads and supply locations for all relevant systems and ensure that electrical power supply and submains are adequately sized to serve the mechanical MCC/distribution board as appropriate. Adjust the mechanical MCC circuit breaker settings on the DB's and MSBs.

Note the Mechanical Contractor shall be responsible for the supplying their respective MCC/control panels and supply the power and control cabling from the control panels to the field equipment where

required this includes the cable containment system. The Mechanical Contractor is to allow for all costs for all wiring from the mechanical MCC's and control panels to the individual items of equipment, fans, etc. and including all termination of the power to the items of equipment.

3.3.3 Electrical for Fire Works

The Contractor shall be responsible for contacting the Fire Contractor to coordinate the location that the electrical power is required to be run to and for coordinating the time that the electrical power is to be connected to the fire components. The power is required to be supplied, installed and terminated including isolators, switches, permanent connection units for the following unless specified otherwise:

- Electrical supply to fire services control panels/Fire alarm panels (final termination by Fire Contractor).
- Earthing and bonding of metallic fire services components
- Liaise with the Fire services Contractor with respect to final equipment loads and supply locations for all relevant systems and ensure that electrical power supply and submains are adequately sized to serve the fire services switchboards and distributed equipment as appropriate. Adjust the fire services circuit breaker settings on the DB's and MSBs.

Note the Fire Contractor is to supply the connection from the control panels and to the equipment where required. The Fire Contractor is to allow for all costs for all wiring from the fire control panels to the individual items of equipment including all termination of the power to the items of equipment.

3.3.4 Electrical for Escalator/Vertical Transport Work

The Contractor shall be responsible for contacting the Escalator services Contractors to coordinate the location that the electrical power is required to be run to and for coordinating the time that the electrical power is to be connected to the respective components. The power is required to be supplied, installed and terminated at the local isolators within the control panel, as shown on electrical drawings and for the following unless specified otherwise:

- Electrical supply to the Escalator/Lift services control panels/DB's (final termination by respective Contractor).
- Earthing and bonding of respective Contractors metallic services components
- Liaise with the Escalator and Lift Contractor with respect to final equipment loads and supply locations for all relevant systems and ensure that electrical power supply and submains are adequately sized to serve the respective services switchboards and distributed equipment as appropriate. Adjust the respective circuit breaker settings on the DB's and MSBs.
- Provide the necessary cable management system for LV and controls from the electrical DB upto the control panel, containment beyond this point will be provided and installed by the Escalator/Lift Contractor.
- Control field wiring and secondary containment from the control panel back to the stations BMS and SCADA system, to be coordinated with the SCADA Control Specialist.

3.3.5 Electrical for Building Management Systems (BMS) Controls Works

The Electrical Contractor shall:

- Provide electrical supplies to the control panels if not supplied from local MCC (final termination by respective Contractor).
- Liaise with the BMS Specialist Contractor to agree suitable remote locations for power supplies including UPS backed supplies.
- Provide the necessary cable management system for LV and controls from the electrical DB upto the control panel, containment beyond this point will be provided and coordinated by the BMS Controls Specialist Contractor.
- Provide the Controls Specialist Contractor with CAD drawings in electronic format of the electrical installation and schematics.
- Earthing and bonding of respective Contractors metallic services components.

3.3.6 Electrical for SCADA Works

The Electrical Contractor shall also allow within their tender submission the following provisions for SCADA, this includes the supply and installation, excluding the design (to be undertaken by the SCADA Control Specialist) and shall be read in conjunction with the Controls Specification and SCADA/Control design drawings provided. This includes the following but not limited to:

- The supply and installation of all control cabling/wiring and terminations, including cable primary and secondary containment from all I/O bases, outstations within the MSB's, UPS', Lighting Control Panels, Mechanical and Hydraulic MCC's and other control equipment panels back to the local SCADA marshalling cabinets as shown on the SCADA layout drawings.
- Supply, install and coordinate the necessary secondary containment i.e. conduits and junction boxes from the control panel/outstation as required by the SCADA Specialist.
- Supply and install all necessary controls cabling, including copper and fibre in line with manufacturers recommendations, from control panels/outstations to field control devices including necessary cable containment and final connections (SCADA Specialist to specify cable type/performance ratings).
- To supply install the IT Comms backbone cabling network including final connections and cable containment for the EMS and BMS control systems to the Comms cabinets/Node points.
- To install the new hardware including, SCADA local marshalling panels, as per layout drawings (equipment/hardware to be supplied by the SCADA Controls Specialist).
- Design, supply and install local power supplies to all SCADA and control equipment, including UPS backed supplies for any life safety critical plant/equipment.
- Design supply and install front end PCs for EMS (located within the BMS Control Room Level B1).
- To install the I/O bases within the MCC/Control panels as per the SCADA design (SCADA bases to be supplied by SCADA Specialist).
- The integration of the EMS to SCADA (coordinated with the SCADA Controls Specialist) for the control and monitoring of electrical systems including, power metering, load shedding, switchgear status, UPS alarms via I/O terminals and SCADA marshalling panels as described in the 'Controls Specification CRL-BTM-BMS-000-SPE-0001'.
- The interfacing of the Intelligent Lighting control system and the Emergency Lighting Monitoring System via I/O terminals and SCADA marshalling panels within the field. Lighting and Emergency Lighting requiring SCADA monitoring and control.
- Design, supply and install for local switched relays/contactors within electrical DBs and panels compatible with for remote SCADA control switching i.e. existing platform and glasshouse lighting.

- Design of dedicated control Ethernet network complete with network interface devices and switches as necessary.
- Supply and installation of an Ethernet compliant connection between the new Control network and the existing SCADA network (Design to be provided by SCADA Controls Specialist).
- Supply and install all control cabling/wiring including final connections and all sub-network cabling and containment between MCC's, outstations, controllers and system interface units as shown on the Controls demarcation schematic.
- Supply and install the the secondary containment from control panels as required and coordinated with the SCADA Specialist.
- Labelling and identification of all plant, equipment, controls, terminations, cabling, control panels etc. in accordance with recognised standards and Mechanical and Electrical specifications, and any other documentation forming part of the contract.
- Equipotential and supplementary earth bonding associated with the Controls System wiring installations.
- Liaison with commissioning engineers and attendance at systems commissioning including electrical commissioning tests and life safety systems tests where interfacing occurs.

The ECS Contractor shall include the following within their tender submission but not limited to:

The CCTV/Security and Access system are stand-alone and works independent of the SCADA. However, the SCADA co-ordinates the switching of the field devices, CCTV picture on the main display in response to a signal from various field devices, for example:

- Fire Control Panel Alarms (Manual Call Points, FOHDS detection, etc)
- Passenger Help Point Activations
- WIP and Emergency Phone Activations
- Access Control Alarms
- EWIS

Activation of the field device is signalled to the SCADA. The SCADA then initiates the activation of a camera, including where provided, to move a PTZ camera to focus on the device.

As part of temporary and permanent works, both new and relocated cameras will be installed and connected back to the CCTV controller in the East end. The camera switching will need to be modified in both the SCADA PLC and CCTV controller. The Comms/CCTV contractor will be required to update the switching matrix and coordinate with the SCADA Specialist.

In addition to the SCADA controls, the ECS Contractor shall provide the following, with the Controls Specialist supervision, but not limited to;

- Demolition/removal of existing SCADA services not required for station operation (Coordinated with the SCADA Controls specialist)
- Diversion of SCADA services hardware and cabling during temporary and permanent works programmes
- Staging of all works necessary for enabling, temporary and permanent works
- Provision of enclosures, fixings and all supports;
- Design and installation of all seismic restraints/supports to comply with NZS 4219
- Isolation and decommissioning of services to the temporary accommodation facilities
- Isolation and decommissioning of services not required to remain or be provided for the permanent works
- Integration of temporary and permanent systems into the station east end (i.e. Controls, Fire etc.)
- Co-ordination of services with other trades
- Submission of shop drawings and samples for approval
- Testing & Commissioning of all installed services to provide fully functioning Controls systems
- Training
- Operating & maintenance manuals
- Warranties on all works and materials
- As built drawings and documentation

3.3.7 Existing Power Systems

Note: Refer to electrical drawings for locations of existing major plantrooms.

3.3.7.1 High Voltage Supply

Currently, Britomart station is supplied via Vector ‘A’ and ‘B’ HV supplies emanating from Quay Street and Hobson St HV substations respectively. The incoming ‘A’ and ‘B’ HV supplies from Hobson and Quay St terminate at a Vector HV substation located at the east end of Britomart station. The Vector substation subsequently provides power to separate Britomart ‘A’ and ‘B’ 11kV substations also located at the east end of the station.

These two HV substations supply three sets of ‘A’ and ‘B’ 11kV/400V substations located at Tangihua St, Britomart east and Britomart west (station plaza east end of the glass house). The existing 11kV ‘A’ and ‘B’ supplies and existing substation arrangement at Britomart west will remain.

3.3.7.2 Station West (Level B1 and B2)

The existing 11kV/400V Britomart West substations supply ‘A’ and ‘B’ main switchboards within electrical switch rooms are located on the north side of level B2 (platform level).

Power supplies to the west end of the station and the CPO building mains cabling emanate from the electrical switch rooms located on level B2 of the station.

A number of electrical and communications supplies emanating from the electrical switch rooms and the communications cabinet on level B2 of the station, that supply station west services, platform services and CPO mains cabling, are in conduits that run under the existing tracks and/or are in close proximity to the new proposed track extensions, station plant rooms and back-of house areas.

The supplies include:

- Mains cabling supplying the CPO building;
- Supplies to station mechanical DB’s (including fan/escalator/lift supplies), lighting, emergency lighting and exit signage, small power, Passenger Information Displays (PIDs), help points, warden information phones, PA, earthing, communications, life safety control cabling, security and CCTV and SCADA control cabling.

The existing ‘A’ and ‘B’ main switchboards shall be retained during construction until such time as the permanent main switchboards are complete and all necessary change-over of supply from the existing main switchboards to the permanent main switchboards is complete.

3.3.7.3 Small Power

Design, supply, install, test and commission a complete LV power installation emanating from the final circuit distribution boards, as shown on the small power and lighting layout drawings and in accordance to AS/NZS3000.

The LV small power installation shall include but not be limited to the following:

- General 10A GPOs for office, staff, plant and BoH areas
- Cleaners GPO’s with local RCD protection
- Lockable type with key switch for public areas
- Socket outlets with additional switches for fridges, microwaves, boiling water units in kitchen and staff areas
- RCD protected outlets (30mA) for public area and damp/external environments

- Suitable sized switched outlets/isolators i.e. 32A HWC where shown on electrical drawings
- Permanent switched outlets for fixed equipment including stoves, ovens, hand dryers, urinal controllers, hot water boilers, radiant heating panels, Vending Reload Devices and etc.
- Supply to fire alarm panel battery charger
- Power supply to mechanical, hydraulic and fire services where described in specification or documented on drawings
- IP56 switched commando outlets in plant room and external areas or suitable for its environment
- Security, PIDs, CCTV, comms and control systems equipment and field devices
- Power to passenger, staff and operational systems and equipment
- Power to lighting, lighting control equipment and emergency lighting/ exit signage
- Power to external and internal illuminated signage
- 230V power supplies to security door hold open devices where installed
- Any additional power requirement as required by the client

3.3.7.4 Design Life

The design of the electrical system shall be such that no major repair shall be necessary for the duration of the maintainable design life from the handover date. Routine replacement of consumables (lamps, filters and the like) and parts subject to normal wear and tear are excluded.

The maintainable design life of elements within the electrical system is detailed in the table below.

Element	Design Life (Years)	Operating Requirements (hours per day – 365 days a year)
Electrical switchgear	40	24
Electrical accessories & outlets	25	24
Electrical power cables	60	24
UPS batteries	10	24

3.3.7.5 Earthing

The Contractor shall establish a local earth system around the perimeter of the site and shall achieve an acceptable resistivity level for safety and the functioning of protective devices to operate in accordance with AS/NZS3000.

The contractor shall engage with an Earthing and Lightning Specialist to assist with the design, installation, testing and commissioning of the system.

Suitable earth rods with accessible earth pits shall be available at each location for periodic testing of the earthing system. Earth cables shall be connected to each earth electrode to form an earth nest for provide a secondary earthing system, which in turn shall be bonded back to the existing station main earth bar located within TX1-1 electrical room.

The earth bar within temporary accommodation switchpanel shall be bonded to the existing main station earth system. This is to ensure equipotential bonding is achieved across the station, as shown on the earthing schematic.

The temporary accommodation switchpanel will be an outbuilding whereby there is no M.E.N link within this panel. A dedicated equipontential ear bar shall be connected from the temporary accommodation switchpanel to provide a clean earth for comms equipment rooms.

A dedicated comms earth earth bar shall be made available for the north and south comms equipment room/cupboard and shall solely be used for the comms equipment/racks as shown on the drawings.

The contractor shall use earthing bonds, clamps and connections from one manufacturer and ensure that all components are made from non-ferrous metals and are resistant to corrosion.

No direct bonds shall be made to the traction earthing system across the installation.

The main earth bar shall also be used to bond the steel canopy frame work and extraneous steel work including, and electrical containment, duct work and the existing glasshouse shall all be bonded to this earth bar for equipotential bonding.

3.3.7.6 Lightning Protection

From the Lightning Risk Assessment based on AS/NZS 1768, the temporary accommodation buildings and canopy does not require any protection. However the steel frame canopy system and the steel columns shall be electrical continuous across the entire structure and bonded at the base to local earth electrodes. This is to ensures a direct path to earth if any flashovers that may occur from neighbouring buildings.

Surge protection devices shall be installed within the switchboard and local DBs as shown on the drawings. Additional lightning surge arresters for sensitive comms equipment shall be provided separately by the comms contractor within the local distribution board/s.

3.3.8 Temporary Works including Temporary Station Entrance

Omitted for clarity. Refer Rev 7 of this specification

3.3.9 Permanent Works

3.3.9.1 Design Intent

The design intent of the station power supply arrangement is to establish a power distribution system that minimises loss of power supply to station and tunnel equipment loads through the provision of a resilient power supply arrangement.

Power supply equipment shall generally be provided on the basis of providing N – 1 redundancy, through the provision of independent 'A' and 'B' Power supplies with separate 'A' and 'B' switchgear and transformers.

The loading of the LV Power supply system shall be balanced between each phase.

LV distribution shall comprise separate 'A' and 'B' distribution for:

- Main switchboards
- Sub-mains cabling
- Sub-distribution boards (where required)
- Final circuit cabling (where required)

'A' and 'B' distribution shall be routed in separate containment and where possible along diverse routes, sub mains in particular

A third source of supply shall be for 'Critical Life Safety' and 'Critical' systems, which shall include:

- On-line UPS systems
- DC battery and charger

During public operation the design intent is for an alternative electricity supply for life critical systems to allow public operation as follows:

Electricity Supply Strategy				
Operation	**Supply 'A'**	**Supply 'B'**	**Life Safety UPS**	**Comment**
Open to Public	Healthy	Healthy	Healthy	
Open to Public	Off	Healthy	Healthy	'A' loads switched to 'B' supply
Open to Public	Healthy	Off	Healthy	'B' loads switched to 'A' supply
Open to Public	Healthy	Healthy	Off	Open with Caution – client to confirm
Evacuate Public	Off	Off	Healthy	
Evacuate Public	Healthy	Off	Off	
Evacuate Public	Off	Healthy	Off	

LV distribution shall be classified as follows:

Critical Life safety
- No break in supply

Essential Life Safety
- Momentary Break in supply during load switching

Critical
- No break in supply

Essential
- Momentary Break in supply during load switching

Non-essential
- Load shed during perturbed operations without loss of railways or public access

Loads between ‘A’ and ‘B’ distribution systems shall be switched automatically with manual local and remote override. A momentary loss of supply is expected during switching except loads also backed up on UPS or local battery systems

The level of resilience and redundancy for the electrical power systems shall be supplied and installed to comply with the RAMS and Fire Engineering requirements for the CRL.

3.3.9.2 Power supply

The Contractor shall supply and install all LV Power to facilitate regular inspections and maintenance. Such inspections and maintenance shall be capable of being undertaken without interference with normal operations or else capable of being undertaken in limited non-traffic hours.

Where items will require replacement during the life of the CRL, they shall be supplied and installed to be replaceable in accordance with a planned intervention method developed as part of the installation. For all elements within the CRL they shall be supplied and installed to the extent reasonably practical, to permit this replacement within limited non-traffic hours where the replacement would otherwise involve disruption to the rail service.

The LV Power system and associated electrical systems shall be;

- Cost effective in terms of their whole of life cost, comprising initial installation and subsequent inspection, maintenance and replacement costs;
- Durable - This shall be achieved by the supply and installation of appropriate materials and high standards of workmanship;
- Robust - including switchgear, cabling, containment, support systems and electrical components;
- Supplied and installed to provide protection against the effects of moisture, vibration, dust, corrosion and where required, fire;
- Supplied and installed to maintain safe segregation from staff and the public;
- Supplied and installed to maintain safe electro-magnetic interference (EMI) levels through physical segregation and where required, shielding;
- Supplied and installed to prevent unauthorised access to cabling, containment and equipment.

The Contractor shall supply and install electrical services within HV/LV plant spaces and reticulation pathways to accommodate LV and associated electrical equipment, including spatial provision for safe access, operation and maintenance of services. This shall include accessibility for maintenance, removal of equipment such as transformers, switchboards and switchgear and access for emergency intervention.

3.3.9.3 Point of Supply and Transformer Arrangement

The point of supply for the west end of Britomart station and CPO shall be via the LV terminals of the existing ‘A’ and ‘B’ 11kV/400V transformers located in separate fire-rated rooms within the substation enclosures located at ground level of the existing station plaza.

Provide and install new fused take-off arrangements for each of the existing ‘A’ and ‘B’ transformers to provide for the new ‘A’ and ‘B’ main switchboards located at B1 of the CPO.

Provide all supports and suspensions for the entire length of the cable reticulation pathway. Underground sections of containment shall be steel.

The Contractor shall include all necessary shutdown requirements, switchgear, supports, cabling and equipment in the existing transformer rooms to facilitate the new connections within the transformer rooms and at the new CPO building main switchboard locations. Shutdowns shall be co-ordinated by the Contractor with AT facilities staff and other relevant stakeholders.

The ‘A’ and ‘B’ transformers in each substation shall be capable of supporting the overall maximum load demand for the west end of the station, temporary accommodation and CPO in the event of failure of either HV ‘A’ or ‘B’ network supply.

The Contractor shall allow for 20% spare provision for any future loads including, electrical switchgear, UPS, DBs, submain and final circuit cabling, but the total utilisation load shall not exceed 90% of the rated capacity of the equipment at any given time.

3.3.9.4 Low Voltage Power Classifications

The Contractor shall provide power to the station, associated tunnel services and ancillary buildings and to maintain essential and critical loads during power failures, HV and LV fault conditions and emergencies.

The Contractor shall provide Britomart Station with five load classifications, Critical Life Safety, Essential Life Safety, Critical, Essential and Non-essential, categorised as follows:

CRITICAL LIFE SAFETY:

Characteristics of a supply to a critical life safety load include:

- Provision of an ‘A’ and ‘B’ supply with local or central automatic change-over facility;
- Provision of a centralised ‘N-1’ 100% redundancy UPS supply;
- Fire rated cabling and containment or segregated routes (acceptable segregated routes for entire length of cable run);
- Cabling supplies shall follow separate, diverse routes for the entire length of run. Each run shall have independent containment systems, and where practicable be run within separate fire cells.

Examples of critical life safety loads include:

- Comms and power DB’s located in the field;
- Critical life safety CER DB’s
- Public address (PA) DB’s
- Emergency lighting DB’s

Critical Life Safety battery and charger loads include:

- Direct Current (DC) rated HV and LV switchgear controls.

CRITICAL:

Typical characteristics of a supply to a critical load include:

- Provision of an ‘A’ and ‘B’ supply with central automatic change-over facility;
- Provision of a centralised ‘N’ redundancy UPS supply.

Examples of critical loads include:

- Critical CER DB’s
- Ticketing and cash DB’s

The train signalling system shall have its own UPS back-up supply, located within its specific system equipment plant room.

ESSENTIAL LIFE SAFETY:

Typical characteristics of a supply to an essential life safety load include:

- Provision of an ‘A’ and ‘B’ supply with local automatic change-over facility;
- Fire rated cabling and containment or segregated routes (acceptable segregated routes for entire length of cable run);
- Cabling supplies shall follow separate, diverse routes for the entire length of run. Each run shall have independent containment systems, and where practicable be run within separate fire cells.

Examples of essential life safety loads include:

- Tunnel ventilation systems;
- Station smoke extract fans;
- Over Track Extract (OTE) fans;
- Fire pumps;
- Fire- fighting intervention lifts and lifts required for station evacuation;
- Escalator DB’s required for evacuation
- Platform screen doors (if required)
- Essential life safety hydraulic pumps

ESSENTIAL:

Typical characteristics of a supply to an essential load include:

- Provision of an ‘A’ and ‘B’ supply with a local automatic change-over or,
- Provision of an ‘A’ and ‘B’ supply at a common essential distribution board, with essential lighting and small power interlaced between separate essential DB’s to maintain 50% capacity of supply;
- Cabling supplies shall follow separate, diverse routes for the entire length of run. Each run shall have independent containment systems, and where practicable be run within separate fire cells.

Examples of essential loads include:

- Combined essential/non-essential DB’s
- Non-life safety lifts, escalators, hydraulic pumps, mechanical services DB’s
- Small power and lighting in selected staff and non-critical operational rooms;
- Non-life safety critical CCTV, building management systems.

NON-ESSENTIAL:

Typical characteristics of a supply to a non- essential load include:

- Provision of an ‘A’ or ‘B’ supply with load-shed capability.

Examples of non-essential loads include:

- Non-essential section of combined essential/non-essential DB’s;

- Retail DB's;
- Public toilets and amenities DB's;
- Non-essential mechanical and hydraulic DB's;
- Station air conditioning chillers (if provided).
- CPO Tenancies

3.3.9.5 Low Voltage Distribution Systems

The Contractor shall supply, install, test and commission electrical distribution systems to provide power to the station, tunnel services, CPO building and ancillary buildings under normal conditions and to maintain essential and critical loads during power failures, HV and LV fault conditions and emergencies.

The Contractor shall design, supply and install new 'A' and 'B' mains cabling supplies emanating from the 400V secondary terminals of the existing transformers and be reticulated via B1 level services routes and within the CPO building to new 'A' and 'B' main low voltage (LV) switchboards at level B1 of the CPO. Cable routes for main LV 'A' and 'B' shall run along diverse routes where possible or fire separation/enclosures shall be used.

LV distribution reticulated to and from the main switchboard rooms, DB cupboards and other plant areas and risers shall be via cable tray at both high level and low level within a purpose made trench system on B1 of the CPO, via segregated 'A' and 'B' containment, segregated containment routes, segregated electrical risers and under platforms.

Segregated 'A' and 'B' routes shall be provided for the North and South sides to provide cabling routes to connect from CPO to Britomart Station. Cables shall run via a service trench accessible from ground level and connect into the BoH area behind the bluestone wall. Cabling shall then transverse across the void within the transfer slab and drop to B2 level behind the lift.

At station platform level, containment reticulation pathways shall be provided at high and low level from the exit points to DB and plant room locations within the station environment.

Risers shall also be provided at North and South locations on level B1 of the CPO to provide access from CPO ground to upper tenancy levels of the CPO.

Sub-circuit cabling shall be reticulated from distribution boards to final terminations via cable tray and catenary wire within ceiling spaces, walls, trenches and under platforms.

The Contractor shall supply and install new sub-circuit cabling to existing station, platform and glass box electrical services, signage, socket outlets, lighting and power, emergency lighting and exit signage equipment that that is to remain.

3.3.9.6 Rail Systems including Tunnel LV Services and OHLE

The fit out of these will not form part of the main station works.

Railway systems designers will be responsible for the full design, size and installation for their fit out within the room. They shall also liaise with the Contractor to provide complete isolation transformers, earthing, isolation earthing (where required) to facilitate the installation and termination.

The C1 design allows for the provision of shell only services to these rooms. Refer Memo CRL-BTM-MEP-000-MEM-0429 for proposed worksMain Switchboards.

Under the temporary works the main supply from each of the transformer 'TX1 and TX1-1' located on street level in the plaza area shall be modified to supply the new main 'MCCB panel A and B' fitted within each transformer rooms. The purpose of the main feeder panel is to provide 3 separate

outgoing supplies to serve the existing, temporary and permanent installation. These works allow the continue operation of the existing station, whilst the permanent works can be energised at different stages and minimising the disruption to the existing railway.

It is intended that once the temporary and existing installation are no longer required, the permanent main feeder cables at the transformer end serving MSB A and B are to be re-terminated into the permanent section of the main feeder panel. The remaining outgoing ways are to removed to prevent any future loads being connected into the station supply. The removal of the temporary panel and the changeover of permanent cable shall a be staged changeover agreed with AT and PTA.

The new main switchboards 'MSB A and MSB B' shall be installed within fire rated, dedicated electrical rooms on level B1 (West end). These will replace the existing MSB's on level B2, which will be decommissioned and removed in the final station design.

Both of these switchboards will be used to serve the West side of the station for levels B1, B2 (platforms), CPO and tenancies on levels 1-3. The switchboards shall also provide LV resupplies to existing operational services including the station ventilation fans, lifts and escalators. These services will require a staged 'changeover' where a temporary shut of service shall be done during a planned station closure. For further details refer to electricall drawings for size, fault level ratings etc...

The Contractor shall supply, install, test and commission 'A' and 'B' main LV switchboards for the. Each main switchboard shall consist of, but not limited to:

- Incoming main circuit breakers
- Metering and power monitor
- Split bus-bar sections and circuit breakers
- CT Compartments
- Outgoing MCCB compartments
- Cableway sections
- Surge suppression devices
- Distribution board (if located in main switchboard)
- EMS PLC/Data processor
- MEN connections and earthing
- DC tripping battery

The Vector HV supply transformers are fed from separate HV substations in the wider Vector.

Each main switchboard shall be designed and constructed to operate on a 400V, 50 Hz, 3 Phase, 4-wire system with a busbar fault rating of 50kA for 1 second, IP54 minimum. A form factor of 4 shall be provided. The main switchboards shall be floor mounted on plinths, front access and provided with top and bottom entry and exit.

Incoming MCCB circuit breakers shall be electronic MCCB type, i.e. Mircologic . Moulder case circuit breakers and split bus-bar circuit breakers shall be motorised to enable remote control operation via the Electrical Management System (EMS).

The main switchboards shall be located within switchrooms and be coordinated with the incoming and outgoing mains and sub-mains supply cable ladders and containment.

The Contractor shall design and install seismic restraints for the main switchboards and associated switchroom equipment to comply with NZS 4219.

Provide space in the main switchboard room layout designs for future installation of power factor correction and harmonic filters.

The main switchboard shall house within a separate enclosure an EMS PLC for data gathering/processing and interfacing to the Electrical Management System (EMS).

Refer to the Station Control specification, EMS points schedule, EMS sections of this specification and Electrical schematic drawings for SCADA and EMS interfacing requirements.

The Contractor shall provide shop drawings for approval, including main switchboard general arrangements, single line diagrams, dimensioned floor plan layout of LV switchroom, earthing arrangements, fixing arrangements and cable tray layouts.

3.3.9.7 Standby Generator Connection Facility and Operation

Omitted from scope.

3.3.9.8 LV Cables

General Requirements
All cables shall be colour coded in accordance with the requirements of AS/NZS300 (taking account of the latest revisions regarding colour compliance. If the contractor is in any doubt as to the colour coding required, particularly with the installation of new cabling within an existing building, then the installer shall seek written confirmation from the ER All cables shall be LSF and Zero Halogen.

All LV and ELV cabling shall be IANZ Accreditation – Qualification approved with Test Report including, type test and compliant to relevant standards including, AS/NZ 3008, 3013 and 5000.1

Low-voltage cables shall have a voltage designation as shown below:

- LSOH – Low smoke and zero halogen
- LSF – Low smoke and fume
- XLPE – Cross linked polyethylene
- SWA – Steel Wired Armoured

For all LV and ELV cabling shall all be of XLPE and LSF construction type, with suitable mechanical protection and rated up to 600/1000V.

Where Fire rated cabling is specified, these cables shall designed to operate during arduous fire conditions. These shall be designed as per AS/NZS3008 standard and shall approved for 120mins (minimum) fire test as per WS52W standard

PVC construction as well as PVC insulated and sheathed cables must not be used.

Reduced neutral conductors in multicore cables are not acceptable and shall be sized as per the phase conductors.

Conductors shall be copper unless otherwise specified. In addition to requirements elsewhere in this specification, unskilled labour shall not be permitted for cable installations.

Note: PVC conduit shall not be accepted unless casted into concrete and be “mechanically protected against damage sufficient to prevent penetration of the cable by nails, screws as a suitable method of providing mechanical protection under this contract unless agreed with the client during the tender period.

All cables shall be delivered to site with appropriate seals if the cable is likely to suffer from water or frost damage. Where cables are supplied on drums, stored for long periods and subject to extremes of

temperature, the cables shall be uncoiled and stored in a manner which eliminates the risk of thermal damage to the insulation.

Labels on cable drums shall indicate the manufacturers name, size, description, AS/NZ number, classification, length, grade and date of manufacture.

All cable types shall be certified and marked. Cables shall have following sheath colour;

- Emergency Lighting – BLUE (To be confirmed by AT)
- PA/VA – White, unless otherwise stated.
- Fire – RED
- HV – RED
- LV – Black, unless otherwise stated.

Records shall be kept of all cable drum numbers and supporting information. This information shall be indicated on the record drawings indicating the precise location of each length of cable.
Copies of the manufacturer's cable test certificates shall be included in the operating and maintenance manual.

Where conductor sizes are not indicated in the specification and/or the associated drawing(s) they shall be selected in accordance with AS/NZ3008 for the current rating required by the circuit loading, the type of cable, the ambient temperature, the conditions of installation and the maximum voltage drop permissible.

3.3.9.9 Distribution Boards

Supply, install, test and commission LV distribution boards as shown on the layout drawings, including but not limited to:

- UPS backed comms/power distribution boards
- UPS backed emergency lighting distribution boards
- General lighting and power essential/non-essential distribution boards
- UPS input/output distribution boards
- Retail distribution boards

General essential/non-essential distribution boards, emergency lighting distribution boards, comms/power distribution boards, UPS distribution boards shall be 3 phase, IP54minimum, Form 1, lockable, top and bottom entry. The number of poles within these DB's shall be determined by the Contractor, to include all documented sub-circuit requirements, plus an additional 25% spare number of poles for future.

Retail spaces shall be provided with a 3-phase, IP42 minimum, Form 1, lockable, top and bottom entry.

Full height lockable distribution board cupboards shall be provided to house the general essential/non-essential DB's, comms/power DB's and emergency lighting DB's. The Contractor shall ensure the tender submission distribution boards have been designed to allow for installation within the electrical cupboards and rooms shown on the electrical drawings, including compliance with AS/NZS 3000 for door clearances.

Distribution boards and other wall mounted panels shall be mounted in lockable cupboards fixed to support frames and spaced off walls. Floor mounted equipment shall be plinth mounted or fixed onto to wall support frames.

The mechanical services and hydraulic services distribution boards/control panels shall be supplied by the mechanical and hydraulic trades. Provide sub-mains to the distribution boards, terminated by the respective mechanical and hydraulic trades. The Contractor shall confirm the final load requirements with the mechanical and hydraulic Contractors, and design and install sub-mains as required, including circuit breaker sizing and associated sub-main cabling. Provide shop drawings of sub-main reticulation and sizing to the engineer for approval, prior to construction.

Surge suppression devices shall be installed within each distribution switchboard to comply with AS/NZS 1768, 50kA minimum.

Final sub-circuits shall be supplied from distribution boards equipped with Miniature Circuit Breakers (MCBs) with type C or D tripping curves as appropriate. The installation of Residual Current Devices (RCDs) shall be provided to power circuits in locations accessible to the public and in staff areas. Where circuits are required to have RCD protection, RCBOs, or din-rail mounted RCD modules shall be provided.

The Contractor shall provide shop drawings for approval, including distribution board general arrangements, single line diagrams, dimensioned floor plan layout of DB cupboards, earthing arrangements, fixing arrangements and cable tray layouts.

Refer to the single line diagram for additional details and ratings of distribution boards. Individual boards (not forming part of the main switchboard) shall be wall mounted.

Refer to the Station Control specification and associated EMS points schedule for SCADA interfacing requirements

3.3.9.10 Metering

Existing HV metering is provided on the existing 11kV ‘A’ and ‘B’ supply transformers supplying station west.

Sub-metering of station and tunnel loads shall be provided to enable monitoring of energy usage by Auckland Transport and shall include:

- Main switchboards;
- Lighting and power distribution boards (individual metering of lighting and power loads), including tunnel services lighting and power;
- Comms/power distribution boards;
- Retail tenancy (tenant billing meters)
- CPO upper level tenancies (tenant billing meters if not already available);
- Mechanical services loads above 50kVA including tunnel ventilation and pressurisation;
- Lift and escalator sub-mains;
- Hydraulic pumps;
- Signalling Equipment Room (SER) power supply
- Tunnel LV room power supplies

Britomart station shall be provided with the following metering classes:

- Incoming supplies to all main switchboards and tenant billing meters (Meter type: IMSB – Incoming Main Switchboards) – Class 0.5 metering;
- Specified outgoing supplies on main switchboards (Meter type: OMSB – Outgoing Main Switchboards) – Class 1 or 2 energy metering;

- Distribution boards as indicated (Meter type: DBM – Distribution Board Metering) – Class 1 or 2 energy metering.

Meters shall be interfaced to the EMS via Electrical PLC's mounted in the main switchboards.

Metering cabinets shall be provided for the North and South CPO ground level retail tenancies. The South side cabinet shall be located within the South mechanical plantroom, the North side shall be located within the North electrical room.

Refer to the EMS scope and technical sections of this specification for further performance, technical requirements and interfacing of the metering system.

Refer to the Station Control specification, EMS points schedule, EMS sections of this specification and Electrical schematic drawings for SCADA and EMS interfacing requirements.

3.3.9.11 Load shedding and control

The Contractor shall provide load shedding and control monitoring to enable power management of the overall station west maximum demand for each of the 'A' and 'B' incoming supplies. Load shedding shall be controlled by either:

- Manual control via the EMS head-end PC;
- Automatically by the EMS system;
- Remote SCADA control

The Contractor shall provide load shedding facilities in the following locations:

- All main switchboard motorised circuit-breakers;
- Contactors within station essential/non-essential DB's

Load shedding shall be initiated by:

- Station maximum demand nearing the maximum capacity of the electrical infrastructure of the 'A' or 'B' supply;
- Emergency scenarios
- Manual shedding via the EMS system or the SCADA control system

The EMS shall be capable of remotely and automatically monitoring the maximum demand of each main switchboard via the data collected by the power monitors located on the main switchboards.

Under an automatic load-shed scenario, the hierarchical order of load-shed shall be:

- Non-essential sections of essential/non-essential DB's;
- Non-essential sections of main switchboards;
- Essential/critical sections of main switchboards.

Refer to the Station Control specification, EMS points schedule, EMS sections of this specification and Electrical schematic drawings for SCADA and EMS interfacing requirements.

3.3.9.12 Surge protection

Surge protection for LV equipment shall be provided in accordance with the following:

- AS 4070 - Recommended practices for protection of low-voltage electrical installations and equipment in MEN systems from transient over voltages;

- AS/NZS 1768 – Lightning Protection.

As a minimum, 100kA surge protection shall be installed on all main switchboards and 50kA surge protection shall be installed on the first distribution board or control panel on any one sub-main supply from a main switchboard.

Additional surge protection shall be supplied and installed locally on all electrical equipment where specifically instructed or recommended by the equipment manufacturer.

Refer to the 'Switchboard Components' technical section of this specification for more specific Electrical and I.T. surge protection requirements.

3.3.9.13 Cabling and Containment

The new main LV cabling route from the transformer shall exit below the existing plaza transformer rooms and run via the B1 BoH service corridor. Both main LV 'A' and 'B' feeder cables run at high level with LVB cables to be fire protected within a 120min rated enclosure along this section.

Main LV cables shall then continue through to the CPO, for LVA these shall continue to run via the service trench within the CPO ground floor and enter into the main LV switchroom through cable ducts. For LVB cabling these shall run at low level of B1 via the service trench and connect into the main switchroom from low level ducts.

Outgoing submain cabling shall exit from the main switchrooms at high and low level to maintain segregation between supplies. For LV cables serving the north side of the station these shall run via the main service trench, which shall then continue east through to the station.

For cables running on the south side these will continue at high level along the main service route above the toilets and connect into the external service trench ground level. Cabling shall then connect back through the pile wall of the station behind the bluestone wall.

Submain cabling which serves the platform supply air fans on B1 level (both north and south side) shall continue further east of the BoH service corridor and connected into the existing MCCs and equipment.

For cabling to level B2 level these connect from BoH B1 level and through the floor void between the B1 concourse floor and transfer slab. Cabling shall then transverse across behind the lifts via service ducts and drop to B2 level. Cabling shall then continue at high level to serve their associated DB and equipment rooms.

Wiring in general shall be provided in dedicated conduit, ducts, trunking, cable trays and ladders for each system e.g. LV cabling, comms cabling, security and CCTV and fire.

All cabling and wiring within public spaces including CPO ground, glasshouse and platforms shall be enclosed in non-combustible steel containment and conduits prevent the spread of fire. PVC conduits shall not be used within any of the installation.

Primary and secondary containment for BoH areas including plant rooms, electrical rooms, store rooms and staff areas shall typically be on steel cable tray and where necessary non-combustible conduits shall be provided for mechanical protection i.e. sump and plantrooms.

All the new cabling within the ground floor CPO ceiling void shall be installed with enclosed steel trunking for the main primary route and steel conduits for secondary 'take offs' for final circuits. The

The PTA design team could not obtain access to the existing ceiling void space therefore the contractor shall carry out an inspection of the CPO ground floor in-ceiling services to investigate the existing cable installation and determine the most practical method of installation for the new cabling and containment system.

All submain and final cabling shall be Low Smoke Fume Zero Halogen (LSFZH) construction no PVC construction shall be used.

Fire rated cabling used for critical life safety systems and emergency lighting shall be to AS/NZS 3013 or BS 6387 equivalent.

Where LV submain cables are open or exposed and are subject to physical damage, suitable mechanical protection .i.e. covers, lids shall be provided.

Service culverts or cable ducts and draw pits will be provided where cables are required to be laid below ground so as to facilitate cable installation, maintenance and renewals.

Conduits for each service shall have unique colours as detailed in AS 1345.

Conduit in underground locations i.e. Levels B1 and B2 within the station environment shall be of metal construction.

Mains cabling containment shall be a minimum performance standard of Uni strut LT5 hot-dip. Sub-mains and sub-circuit cable tray shall be a minimum performance standard of Unistrut LT3 hot dip galvanised.

Consideration shall be provided to the use of double dipped galvanised containment in underground locations.

Communications cable tray shall be Cablofil cable basket or approved equivalent. Other building services extra low voltage (ELV) and control cabling, security, CCTV, mechanical services control cabling shall share the communications cable baskets.

Cabling containment shall be installed to provide no less than 25% spare capacity for future.

Ensure correct bending radius for submain cabling as per the manufacturers requirements is provided along all containment systems.

All submain cabling shall be fixed onto cable trays/ladders with either cable cleats or stainless steel straps, no PVC or plastic cables ties shall be used.

Cabling and containment systems providing pathways for cabling supplying Critical Life Safety and Essential Life Safety shall be fire-rated to a performance level complying with AS/NZS 3013 as a minimum. Where dual supplies are provided to life-safety loads, according to the load classifications as described in the load classification section of this specification, additional fire-rated cabling may be required for these supplies (where cables cannot be fully segregated). The Contractor shall include in their Tender submission for the provision of fire-rated cabling and containment to all Critical life-safety and essential life safety loads.

Cable sizing within stations shall provide a cabling power distribution system design of sufficient capacity to cater for the following:

- Station and tunnel maximum demand loads;
- Electrical fault conditions;
- Voltage drop;
- Power factor and harmonic distortion losses.

The maximum design volt drop shall be 5% from the low voltage terminals of each dedicated station supply 11kV/400V transformer to the termination point of all sub-circuits (excluding existing circuits which are to be resupplied). The voltage drop for submain cables from the source to distribution boards and MCC's has been design up to 2.5% and 3.5% respectively.

The mains power supply, sub-main cabling and sub-circuit cabling shall be sized, supplied and installed to comply with AS/NZS 3000:2011 and AS/NZS 3008:2010

The mains and sub-mains cable sizing contained within the electrical drawings and documentation shall be checked by the Contractor and submitted to the electrical engineer for approval. The Contractor shall liaise and confirm with the mechanical, hydraulic and fire Contractors all final equipment loads, final cable routes and reticulation pathways and submit final cable sizing and calculations.

The design cable lengths from the cable schedule shall be measured on site and checked by the Contractor. If cable lengths measured on site vary significantly, then the Contractor shall notify the Electrical Engineer to confirm if cable conductor size is adequate before cables are to be ordered, otherwise it will be the Contractors responsibility to recalculate and to demonstrate that the cable complies with the electrical requirements.

Sub-circuit allocations have been shown on electrical drawings, however circuit number allocations and sub-circuit cable sizing shall be by the Contractor. Submit distribution board schedules for approval, prior to construction, showing as a minimum: DB fault rating, chassis rating, circuit designations, MCB ratings, fault ratings of MCB's, cable sizes, purpose of circuit, cable type and insulation type. Lighting and power cabling shall be minimum 2.5mm sq. Cu TPS or to suit installation.

General purpose essential and non-essential power supplies will generally be circuited from a local essential/non-essential DB such that supply to a minimum of 50% of the equipment in adjacent areas is maintained under power failure of the 'A' or 'B' supply.

3.3.9.14 Segregation

Due to the nature of the CRL environment and the wide range of systems operating, including the range of life safety and critical systems that will be present, the separation distances as detailed in the following table shall be adopted in the first instance:

Services	Minimum Separation
HV and LV cabling	150mm
Sub main and final circuit cabling	150mm
HV and ELV cabling	450mm
LV and ELV cabling	150mm
ELV cabling for different ELV services	50mm
Cabling for life safety systems separated from general cabling.	300mm
All electrical cabling shall be separated from other services (mechanical, hydraulics etc.)	300mm

Separation distances if not shown above shall comply with NZ Safety Regulations, AS/NZS 3000:2011 and AS/ACIF S009 requirements.

Where there are instances the minimum segregation requirements summarised above are not achievable due to spatial constraints, structure and architectural elements, the Contractor shall provide shielding between power services and comms containment, to eliminate interference from stray currents and EMI (Electro-Magnetic Interference).

3.3.9.15 Small Power

The Contractor shall design, supply, install, test and commission a complete LV power installation emanating from the final circuit distribution boards, generally in accordance with the small power and lighting layout drawings.

The LV power installation shall include but not be limited to the following:

- General 16A GPOs
- Cleaners GPO's
- Socket outlets with additional switches for stoves, rangehoods, ovens etc. in kitchen and staff areas
- 16A, 20A switched outlets where shown on electrical drawings
- Permanent switched outlets for fixed equipment including, hand dryers, urinal controllers, hot water boilers, PIDS, Vending Reload Devices, cameras pan tilt mechanism, automatic doors as shown on the electrical layout drawings.
- Supply to fire alarm panel battery charger
- Power supply to mechanical, hydraulic, fire services where described in specification or documented on drawings (to be coordinated with the MFH contractor)
- IP56 switched outlets in plant room and external areas(where shown on drawing)
- Power to security, CCTV, comms and control systems equipment and field devices
- Power to passenger, staff and operational systems and equipment
- Power to lighting, lighting control equipment and emergency lighting/ exit signage
- Power to external and internal illuminated signage
- 230V power supplies to security door hold open devices where installed
- Any additional power requirement as required by the client (to be agreed)

3.3.9.16 Retail Provisions

- Metered electrical DB for each retail space
- General lighting to minimum code compliance of 20 lux average maintained
- Exit signage and emergency lighting to minimum code compliance
- 4 off telephone connection cables (4 pair category 6 cable each);

3.3.9.17 Power Quality and Electromagnetic Interference (EMI)

The Contractor shall ensure the EMI within all parts of CRL complies with all parts of AS/NZS 61000 - Electromagnetic compatibility (EMC). The LV Power installation shall include the requirements of the ICNIRP guidelines and the National Radiation Laboratory.

The Contractor shall design, supply, install and test power conditioning equipment to ensure that levels of electromagnetic interference (EMI) within all areas of Britomart station and associated buildings are below the thresholds of all items of equipment required to operate in each area, in order to maintain electromagnetic compatibility between all systems, including signalling and train control systems.

Power quality shall be maintained to 0.95 lagging power factor or above, to comply with Vector requirements and to maintain CRL sustainability targets. Power conditioning will consist of power factor correction and power filters. Spatial provision for power factor correction and harmonic filters has been made within each of the 'A' and 'B' main LV switchboard rooms for future connection of separate power factor correction and harmonic filter floor standing cabinets.

Analysis of the harmonic content cannot be achieved during design stages due to uncertainties of equipment loading and requirements. Before any bulk power factor and harmonic equipment is

installed, a separate site monitoring study shall be conducted by the Contractor to ensure compatibility and co-ordination of equipment selected I.e. variable speed drives.

The Contractor shall measure the harmonic contents generated by the stations infrastructure after the station comes into beneficial use, in accordance with AS/NZS 61000 - Electromagnetic compatibility, ICNIRP guidelines and any additional Vector requirements.

3.3.9.18 Uninterruptible Power Supply (UPS)

The Contractor shall design, supply, install, test and commission UPS systems to provide maintained power to critical life safety and critical loads under failure of normal 'A' and/or 'B' power supply or under fault, maintenance and equipment failure scenarios.

There shall be two levels of redundancy for UPS's. Critical UPS's shall be provided with an 'N' level of redundancy. Critical life-safety UPS's shall be provided with 'N-1' level of redundancy. 'N-1' arrangements shall be separate free-standing parallel UPS cabinets, not modular 'N-1' parallel UPS cabinets.

The UPS's shall be supplied and installed into five dedicated, fire-rated rooms located on level B1 of the CPO. Critical life-safety comms and power UPS's and associated batteries shall be contained within individual 'A' and 'B' rooms, Critical life-safety emergency lighting UPS's shall be contained within individual 'A' and 'B' rooms, the critical UPS and associated batteries shall be contained within one room.

In normal station operation, the N-1 'A' and 'B' UPS's will share approximately 50% of the full load. In the event of a UPS failure the other UPS shall be able to support 100% full load for both outgoing 'A and B' switch panels.

For the UPS serving emergency lighting each module shall be connected via static switches. In an event of a UPS failure the static switches shall changeover between supplies to allow both outgoing switch panels to be supported by the operational UPS.

For each local distribution board serving comms power shall be supplied by 2 UPS supplies connected to a local static switch. During the failure of a UPS system the static switch shall switch to the available UPS supply.

For the emergency lighting UPS' only emergency lighting circuits shall be connected and no other type of circuits shall be supplied from it. All outgoing emergency lighting DBs shall be enclosed in fired rated enclosures/cupboards.

All cabling for critical life safety systems shall all be suitable fire rated cabling and be installed on separated dedicated containment.

Each UPS shall be supplied and installed with the following general requirements:

- Each UPS shall be on-line, double conversion with batteries, rectifiers, static switch, UPS input switchboard and UPS output switchboard. The UPS shall provide galvanic separation between input and output under all conditions, if separate supplies are provided at the rectifier and internal static bypass.
- An automatic internal by-pass and physically separate, externally mounted manual maintenance by-pass switch shall be provided.
- Loads shall be supplied from an inverter at all times other than when a bypass is in operation.
- The UPS inverters & batteries shall be sized accordingly to ensure adequate fault current is generated (after autonomy of batteries is exceeded) to trip the down-stream protective devices.
- UPS protection model to be prepared to demonstrate all faults can be cleared within maximum disconnection times.

- The UPS shall be able to operate normally while disconnecting faulty LV circuit's on-battery source. This shall be achieved by supplying sufficient fault currents to trip the largest Circuit Breaker downstream of the UPS (I.e. 20A type C MCB) within half a cycle (10ms).

The Uninterruptible Power System (UPS) shall comply with the following RAMS requirements:

- UPS, single module: minimum MTBF of 175,000 hours in continuous operation, excluding batteries. In addition MTBF of 80,000 hours is required at each LV output of UPS distribution board for conditioned power supply (including batteries).
- Provide Fault tree analysis using MIL standards or equivalent shall be provided in order to demonstrate the achievement of MTBF targets and assess on demand availability of back-up mode.

  RAM Data to be used are :

  - Field data from statistically significant populations of existing assets already in operation in environments similar i.e. Crossrail UK.
  - Data from technical specifications or requirements applicable to components or results from RAM calculations or simulations.
- The UPS shall be provided with facilities and functions to allow safe maintenance of equipment and provide electrically segregated and isolated parts to allow other areas to be energised.

  Seismic bracing of UPS's and batteries to comply with NZS 4219.

Each battery system shall be supplied and installed with the following general requirements:

- Batteries shall be Sealed Lead Acid (SLA) type, dedicated free standing, open rack type.
- Batteries shall be sized to provide battery autonomies as per the UPS schedule at full load capacity, 0.8 power factor for critical life-safety UPS's (e.g. for a full load of 40kW, 90 minutes). Critical UPS shall be provided with an autonomy of 3 hours. See UPS schedule for ratings of UPS and battery load requirements.
- The provision of 24 hours autonomy for the PA system in quiescent mode followed by 30 minutes load shall be supplied from the critical life-safety UPS's.
- The UPS battery charge system shall be capable of recharging a fully discharged battery to 80% fully charged within 8 hours and to 95% capacity in a further 12 hours.
- The UPS battery and charging system for the emergency lighting shall also be designed so that on a partial discharge test of 20% load for 1 hour, the battery shall have the required 90 min autonomy after 3 hours recharge.

Further battery performance requirements and back up support requirements are provided in the following table:

System	Back-up Time
Master clock system	90 min
CCTV	90 min
PIDS	90 min
PA	90 min (plus up to 24 hours quiescent)
Critical and essential communications systems	90 min
Critical operational room lighting and power	90 min
EWIS	90 min
Staff and emergency radio systems	90 min
Digital voice recorder systems	90 min

Main control system	90 min
Station control system	90 min
UPS and selected plant room ventilation systems	90 min
Station and tunnel emergency lighting	90 min
Fire services communications systems	90 min

Some of the following systems may require their own dedicated backup instead of UPS:

- Telephone system (PABX and direct line);
- Platform screen door motors and control systems (if provided);
- Lift car's emergency lighting, intercom and control;
- Automatic fire alarm system.

Refer to the UPS section of this specification for additional performance and technical UPS requirements.

Refer to the Station Control specification, EMS points schedule, EMS sections of this specification and Electrical schematic drawings for SCADA and EMS interfacing requirements.

3.3.9.19 Earthing

A new earthing system for the permanent works will be designed to minimise electric shock and step and touch potentials, providing a pathway for fault currents and provide segregation between traction and station earthing systems (where possible). The earthing systems shall be designed in accordance to AS/NZS3000, and NZECP.

The existing station MEN earthing system must remain electrically separate from the traction earthing system in the permanent CRL works. Prior to the permanent works, the new feeder panels are to be installed during the temporary phase to facilitate the permanent connection whilst the existing and temporary plaza building remains operational. Part of these works requires the HV/LV 'TX1' and 'TX1-1' transformers to have their star neutral points be connected directly to the existing main earth bar 'MEB1'. Earth bar MEB1 shall be relocated from electrical room MSB1-1 into TX1-1 room on street level and including the existing main earth connection and structural earths.

As part of the new permanent works, a new earth grid is to be installed under the CPO on level B1 BoH. This shall be the main earthing system for CPO building including levels B1 and B2. The new earth grid will comprise of a number of earth electrodes which are to be driven into the soil/alluvium clay, This earth grid will be connected to a new main bar 'MEB 2' which is to be equipotential bonded to the existing earth bar 'MEB1'. In addition to the new earth grid, a connection to the new structural reinforcing within the B1 floor slab and including the existing structural columns along the north side of the building which rise up to through levels 1 to 3 are also to be electrical bonded.

The new earth bar 'MEB 2' is to be located within the new main electrical switchroom 'MSB A'. The earth grid shall be arranged to achieve a low resistivity. A test earth pit shall be provided at the last terminating point before the earth bar MEB 2.

The new earthing system shall serve as a function earth for the safe operation of protectives under fault conditions and provide the equipotential bonding of MEP equipment and structural steel work.

This earth grid must remain electrically separated from the existing traction earth and shall only be part of the station MEN earth system.

Both new main switchpanels ‘MSB A and B’ earth bars shall be connected to ‘MEB 2’. The neutral busbars of MSB A and B shall be connected back to their respective main neutral bar at the main feeder panels located within TX1 and TX1-1.

Both MSB A and B shall have a M.E.N connection via removable link within their panels, thus allowing the neutral conductors to carry earth fault current back to the star point of transformer secondary winding.

As part of the equipotential bonding a network of earth rings shall emanate from MEB 2 and connect to local plantrooms and electrical rooms. A dedicated clean earth ring shall be provided for comms/IT equipment rooms. To maintain the integrity of the earthing system, permanent ‘C’ crimps (sized to suit maximum fault) from the earth ring to local room earth bars. For testing purposes removable test links shall be provided at all earth bars.

Separate functional earths or CPC’s (circuit protective conductor) to DBs and electrical equipment shall also be provided from the new main LV switchboards.

A network of earth rings shall emanate from the MEB 2 and distribute to local plantrooms and electrical rooms for equipotential bonding. A dedicated clean earth ring shall be provided for comms/IT equipment rooms. To maintain the integrity of the earthing system, permanent ‘C’ crimps (sized to suit maximum fault) from the earth ring to local room earth bars. Earth cable shall be sized to withstand the maximum fault current of the equipment. Refer to electrical earthing schematics for details and sizes.

Separate functional earths or CPC’s (circuit protective conductor) to DBs and electrical equipment shall also be provided with their submain cable from the main LV switchboards.

Generally any exposed steel work that can be touched could become live under a fault condition shall be bonded to earth. This applies to;

- Metal grids/frames of suspended false ceiling systems with electrical equipment fixed to them or in contact with.
- Metal screens or cladding with electrical metal containment/equipment/outlets fixed to them
- Metal glazing frames/bars with electrical containment/equipment/outlet fixed to them
- Metal raised floor systems including service trench with electrical accessories fixed to them
- Metalwork of electrical systems including cable ladders, cable trays, steel conduits and enclosures for electrical controls and distribution equipment.
- Metal pipe and duct work
- Metal platforms/ladders/walkways/barriers with electrical containment/equipment/outlets fixed to them.
- Structural steel work with electrical containment/equipment/outlets fixed to it or in contact with.

For the railway systems rooms including OHLE, SER, PSD and tunnel LV rooms, their earth will be derived from the new traction earth system located under lower Queen Street. It will be the responsibility of Rail Systems Contractor to bond their earthing system to their equipment and to align with the overall CRL Earthing and Bonding Strategy. However this strategy is yet to be further developed by the CRL Contractor, which includes the co-habitation of the new CRL main works with the existing separated earthing and bonding arrangements for Britomart.

Electrical supplies into Rail Systems rooms will be via an isolation transformer. This to ensure the station MEN earth remains electrically separated including any steel/structural work. The electrical contractor shall provide a terminated submain cable into an isolator, which will be the demarcation between stations services and Railway Systems contractor. Other MEP services shall be capped before the room.

3.3.9.20 Lighting

General:
The purpose of the lighting installation to the Britomart station shall be to facilitate the safe movement of all persons internal and external to the stations and associated buildings, provide a safe and welcoming environment and allow visual tasks to be performed accurately by all persons.

The scope of services for the lighting installation for the Britomart station and associated ancillary buildings is as follows:

- Re-circuiting (rewiring) existing lighting system (e.g. platform and BoH lighting)
- Cleaning and re-lamping of all existing luminaires, which have exceeded their design life. The Contractor shall allow for a provisional sum within their tender price for the full replacement of lamps which are to be re-supplied from the new Station West LV distribution. The Contractor shall liaise with the client (closer at time), which lamps are scheduled to be replaced.
- Reinstating street lighting above the cut & cover - Urban realm worksInstallation of emergency lighting and illuminated exit signage
- Control of emergency lighting and exit signage via SCADA / EMS;
- Provision of architectural and specialist lighting;
- Interfacing of the new lighting control system to the EMS, station control system (SCADA), fire system, security systems, emergency lighting monitoring system.
- Installation of a new addressable lighting control systems;
- Provision of lighting and emergency lighting to retail spaces for code compliance

Retail spaces shall be provided with general lighting, as shown on the drawing, to provide NZBC F6 and F8 safe movement of 20 lux minimum average maintained and emergency lighting/exit signage to comply with AS/NZS 2293 and the NZBC.

Note: Tenant to provide their own function lighting system within respective retail space.

Lighting control will include 24hr time clocks, push buttons, photo-electric cells and motion sensors. Lighting services shall be interfaced to the existing station SCADA system which currently controls selected station west lighting.

The Contractor shall supply and install lighting systems in consideration of station operations and aesthetics, including architectural consideration, accessibility and maintenance, energy efficiency and commonality of luminaires and lamps for the life of the station. Surface mounted or suspended LED lighting shall be provided for the general lighting. Exit signs shall be maintained LED. For information with regards to existing luminaires, please refer to as built drawings and as built luminaire schedule.

Lighting shall be supplied and installed to comply with AS/NZS 1680 for interior lighting and AS/NZS 1158 for exterior lighting. For the permanent works the minimum lighting levels and uniformity for all areas shall comply with the CRL Functional Requirements and Design Manual.

The minimum installation requirements for the performance of the lighting systems shall be as follows:

Element	Permanent Works Requirement
General Lighting	

Minimum point illuminance (internal)	50 lux
Minimum point illuminance (external)	20 lux
Maximum glare rating (Unified Glare Rating)	25
Maximum maintenance factor for lighting design	0.7
Maintainable life of the lighting installation	25 years
Emergency Lighting	
Emergency lighting level – Public Egress	5 lux minimum at any point public egress.
Emergency lighting level	1 lux minimum at any point other areas.
Emergency lighting duration	1.5 hours
Luminaires and Lamps	
Minimum colour rendering index (CRI) of light sources	65
Minimum colour rendering index (CRI) of light sources in areas where display screens are used and viewed	80
Minimum colour temperature of light sources	4000K
Minimum power factor of the lighting installation	0.95
Maximum leakage current for electronic ballasts	0.5mA
Minimum ingress protection (IP) rating for external and below ground areas	IP65
Minimum impact resistance (IK) rating for public areas	IK10

All new luminaires shall be high efficiency LED. Where fluorescent luminaires are specified or existing, Tridonic Atco one-4-all electronic ballasts shall be provided. Halogen lamps shall not be used.

Lighting power supply:
Existing luminaires shall be circuited from respective new distribution board via contactor controlled distribution board as shown on the electrical drawings.

The lighting installation shall be supplied and installed so that on failure of a single lighting circuit (or isolation of a circuit or distribution board for maintenance), the number of luminaires not available for service in any one area shall be no more than 50% of the luminaires in that area, and the point minimum illuminance (Emin) in any public area shall not fall below 50 lux in covered areas and 20 lux in open areas.

UPS power shall be provided for the emergency lighting via emergency lighting distribution system including:

- Exit signage and emergency lighting;
- Tunnel lighting and rail systems (lighting designed by others);
- Critical operations rooms lighting;
- Critical plant room lighting.

Equipment Selections:

Where alternatives to specified equipment is submitted for consideration, all luminaires, lamps, control gear, field devices and associated accessories shall be from recognised brands. Equipment selections shall take into account obsolescence of equipment, likely future changes in technology, local

availability of spare parts and ensure the lighting system can be maintained for the whole service life of the installation. All light sources shall be high efficiency, low maintenance and with long service life.

Equipment selection shall be standardised so that the number of different lamp types, ballasts, luminaire types and components used throughout CRL is kept to a minimum in order to reduce the number of different spare parts required.

All light fittings in public areas shall be durable and vandal resistant, and require specialist tools to access lamps and control gear, and have tamper resistant screws.

Luminaires shall be selected with easily accessible lamps and control gear. Detachable diffusers, louvers etc. for ease of luminaire cleaning shall be provided. Removal of luminaire diffusers in public areas shall be tamper-proof and require specialist tools. All luminaire components shall be replaceable.

Light sources, luminaires and control gear shall be suitable for installation in the CRL environment in below ground areas. Luminaires and components shall be durable and take into account the effects of vibration, dust, moisture, corrosion, insulation degradation, hazardous chemicals and where required, fire.

External Lighting:

The existing external lighting system associated with the Britomart station shall be re-circuited and interfaced to the proposed the new lighting control system. External building mounted security lighting (if required) shall be controlled via the following:

- Photocell and motion detector with over-ride on/off (security lighting).
- Photocell only with over-ride on/off (amenity and pedestrian lighting).

External lighting shall be controlled via the centralised lighting control system with interfacing to the existing station control system (SCADA).

For the cut & cover area, the Contractor shall provide new street lighting system for the urban realm shared spaces and footpath.

Tunnel Lighting

Tunnel lighting is not part of the station works package and shall be designed by Railway systems at a later date including the electrical rooms and distribution.

Emergency Lighting and Exit Signage:

The emergency lighting system shall be centrally monitored using a proprietary emergency lighting system compliant with AS/NZS 2293. The central monitoring and control system shall include the following functions:

- Inform the system operator of a fault with any emergency luminaire within the station
- Inform the operator of the location and reference of the luminaire and the nature of the fault
- Interfacing with the SCADA & EMS
- The lighting control system shall automatically complete all routine and periodic tests on the emergency lighting system.

The new emergency evacuation and anti-panic lighting shall be provided to all public and selected back of house areas to allow safe evacuation of the stations under emergency or loss of supply conditions.

The Contractor shall supply, install, test and commission emergency lighting and exit signage to comply with all New Zealand legislation including the NZBC F6 and F8.

Emergency lighting for Britomart station shall be categorised as risk group A as described in NZBC F6 and comply with AS/NZS 2293.

Exit signage shall be provided to comply with the NZBC clause F8 and AS/NZS 2293.

In addition to the requirements of the NZBC, emergency lighting shall also be provided in areas including;

- Public circulation and concourse areas;
- All WC's, plantrooms, switchrooms and distribution board cupboards;
- Station staff areas including accommodation, offices and welfare
- Rooms used for emergency evacuation purposes, such as control rooms and CCTV rooms, to allow continual operation of these areas during a total power failure.

A higher emergency lighting level than that required under the New Zealand Building Code (NZBC) shall be provided in specific areas including:

- Public areas that are required to have new emergency lighting luminaires and are also designated as egress routes, shall be 5 lux minimum at any point.
- Other areas such as back-of house plant areas, public areas, staff facilities and other non-public areas shall be provided with 1 lux minimum at any point.

Emergency lighting and exit signage shall be provided with a centralised UPS battery back-up system. All new emergency lighting/exit signage and existing emergency lighting requiring a new power supply shall have a minimum autonomy duration of 1.5 hours. Refer to the UPS sections in Part B and Part C of this specification for further UPS and battery requirements pertaining to the emergency lighting and exit signage system.

Emergency lighting shall be LED, non-maintained. Exit signage shall be LED self- illuminated, maintained. Emergency lighting shall operate upon loss of supply to the general lighting in each area served, to comply with AS/NZS 2293.

A centralised emergency lighting and exit signage monitoring system shall be provided using a proprietary emergency lighting system compliant with AS/NZS 2293.3.

All cabling and wiring from Life safety UPS/DBs shall be fire rated in accordance to AS/NZS3013 and WS52W (minimum) to emergency lighting circuits/fittings. All cabling shall be installed on dedicated Life safety cable trays/trunking.

The system shall inform the system operator of a fault with any emergency luminaire or exit sign within the station in addition the location and reference of the luminaire and the nature of the fault.

The central monitoring system shall be capable of interfacing with the station control system, via the EMS.

The central monitoring system shall have the facility to automatically complete all routine and periodic tests on the emergency lighting and exit signage system and shall provide a status of the emergency test including discharge and recharge time of central battery systems. The initiation of the emergency lighting test shall align with the current testing procedure, this is be agreed with Client.

The central monitoring system shall be capable of interfacing with the existing station control, via the EMS. The central monitoring system shall have the facility to automatically complete all routine and periodic tests on the emergency lighting and exit signage system.

The central monitoring system shall also have the option to be integrated to the permanent works Intelligent Lighting Control system. This will allow the station maintainer to use the lighting control platform to simulate an emergency light test in accordance with AS/NZS 2293. This however will need to be further developed and agreed with AT.

In addition to the centralised emergency lighting monitoring system, manual test facilities complaint with AS/NZS 2293.1:2005 shall be provided for any existing self-contained emergency lighting/exit signage at each distribution board. The test switch shall energise the emergency lights and exit signs and automatically reset controls and revert to normal operating mode after a maximum of 2 hours. Provide local contactors within distribution board as required.

Submit shop drawings of emergency lighting and exit signage location plans and architecture/testing schematics to the engineer for approval, prior to construction.

Lighting Control:

The Contractor shall supply, install and test a programmable and expandable networked lighting control system consisting of control panels, a lighting control head-end (centralised processing equipment), lighting control inputs/outputs, field devices and interfaces to other systems. The lighting control system shall be Clipsal DALI control or approved equivalent.

A network of lighting control panels shall be distributed across the station (as shown on layout drawings) to serve local lighting circuits. All panels shall be connected via a dedicated Ethernet network to enable the communication between panels. This will allow the entire lighting control network to be controlled in unison or independently for the switching of lighting circuits. Each control panel shall also allow the functionality to control and program other remote panels.

The lighting control head end unit (located within the BMS room) shall have a PC based software platform and graphical interface showing locations of all fittings/devices on a plan of the station and graphically display the status of individual luminares, field control and sensor devices.

All luminaires for public and BoH areas (new permanent works) shall be individually addressable allowing control groups to be set from the lighting control system head-end. Switching and dimming of individual luminaires and control groups shall be possible from the lighting control head-end and shall have the facility to be monitored and controlled off-site.

The lighting control system shall monitor the status of all fittings and give notification of any faults and maintenance requirements, including but not limited to: lamp and ballast status and fitting disconnection.

The lighting control system shall allow automatically and manually controlled switching and dimming of the lighting installation using inputs from switches, presence and daylight sensors, time clocks and inputs from other systems to maintain the required lighting levels, conserve energy and prolong lamp life.

For any fittings that are existing or are not addressable i.e. external façade and platform lighting, these shall be switched via relay contactors at the distribution board. This will allow non-DALI circuits to be digitally interfaced within the lighting control system. For existing BoH areas, including plantrooms for supply air fans these shall have no remote lighting control functionality and shall remain manually switched.

Lighting in all public areas shall be automatically controlled using a combination of presence detectors, photocells and time scheduling. All lighting control units (photocells, Passive Infrareds (PIR's), ultrasonic detectors, pushbuttons, 24 hr time-clocks, switches etc.) shall be capable of being assigned to control any lighting control group at the lighting control head end. The automatic control of all lighting shall be capable of being manually over-ridden for maintenance, operational and emergency intervention purposes.

The lighting installation shall, where practicable make use of the available natural light and be capable of turning off or dimming the luminaires in all areas with natural light to reduce energy consumption.

Offices and general staff areas shall be controlled via a combination of wall pushbuttons, and presence detection. Plant rooms and electrical rooms shall be local switched control only.

Corridors and evacuation routes shall typically switched via PIR, local push buttons shall also be located in BoH corridors.

The lighting control strategy will need to be further developed and agreed with AT.

The pre-programmed lighting modes, operated via the LCS or EMS system, shall include as a minimum:

- Station open – maintenance (times to be confirmed the station manager)
- Station open – public / 15miniutes before the first train
- Station closed (15 minutes after the last train)
- Station emergency
- Station engineering and maintenance

The lighting control strategy will need further development and agreement with AT during the testing and commissioning stage of the system.

An interface shall be provided between the lighting control system and the existing station SCADA system allowing for pre-configured modes to be activated upon inputs from other systems, including EMS, security systems, fire systems and the station control system (SCADA) controlled from the Main Control Room. For further details for SCADA and control interface refer to document Station Control CRL-BTM-BMS-000-SPE-0001

For existing lighting circuits that are to be resupplied from a new lighting DB and are non addressable shall be controlled/switched from local relays provided within the DB. The local relays shall be connected to the existing SCADA network and will continue to be controlled at the MCR, this includes but not limited to;

- Platform lighting
- Glass bridge
- Glasshouse
- External and façade lighting
- Existing public and street lighting

3.3.9.21 Electrical Management System (EMS)

Selected station electrical sub-systems will be monitored and controlled through an Electrical Management System (EMS). In the final CRL configuration the EMS will act as an intermediary control platform between the Station Management System SCADA (SMS-SCADA) and electrical sub-systems via high and low-level interfacing.

For the Britomart permanent works, primary monitoring and control of electrical sub-systems is via the EMS, with secondary over-riding control and monitoring of critical functions via the SCADA system.

The electrical sub-systems shall include:

- Lighting control system

- Emergency lighting monitoring system
- LV switchgear monitoring and control,
- UPS monitoring,
- Electrical metering monitoring.
- Load shedding
- Lift and Escalator emergency control and monitoring

Refer to the Station Control specification, EMS points schedule, EMS sections of this specification and Electrical schematic drawings for SCADA and EMS interfacing requirements.

3.3.9.22 Design Life

The design of the electrical system shall be such that no major repair shall be necessary for the duration of the maintainable design life from the handover date. Routine replacement of consumables (lamps, filters and the like) and parts subject to normal wear and tear are excluded.

The maintainable design life of elements within the electrical system is detailed in below.

Table 3-1 Electrical power supply design life requirements

Element	Design Life (Years)	Operating Requirements (hours per day – 365 days a year)
Electrical switchgear	40	24
Electrical accessories & outlets	25	24
Electrical power cables	60	24
UPS batteries	10	24

The design life for each element of the system shall be based on the expected environmental conditions and the installation method used.

Unless otherwise specified, all equipment shall be designed for a minimum maintainable design life of 40 years, operating 365 days a year, 24 hours per day.

3.3.9.23 Equipment Sizing

The equipment sizing and details for main plant equipment are listed in the table below, this shall be read in conjunction with the electrical drawings.

Type	Size (minimum)	Rating	Details (TBA)
Main Electrical Switchboard	2500A (Busbar)	50kA (Fault Level)	Form 4, IP54 (Minimum)
Main Electrical Switchboard (Temporary Accommodation)	630A (Busbar)	35kA (Fault Level)	Form 4, IP54 (Minimum)
Sub Switchboards and MCC (Dependant on kVA rating)	630A (Busbar)	50kA (Fault Level)	Form 4, IP54 (Minimum)
Distribution Board	160A (Busbar)	25kA (Fault Level)	Form 1 IP54 (Minimum)
Distribution Board (Retail)	100A (Busbar)	20kA (Fault Level)	Form 1 IP42 (Minimum)

UPS	20-80kVA (Double conversion)	Overload capability 150% for 1minute	N, N+1 depending on load classification
Batteries	1.5hours for Critcal Life safety UPS loads 3 hours for Critical UPS loads	TBD	Seal Lead acid type

3.3.9.24 Continuity of Station Operation

Omitted for clarity. Refer to revision 7 of this specification

3.3.9.25 ESD Initiatives

General Requirements

Provide the following initiatives as part of the electrical scope of work including reports. Any alternatives offered against specified items shall take into account the ESD implications of the alternative product in addition to considering the technical equivalence of the product.

Scope

The ESD responsibilities associated with the Electrical package include the following:

- Commissioning
- Building Fine Tuning
- Sub-Metering of all distribution boards and mechanical/hydraulic/fire loads above 50 kVA
- Use of LED luminaires and fluorescents with electronic ballasts.
- PVC minimisation
- Use of Low Smoke Zero Halogen cabling (LSZH)

A summary of the specific requirements for electrical services are as follows:

Commissioning

Provide testing and commissioning in accordance the Testing and Commissioning section of this specification and as follows:

Building Services Information:

Information/documentation to be provided as a part of the operation and maintenance manuals shall include basic functions and operations of the following, with descriptions of energy saving features of the:

- Electrical Systems
- EMS system
- Lighting and Lighting Control Systems
- In each case there is to be:
- Extract from the design specification describing the project's commissioning requirements and information transmittal.
- A project timeline demonstrating the inclusion of the commissioning period.

- A design intent report covering energy, environmental strategy, monitoring and targeting, and building services.
- A simplified diagram of each system
- An explanation of how it operates
- A list of what the main components are (including controls) and the importance of their efficient use
- Details on maintenance, including recommended frequency
- A list of likely and tell-tale signs of system failure, system 'do's and don'ts' and notes on efficient operation.

Commissioning Report

Liaise with the independent commissioning agent (ICA) for all commissioning and agree all commissioning plans with the ICA.
Provide a report that commissioning of each system or feature is in compliance with the contract documents. The report must also include a documented list of outstanding commissioning issues, records of all function/commissioning testing undertaken and list any seasonal testing required in the future.

Building Fine Tuning

Provide a 12 month building tuning period following practical completion. This requires minimum monthly reviews and a final re-commissioning after 12 months to ensure optimum energy efficiency and comfort.

The Building tuning shall include the following,

- Lighting control system
- Emergency lighting monitoring system
- EMS system

At each quarterly review undertake detailed investigation of control issues and locations of excessive energy consumption and rectify. Provide a monthly report of activities and outcomes.

Provide a Building tuning report after the 12 month period detailing the building tuning carried out, there areas requiring tuning and any on-going areas of concern.

Electrical Management System:

An electronic Electrical Management System is required as detailed in this specification monitor and control electrical systems including meters, LV switchgear, lighting control, emergency lighting monitoring.

Required Documentation:

- An extract from the controls specification demonstrating that the EMS will monitor energy from all sub-meters.
- A points list detailing each of the points monitored or controlled.

LED's and High Frequency Ballasts:

Scope:

LED's shall be supplied and installed where practicable. Where fluorescent luminaires are installed, they shall have high frequency electronic ballasts in all cases.

Required Documentation:

A short report that includes as a minimum:

- Identification of all luminaires with types of ballasts and quantities nominated.
- The Operational Floor Area served by luminaires with high-frequency ballasts.

Electrical Sub Metering:

Scope

Provide sub-metering for loads within the building as documented. Sub-meters must also be connected to the Electrical Management System.

Required Documentation

A short report that includes the following as a minimum:

- A summary table of all separately metered spaces in the building.
- A description of how the energy consumption data will be effectively monitored during the building's operation.
- Schematic electrical drawings with all uses and loads clearly indicated and the location of all sub-meters clearly marked.
- EMS point schedule showing inputs from the sub-meters and that they are duly connected

Lighting Zoning and Control:

Scope

Lighting control and zones as documented.

Required Documentation:

- A report that describes how the Target Criteria has been met and provides a summary table that lists all separately switched zones and their area.
- Floor plan drawings indicating the location of the switches, each individually switched lighting zone and its area.
- Electrical drawings indicating the locations of, and the area controlled by each switch.
- Confirmation that the system has been installed and wired as designed.
- Extract from the Commissioning Report demonstrating that the lighting system has been commissioned and operates as intended in the design.

High Efficacy External Lighting:

Scope

All externally-lit spaces over the entire site must meet the following criteria:

- All external lighting has a light source efficacy of at least 65 lumens/watt;

- 95% of outdoor spaces meet or exceed the minimum requirements of AS1158 for illuminance levels; and
- 95% of all external lights are connected to daylight sensors.

This target does not include emergency lighting required for NZBC F6 compliance or lighting to provide safe access for staff and visitors after-hours.

Required Documentation

The schedule of external lighting fixtures indicating quantity, locations and compliance with the Credit Criteria.

PVC Minimisation:

Scope

Reduce PVC content for major typical uses in the project by 10-30% (by cost) by replacing with alternative materials. The submains already specified as non-PVC can be included in the cost reduction by comparison with Non-PVC alternatives.

Required Documentation

A report that includes the following as a minimum:

- Identifies all major standard PVC uses within the project.
- Identifies the reference case for anticipated cost of PVC in the project.
- Identifies the expected cost of PVC within all of the major standard PVC uses in the project.
- Nominates through calculations and a summary table how the cost of PVC has been reduced against the reference case.
- Identifies the actual cost of non-PVC product which have been used on the CRL.

Light Pollution:

Scope

The lighting design complies with AS4282 ‘Control of the Obtrusive Effects of Outdoor Lighting’.

Required Documentation:

- A short report describing the design details of all external lighting showing that it meets the criteria of this initiative.

3.3.9.26 Communications Convergence

Converged Engineering Services

The following Ethernet / IP based Electrical building engineering services systems shall use the Britomart communications LAN for the distribution of their data within the station:

- Electrical Management System (EMS)
- Lighting Control System
- Emergency Lighting Control System
- CCTV/Security

Interfaces

This section details the termination points between electrical trades and the communications works.

The following are mandatory requirements for connection of devices to the Converged Network:

- All fixed data connections will be 802.3az (1 Gbit/s) compliant
- Will connect to the Britomart fixed data network via Cat 6e copper cable
- Wireless access will be via the 802.11n standard only (2.4 and 5 Ghz supported). Wireless devices will have mandatory support for WPA2 pre shared key authentication and preferred support for WPA2 certificate based authentication.
- Smartcards for user authentication will be supported
- Microsoft Active Directory integration is required for authentication and management
- Local Storage will be used as temporary storage only (where present). All data will be replicated to the Britomart centralised storage within 4 hours of capture
- Storage replication will be done using the NFS or iSCSI protocols
- Images and video captured will be stored in a standard image format to ensure compatibility with open standards based systems and applications
- Metadata including date, location and recording person will be embedded in images and videos
- Equipment will be SNMP v3 (possible v2) compliant for remote monitoring
- Equipment will support SSL and SSH for remote management by the vendor
- The solution will be capable of customised views to suit the user
- The solution will store user customised options and automatically recall these when the user authenticates
- The solution will support browser based ICA/VDI sessions
- The solution will enforce access rights to information in compliance with MS Active Directory rights and privileges
- The SIP communication protocol should be supported for Voice and Video communication

Liaison with communications sub-Contractor:

Liaise with the communications sub-Contractor to:

- Ensure compliance with the mandatory, functional, software and operational requirements prior to purchasing any equipment which may connect to the Converged Network
- Confirm the point of demarcation shown in the Convergence drawings.
- Produce revised shop drawings if necessary for approval by the Managing Contractor.
- Obtain configuration information for all equipment connecting to the Converged Network from .
- Receive configuration information (IP addresses, gateways, DNS servers and any other information required)
- Confirm the number of equipment cords required for the electrical work.
- Provide all other equipment as details to the communications sub-Contractor
- Install the equipment cords and connect electrical equipment to the converged network as part of this sub-contract.

Active Equipment:

All active equipment will be provided as part of the communications sub-contract.

Electrical Management System (EMS)

The point of demarcation between the EMS and communications services is at a telecommunications outlet at each EMS device and at the head-end equipment as detailed in the EMS and electrical schematics. Equipment cords between the telecommunications outlet and each EMS device shall be procured by the communications subContractor and installed by the electrical subContractor.

EMS Generally:

- Liaise with the Communications sub Contractor to obtain all relevant EMS/communications drawings and schematics. Review and understand the points of demarcation.
- Pay particular attention to maintaining the mandatory separation distances detailed in AS/ACIF S009:2006.
- If an area is encountered where compliance with AS/ACIF S009:2006 may be compromised, report this to the Managing Contractor prior to installation.

Electrical Management System

This section details the Converged Network requirements for the electrical management system.

- The point of connection to the Converged Network for the EMS is generally at a TO adjacent to electrical switchboard panels containing Programmable Logic Controllers (PLCs) as detailed on the communications layout drawings.
- Additional outlets may be installed for other specific items of equipment. These outlets are also detailed on the communications layout drawings.
- Refer to the electrical drawings for the electrical equipment.

Lighting Control System

- The point of connection to the Converged Network for the Lighting Control System is generally at a TO (by Comms) adjacent to electrical switchboard panels containing DALI controllers/Ethernet gateways as detailed on the communications layout drawings.
- Additional outlets may be installed for other specific items of equipment. These outlets are also detailed on the communications layout drawings.
- Refer to the lighting drawings and schematics for the control equipment locations.

Emergency Lighting Control System

- The point of connection to the Converged Network for the Lighting Control System is generally at TOs (by Comms) mounted within electrical riser cupboards adjacent to emergency lighting area controllers.
- Additional outlets may be installed for other specific items of equipment. These outlets are also detailed on the communications layout drawings.
- Refer to the electrical drawings for locations and schematics of equipment.

4 Scope - Communications

4.1 General

The purpose of communications services to the CRL is to provide communications to stations, tunnels and associated buildings for operations and equipment, and to establish a communications system that minimises loss of communications to station and tunnel equipment and services.

The communications system shall support the following station systems:

- Passenger, staff and operational systems
- Mechanical, Electrical, Fire, Hydraulic, Vertical Transportation services
- Station Control, Security, CCTV, monitoring and signalling systems
- PA/EWIS systems
- Interfacing to station systems and wider network systems

The tunnel systems communications will be carried out by others and does not form part of the Construction Contract 1 works.

The supply and installation of communications systems shall incorporate the concept of Reliability, Availability, Maintainability and Safety (RAMS). Selection of all systems and system components must consider the service life of all systems, system reliability and resilience, and the installation methods to ensure that the system is suitable for the application, is safe and maintainable.

Communications systems plant and equipment shall be selected to comply with the agreed RAMS requirements (as stated in the RAMS specification, please refer to RAMS specification for details). The supply and installation, including the selection of equipment and spares, shall provide for suitable protection from obsolescence.

The supply and installation of the communications systems shall incorporate the Fire Safety requirements.

All equipment and installations shall with AT COMMS Specification Any descrepency between this document and AT COMMS Specification shall be submitted to the engineer or client's representative for approval prior to commencing works.

Systems shall be supplied and installed to reduce the safety risks to as low as reasonably practical (ALARP).

The supply and installation of communications systems shall be such that no major repair shall be necessary for the duration of the maintainable design life. Routine replacement of consumables and parts subject to normal wear and tear are excluded.

The communications systems shall be supplied and installed to facilitate regular inspections, maintenance and replacement of equipment, cabling and containment. To the extent reasonably practical such inspections and maintenance shall be capable of being undertaken during either off peak operational hours, where this does not interfere with operations, or within limited non-traffic hours each night.

The various station packages that will need interfacing with the existing station include;

- Access control
- Intruder detection

- CCTV/VMS
- Public help points.
- Public Address / Voice Alarm system including Hearing Augmentation Loops (HALs) / Induction Loops.
- Passenger Information Display System (PIDS).
- Automatic Ticket Gates (ATG's) & Vending and Reload Device (VRD's).
- Master clock system.
- Emergency services radio systems.
- Staff radio system.
- Public and Staff Wi-Fi.
- Mobile Phone service.
- Telephone systems.
- Voice recording system.
- SCADA.
- Building and Electrical Management Systems (BMS/EMS).
- Local Area Network (LAN) systems to support all operational and station Communications and Control systems including Office PC-based IT systems.

Location and Design of Network Termination Points – The Construction Contract 1 works does not include any requirements for a Wide Area Network (WAN). All new cables connecting the new Telecoms assets for the scheme shall terminate in the equipment cabinets located in the East comms rooms. All terminations shall be as per the design drawings including schematics (See Appendices).

4.1.1 Tender Requirements

There will be a provisional sum for the following communications systems following tender returns:

- Passenger Information Displays (PIDs)
- Passenger Help Points (PHPs)
- Vending Reload Device (VRDs).

The detailed design allows for power and data to each of the equipment in the proposed locations as shown on the Communications drawings.

4.2 Scope

Supply, delivery, installation, commissioning, defects liability, warranty and maintenance of all communications services, including: testing, samples, shop drawings, building penetrations, seismic restraints, plinths, noise and vibration control, finishes, site painting, identification, testing and commissioning, documentation, as built drawings, operation and maintenance manuals, user guide, training, spare parts, cleaning and system integration and all minor and incidental works.

The scope of the contract communications works as detailed within this specification and associated drawings shall include, but not be limited to, the design, supply, installation, testing and commissioning of the following:

- Verifying existing communications systems internal and external to Britomart Station and the CPO building

- Isolation, decommissioning and removal of existing communications services not required for station operation
- Communications services required for the temporary works including LAN, WLAN, Comms racks, comms head-end/ field equipment, patching and cabling, field outlets, EWIS, PHP's, PID's, PA, WIP's, SCADA, Optical fibre, earthing and bonding;
- Communications services required for the permanent works including LAN, Comms racks, comms head-end/field equipment, patching and cabling, field outlets, EWIS, PHP's, PID's, PA, WIP's, SCADA, Optical fibre, earthing and bonding;
- Continuity of station operation during temporary and permanent works programmes
- Diversion of communications services during temporary and permanent works programmes
- Staging of all works necessary for enabling, temporary and permanent works
- Provision of secondary containment for communications services which may include ducting, conduits, trunking and catenary wire throughout the entire facility, incoming services and tunnels (where required for station services reticulated in tunnels e.g. comms backbone cabling);
- Provision of enclosures, fixings and supports including ducting, in-slab conduits, equipment supports and bracing;
- Design and installation of all seismic restraints for secondary communications services and equipment to comply with NZS 4219 where not provided by the electrical scope;
- Provision of fire-rated cabling and containment systems for critical life safety and essential life safety services for all works and tunnels (where required for station services reticulated in tunnels e.g. comms backbone cabling);
- Provision of fire-stopping of penetrations for communications services.
- Provision of earthing and bonding systems for all works and provision for interfacing to the electrical earthing and bonding systems
- Surge protection on all communications equipment;
- Provision of 'future' communications services for the Rail Systems rooms but not installed;
- Provision of interfaces of communications systems (including PIDs, VRDs and PHPs) to other systems such as fire, mechanical (including escalators), hydraulic, electrical (including lighting), security, CCTV, BMS, EMS, WAN (Wide Area Network);
- Provision of a 1 off communication connection cable (2 fibre) to all 'fixed' temporary retail spaces from the street via in ground conduits
- Provision of 4 off telephone connection cables (4 pair category 6 cable each) to all permanent retail spaces in the CPO Ground floor;
- Isolation and decommissioning of services to the temporary accommodation facilities;
- Isolation and decommissioning of services not required to remain or be provided for the permanent works;
- Integration of any new, relocated or diverted services into the existing station east systems e.g. SCADA and Comms systems (SCADA cabling to be carried out by control specialist);
- The design and installation of the Britomart and CPO Communications systems shall incorporate the Fire Engineering requirements as defined in the Fire Engineering Brief;

4.3 Design life

The design of the temporary works communications systems shall be such that no major repair shall be necessary for the duration of the maintainable design life from the handover date. Routine replacement of consumables (lamps, filters and the like) and parts subject to normal wear and tear are excluded.

The maintainable design life for system elements is as detailed in the table below.

The design life for the Communications and Control systems shall be based on the expected environmental conditions and the installation method used.

Communications systems design life requirements

Element	Design life (years)	Operating Requirements (Hours per day – 365 days a year)
Communications cables	25	24
Active communications equipment	25	24
Computers (head end equipment)	5	24

4.4 Existing Communications Systems

Existing Communications systems at Britomart include:

- Optical Fibre Network
- LAN
- WLAN
- Emergency Warning and Information System (EWIS), comprising:
  - Public Address (PA)
  - Warden Intercommunication Points (WIP)
  - Emergency Telephones (ET)
  - Visual Alarm Beacons
- Passenger Information Displays (PIDs)
- Passenger Help Points (PHPs)
- Supervisory Control and Data Acquisition (SCADA)
- Telecommunication network providers (phone/broadband)

4.4.1 Incoming Telecommunications

The existing west end of the station and CPO building is served by a number of existing telecommunication providers.

- Chorus
- SPARK
- Vodafone
- 2 Degrees
- Telstra
- Kordia (Leaky Feeder and Aerials)

4.4.2 Leaky Feeder Radio Network (LFRN)

The communications system in Britomart has been installed by Kordia and uses the 400 MHz and 800 MHz Ultra High Frequency (UHF) range distributed via a LFRN. The LFRN originates in the East Comms Room (B1.511) and includes a KorKor base station and repeaters. Radiating cabling distributes from the east end to the west end and connects to a number of antennae's. The following services use the LF network;

- New Zealand Fire Service (NZFS)
- NZ Police
- Station Operations/AT Radios
- KorKor clients

The frequencies in use at the station are described in the below table;

Station Radio Frequencies

Description	Quantity	Provided
Police 400 MHz UHF Mobile	1	Police
Fire Service 400 MHz Mobile	1	Fire Service
Korkor 800 MHz Mobile	1	Kordia or TA
10 watt 50Ω load	1	Kordia

4.4.3 Very High Frequency (VHF) Coverage

St Johns' Ambulance in the Auckland area use VHF. The communications system in Britomart is 400 MHz and 800 MHz systems (UHF) and St Johns has no UHF system in Britomart. However, they do have spectrum allocated in the 490 MHz area and have not taken up this in the Auckland area because of the use of VHF.

St Johns' has indicated that they generally have good VHF coverage from Sky Tower in the public areas of the station due to the existing station skylights offering good views of the Sky Tower.

4.4.4 Optic Fibre Network (OFN)

The corporate IT and data transmission systems currently provides desk top corporate and operational Information Technology (IT) requirements. The needs of IT users are currently provided through the network of data transmission nodes distributed around the station. These are linked through the existing Optical Fibre Network (OFN) and use this in common with other communications and control systems operating in the station.

The OFN links all the communications and control systems and provides data transmission capabilities enabling field equipment to communicate and interact with control room and plant room equipment.

The current network connects to the East End CER (Equipment room B1.519) and provides optical fibre pathways to all communications nodes around the station, including those at the West end of the station, in the following locations:

- Cab A/D/E (East End)
- Cab B (B2 Level – B2.121)
- Cab BB (B2 Level – Transdev)

- Cab C (B1 Level – B1.005)
- Cab F (B1 Level – B1.002)
- Cab G (B2 Level – B2.108)

The existing network comprises both single mode and multimode fibre with cable routes both North and South sides of the station in the Over Track Exhaust plenums (OTE) and buried in the base slab.

A 96 core OFN has been provided for 'future' works. This routes via the south OTE and terminates at Cab C (B1 Level – B1.005).

4.4.5 Local Area Network (LAN)

The local distribution of signals to the desktop and via Wi-Fi access points is delivered through a network of category 5 structured cabling. This copper access network provides a radial feed from comms node points to sockets terminated in the field, to which field devices (PCs, etc.) connect. The copper cables are terminated on patch panels at the comms nodes and provide a flexible system which can be easily reconfigured to suit the changing needs and environment of the station.

The existing system of comms nodes and structured cabling patch panels has been installed piecemeal over a number of years and has now grown to the point where space is limited and certain cable terminations difficult to access and maintain. In addition records of the existing network are not comprehensive so a tag and trace survey was carried out in July 2015 to determine cable routes.

4.4.6 WLAN

A WLAN is provided on the station to provide Wi-Fi access for public use. The system is delivered into the station environment by NZ telecoms operator SPARK. The system uses Wi-Fi access points connected by multi-mode optical fibre cable to deliver Wi-Fi service around the station.

4.4.7 Emergency Warning and Information Systems (EWIS)

The EWIS and Public Address (PA) is supplied as an integrated system that uses a common network of loudspeakers to provide emergency announcements, general paging and background music.

Additional items of the EWIS and PA system include the Warden Intercommunication Phones (WIP), the Emergency Telephones (ET) and the Visual Alarm Beacons. The above items are independent of the integrated EWIS/PA system but are used in conjunction with it during an emergency evacuation.

4.4.8 Public Address (PA)

The PA system provides the facility for broadcasting audio announcements to passengers and staff. The PA system uses zones for broadcasting different audio messages in areas of the station and priority levels to allow high priority messages to override those which are less important. The head-end amplifiers & audio control equipment is located in the east end equipment room (B1.519).

The PA zones in the station west and CPO are located as follows:

- Zone 4 – B2 Concourse and Glass House
- Zone 5 – B1 Concourse under CPO
- Zone 6 – CPO ground floor

4.4.9 Warden Intercommunication Point (WIP) /Emergency Telephone (ET)

The WIPs and ETs provide a dedicated telephone communication link to the main and emergency control rooms at the east end of the station. ETs are configured as hands free intercoms and are

provided in the tunnel section of the station. The location and status of each WIP or ET is shown on the SCADA mimic screens.

The WIPs in the station west and CPO are located as follows:

- WIP 18 – B1 Concourse
- WIP 19 – CPO Ground Floor - North Ticket Office
- WIP 20 – CPO Ground Floor – Flower Shop (old South Ticket Office)

4.4.10 Visual Alarm Beacons

There are approximately 60 strobe lights installed throughout the station and tunnel used as Visual Alarm Beacons. The strobe lights are used to warn personnel in the plant rooms that an evacuation message has been issued and are provided where noise levels from plant equipment may prevent an emergency evacuation message delivered over the loud speaker network from being heard.

4.4.11 Passenger Information Displays (PIDS)

The PIDs provide passengers with live train running information to enable passengers to make informed decisions about their journey.

The PIDs head end control system is located at the east end of the station. Communications between the PIDs and the control system has been split between the Station SCADA Ethernet Network and IT network. Ethernet communications are converted to serial communications local to each sign to achieve the required RS232 interface.

Interfacing between the PIDs system and the SCADA system is via a hardware communications module provided at the PIDs control system.

4.4.11.1 West End PIDs

The existing West end PIDs are linked to an Ethernet Fibre Switch connected to the west PLC and located;

- West end platform PIDs
- Centre of platform PIDs
- East end platform PIDs

4.4.11.2 CPO Building PIDs

PIDs in the CPO building are controlled via the IT network (not Station SCADA Ethernet Network) and located;

- Summary of Departures PID 1 – CPO ground floor
- Summary of Departures PID 2 – CPO ground floor
- Next Train / Platform Information – Level B1 Concourse

4.4.12 Public Help Points (PHP)

PHPs provide passengers with the facility to make information or emergency calls to staff in the station control room. PHP calls are answered in the Main Control Room at the east end of the station and are interfaced with the SCADA system to enable CCTV view of a PHP when activated.

PHPs are located on Platforms and the B2 Concourse (unpaid) only and are independent of the PA/EWIS system.

4.4.13 Automatic Ticket Gates (ATG's) & Vending Reload Devices (VRD'S).

The existing ATG's are located on the B2 concourse.

The existing VRD's are located in the CPO ground floor and level B1 concourse.

4.4.14 Station SCADA System

The existing SCADA system controls and/or monitors various station systems. The control front end is based around the Citect SCADA platform and allows full control and monitoring of station field assets from the Main and Emergency control rooms. The control (PC based server and display clients) is located in the east end of the station in the station main control room.

The SCADA system comprises two distributed optical fibre I/O networks connected over a dual redundant Ethernet network. The distributed I/O networks are divided into East and West Sectors, serving the relevant station areas. The West Sector distributed I/O network includes I/O points in the western half of the station and the CPO.

The SCADA system interfaces with the following systems:

- Ventilation Systems
- CCTV System
- Access Control System
- Public Help Points
- WIP & Emergency Phones
- EWIS & PA
- PIDs System
- Power Distribution Network
- UPS Modules
- Lighting Systems
- Lifts & Escalators
- Mechanical Services
- Motorised Doors
- Train Presence Sensing Equipment
- Air Quality Monitoring Equipment

The West end SCADA PLC is located in the B2 Platform Switch room (MSB1-1) with marshalling panels located on Level B1 (beneath the escalators) and in the B1 Level comms room (south).

4.5 Temporary Works

Omitted for clarity. Refer Rev 7 of this specification.

4.6 Permanent Works

4.6.1 Structured Cabling System:

The contractor shall supply, install, test and commission a complete, integrated, end-to-end structured cabling system in accordance with appropriate local and international standards; and the technical and performance criteria set out in this document.

All structured cabling works shall be installed in strick compliance with the Auckland Transport Business Technology (BT) Communications Cabling Infrastructure specifications and the latest applicable TE Connectivity, Enterprise Networks warranty specification.

The system shall be supplied with all equipment, hardware, software, cabling, coordination, interfacing, testing, commissioning and ancillary services as required to provide an integrated structured cabling system complete and functional in all respects. The tenderers are to familiarise themselves with the existing site and with all matters related to the supply and installation of the integrated structured cabling system and include all costs in the tender submission.

The Contractor shall prepare a submission detailing specifications of all proposed equipment associated with the structured cabling installation as part of the tender return for approval by the client.

A complete Category 6 UTP cable installation utilising a T568-B wiring pattern, cable management and infrastructure system comprising of conduit, trunking, cabling and a cable basket network shall be provided by the contractor throughout the temporary works buildings to serve all RJ45 voice and data outlets as detailed on the power & data drawings, electrical schematics and this specification and appendices.

Refer to electrical power and data layout drawings for data outlet locations, comms room locations, electrical, security and CCTV schematics for additional data outlet provisions, locations and connectivity requirements.

4.6.1.1 IT Network

Provision for a cable containment route to the retail units from the IT racks located in the Communications rooms has been provided. AT IT to ensure that spare ports are allocated on the IT patch panels for the retail unit cable connections. It should be noted that the IT equipment to be housed inside the retail units is yet to be confirmed; therefore the size and number of cables feeding the units are assumptions at this stage. As a result the cross sectional area of the containment required may be subject to change

4.6.1.2 Station Controls Network

The Contractor shall supply and install a new dedicated Ethernet network within the station for interconnection of control equipment. The equipment connected to the ‘Control’ network includes;

- BMS management servers
- EMS management servers
- Lighting controllers
- EMS stations (ie. Switchboard monitoring and control)
- HVAC/PH/Fire interfacing BMS stations

The ‘Control’ network shall utilise spare fibres in the station wide data network cable. The data network fibre cables terminate in data cabinets positioned throughout the station. Room will be provided for patch panels and Ethernet switches to be installed within or adjacent to the data cabinets. Fibre and copper patching shall create a ‘ring’ network similar to that configured for the data network.

Field mounted BMS and EMS stations and servers will connect into the 'Control' network at the nearest (within 90 metres) data cabinet.

The Contractor shall supply and install an Ethernet compliant connection between the new Control network and the existing SCADA network. As the IP addressing of the existing SCADA network is incompatible with future requirements, the networks are to be connected via router(s) to perform Network Address Translation (NAT).

In conjunction with the new BMS and EMS systems, new interfaces to the SCADA shall be installed to enable status and alarm reporting to the station operator using the existing SCADA displays that shall be revised to suit the new configuration. The new interfaces shall be compatible with the existing SCADA IO network (FIPIO).

Refer to the Station Controls Specification (CRL-BTM-BMS-SPE-0001) for more information.

4.6.2 Incoming Telecommunications:

The design has provided two telecoms equipment rooms on B1 Concourse level to house equipment and terminate incoming cables for third party telecoms suppliers.

This room allows for the provision of both fixed and mobile telecoms services from public providers and acts as a distribution and demarcation point for these.

Third party providers will be able to access this room for maintenance of their respective telecoms services as required at the station.

The third party telecoms supplies shall be responsible for their own design, supply and installation.

The Contractor shall liaise with the telephone provider to ensure that provision of 4 off telephone connection cables (4 pair category 6 cable each) to all permanent retail spaces in the CPO Ground floor is allowed for in the installation. It should be noted that a 3rd party cable containment route to the CER has been provided with the termination point in the AT POP cabinets for the telephone line.

4.6.3 Local Area Network (LAN)

4.6.3.1 Optical Fibre Network (OFN)

The existing Optical Fibre ring shall be extended into the permanent works areas of the west end of the station and the CPO

The intention shall be to maintain the following cabinets during these works;

- Cab A/D/E (East End)
- Cab B (B2 Level – B2.121)
- Cab BB (B2 Level – Transdev)

The OFN cabling between Cab B and Cab BB shall be isolated and removed once the ticket gate line is installed and commissioned in the permanent works.

The Contractor shall supply, test and commission a complete optical fibre ring including new comms nodes/cabinets for the permanent works. Refer CRL-BTM-MEP-000-MEP-0386.

The optical fibre network shall be provided to enable all of the data transmission needs of the other communications and control systems. The new comms node and CER will act as concentration points for the field copper cabling and will contain head-end equipment for the onward transmission to the existing comms rooms and control rooms at the east end of the station.

The contractor shall provide and install all necessary containment, cabling, equipment, pathways, interfacing and connectivity.

4.6.3.2 Comms Splice Rooms:

Two separate splice rooms are required to maintain network diversity and prevent the instance of a single point of failure. These rooms form part of 'future' CRL works and will not be fitted out for the Construction Contract 1 Works.

The C1 design allows for the provision of shell only services to these rooms. Refer Memo CRL-BTM-MEP-000-MEM-0429 for proposed works.

These rooms house equipment to terminate the optical fibre cables running through each of the tunnels, providing connectivity between Britomart station and the wider network

The splice rooms also act as a demarcation point between the tunnel and station networks, allowing the aggregation and distribution of data to/from the respective transmission domains.

The contractor shall allow for the provision only of optical fibre cables but not the installation. The contractor shall ensure that sufficient 'future' space is allowed for on cable trays excluding the 25% spare capacity.

4.6.3.3 CER and Comms Node:

A new Communications Equipment Room (CER) shall house the new communications, security, CCTV, PA/EWIS and control systems head-end equipment.

The CER and new comms node are provided in the following locations:

- CER - B1.020
- Comms Node – B1.056, B1.004, B2,115 B1.115A
- 3rd party utilities – B1.008, B1.057

All systems requiring access to the network, including IT and office data systems shall be connected to the CER or comms node, providing access into the station LAN.

The contractor shall supply, install, test and commission all cable basket/tray, cabling, containment, racks, seismic restraint, fixings, supports and associated equipment listed below, within the CER and comms node to provide a fully functioning communications system.

Typical permanent works services connected to the nodes include:

- CCTV
- PIDS (IT Ethernet switch)
- PHP/WIP
- VRD
- Voice
- Data
- SCADA
- PA/EWIS
- Wifi
- Access Control
- Electrical and security/CCTV sub-systems

The contractor shall provide new racks in the CER and comms racks in the comms node to support the IT and data network needs of the permanent works infrastructure. The CER will house the following cabinets (refer to drawing CRL-BTM-COM-000-DRG-1040 for comms room layouts):

Each comms rack shall include as a minimum:

- 'Q' series – 45ru, 25" Modempak free standing comms rack [800 x 800 x 2100mm (w x d x h)]
- 24-port horizontal and voice patch panels
- Fibre optic break-out trays
- All CAT 6 UTP and fibre optic patching cords
- Vertical and horizontal cable management
- 2 No 12 Way Horizontal Power 6 IEC + 6 NZ (Mounted at back with UPS type Plug to overhead captive socket outlets
- 15A captive socket outlet mounted on cable tray above each rack with dedicated circuit from local UPS backed DB.
- Top Waterfall Support Tray
- Fan kits
- Removable, lockable, perforated steel doors and side panels
- Shelf rails and shelves (20kg capacity)
- CES earth bar and connection to MSB room building earth bar
- Testing and commissioning of all comms systems and cabling.
- Data outlets for WAP devices in selected locations
- Client supplied and installed equipment:
  - Active switches
  - WAP devices (data outlets by contractor)
  - PC and laptop fly-leads (between data point and PC/laptop)

UPS and associated cabling infrastructure and power outlets/lighting in the comms room shall be provided by the contractor. Provide power to the racks from the UPS DB via overhead captive socket outlets. Provide connectivity from the captive outlets into the racks. One 15A captive socket outlet shall be provided. Refer to the Electrical section of this specification and the electrical drawings for more detail of UPS requirements.

4.6.3.4 Public WIFI

The Contract 1 Works does not include any requirements for public Wi-Fi.

4.6.3.5 Telephone Systems

The Contract 1 Works includes for staff telephones. However, physical or soft phones to be determined as per ATBT guidelines.

4.6.4 Wireless Local Area Network (WLAN)

The Contract 1 Works includes for a WLAN. Staff Wi-Fi shall be provided.

4.6.5 Passenger Information Displays (PIDS)

The PID design strategy for the Britomart Station permanent works is to provide real-time information to passengers at key decision points throughout the station as described below.

Passenger Information Strategy

Area	Information
CPO Ground Floor	Clock Summary of Departures Special Notices / General Travel Information
Level B1 Concourse	Clock Next Travel / Platform Departure Information

Specific details of the PID installations (orientation, fixing arrangement) shall be determined once AT confirms the type and functionality of the displays.

4.6.5.1 Colour Selection:

The use of colours or similar in hue or tone shall be avoided. The following colour relationships shall only be used:

Background	Active Text
White	Black or Dark Blue
Black or Dark Blue	White or Yellow

4.6.5.2 PID positioning:

The contractor shall install two new CPO PIDS located on the CPO ground floor. The current proposal is to mount these above the VRD's on the East walls. The intention is for PIDs to be in full view of the passengers on the approach down to the B1 level. Additionally the PIDs are unobtrusive to the CCTV cameras field of views in the proposed position.

The contractor shall also provide new connectivity from the existing PID located at the top of the existing escalators at B1 (PID to remain in current location).

When determining the position of a suspended passenger display, the following requirements have been considered to demonstrate that the proposed position is appropriate. However, the contractor will need to ensure these are adhered to during installation:

a) The distance at which a customer display would normally be read;

b) The view angle of the display to the horizontal;

c) The angle of vision from the viewer's eye level.

The figure below illustrates these relationships for a display mounted at 2.5m from Finished Floor Level (FFL) for all selected classifications of adult heights.

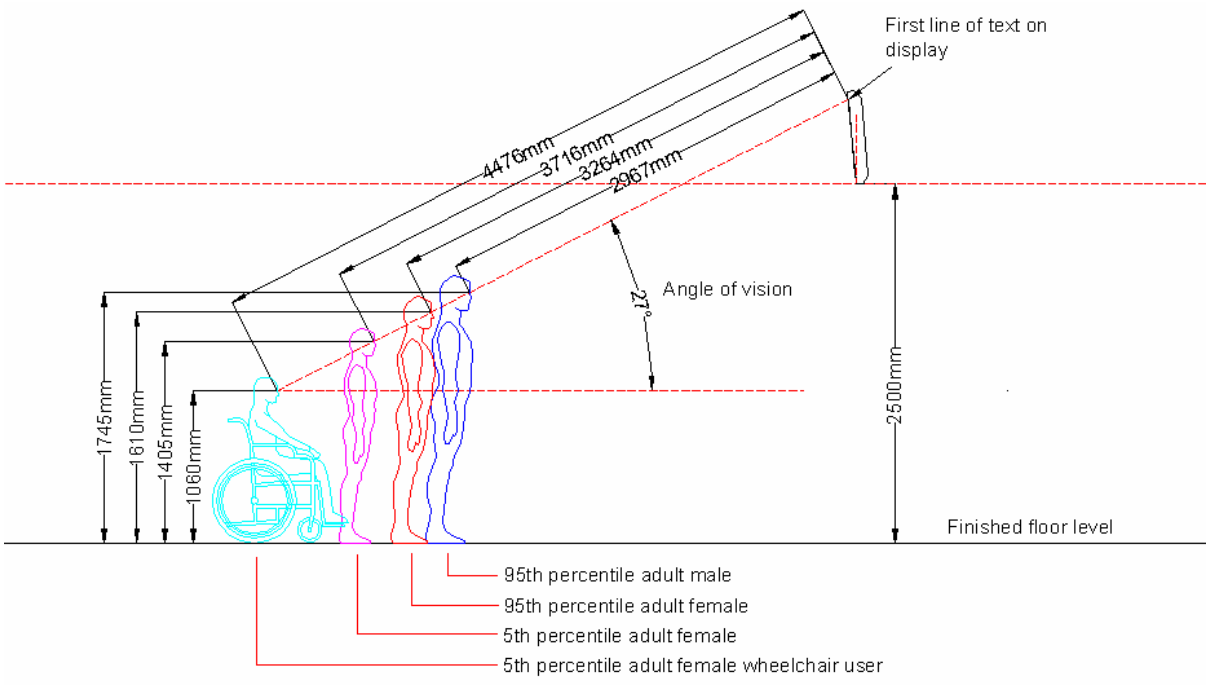


Figure: Passenger display positioning

4.6.5.3 The viewing angle of the display of the horizontal:

The passenger display shall be mounted at a height such that the viewing angle to the display is no more than 27 degrees off the horizontal plane taken from the viewer's eye level.

4.6.5.4 The angle of vision from the viewer's eye level:

The display shall be mounted such that it angles towards the viewer at an angle of up to 20 degrees taken from the vertical plane through the centre of the display.

4.6.5.5 PID data and power requirements:

The proposed CPO PIDs are to be connected via the IT LAN via an existing cabinet at the west end. These shall be connected to a network switch housed in the new IT cabinet in the CER.

The exact power requirements for the proposed PIDs are to be determined once the exact make and model of the PID units has been confirmed. However, the PID shall be locally powered by a DNO mains supply.

The contractor shall provide new cabling, containment and connectivity from the two new and existing PID locations to new PIDS head-end equipment which shall be located in the new temporary works comms nodes located at ground level.

The new head-end equipment installed for the permanent works shall be interfaced to the existing east end PIDS head-end equipment via the station Ethernet network.

4.6.6 Emergency Telephones (ET)

There are no existing Emergency Telephones affected by the permanent works and no new ET's required for the temporary works.

Visual Alarm beacons shall be provided in selected noisy plant rooms in the locations shown on the drawings.

4.6.7 Warden Intercommunication Points (WIP)

The CPO Ground Floor will be provided with WIP facilities to allow staff members to communicate with the Station Control Room in the event of an emergency. WIP's will be located in the following locations;

- Excess Fare Booth (G.010)
- Customer Service Booth (G.027)

The WIP system shall be determined as per ATBT guidelines.

The Contractor shall design, supply and install the WIP system including integration with the east end.

4.6.8 Passenger Help Points (PHP's)

The contractor shall supply, install, test and commission PHPs to provide the facility for passengers to make information and emergency calls in areas that do not have an immediate staff presence.

The contractor shall provide PHP's for the permanent works in the following locations:

- Glass House Entrance
- CPO Ground Floor
- B1 Concourse Level
- B2 Platform Level – Lift Entrance Areas

Specific details of the PHP installations (fixing arrangement) shall be determined once the type of unit is confirmed by AT. However, AT has indicated that the PHPs will be a post mounted type similar to the help points being used at other AT above ground stations. The PHP units shall be supplied with an induction loop to be provided by the PHP manufacturer.

The PHP system shall be installed as a VoIP system for end to end digital communication. The units are to be monitored in the MCR.

4.6.9 Automatic Ticket Gates (ATGs) & Vending Reload Devices (VRDs)

New ATGs proposed for the permanent works shall be located on the CPO ground floor level and in the Glass House entrance area. The existing ATG's on the B2 concourse shall be removed and decommissioned. It should be noted that the data connections to new ATG's are to be confirmed with AT.

The VRDs relocated to the temporary accommodation shall be reused where possible in the CPO in its final layout. Similarly, the VRDs on the level B1 concourse that were removed during the temporary works shall be reused for the VRDs located on the level B1 concourse in its final layout.

The VRDs are to be connected via the LAN which is required to AT's WAN via a fibre optic cable.

4.6.10 Leaky Feeder Radio Network

The Kordia installed LFRN will be impacted by the permanent works. Kordia shall be engaged to carry out the following works on the LFRN;

1. Testing of the LF prior to disconnection for permanent works;
2. Detail and prove proposed permanent works modifications required prior to installation to prove continuity of coverage for LF users (including Police, NZFS, Korkor, AT radios etc);
3. Design, supply and install permanent works modifications and test.

The number and location of the testing locations shall be confirmed with Kordia but as minimum the following information shall be gathered;

- Emergency Services communication with their respective bases and note quality
- Korkor service communicate with base and note quality
- Note signal strength of 400 MHz and 800 MHz if field strength meter available
- Take special note of weak communication contacts

At the conclusion of testing Kordia shall provide the following;

- Qualitative measurements;
- Whether interim additional antennas/radiating cable are required or not;

It should be noted that a maximum bending radius of approximately 500mm has been provided in the main containment route.

The Contractor shall liaise with Kordia to carry out the design and installation of works to the leaky feeder system.

4.6.11 Very High Frequency (VHF) Coverage

St Johns' Ambulance use VHF in the Auckland area. The communications system in Britomart is 400 MHz and 800 MHz systems (UHF) and St Johns has no UHF systems in Britomart. No works are required as part of the Contract 1.

4.6.12 Public Address (PA)/Emergency Warning and Information Systems (EWIS)

The contractor shall provide, install test and commission a new PA/EWIS controller system which shall include the following:

- PA Zone 1:

  Digital based speakers connected via a PA amplifier to the new audio controller with a new data link back to the existing PA/EWIS controller in the existing control room B1-519.

- PA Zone 2:

  Digital speakers connected via a PA amplifier to the new audio controller with a new data link back to the existing PA/EWIS controller in the existing control room B1-519.

- PA Zone 3:

  Digital speakers connected via a PA amplifier to the new audio controller with a new data link back to the existing PA/EWIS controller in the existing control room B1-519.

The new audio controller shall interface with the following:

- Staff Radio System
- SCADA
- Master Clock System
- On-Train PA System
- Train Timetable Database/Live Train Running Information Server

The PA system shall be provided for announcements of live or pre-recorded messages and generation of alert and evacuation messages and tones. The announcements shall be originated from the MCR and authorised personnel carrying portable radio transceivers with a radio-PA function.

The PA system shall be designed for automatic broadcast of all routine announcements through the existing integrated workstations in the MCR. During a failure of the integrated workstation, the operator shall use manual control of the PA control functions.

The public address system shall be provided to the following station west areas:

- Concourses
- Entrances and Exits
- Stairs
- Escalators
- Public amenity spaces
- Selected Back of House (BOH) staff areas

The system shall be configured for multiple audio input priority levels, where the presence of an input signal on the higher priority level shall override the lower priority audio inputs.

The PA system shall support the following announcements (audio inputs):

- Cordless microphone(s) in various staff locations and control centres
- Automated voice announcements for station and train services, train disruptions, etc.
- Remote access by station staff via radio systems input
- Background music

The PA system shall have the facility to allow authorised personnel in the stations to use hand-portable radio transceivers to control and make announcements through the PAVA system.

The PA system technology shall include the following features:

- The use of a very narrow beam sound system, for improved platform message clarity
- All sub-systems shall support secure remote configuration, remote firmware upgrade, time synchronisation and alarm monitoring
- All sub-systems shall support self-testing and diagnostic capabilities and remote diagnostics and SNMP reporting to network management

The PA system shall as a minimum meet the following performance criteria:

- The Sound Pressure Level (SPL) of PAVA announcements shall be maintained between 10 and 15dB above the ambient noise level. The reference height of the measurement shall be at 1.6m above floor level.
- The peak SPL of the system shall not exceed 95dB (A) and the lowest value shall not fall below 70dB (A).
- The variations of SPL within a PAVA zone shall not exceed ±3dB.

- The PAVA system shall meet BS EN 60849 - Specification for Sound Systems for Emergency Purposes.
- Speech intelligibility of all PAVA announcements shall achieve a minimum Speech Transmission Index (STI) of 0.45 for 95% of areas. The remaining 5% of areas with STI below 0.45 shall only be scattered uniformly among the station areas and shall not form clusters of appreciable size.

Typical noise levels for different station areas under the condition of no passengers are described in the table below.

Typical noise levels

Locations	Typical Noise Level (dB)
Platform (with Platform Screen Doors (PSD's) closed)	50
Platform (with PSD open, train in station, train services shut down)	65
Concourse	50
All areas under emergency operation	50

The PA system shall be designed to cater for the increase in noise levels when there are passengers in the stations through the use of Ambient Noise Sensors.

Typical reverberation time figures for different frequencies and ceiling height are detailed in the below table;

Typical reverberation times

Height of Space (m)	Reverberation Time (s)		
	Octave Band Centre Frequency (Hz)		
	500	1,000	2,000
3 to 6	1.50	1.45	1.30
7	1.55	1.45	1.30
8	1.55	1.50	1.40
9	1.60	1.50	1.40
10	1.70	1.55	1.45

Other requirements are as follows:

- The frequency response of the system shall be from 100 to 7,000Hz ±3dB, excluding microphones, speakers, cablings and input source provided by others such as wireless PAVA and remote PAVA from SGCC.
- Total harmonic distortion of the whole system shall not exceed 3% at full rated output.
- Total hum level shall be at least 80dB below full rated output.
- Signal to noise ratio of the system shall be better than 40dB.

- The processing and switching time contributed by the PAVA equipment shall be less than 250ms for any type of command.

The contractor shall supply, install, test and commission hearing induction loops, interfaced to the new permanent works amplifier/PA system head-end.

Hearing augmentation loops / induction loops shall be provided for station entrances, platform areas, corridors, passageways, concourses, lifts and escalators to comply with the requirements of NZS 4121:2001 Design for access and mobility: Buildings and associated facilities.

The contractor shall interface the new hearing loops to the new PA head-end equipment located within the new CER (B1.020) and Comms node (B1.056), including equipment, cabling and testing of the hearing loop installation to comply with codes and this specification.

4.6.12.1 PA Loudspeakers

The detailed design has allowed for 2 no. beam steered loudspeaker arrays type DC 280 that will provide the required sound level and speech intelligibility for the CPO ground floor area. It is the intention to re-use the single beam steered loudspeaker type JBL DC 280 speaker proposed in the courtyard area for the temporary above-ground works in the CPO renovation.

The BOH staff and public areas including offices, toilets, corridors and other selected rooms in the permanent works will be provided with standard digital ceiling mounted loudspeakers without any constraint; generally 1 or 2 per room. The Contractor shall carry out acoustic modeling to confirm these requirements.

Each digital loudspeaker shall be connected as part of a 100 Volt line loudspeaker chain within that zone “A” Network “Daisy Chain” arrangement. The speakers shall be connected via an IP rated connection box, which will enable the loudspeaker connections to be easily accessible for configuration and maintenance purposes

The digital loudspeakers are to be connected externally via duct grade cable (or similar AT approved product). All cables are to be labelled and cables shall be terminated in accordance with the design.

The digital loudspeakers are to be tapped in accordance with the acoustic modelling, although it is recognised that changes to particular loudspeaker tappings may need to be made at the time of commissioning in order to achieve the correct SPL perhaps owing to local conditions.

4.6.13 SCADA

The permanent works arrangement for the SCADA will include for a new network of distributed I/O connected to the station LAN.

Works required are described in more detail in the Station Controls Specification (CRL-BTM-BMS-000-SPE-0001).

4.6.14 Design life

The design of the permanent works communications systems shall be such that no major repair shall be necessary for the duration of the maintainable design life from the handover date. Routine replacement of consumables (lamps, filters and the like) and parts subject to normal wear and tear are excluded.

The maintainable design life for system elements is detailed in the below table.

The design life for the Communications systems shall be based on the expected environmental conditions and the installation method used.

Communications systems design life requirements

Element	Design life (years)	Operating Requirements (Hours per day – 365 days a year)
Communications cables	25	24
Active communications equipment	25	24
Computers (head end equipment)	5	24

4.6.15 Cabling, Containment and Segregation

Communications cabling and cable containment shall be of LSZH construction. Conduit in station environment shall be of galvanised metal construction.

Segregation shall be provided between communications cabling and cabling for different systems of at least 300mm.

Cabling for life safety systems shall be separated from general cabling with a separation distance of at least 300mm.

Conduits for each service shall have unique colours as detailed in AS 1345.

Cabling containment shall be installed to provide no less than 25% spare capacity for future.

4.6.16 Converged Network

One of the key principles of the provision of a Communications Backbone for staff, operational and passenger services is that the data is converged onto a single infrastructure as far as practicable, to realise efficiencies and provide a common platform for system communications.

The contractor shall provide convergence for the following systems:

- Staff, operational and passenger systems
- BMS, EMS, lighting control and associated sub-systems
- Security and CCTV
- SCADA

The following are the requirements for the converged network and for the connection of devices which shall be implemented into the detail of the backbone and station network designs.

- Where appropriate, all fixed data connections shall be 802.3az (1 Gbit/s) compliant to ensure efficient energy usage
- Wireless access shall be via the 802.11 series of standard interfaces, in order to provide communications for the large base of 802.11 compliant devices
- Images and video captured shall be stored in a standard image format to ensure compatibility with open standards based systems and applications
- Metadata including date, location and recording person shall be embedded in images and videos
- Equipment shall be Simple Network Management Protocol (SNMP) compliant for remote monitoring and management
- The Session Initiation Protocol (SIP) communication protocol shall be supported for voice and video communication

- Equipment shall support Transport Layer Security (TLS as defined by the IETF), Secure Sockets Layer (SSL as defined by the ITU-T) and Secure Shell (SSH as defined by the IETF)

4.6.17 Continuity/Staging of Station Operation

The PA/EWIS system is a life safety system and must be kept operational during the Construction Contract 1 Works.

5 SECURITY/CCTV

5.1 General

The design intent of the Security (Access Control and Intruder Detection) and CCTV systems for Britomart Station and the CRL is to provide a safe and secure environment for public and staff.

The intruder detection, access control and CCTV systems shall be based on Ethernet/IP technology and utilise the Station LAN and CRL core transmission network as the distributed IP network.

The Security (access control and intruder detection) and CCTV systems shall enable restricted access to back of house areas, raise alarms in the event of unauthorised access into station areas and to monitor passenger and staff activity.

The contractor shall supply and install CCTV cameras to provide ATOC and Britomart staff the ability to view, record and perform video analytics of Britomart and CRL tunnel. CCTV cameras shall be located to provide coverage inside the station (e.g. platforms, concourses, ticket offices) and externally (e.g. adjacent streets, tunnel entrances).

The Contractor shall assume that the existing analogue CCTV cameras at Britomart where unaffected by the permanent works will remain in place.

Security systems plant and equipment shall be selected to comply with the agreed RAMS requirements. The supply and installation, including the selection of equipment and spares, shall provide for suitable protection from obsolescence.

The supply and installation of the security and CCTV systems shall incorporate the requirements of the Fire Engineer Report.

Systems shall be supplied and installed to reduce the safety risks to as low as reasonably practical (ALARP).

The Security and CCTV systems shall have a rated design life of 25 years for all systems operating 365 days per year at 24hrs per day. The design life for each element of the systems shall be based on the expected environmental conditions and the installation method used.

The supply and installation of Security and CCTV systems shall be such that no major repair shall be necessary for the duration of the maintainable design life. Routine replacement of consumables and parts subject to normal wear and tear are excluded.

The Security and CCTV systems shall be supplied and installed to allow regular inspections and maintenance by AT selected maintenance partner for CCTV equipment on Rail and Bus stations. This may be different from the installation partner. To the extent reasonably practical such inspections and maintenance shall be capable of being undertaken during either off peak operational hours, where this does not interfere with operations, or within limited non-traffic hours each night.

5.2 Scope of Works

Supply, delivery, installation, commissioning, defects liability, warranty and maintenance of all access control, intruder detection and CCTV services, including testing, samples, shop drawings, building penetrations, seismic restraints, plinths, noise and vibration control, finishes, site painting, identification, testing and commissioning, documentation, as built drawings, operation and maintenance manuals, user guide, training, spare parts, cleaning and system integration and all minor and incidental works.

The scope of the contract security and CCTV works as detailed within this specification and associated drawings shall include, but not be limited to, the design, supply, installation, testing and commissioning of the following:

- Verification of all existing security and CCTV systems internal and external to Britomart Station West and the CPO building
- Demolition of existing security and CCTV services not required for station operation
- Security and CCTV services required for the temporary works including access control, intruder detection, CCTV, head-ends/ field equipment, patching and cabling, earthing and bonding;
- Security and CCTV services required for the permanent works including access control, intruder detection, CCTV, security and CCTV head-ends/ field equipment, patching and cabling, earthing and bonding;
- Continuity of station operation during temporary and permanent works
- Diversion of power supplies during temporary and permanent works
- Staging of all works necessary for enabling, temporary and permanent works
- Provision of secondary containment for security and CCTV services which may include ducting, conduits, trunking and catenary wire throughout the entire facility, incoming services and tunnels (where required for station services reticulated in tunnels e.g. security/CCTV backbone cabling);
- Provision of enclosures, fixings and supports including ducting, in-slab conduits, equipment supports and bracing;
- Design and installation of all seismic restraints for secondary security/CCTV services and equipment to comply with NZS 4219 where not provided by the electrical scope;
- Provision of fire-rated cabling and containment systems for critical life safety and essential life safety services for all works and tunnels (where required for station services reticulated in tunnels e.g. security/CCTV backbone cabling);
- Provision of fire-stopping of penetrations for security/CCTV services.
- Provision of earthing and bonding systems for all works and provision for interfacing to the electrical earthing and bonding systems
- Surge protection on all security/CCTV equipment;
- Provision of interfaces between the security and CCTV systems;
- Provision of interfaces of security/CCTV systems to other systems such as Fire, Mechanical, Hydraulic, Electrical, BMS, EMS, LAN;
- Isolation and decommissioning of services to the temporary accommodation facilities;
- Isolation and decommissioning of services not required to remain or be provided for the permanent works
- Integration of any new, relocated or diverted security/CCTV services into the existing station east systems;
- The design and installation of the Security/CCTV systems shall incorporate the Fire Engineering requirements.

5.2.1 Tender Requirements

Equipment selection including the exact make and model will be determined following tender returns, however, the recommended suppliers for each system include:

- New CCTV cameras and equipment (temporary and permanent) – HikVision CCTV cameras or similar AT approved. Supplied via AT's preferred supplier for AT cameras
- Security – Gallagher 6000 (formerly CARDEX) or similar AT approved

The contractor to ensure that all new equipment is compatible with the existing security system

5.3 CCTV Requirements (Permanent)

The minimum resolution of each camera is HD (1280 x 720). However the use of higher resolution cameras (Full HD and above) shall be considered following the CCTV Field of View calculations.

The Contractor shall carry out and conduct the CCTV Field of View calculations for the Construction Contract 1 Works (Temporary and Permanent) and provide the following for ER approval;

- Screen shots of the Field of Views (FOV) for each CCTV camera
- CCTV camera installation details for each CCTV camera including:
    - Sensor Size (Lens)
    - Distance of FOV
    - Width FOV
    - Height FOV
    - Tilt Angle
    - Focal Length
    - Resolution

The contractor shall provide I/O terminals and connectivity within the comms rooms (temporary and permanent) for interfacing to the existing CCTV infrastructure via the existing SCADA system.

CCTV camera selection for the temporary works has been undertaken by ATBT. Refer to the appended CCTV schedule and co-ordinate with ATBT for details.

5.3.1 Performance criteria

The below table summarises the key performance criteria for the CCTV cameras:

CCTV key performance criteria – Camera performance required

Element	Criteria
Recording storage capacity of AT BT HP VMS	7 days minimum
Recording frame rate (normal recording)	15 - 25 fps as configured by AT
Recording frame rate (triggered event recording)	25 fps
Live viewing frame rate	25 fps
Minimum resolution	HD (1280 x 720)

Design Life	25 years
MTTBF	5 years for fixed cameras 3 years tor mechanical PTZ cameras

5.3.2 Level of service

The CCTV system shall be supplied and installed to achieve the levels of coverage as provided in the below table and in accordance with AS 4806.2 – Closed Circuit Television (CCTV) - Part 2: Application Guidelines.

CCTV levels of service

Level of Coverage	Minimum size of 1.6m target as % of screen height
Detect	10%
Recognize	50%
Identify	120%

For CCTV cameras required to perform vehicle number plate recognition, the license plate characters shall not be less than 5% of the monitor height.

The equivalent requirement for IP technology is expressed in the number of pixels per 1m of the target and is defined in the below table.

CCTV levels of service – IP Technology

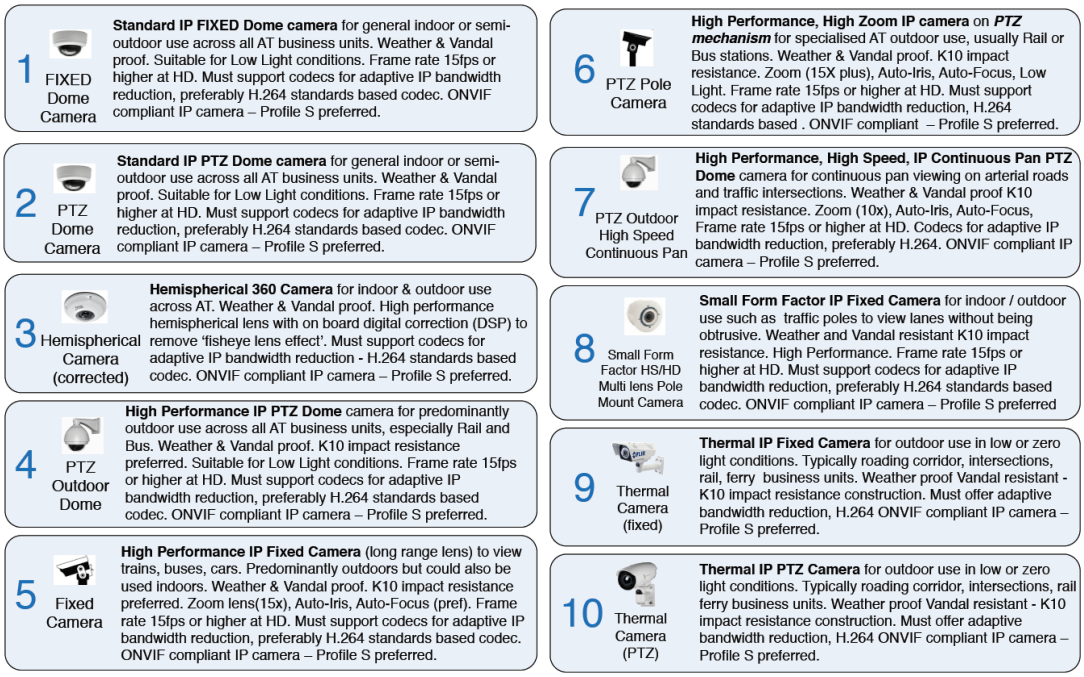
Level of Coverage	ANALOGUE	DIGITAL IP	
	Minimum size of 1.6m target as % of screen height	Image quality /resolution	No. of pixels required for 1.6m target
Detect	10%	1 pixel = 40mm of real object	40px
Recognize	50%	1 pixel = 8mm of real object	200px
Identify	120%	1 pixel = 4mm of real object	480px
Inspect*	400%	1 pixel = 1mm of real object	1600px

* The Inspect level is not a requirement for fixed CCTV cameras but should be achieved by PTZ cameras as defined in the CRL CCTV Risk Assessment.

Auckland Transport (AT) has a top 10 CCTV camera requirements list that the Contractor shall base their selection against. Refer to the below table.

The detailed design proposes a mixture of fixed, dome and PTZ type CCTV cameras. The final selections shall be agreed with AT.

Auckland Transport (AT) Top 10 CCTV Camera List



5.3.3 Passenger Help Point CCTV

The contractor shall integrate the CCTV system with the Passenger Help Points (PHPs) so that when a PHP call is activated, the MCR operator is presented with a live view of the event, either via static camera trained on the help point or a pre-programmed PTZ camera.

The audio from help points shall be recorded on the CCTV system (synchronised with the video) in addition to the system wide voice recording.

5.3.3.1 CCTV monitoring and control

The CCTV cameras will be streamed and controlled by AT BT's Hewlett Packard VMS system. Vidsys clients to view and control these. Monitoring and control shall be provided to the existing SCR/FCR and SGCC, police control rooms and the NZTA existing CCTV NCC. However the network termination point for the Construction Contract 1 Works is in the SCR in the East end. Supply of equipment at SGCC and Integration with the system is outside of this contract's scope of works.

- Viewing of CCTV images at the SCR/FCR shall be via an AT BT Vidsys client. Replacing the existing monitors int eh control room is outside the scope of works, however, it shall be reviewed by AT at a later stage.
- The monitoring and control system shall be accessible via the HP VMS.
- All control stations shall have facilities to play back recorded images from all cameras, and facilities to transfer recorded images onto digital media (DVD or similar). Transfer of recorded images shall only be possible by users with the correct authority.
- The CCTV monitoring system shall be interfaced with the train CCTV system to allow pictures from the in-car cameras to be viewed from all control rooms.
- The CCTV cameras shall be compatible with AT's existing CCTV control centres called ATOC
- Cameras and associated network components shall have the capability for SNAP monitoring and remote configuration.

All images from the CCTV cameras shall be selectable on any monitor via the AT BT HP VMS system.

5.3.3.2 CCTV Recording

Recording of CCTV cameras shall be handled by AT BT VMS.

5.3.3.3 CCTV Pictures, Audio and Encryption

The CRL system wide intent is that CCTV pictures shall be digitally stored on the AT BT HP VMS as per AT BT specification with encryption to prevent modification and use of the data by unauthorised persons. The encryption technique shall as per AT BT specification for the HP VMS system.

Facilities to record audio synchronised with the CCTV pictures may be deployed by AT BT. Audio from platform and lift help points may be recorded so the CCTV cameras should be capable of this.

5.3.3.4 System resilience

The CCTV cameras, cabling and network switches shall meet the reliability and availability targets defined by AT BT. The system shall be designed to avoid single points of failure of any main components causing failure of the whole CCTV system.

Report/Specification No.	Description
FMECA Report	CRL-BTM-SSA-000-RPT-0006
Safety and RAMS Requirement Specification	ATCRL-PRW-SSA-SPE-000193

The system shall be designed to avoid single points of failure of any main components causing failure of the whole CCTV system.

Whilst not considered a life-safety system, the CCTV system shall have a high level of resilience such that it can be used to assist the coordination of an emergency evacuation of the station.

The CCTV system is essential to operation of the CRL station therefore all elements of the CCTV systems shall be supplied from the critical life safety power supply of each station.

Core systems components (e.g. video recorder servers), shall have a dual-redundant power supply.

5.4 Existing Station West Security/CCTV Systems

The existing Security (Access Control and Intruder Detection) system is a sub-system of the station wide SCADA network.

The existing CCTV system is an analogue camera system with a mixture of fixed and Pan, Tilt, Zoom (PTZ) cameras. To enable video signals to be transmitted from the cameras, satellite ‘CCTV nodes’ are located around the station which collect analogue inputs and transmit the signal over fibre optic cable. The fibre optic cables transmit the signals to a main head end where the video signals are recorded and processed for displaying on video monitors. The fibre optic cable is also used to send the data for the PTZ function.

The main head-end recording and control equipment is located in the east end equipment room (B1.519). CCTV images are viewed in the Station Control Room.

5.4.1.1 Station West and CPO Building (Level B1, B2 and Ground Level)

Security, Access Control and CCTV equipment are fed via dedicated fibre optic rings and are also interfaced to the SCADA ring network via SCADA I/O modules.

The CCTV node for the CPO is located in the CPO B1 south riser plant room (Fibre Box FB07). This node feeds cameras in the CPO and external PTZ cameras (Queen Street).

In addition, a CCTV node is located under the existing escalators at station level B2 (Fibre Box FB01). These two CCTV nodes are cabled back to the head end with multicore optical fibre cable.

5.5 Temporary Works

Omitted for clarity. Refer Rev 7 of this specification

5.6 Permanent Works

5.6.1 Demolition of Services

All security and CCTV systems installed as part of the Temporary Accommodation buildings will be isolated, decommissioned and removed as part of the Construction Contract 1 works.

5.6.2 Plaza Reinstatement (external to Glasshouse)

Once all the security and CCTV systems associated with the Temporary Accommodation buildings have been removed the reinstatement of all Plaza Security and CCTV systems will be carried by the Urban realm works.

5.6.3 Rail System Rooms

The following Rail Systems Rooms will form part of a ‘future’ fit out;

- Overhead Line Room (OHLE)
- Tunnel LV Room
- Tunnel Comms nodes (x2)
- Signalling Equipment Room (SER)
- Platform Screen Doors Room (PSD)

The C1 design allows for the provision of shell only services to these rooms. Refer Memo CRL-BTM-MEP-000-MEM-0429 for proposed works. The Contractor shall allow for the provision of access control systems to these rooms.

5.6.4 Access Control and Intruder Detection (Security)

The contractor shall supply, install, test and commission an integrated, end-to-end security system in accordance with appropriate local and international standards, and the technical and performance criteria set out in this document.

The Security systems installed for the permanent works stage shall be monitored and controlled via the existing Britomart control room located at the east end of the station.

The Access Control and Intruder Detection system shall include head-end equipment, software, cabling, containment, fixings and supports, field devices and interfacing to the existing security network, wider network and other station systems, to provide a fully functioning system.

The new permanent works access control and intruder detection system shall be a Gallagher 6000 system as a minimum requirement (formerly CARDAX), with provision to interface into the existing station security system.

The system shall be supplied with all equipment, hardware, software, cabling, coordination, interfacing, testing, commissioning and ancillary services as required to provide an integrated security

and access control system complete and functional in all respects. Main controllers/control panel and associated field device input devices for the permanent works Access Control and Intruder Detection Systems shall be wall mounted in the new CER room and new comms node rooms.

All access control and intruder detection devices shall be individually addressable by the head end equipment. The head end equipment shall be capable of grouping devices into zones with different operational characteristics.

The access control and intruder detection system shall have the facility to integrate with the CCTV system, for example on opening a door to a secure location, the CCTV system shall have the capability to record images at a higher resolution and/or frame rate for a set period either side of the event, or Pan Tilt Zoom (PTZ) cameras shall be programmable to automatically zoom onto a secure door when it is operated.

The access control system shall make specific areas of the station secure allowing access to authorised persons only.

The access control field devices shall be connected to a local interface panel which communicates with the Station Management System (SMS) via the station LAN.

The access control head end shall be programmed to activate and de-activate access control zones and individual doors from the control room, amend and program operating characteristics, adjust system settings, zones and time schedules, locally program and issue electronic proximity cards and tokens.

The contractor shall provide and install Access Control field devices for the permanent works including:

- Access control card readers, electronic tokens (key fob, access control cards), keypads and programming equipment
- PIR detectors
- Audible and visual alarms
- Duress alarms and call points
- Electronic remote door locks, electric strike locks, electric mortice locks, drop bolts and mag locks
- Magnetic hold open devices on internal double doors where shown on the security plans
- Emergency break-glass units
- Push-to release exit buttons
- Audio/video intercom systems
- Monitored reed switches on access control doors and other selected doors.

Access control in the form of electronic proximity readers shall be provided on doors in locations as shown on the layout drawings. All electrically held doors forming part of the security system shall be provided with door position monitoring and hold open alarm function.

Electrically held access control doors shall be ‘fail open’ in the situation of power fail to the door electric locking mechanism.

Provide emergency break-glass door release and push-button release facility adjacent doors as shown on the security layout plans.

Electric door locks shall be provided under the door hardware contract. Supply all necessary power and control cabling to all electrically controlled or electrically held door locations.

Provide the following interfaces:

- The motor controlled main entry doors to enable access control after hours and auto control during normal hours.
- The contractor shall provide I/O terminals and connectivity within the comms rooms for interfacing to the existing security infrastructure via the existing SCADA system.

  Electrically held access control doors and magnetically held 'hold open' doors shall be provided with an interface to the fire alarm panel to release the door on activation of the fire signal. The contractor shall liaise with the Architect and the fire contractor and confirm all doors that require this release function on fire alarm activation. This shall include an interface for the station entry automatic doors.

The contractor shall also provide the following for the Access Control System:

- Video and / or audio intercom units shall be provided to specific secure doors or entrances. The intercoms shall have the capability of being operated from the SCR/FCR and SGCC.
- One entrance shall be designated as an after-hours entry / exit to accommodate maintenance staff, contractors, Police or NZFS personnel. The designated entrance shall be provided with a video/audio intercom connected to the MCR
- On activation of an emergency door release, an alarm shall automatically sound in the MCR to notify security staff of the event.
- Access control doors shall be operable by the use of electronic tokens (key fob, access control cards etc), keypads, voice and video intercoms or a combination of these devices. The type of electronic tokens to be used shall be confirmed with AT and be compatible with existing systems as required.
- Vehicle boom gates or roller shutters shall be integrated with the access control system and be capable of using the same electronic tokens.
- The access control system shall record all events including the time and date that all access controlled doors are opened, and the user that accesses the controlled area. The event logging data shall be held in a secure location and be suitably encrypted to prevent unauthorised access to or manipulation of the data.

The Contractor shall liaise with the door and security hardware specialist when installing the access control equipment.

The existing CPO ground floor entrance doors currently operate on a timer schedule as opposed to card readers. The timer schedule is controlled by the BIS (individual standalone PC) and partly by the SCADA system in the Main Control Operator (MCO) with a flip up page to open and close doors. The CPO entrance doors close approximately 30 minutes after the last train has arrived/departed the station and PA announcements inform passengers to make their way out of the station. The new CPO station entrances will also operate on a timer schedule with an 'emergency door release press to activate' function.

It should be noted that an old card reader system is currently installed at the station and may need to be upgraded to be compatible with the proposed card reader's for the Construction Contract 1 Works. Access Control is proposed predominantly in areas that are defined as 'critical plant rooms' (agreed between PTA and ET) in line with the functional requirements and design manual.

5.6.5 CCTV System

A digital IP CCTV system shall be provided for the permanent works. New IP CCTV cameras shall be provided in locations as described in this section and as shown on the permanent works layout drawings.

The contractor shall supply, install, test and commission a fully integrated end-to-end IP based CCTV system in accordance with appropriate local and international standards; and the technical and performance criteria set out in this document.

The CCTV system shall be supplied and installed with all head-end equipment, hardware, software, cabling, containment, fixing supports, coordination, interfacing, field devices, testing, commissioning and ancillary services as required to provide an integrated CCTV system complete and functional in all respects.

The CCTV system shall monitor all new and existing CCTV cameras via the existing station CCTV system east end station control room.

Note: All cameras for the permanent works shall be new digital types. However there may be an opportunity for the Contractor to reuse a number of the temporary IP cameras for the permanent works. The Contractor shall advise AT on the extent of works and any merits of re-using existing cameras for these works. It should be noted that the new digital system is reflected on the detailed design drawings only.

The contractor shall provide and install CCTV equipment and field devices for the permanent works including:

- Fixed, Dome and PTZ IP CCTV cameras
- CAT 6 UTP cabling for each camera
- 230V power supply for PTZ cameras
- Mounting and fixing supports for each camera
- Rack mounted Network Video Recorders (NVR's), fibre trays, patch panels, power supplies
- CCTV video control and Video Management Software for monitoring from the east end control room
- Keyboard, mouse and video controller at the east end control room

The Contractor shall prepare a submission detailing specifications of all proposed equipment associated with the CCTV installation for approval by AT.

Head-end equipment for the new permanent works shall be located in the new CER room and new Comms Node Rooms.

The contractor shall also provide the following for the CCTV System:

- CCTV cameras shall be high resolution, digital colour IP addressable, connected to the structured cabling system of the station. Each camera shall be provided with an adjacent accessible data outlet, connected via fly-lead from the outlet to the camera.
- All cameras shall be capable of producing colour images under emergency lighting conditions of sufficient quality to be used for station evacuation coordination. Under low light conditions, cameras shall be able to switch to black and white operation.
- CCTV cameras shall be capable of combined CCTV and PIR detection in tunnels and tunnel/platform interfaces.

- Control of PTZ and fixed cameras shall be from the SCR/FCR and SGCC, with provision to extend the control to external control rooms.

PTZ cameras shall be configured to return to a pre-set position when not in use by an operator. PTZ cameras shall have the required rotation and optical zoom capability to achieve the specified coverage level.
The contractor shall provide a local video monitoring and control system in the existing Control Room at Britomart Station comprising equipment for live video viewing and control and video playback.

A summary of the CCTV cameras proposed including views, mounting arrangements and coverage requirements in each area is detailed in the CCTV camera schedule in Appendix 2.

5.6.5.1 CCTV cameras

The permanent works proposes a mixture of fixed, dome and PTZ type CCTV cameras.

New CCTV cameras shall be digital IP CCTV camera powered via PoE and mounted within an internally or externally rated housing dependant on the location of the CCTV camera.

A summary of the CCTV cameras proposed in each area is shown in the CCTV camera schedule appendix.

The CCTV cameras shall interface into the new CCTV head end equipment which is housed in the new Control Equipment Room (B1.020). A fibre optic cable will connect the west end head equipment to the east end head end equipment which is located in the existing Comms room (B1.519).

The camera lens size for each CCTV camera cannot be determined at this stage, the CCTV camera make and model is to be confirmed by AT.

5.6.5.2 Lift CCTV

Works to the existing lift cars is not part of the scope of works. No modifications to the existing CCTV camera coverage and help points inside the lift cars will be carried out.

5.6.6 Cabling, Containment and Segregation

Security and CCTV cabling and cable containment shall be of LSZH construction. Conduit in underground locations within the station environment shall be of galvanised metal construction.

Segregation shall be provided between Security and CCTV cabling and cabling for different systems of at least 300mm.

Cabling for life safety systems shall be separated from general cabling with a separation distance of at least 300mm.

Conduits for each service shall have unique colours as detailed in AS 1345.

Cabling containment shall be installed to provide no less than 25% spare capacity for future.

6 Technical - Electrical

6.1 CABLE SUPPORT AND DUCT SYSTEMS

6.1.1 Responsibilities

General: Provide cable support, trunking and duct systems as documented.

Cable supports to be provided include (but not limited) to the following:

- Ladder rack
- Cable tray
- Conduits and associated fittings
- Catenary Wires
- Cable basket (Communications)

Conduit in underground and underground station locations shall be HDG metallic conduit. PVC is not permitted on the project.

6.1.2 Submissions

6.1.2.1 Shop drawings

Submit shop drawings showing the following:

- Cable ladder, cable tray and trunking routes.
- Dimensions of all cable tray and trunking
- Layout of cable supports and enclosures on the current architectural background coordinated with the structure and other services.
- Layout of underground conduits, pits and drainage trenches.
- Invert levels for underground conduits.
- Depth of burial for cables and conduits.
- In situ pits.
- Provision for expansion and ground movement.
- Fabricated columns.
- Footing for columns.

6.1.2.2 Technical data

Submit technical data for the following:

- Ducted wiring enclosure systems.
- Cable support systems.
- Proprietary pits.

- Proprietary columns.

6.1.3 Products

6.1.3.1 Conduits

Standards:

- AS/NZS 2053.1
- AS/NZS 2053.2
- AS/NZS 2053.3
- AS/NZS 2053.4
- AS/NZS 2053.5
- AS/NZS 2053.6
- AS/NZS 2053.7
- AS/NZS 2053.8

Associated fitting for conduits shall be the same type and material as the conduit.

Wall boxes. Provide prefabricated earthed metal boxes.

Provide inspection-type fittings only in accessible locations and where exposed to view.

Conduit for emergency lighting cabling shall be to the requirements of AS2293.1-2005.

Metallic conduits and fittings

To AS/NZS 2053, hot-dip galvanized to AS/NZS 4680, for damp or exterior situations and complete with fittings and accessories brand matched as required by the conduit manufacturer.

Standard

- AS/NZS 2053.7
- AS/NZS 2053.8.

Type

General: Screwed steel.

Corrosion protection

Steel conduits: Paint ends and joint threads with zinc rich organic primer to APAS-2916.

Flexible conduit

Provide flexible conduit to connect with equipment and plant subjected to vibration. If necessary, provide for adjustment or ease of maintenance. Provide the minimum possible length.
To AS/NZS 2053.1 and 4.b, PVC or rust proofed steel sheathed with PVC. Securely terminated in purpose made fittings when connected to equipment enclosures and maintaining the degree of protection of the enclosure. Minimum degree of protection IP54 to AS1939.

6.1.3.2 Cable Duct/Trunking

Standards:

To AS/NZS 4296

Cable Trunking

Cable trunking shall conform to the following requirements:
Material: Aluminium extrusion, powder coated.

Construction: Solid

Two-compartment

Covers for accessible locations: Screw-fixed or clip-on type removable only with the use of tools.

Accessories: Purpose-made to match the duct system.

Cable Support: Except for horizontal runs where the covers are on top, support wiring with retaining clips at intervals of not more than 1000mm.

Provide purpose-made ducts, skirting trunking and floor ducts, incorporating segregation where used for multiple services. Provide rigid supports. Round off sharp edges and provide bushed or proprietary cable entries into metallic ducting.

Provide purpose made accessories and covers to match the duct system; provide screw fixed covers or clip-on covers removable only with the use of tools.

Proprietory Trunking Systems

Provide proprietary, skirting duct, wall duct, floor duct and service column systems, incorporating segregation where used for multiple services. Provide rigid supports. Round off sharp edges and provide bushed or proprietary cable entries into metallic trunking.
Provide proprietary fixings and mountings facilities for accessories and outlets.

Screw fixed or clip-on type Covers removable only with the use of tools.

Accessories

Provide purpose-made accessories and covers to match the duct/trunking system. Provide screw-fixed covers or clip-on covers removable only with the use of tools.

Cable support: Except for horizontal runs where the covers are on top, support wiring with retaining clips at intervals of not more than 1000 mm.

6.1.3.3 Cable Trays and ladders

Mains and sub-mains cable tray for all works shall be a minimum performance standard of Unistrut LT5 hot-dip galvanised. Fire rated tray may require a higher specification.

Sub-circuit cable tray for all works shall be a minimum performance standard of Unistrut LT3 hot-dip galvanised.

Communications cable tray shall be Cablofil cable basket or approved equivalent.

Fabricated from galvanized steel, grade 6351 T6(NZ) or 6061(Aus), with rungs at 300mm centres and complete with ladder manufacturer's standard bends, risers, curves and reducers and of sufficient strength for the envisaged cabling without deflection. Size 20% over width for designed cable loading including spaces between to avoid de-rating cables. Form fixing holes and slots before galvanizing. Allow for expansion joints where necessary.

Provide a complete cable support system consisting of proprietary trays, ladders and including brackets, fixings and accessories, from a single manufacturer for the same support system, as follows:

- Standard: NEMA VE-1.

- Type tests: To NEMA VE-1.
- Selection: Select cable tray/ladder in conjunction with support system installation to achieve the documented loading and deflection requirements.
- Spare capacity:
- Support: Power cables: double suspension rods
- Communications cables: double suspension rods suitable for Cablofil basket to manufacturers specification
- Dimensions: To the preferred dimensions nominated in NEMA VE-1.
- Material: Corrosion-resistant finished steel.
- Material finish: Metallic-coated to AS 1397, Grade G2, Coating Class Z275.
- Covers: Provide ventilated flat covers to cable trays/ladders installed in accessible locations.
- Finish: Hot dipped galvanized.
- Run cables < 13 mm diameter on cable trays or in ducts.

6.1.3.4 Catenary systems

Catenary systems may be used within suspended ceiling spaces in lieu of cable tray and ladder systems.

Provide proprietary stainless steel or coated galvanised cable and couplings for internal catenary systems.

6.1.3.5 Cable pits

Provide cable draw-in-pits as documented. Sizes given are internal dimensions.

Pits 1200 x 1200 mm: Provide proprietary concrete or polymer moulded pits.

Pits > 1200 x 1200 mm: Provide in-situ pits. Construct walls and bottoms from rendered brickwork or 75 mm thick reinforced concrete. Incorporate a waterproofing agent in the render or concrete.

Pit covers:

- Provide pit covers to suit external loads. Fit flush with the top of the pit.
- Standard: To AS 3996.
- Weight: < 40 kg for any section of the cover.
- Lifting handles: Provide a lifting handle for each size of cover section.

Drainage:

- Provide drainage from the bottom of cable pits, either to absorption trenches filled with rubble or to the stormwater drainage system.
- Absorption trenches: Minimum size 300 x 300 x 2000 mm.

6.1.3.6 Columns

Conform to the following requirements for fabricated columns more than 2400 mm high which are designed to support accessories outdoors.

Standards: Comply with the following standards as appropriate:

- AS 1798 for public lighting poles.
- AS 3600-2009 for concrete structures.
- AS 4100 for steel structures.
- AS/NZS 4676 for structural design of columns.
- AS/NZS 4680 for hot-dipped galvanized (zinc) coatings on ferrous articles.
- Provide columns designed, manufactured and tested by a specialist manufacturer. Dimensions to AS 1798.
- Finish: Hot dip galvanized columns and fittings after fabrication.
- Bases: Provide columns with mounting bases for fixing to reinforced concrete footings via rag bolt assembly.
- Rag bolt assembly: Cut holding bolts within 3 threads above top of base plate top lock nuts.
- Base fixing: Galvanized holding down nut with galvanized lock nut above.
- Base sealing: Seal space under pole base plate with grout.
- On-site Finish: Paint, colour as documented.
- Accessory mountings: Provide adjustable mountings, to suit accessories. Include provision for rigidly clamping each item in position, once adjusted correctly.
- Maintenance access: Provide pole stirrups secured to either side of the column for access to accessories. Locate the first stirrup ≥ 3 m above ground level.
- Electrical connections: Provide a recess fitted with a flush mounted cover at the base of the column for access to cable connections and equipment.
- Cable support: For connections higher than 3 m provide a catenary wire cable support system.
- Hinged Columns: Provide the appropriate counterbalance for each column type.

All column mounted light fittings shall be installed complete with proprietary bird deterrent spikes to match the column and luminaire.

6.1.4 Execution

6.1.4.1 General

Carry out work to NZBC G9/VM1, AS/NZS 3000 and relevant Electrical Codes of Practice and all applicable Standards.

Locate and space for the electrical installation to ensure co-ordination with the structure and other services. Fix with brackets and hangers to the tray manufacturer's requirements, parallel with or normal to the structure, in straight runs, reducing the number of bends or sets to a minimum. Bends to be no tighter than minimum radius of cable. Fix and support rigidly and to limit the mid-span deflection to 1 in 400 where exposed and 1 in 250 elsewhere. Leave at least 150mm clear above.

If non-structural building elements are not suitable for fixing equipment and services to, fix directly to structure and trim around holes or penetrations in non-structural elements.

Install equipment and services plumb, fix securely and organise reticulated services neatly. Allow for movement in both structure and services.

Conceal all cables, ducts, trays, pipes etc. unless installed in plant spaces ceilings, riser cupboards, etc. or unless otherwise documented.

Provide heavy items of equipment with permanent fixtures for lifting as recommended by the manufacturer.

Keep all parts of services under suspended ground floors > 150mm clear of the ground surface. Make sure services do not impede access.

Arrange services so that services running together are parallel with each other and with adjacent building elements.

Installations below ground to AS/NZS 2865 and OSH Approved code of practice for safety in excavation and shafts for foundations.

Differential Movement

Allow for differential movement control joints where movement is expected and/or defined.

If the geotechnical site investigation report predicts differential movements between buildings and the ground in which conduits are buried, provide movement control joints in the conduits.

Location: Adjacent to the conduit supports which are closest to the perimeter of the building.

Arrangement: Arrange conduits to minimise the number of movement control joints.

Magnitude: Accommodate the predicted movements.

Wiring Installation

Space one cable diameter (minimum) apart between adjacent cable groups including parallel sets of cables. Do not bend more than the minimum radius required by the cable manufacturer. Fix cables of essential services to the permanent structure above ducts, pipes and other elements that can be dislodged.

6.1.5 Building Penetrations

6.1.5.1 Sealing Penetrations

Seal all penetrations, including in and around conduits and sleeves. For Fire and/or Acoustic rated elements, maintain the rating with the seal systems.

Cable Sleeves

For cables penetrating solid building elements, provide PVC sleeves formed from pipe sections, unless Fire and/or Acoustic systems require sleeves for other building elements and/or different material for the sleeve

6.1.6 Unsheathed cables – installation

Provide permanently fixed enclosure systems, assembled before installing wiring. Provide draw wires to pull in conductor groups from outlet to outlet, or provide ducts with removable covers.

6.1.7 Conduit systems – installation

Install conduit installations as follows:

- If exposed to view, install conduits in parallel runs with right angle changes of direction.
- Install conduits with the equivalent of ≤ 2 right angled bends per cable draw-in run.

- Conduits in roof spaces: Locate below roof insulation and sarking. In accessible roof spaces, provide mechanical protection for light-duty conduits.
- Inspection fittings: Locate in accessible positions.
- Draw cords: Provide 5 mm2 polypropylene draw cords in conduits not in use.
- Provide draw-in boxes as follows:
- Spacing: < 30 m.
- At changes of level or direction.
- Underground draw-in boxes: Provide casketed covers and seal against moisture.
- Allow for thermal expansion/contraction of conduits and fittings due to changes in ambient temperature conditions. Provide expansion couplings as required.
- Rigid conduits: Provide straight long runs, smooth and free from rags, burrs and sharp edges. Set conduits to minimise the number of fittings.
- Run conduits concealed in wall chases, embedded in floor slabs or installed in inaccessible locations directly between points of termination, minimising the number of sets. Do not provide inspection fittings.

6.1.7.1 Concealed Conduit

Minimum 20mm diameter concealed conduit for the complete electrical installation, run concealed in slabs, in ceiling or wall spaces, or chased into walls and complete with all fittings and 5mm2 polypropylene draw wires. Separate conduits for light, power and low voltage wiring.

Place above insulation in ceiling spaces, above bottom steel in slabs, not in contact with basecourse, and without penetrating damp-proof membranes or allowing the entry of moisture. Set using approved conduit benders, at changes of direction where concealed with draw-in boxes at 20 metres maximum centres and a maximum of 2 right angle bends between boxes. Terminate at deep pattern junction boxes for ceiling outlets in concrete, standard depth junction boxes for outlets above suspended ceilings and steel to match conduit, wall boxes for all flush wall outlets and switches.

Place in slabs, walls and columns with a minimum cover of 25mm or to AS/NZS 3000 whichever is greatest, and with a minimum space of 50mm between conduits. Fit flexible coupling in conduit at all seismic or expansion structural joints. Swab out to remove all moisture before wiring and seal to prevent ingress of moisture and other obstructions.

Steel conduits, paint ends and joint threads with zinc rich organic primer to AS/NZS 3750.9. Provide inspection-type fittings only in accessible locations and where exposed to view.

6.1.7.2 Exposed Conduit

Minimum 20mm diameter exposed conduit for the complete electrical installation, installed in straight runs parallel with or normal to the structure, avoiding moisture traps and complete with fittings and draw wires. Confirm on site final routing and positioning. Secure with spacer bar type double sided fixed saddles grouped symmetrically, providing 3mm clearance of the fixing surface. Fit flexible couplings in conduit at seismic or expansion structure joints. Provide an expansion joint every straight run at 6 metres minimum and secure at 600mm centres maximum.

Swab out to remove all moisture before wiring, and seal to prevent ingress of moisture and other obstructions. Paint conduit and all fittings with 2 coats (1 prior to fixing) of enamel coating system to specified colours.

6.1.7.3 Flexible Conduit

Provide between fixed conduit and equipment subject to movement or vibration with brass or nylon terminators, using a flush mounted junction box with the terminator secured by locknuts to the cover plate.

6.1.7.4 Conduits in concrete slabs

Route: Do not run in concrete toppings. Do not run within pretensioning cable zones. Cross pretensioning cable zones at right angles. Route to avoid crossovers and minimise the number of conduits in any location. Space parallel conduits 50 mm apart.

Minimum cover: The greater of the conduit diameter and 20 mm.

Fixing: Fix directly to top of the bottom layer of reinforcing.

Locate conduits in the core-filled sections of precast hollow-block type floors.

6.1.7.5 Conduits in Columns

Install conduits in columns as follows:

- 4 per column.
- 25mm diameter.
- Locate conduits centrally in each column.
- Bends: Enter columns via 150 mm radius bends. Do not use elbows.
- Chasing: Do not chase columns.

6.1.8 Cable tray/ladder support systems – installation

Install cable tray and ladder support systems as follows:

6.1.8.1 Fixing to building structure

Fix supports to the building structure or fabric by means of ≥8 mm threaded rod hangers attached to hot dipped galvanized U-brackets, or by means of proprietary brackets.

6.1.8.2 Cable fixing

Provide strapping or saddles suitable for fixing cable ties.

MIMS cables: provide non-magnetic straps.

6.1.8.3 Bend radius

Provide bends with an inside radius 12 times the outside diameter of the largest diameter cable carried.

6.1.8.4 Cable protection

General: Provide rounded support surfaces under cables where they leave trays or ladders.

6.1.8.5 Access

General: Locate trays and ladders to provide ≥ 150 mm free space above and ≥ 600 mm free space on at least one side.

6.1.8.6 Clearances

From hot water pipes: > 200 mm.

From boilers or furnaces: > 500 mm.

EMI: Locate support systems for electrical power cabling and communication cabling to minimise electromagnetic interference.

Support all cable tray, baskets and ladder with proprietary fittings with spacing to the manufacturer's requirement. All attachments to the building structure shall be proprietary for that purpose, and shall approved by the Structural engineer.

6.1.9 Catenary systems – installation

Install Catenary systems as follows:

- Anchor catenary systems to the structure using proprietary fittings. Do not fix to any part of a suspended ceiling system.
- Provide catenary systems designed to support the proposed load of the cables with a spare capacity of 50% loading.
- Fix cables to the catenary system such that no cable is under stress due to tension or compression. Use proprietary fixings that allow cables to be added or removed without destroying the integrity of the system.
- Pre-tension all catenary wires prior to installation of cabling.

6.1.10 Cables in trenches – installation

Install cables in trenches as follows:

- Provide clean sharp sand around cables and conduits installed underground.
- Seal buried entries to ducts and conduits with waterproof seals. Seal spare ducts and conduits immediately after installation. Seal other ducts and conduits after cable installation.
- Where electric bricks or covers are not provided over underground wiring, provide a 150 mm wide yellow or orange marker tape bearing the words 'WARNING – electric cable buried below', laid in the trench 150 mm below ground level.
- Install all cabling to the depths and with the levels of mechanical protection specified in AS/NZS 3000.

6.1.11 Columns – installation

Install columns as documented including the provision of in situ reinforced concrete footings to the Wiring enclosures and cable support systems schedule.

6.1.12 Power Poles – Installation

Install to the Service and Installation Rules and to the standards published by the local Network Distributor for the project environment and for the selected aerial arrangement.

6.1.12.1 Hardwood poles

Burying depth: 1600mm minimum

Support: Baulk and stay to suit the design loads

Cable Protection: Provide protection for cables and conduits installed in the exterior of the pole to a height of 2000mm above and 150mm below ground using either galvanized water pipe or 3.2mm thick hot dipped galvanized channel.

6.1.13 Excavation

Excavate for underground wiring straight from point to point without joints, of uniform grade, carrying out safety procedures as required by OSH: Approved code of practice for safety in excavation and shafts for foundations, and keeping clear of falling material and water. Backfill with excavated material, firmly compacted in 200mm layers. Use clean sand for bedding and avoid sharp materials in backfill. Use a 2 stage process for backfilling, placing plastic warning tape and any protection required by Standards in between backfill layers.

Install warning plates above underground wiring routes where cable passes through the external walls of the building.

6.1.13.1 Wiring enclosures and cable support systems schedule

Cable ladder (Mains and sub-mains)

Cable Tray Type	Ladder tray Unistrut LT5
Material	Steel
Finish	Hot dip galvanised
Tray dimensions	As documented
Usable width	As documented
Usable depth	50mm Minimum
Minimum thickness	As per Unistrut LT5
Unit length	3m
Connector type and material	Same manufacturer and range as tray

Cable tray (Sub-circuits)

Cable Tray Type	Ladder tray Unistrut LT3
Material	Steel
Finish	Hot dip galvanised
Tray dimensions	As documented
Usable width	As documented
Usable depth	50mm Minimum
Minimum thickness	As per Unistrut LT3
Unit length	3m
Connector type and material	Same manufacturer and range as Tray

Catenary systems

Maximum number of cables permitted to be supported by a catenary system:

Lighting circuits	8
Socket outlet circuits	8
Telecommunications cabling	16

6.2 LOW VOLTAGE POWER SYSTEMS

6.2.1 System description

This section relates to the supply, fixing and testing of general power distribution circuits for power and lighting.

Provide elements for the complete electrical installation in accordance with current practice and allowing for stated and necessary conditions of use for safe, robust, low maintenance and energy efficient use. Work to be aligned and positioned to suit surrounding finishes and symmetry.

6.2.2 Distribution system

Provide an LV power distribution system to the development as detailed below and as shown on the associated drawings and documents.

6.2.2.1 Low Voltage installations

Provide a full LV small power installation to the development as detailed below and as shown on the associated drawings and documents.

6.2.2.2 Cross references

Associated work-sections

Conform to the following associated work sections:

- Preliminary and General requirements
- Scope
- Cable support & duct systems
- Switchboards
- Switchboard components.
- Lighting.

6.2.2.3 Standards

General: To

- AS/NSZ 3000
- AS/NZS 3439
- Electrical equipment: To AS/NZS 3100.
- Fire and mechanical performance classification: To AS/NZS 3013.
- Selection of cables: To AS/NZS 3008.1.2.
- Distribution cables: To AS/NZS 4961.
- Testing: To AS/NZS 3017.

6.2.2.4 Submissions

Samples

General: Submit samples of all visible accessories and equipment.

6.2.2.5 Technical data

General: Submit the following information for each main, submain and final subcircuit for which calculation is the responsibility of the Contractor.

- Single line diagram.
- Fault Levels at switchboards.
- Maximum demand calculations.
- Cable and conductor cross sectional area and insulation type.
- Cable operating temperature at design load conditions.
- Voltage drop calculations at design load conditions.
- Protective device characteristics, e.g. curves, I2t.
- Discrimination and grading of protective devices.
- Prospective short circuit current automatic disconnection times.
- Final subcircuits may be treated as typical for common route lengths, loads and cable sizes.
- Earth fault loop impedance calculations for testing and verification.
- Certify compliance with AS/NZS 3000 clause 1.8, for electrical services.

6.2.2.6 Shop drawings

Submit shop drawings of the following, in addition to those detailed in the general requirements section:

- Cable routes.
- Busduct systems including routes, dimensions and connection details.
- Low voltage power systems installation layouts

6.2.3 Wiring systems

6.2.3.1 General

Selection: Provide wiring systems appropriate to the installation conditions and the function of the load.

6.2.3.2 Standards

- Polymeric insulated cables: To AD/NZS 5000.1
- Classifications to AS/NZS 3013.
- Aerial Cables: To AS 1746
- XLPE cables: To AS/NZS 5000.1.
- Underground residential distribution systems: Select cables according to AS/NZS 4026.
- Distribution cables: To AS/NZS 4961.
- Cable de-rating factor to AS/NZS 3008.1.2.

6.2.3.3 Selection

All cabling to be installed over routes, without joints, that have been fully co-ordinated with other services but generally following the basic routes shown on the drawings.

Confirm details of busbars, fixings, studs and clearance required for the termination and connection of sub-mains to equipment and switchboards. Cable sizes for sub-mains to equipment and systems to be verified with the installer before ordering. Confirm the proposed loadings and the adequacy the sub-mains.

Select multi-stranded copper cable generally, except for mineral insulated metal sheathed (MIMS).

TPI Cables for Conduit

To AS/NZS 5000.1, insulated with 0.6/1 kV grade PVC compound or higher.

Neutral Screen Cables

To AS/NZS 5000.1, insulated with 0.6/1 kV grade PVC or XLPE compound.

TPS Cables

To AS/NZS 5000.1, insulated with 0.6/1 kV grade PVC compound or higher.

MICC Cables

To AS/NZS 60702.1, 1 kV grade, with copper sheathing magnesium oxide insulated and terminated to AS/NZS 60702.2.

Other Fire rated cables

To AS/NZS 3013, WS 52W (minimum) classification.

Flexible Cords

To AS/NZS 3191, PVC insulated and PVC sheathed.

XLPE Cables

To AS/NZS 1660.2.2, XLPE insulated with 0.6/1 kV grade compound.

Tough plastic sheathed copper conductors to AS/NZS 5000.2, stranded above 1.0mm2, and to AS/NZS 3008.1.2. Minimum sizes as below. Increase sizes if the method of installation, thermal insulation, cable length or load will reduce the cable rating below that of the MCB rating, or produce an excessive voltage drop.

Minimum Size:

- Lighting circuits: 2.5mm2 on 10 amp MCBs with RCD’s (RCD’s where required by scope sections of this specification)
- Power circuits: 2.5mm2 on 16 amp MCBs with RCD’s (RCD’s where required by scope section of this specification). Provide larger cables where required by AS/NZS 3000 and AS/NZS 3008 with respect to installation method, grouping, volt drop or earth loop impedance.

Heat resistant cable for final connections to all heated appliances, and high temperature cable in ambient conditions that may be above 35°C.

Fault loop impedance:

Select final sub-circuit cables selected to satisfy the requirements for automatic disconnection under short circuit and earth fault/touch voltage conditions.

Fault ratings graded to suit the NUO stated prospective fault level and fully discriminated through the installation.

6.2.3.4 Conductor colours

General: For fixed wiring, provide coloured conductor insulation. If this is not practicable, slide at least 150 mm of close fitting coloured sleeving on to each conductor at the termination points.

- Active conductors in single phase circuits: Red.
- Active conductors in polyphase circuits:
- A phase: Red.
- B phase: White.
- C phase: Blue.
- Sheath: White

6.2.3.5 Voltage Drop

Select final subcircuit cables within the voltage drop parameters dictated by the route length and load.

Voltage drop allowance 5% from point of supply.

6.2.3.6 Spare Capacity

Allow for fully fitted out current load (amps) plus the following spare capacity:

- 20% for mains
- 20% for main switchboard
- 25% for submains (10% for fixed loads, lifts, mechanical and similar)
- 30% for distribution switchboards.

6.2.3.7 Fire-rated (other than mims)

General: If exposed to mechanical damage, provide protection to AS/NZS 3013.

6.2.3.8 Conductor terminations

Copper Conductor terminations

Other than for small accessory and luminaire terminals, terminate copper conductors to equipment, with compression-type lugs of the correct size for the conductor. Compress using the correct tool or solder.

Within assemblies and equipment, loom and tie together conductors from within the same cable or conduit from the terminal block to the point of cable sheath or conduit termination. Neatly bend each conductor to enter directly into the terminal tunnel or terminal stud section, allowing sufficient slack for easy disconnection and reconnection. Provide durable numbered ferrules or other approved labels fitted to each core, and permanently marked with numbers, letters or both to suit the connection

diagrams. Identify spare cores and terminate into spare terminals, if available. Otherwise, neatly insulate and neatly bind the spare cores to the terminated cores.

6.2.3.9 De-rating

Conductor sizes specified are minimum sizes. Install cables in size, grouping, spacing, enclosure and locations so that the current rating of conductors as permitted by the Electricity (Safety) Regulations 2010 and AS/NZS 3008.1.2 (after the appropriate de-rating factors have been applied) is not less than the specified current rating of the circuit breaker/fuse protecting the conductor. If the de-rated current rating is less than that specified increase the size of the conductor accordingly.

6.2.3.10 Installation

Install wiring systems to AS/NZS 3000. All cabling shall be run concealed. No TPS cable laid directly in concrete. Locate holes in timber framing for the passage of cables at the centre line of the timber member. Install cable in conduits where required to pass through concrete or underground. In walls run cabling horizontally and vertically in straight lines. In ceilings either run cabling along ceiling framing or attached to catenary wires. Clip cabling to ceiling framing/catenary wires.

Where cables are installed within the building fabric, the cabling shall be installed such that they are at least 50mm from the finished surface of all accessible sides of the building element. Where the minimum depth of 50mm cannot be achieved the cable shall be provided with additional mechanical protection or an RCD installed at the distribution board, to comply with AS/NZS 3000 – 2007.

Fix and support cables for the complete electrical installation with purpose made clips, cleats and saddles, with adequate air circulation around each cable and without any joints between equipment. Install on the loop-in, loop-out principle without the use of connectors for sub-circuit wiring.

Space one cable diameter (minimum) apart between adjacent circuit or sub-main groups including parallel sets of cables. Do not bend more than the minimum radius required by the cable manufacturer. Fix cables of essential services to the permanent structure above ducts, pipes and other elements that can be dislodged.

Enclose PVC conduit wire within conduits, on the loop-in system without using connectors and jointed only at outlet or switch positions. Enclose TPS cables in conduit in slabs, walls and columns and in steel conduit where liable to damage.

Install only where cable can be easily withdrawn for re-wiring or relocation, through correctly located and sized access holes in timber framing. Do not secure or clip in inaccessible locations. Install multiple runs over common routes in groups on trays or ladders and in ducts. Install in trefoil formation for single core TPS conductors using purpose made clamps so that proximity effects in adjacent ferrous metals are minimised and equal reactance values between phases are achieved. Fit cable glands on all circular cables penetrating equipment enclosures. Laying flat and spaced, instead of trefoil, may be required for current rating of cables selected.

Do not run PVC insulated cables or sheathed cabling within or against expanded polystyrene sheet. Where this is impracticable, support cables at 600mm centres fixed to the main structure. Alternatively use a PVC insulation containing non-migratory plasticiser, with cable sheaths coloured to differentiate.

Provide separate circuits for lighting and power in accordance with the drawings and this specification. Individual lighting circuit load not to exceed 8 amps single phase unless otherwise specified. Install all circuits with the appropriately rated cable and circuit protection. Install with a maximum of 8 light switch units or 6 double or single switched socket units on any circuit. Separate circuits for all electric heating appliances. Kitchen sockets to be on at least two different circuits.

Handling cables: Report & repair damage to cable insulation, serving or sheathing.

Stress: Ensure that installation methods do not exceed the cable's pulling tension. Use cable rollers for cable installed on tray/ladders or in underground enclosures.

Straight-through joints: Unless unavoidable due to length or difficult installation conditions, run cables without intermediate straight-through joints.

Cable joints: Locate in accessible positions in junction boxes.

Extra-low voltage circuits: Individual wiring of extra-low voltage circuits: Tie together at regular intervals.

6.2.3.11 Set-out

The position of outlets and equipment shown on drawings is indicative of requirements. Confirm documents and site conditions are not in conflict with other services or features. Resolve conflicts and discrepancies before proceeding with work affected. Confirm on site the exact location, disposition and mounting heights of all outlets, fittings, equipment, penetrations, and use of exposed wiring. Fix outlet items level, plumb and in line. Refer to Architects drawings for heights and locations of outlets.

6.2.3.12 Catenary Systems

Anchor catenary systems to the structure. Do not fix to any part of a suspended ceiling system designed to support the proposed load of the cables with a spare capacity of 50% loading. Fix cables to the catenary system such as that no cable is under stress due to tension and compression.

6.2.3.13 Wiring, MICC Cables

Use electricians skilled in the installation of MICC cables.

Seal ends of MICC cable immediately after cutting, terminate and install using tools, levers and straighteners, fitted with all standard accessories as supplied and required by the cable manufacturer. Straighten cable, run in trefoil formation on parallel paths with minimum 6 x cable diameter radius curves electrically bonding the sheathing of groups of single core conductors at 20 metre centres maximum and all securely fixed on saddles at 600mm centres maximum. Do not joint.

Fit MICC cables with surge diverters at their origin, PVC shrouds on cable gland terminations for PVC served MICC conductors and PVC serve where installed underground. Transpose, where route lengths of single core cables exceed 100 metres, each third of the distance so that each phase conductor occupies the same material position for an equal length.

Marking and Labelling

Tagging

General: Identify multicore cables and trefoil groups at each end with stamped non-ferrous tags clipped around each cable or trefoil group.

Marking

General: Identify the origin of all wiring by means of proprietary machine printed labels.

6.2.4 Accessories

6.2.4.1 General

General: Conform to the following and to the Schedules.

Conformity: All accessories and outlets located in close proximity are to be the same manufacture, size and material.

6.2.4.2 Prospective fault level

Confirm fault current level at consumer's point of connection with the NUO, but allow for no less than 50kA, 1 second.

6.2.4.3 Wall Boxes

Standard grid size or equivalent to be manufactured from metal, with 2 or more gang size to be metal with steel inserts for accessory securing screws. Wall boxes to be screw fixed.

6.2.4.4 General purpose socket outlets

Standards:

- General: To AS/NZS 3112.
- Industrial: To AS/NZS 3123.

Single phase 10A or 15A, 230V mechanisms as required, rocker switch operation with 3 pin (flat earth pin) plug base mounted under a moulded polycarbonate flush plate and with 2 switches and plug bases in a standard flush plate for double socket outlets. Install industrial IP56 type in plant areas. To AS/NZS 3000 for outlets in damp or exterior situations. Mount outlets with the earth pins at the 6 o'clock position.

6.2.4.5 Earth Leakage Protection

Install RCD protection to AS/NZS 3000 and as required by the scope sections of this specification.

For installations in high risk areas (as defined in AS/NZS 3000), install 30mA RCDs at the distribution board for areas not covered in Domestic installations, or using fixed wired RCD protected socket outlets in areas that may represent increased risk of electric shock to the user:

- Wet areas: bathrooms, laundries, kitchens.
- Near pools and water features.
- Where intended for use with cleaning equipment.
- Hand-held tools subject to movement in use, i.e. work-shops, garages.

6.2.4.6 Switch Units

Single pole switches to be 16 amp minimum rated. Double pole or intermediate to be 16 amp minimum rated. All switches to be 230 volt a.c. polycarbonate flushplate units. Refer to drawings/schedules for number of switches per unit, dimmer units, neon (indicator or toggle) units and 2 way units.

Switches for applications other that general lighting shall be engraved to indicate their purpose.

Provide plugs with integral pins of the insulated type to AS/NZS 3112 for all equipment.

6.2.4.7 Isolating switches

Locate isolating switches in positions as confirmed by the Client, when not specifically shown on the drawings. Standard: To AS/NZS 3133.

6.2.4.8 Emergency stop switches

Standard: To IEC 60947.5.5.

6.2.4.9 3-phase outlets

Three phase outlets press or rotary switch operated with 5-pin screw-neck plug socket, spring loaded flap and flush mounted in a polycarbonate enclosure. Provide ratings as shown, to suit equipment or 20 amps, whichever is the greater.

Construction: Surface mounted type of high-impact resistant plastic, with flap lid on the outlet.

Minimum: 20 A, 400 V a.c.

Pin arrangement: Five round pins mounted with earth pins at the 6 o'clock position, neutral pins in the centre and the red, white and blue phases in a clockwise sequence when viewed from the front of the outlet.

Plug: Provide a matching plug top for each outlet.

Damp area and exterior outlets to be RCD protected (30 mA), to AS/NZS3190.

IP65 Rated

6.2.4.10 Installation Couplers

Standard: To AS/NZS 3000 and AS/NZS 61535.1.

Location: Accessible

6.2.4.11 Outdoor switches & sockets

Using materials with superior UV protection, impact strength, and addition chemical resistance when compared with interior polycarbonate fittings. Weather protected, switches to IP56 minimum, and sockets to IP53 minimum. Sockets fitted with safety shutters behind socket pins, and all products able to be padlocked off or on.

6.2.5 Accessories Installation

Install to NZBC G9/VM1, AS/NZS 3000, AS/NZS 3008.1.2 and relevant Electrical Codes of Practice.

Refer to Architect's elevation drawings for mounting heights of all outlets.

Default mounting heights for accessories (unless stated otherwise by Architects drawings):

Item Mounting Height

Outlets 500mm

Switches and Controls 1100mm

General requirements:

Provide flush mounted accessories except in plant rooms.

Mount adjacent flush mounted accessories under a common faceplate.

Do not install wall boxes across junctions of wall finishes.

for surface mounted accessories provide proprietary mounting blocks.

Wall construction	Installation and concealed cabling facilities
Rendered masonry partition	Flush wall box with conduit chased into wall
Double sided face brick partition	Vertically mounted flush wall box with conduit concealed in cut bricks
Face brick external cavity wall cavity run	Flush wall box with thermoplastic insulated cables in conduit run in and tied against inner brick surface, or thermoplastic sheathed cables in cavity
Stud partition	Rewirable

Setting Out

At the earliest opportunity set-out the position and sizes of holes, recesses and chases as necessary for the accommodation of the electrical services for the complete electrical installation. Arrange for those trades affected to carry out this work during construction or afterwards by cutting out and making good.

Outlet and Equipment locations

Outlet and equipment locations shown on the drawings for the complete electrical installation are their actual location, but subject to verification for final height and position. Confirm final positioning on site. Allow for up to 2 metres of movement prior to installation.

Light switches and Switch panels

Install flush, plumb and level at the mounting heights shown on the drawings and finalised on site, ensuring that cover plates or flush plates fully cover the edges of the opening in the wall behind.

Fit all single and double switch units, all sockets to the following heights (to the centre of the unit) unless shown otherwise on the drawings:

Switch Units - 1100mm

Socket Units - 300mm above work benches

500mm elsewhere or unless otherwise shown on architects drawings

Mount light switches and switch socket outlets vertically and socket units horizontally. Label all switch units that control electrical equipment or special lighting circuits by colour filled engraving on the switch. Use proprietary engraved switch mechanisms where applicable.

Wall boxes and Power outlets

Flush mounted in cavity construction. Fix vertically mounted wall boxes to studs. Fix horizontally mounted switched socket outlet wall boxes to solid blocking or nogs. Fix switch panel wall boxes to solid blocking. Install, flush, plumb and level at the mounting heights shown on the drawings and finalised on site, ensuring that cover plates fully cover the edges of the opening in the wall behind.

Permanently connected equipment

Supply and set into position. Install an isolating switch of the correct current rating, weatherproof flush mounted in a metal wall box, flush plate or protected type surface mounted to suit the location, with conductors between conduit and equipment enclosed in PVC flexible conduit.

6.2.6 Seismic Restraint

Seismically restrain electrical service equipment, including recessed and suspended light fittings, switchboards, cabinets, comms racks and other machinery and racks to NZS 4219.

6.2.7 Power for Mechanical, Hydraulic, Fire, Lift, Escalator, Comms, Security

Provide sub-mains and power supplies as described in the work by other trades section of this specification and as shown on the electrical drawings. Coordinate sizes of cables with the relevant sub-Contractor.

Coordinate the programming of works with the relevant sub-Contractor.

6.2.8 Earthing & Bonding

The Electrical Contractor shall provide an earthing and bonding system as detailed below.

6.2.8.1 Standards

Electrical system earthing to the Electricity (Safety) Regulations 2010, AS/NZS 3000, Electrical Codes of Practice and the NUO's requirements.

6.2.8.2 Communications applications:

Provide earthing systems for communications applications complying with AS/ACIF S009.

6.2.8.3 Electrodes

Provide electrodes to suit soil resistivity.

6.2.8.4 Plumbing/ Mechanical Systems

Bond together and to earth all plumbing fittings not adequately isolated, to AS/NZS 3000; the Electricity (Safety) Regulations 2010 and the fitting manufacturer's requirements.

Bond to all sinks and pipework.

Bond to all metallic cable support systems

Bond all metallic ductwork, sprinkler pipes, metallic pipework etc.

6.2.8.5 Earth and bonding clamps

General: Provide proprietary earthing and bonding clamps.

Standard: To AS 1882.

Mineral insulated metal sheathed cable (mims)

6.2.8.6 Seals

General: Maintain manufacturer’s seals until joint or termination is made. Remove moisture by heating cable ends.

Temporary seals: Fit temporary seals to the open ends of cables cut and not immediately used.

Terminations: Fit termination seals at ends of cable runs as soon as the cable has been cut to length, stripped back, and the moisture driven out.

Through joints: Same fire-rating as the cable.

6.2.8.7 Sheath earthing

General: If MIMS cables enter metal enclosures, earth sheaths to non-ferrous plates secured to the enclosures. Where sheaths terminate at plates, fully insulate, colour code, and fix the conductors to the enclosures.

Bonding

General: Bond metal sheaths of single core cables in multi-phase circuits with proprietary earth bonding clips or clamps.

6.2.8.8 Separation

General: Separate MIMS cables from tough plastic sheathed (TPS) cables and UPVC conduits by at least 25 mm.

6.2.8.9 Eddy currents

General: Arrange single core cable entries into non-ferrous metal gland plates to minimise eddy currents.

6.2.8.10 Vibration

Connections with vibrating equipment: Loop cables in a complete circle next to the point of connection.

6.2.8.11 Completion tests

Site tests

Inspection: Visually inspect the installation to AS/NZS 3000 before testing. Record on a checklist.

Test and verify the installation to AS/NZS 3000 Section 6 (Mandatory and Optional tests), using the methods outlined in AS/NZS 3017. Record the results of all tests.

Dummy load tests

General: Where electrical tests are required and the actual load is not available, provide a dummy load equal to at least 75% of the design load.

6.2.8.12 Spare parts

Provide spare parts as documented in the Spare parts schedule.

6.2.8.13 Schedules

The Contractor shall provide design and documentation drawings showing for details of all final circuit and submain cabling.

6.3 SWITCHBOARDS

6.3.1 Responsibilities

This electrical section relates to the design, supply, fixing and testing of low voltage switchboards, including but not limited to the following:

- Main switchboards
- Distribution boards
- Lift and Escalator change-over DB's/control panels
- Change-over panels for mechanical, hydraulic, fire, Comms, Security DB's/control panels

General: Provide switchboards as follows and as described on the electrical distribution board schedules

6.3.2 Cross references

Associated worksections: Conform to the following:

- General Requirements
- Scope
- Low voltage power systems
- Switchboard components

6.3.3 Standard

Standards:

- To AS/NZS 3439.1

- AS 60947
- AS/NZS 3000
- AS/NZS 3439.3

6.3.4 Interpretations

6.3.4.1 Abbreviations

For the purposes of this worksection the abbreviations given below apply:

- TTA: Type tested assemblies.
- NTTA: Non-type tested assemblies.
- PTTA: Partially type tested assemblies.

6.3.4.2 Definitions

For the purposes of this worksection the definitions given below apply:

- Custom-built assemblies: Low voltage switchgear and controlgear assemblies manufactured to order.
- Proprietary assemblies: Low voltage switchgear and controlgear assemblies available as a catalogue item, consisting of manufacturer's standard layouts and equipment.
- Rated currents: Rated currents are continuous uninterrupted current ratings within the assembly environment under in-service operating conditions.
- Rated short-circuit currents: Maximum prospective symmetrical root mean square (r.m.s.) current values at rated operational voltage, at each assembly incoming supply terminal, excluding effects of current limiting devices.

6.3.5 Tests

Carry out routine tests to AS 3439.1. Electrical and mechanical routine function tests at the factory using externally connected simulated circuits and equipment and Dielectric testing, 2.5 kV r.m.s. for 15 s, give sufficient notice so inspection may be made with busbars exposed and functional units in place and ready for routine testing.

Assemblies: Electrical and mechanical routine function tests at the factory using externally connected simulated circuits and equipment.

6.3.6 Inspection

Give sufficient notice so inspection may be made at the following stages:

- Fabrication and painting completed.
- Factory assembly completed, with busbars exposed and functional units in place.
- Assembly ready for routine testing.
- Assembly installed prior to connection.
- Assembly installed and connected.

6.3.7 Submissions

6.3.7.1 Product data

Supply the name of the switchboard manufacturer, details of any changes to the original design, documented confirmation that the switchboard will give a short circuit rating of a minimum of the value specified, or as advised by the NUO, whichever is greater, and the sizes and brand names of all boxes and cabinets.

Submit the following:

- Makes, types and model numbers of items of equipment.
- Type test certificates for components, functional units and assemblies including internal arcing-fault tests and factory test data
- Overall dimensions.
- Fault level.
- IP rating.
- Rated current of components.
- Number of poles and spare capacity.
- Mounting details.
- Door swings.
- Description of materials and finishes
- Paint colours and finishes.
- Access details.
- Schedule of labels.
- Submit design calculations of non-type tested and non-proprietary busbar assemblies.
- Submit detailed certified calculations verifying design characteristics to AS 3865 and AS 4388.
- Submit type test certificates for components, functional units and assemblies. Verify that type tests and internal arcing-fault tests, if any, were carried out at not less than the designated fault currents at rated operational voltage.
- Alterations to TTAs: Submit records of alterations made to assemblies since the tests.
- Submit reports results of all routine tests.

6.3.7.2 Shop drawings

Supply drawings required for co-ordination of the work. Confirm overall dimensions. Design to fit the available space with clearances required by Standards.

Submit shop drawings showing:

- General arrangements of all switchboards, single line diagram of each switchboard, full equipment list for each switchboard, dimensioned plan of plant rooms and electrical cupboards showing switchboard and surrounding walls/ceiling/doors.

- Full distribution board schedules for all distribution boards and shall include circuit designations, area served, function of circuit (e.g GPO's, lighting), protective device type, cable type and size
- Types, model numbers and ratings of assemblies.
- The weight of switchboards over 500kg.
- Component details, functional units and transient protection.
- Detailed dimensions.
- Shipping sections, general arrangement, plan view, front elevations and cross-section of each compartment.
- Projections from the assembly that may affect clearances or inadvertent operation, such as handles, knobs, arcing-fault venting flaps and withdrawable components.
- Fault level and rated short circuit capacity characteristics.
- IP rating.
- Fixing details for floor or wall mounting.
- Front and back equipment connections and top and bottom cable entries.
- Door swings.
- External and internal paint colours and paint systems.
- Quantity, brand name, type and rating of control and protection equipment.
- Construction and plinth details, ventilation openings, internal arcing-fault venting and gland plate details.
- Terminal block layouts and control circuit identification.
- Wiring diagrams and schematics of instrument protection and control circuits
- Single line power and circuit diagrams, internal wiring and ratings.
- Details of mains and submain routes within assemblies.
- Busbar arrangements, links and supports, spacing between busbar phases and spacing between assemblies, the enclosure and other equipment and clearances to earthed metals.
- Dimensions of busbars and interconnecting cables in sufficient detail for calculations to be performed.
- Form of separation and details of shrouding of terminals.
- Clearances between live parts and live parts and earth
- Labels and engraving schedules, including size and wording

6.3.8 Design & Construction

Design to AS/NZS 3000 and AS/NZS 3439. Fault ratings graded to suit Network Utility Operators stated prospective fault level fully discriminated through installation.

Allow for fully fitted out current load (amps) plus the following spare capacity:

- 25% for distribution boards, 20% for main switchboards
- Minimum forms of separation, to AS/NZS 3439.1:
- Distribution boards: Form 1, IP42, main switchboards: IP42, Form 3B
- Fault rating graded to suit maximum prospective fault from NUO
- minimum 20kA
- Complete, fully wired, factory tested, of sizes to suit space allocated, with clearances required in Standards, designed to give easy access to and removal of component parts.

6.3.8.1 Construction

Fabricate enclosures from rigid folded and/or welded construction 1.6mm thick metallic-coated sheet steel finish coats: Thermoset powder coating to AS 4506 or two-pack liquid coating of AS/NZS 3750.13 primer and proprietary or epoxy acrylic full gloss spray finish. Ventilation rated for full load, cover ventilation openings with non-combustable and corrosion resistant 1mm mesh. Equipment mounting panels to support the weight of mounted equipment, using □ 3mm thick metal with heavy metal angle supports or plates bolted or welded to enclosure sides.

The switchboard cabling compartments shall be of adequate size to accommodate all cable tails on to protective devices. Space shall be adequate for cables to be connected to all ways, including allowance for spare ways using similar size cables to those installed as part of the works. Cables shall be dressed into the switchboards in such a way that they do not obstruct spare ways and do not impinge on any covers etc.

Cable trays shall be provided within all cabling compartment to supports the cables. The inner sheath of all sub-main cables shall be left on to maintain the Form 1 form of separation. Cabling compartments shall include glanding plates along the top and bottom of the switchboard to which the outgoing cables shall be glanded.

An integral earth bar shall run the full length of the switchboard. All incoming and outgoing main, sub-main and Circuit Protective Conductors (CPC's) shall be bonded to this bar. Armoured cables shall be terminated with Earth tags, which shall be provided with Copper XLPE insulated green yellow OHLS cable from the tag to the earth bar.

Provide rigid, ventilated, insect screened enclosures, giving the documented enclosure, separation and degree of protection. Provide adequate ventilation to maintain design operation temperatures at full load. Cover ventilation openings with non-combustible and corrosion resistant 1 mm mesh.

6.3.8.2 Distribution Boards.

Recessed mount board manufactured to AS/NZS 3439.3 and installed in accordance with AS/NZS 3000. Manufactured from engineering grade resin with a glow wire rating of 850°C, complete with neutral and earth busbars, and insulated comb phase bar. Distribution board to have 25% spare capacity for future additions and alterations.

6.3.8.3 Supply authority’s equipment

Install equipment supplied by the Distribution Company/ Retailer/ Supply authority, and provide wiring to complete the installation.

Tariff meter compartment: Install the supply authority's tariff metering equipment in a separated, sealed meter compartment or separate meter panel.

6.3.8.4 Layout

Position equipment to provide safe and easy access for operation and maintenance. Group devices according to function.

Separate shipping sections, subsections, cable and busbar zones, functional unit modules and low voltage equipment compartments by means of vertical and horizontal steel partitions which suit the layout and form of separation.

Form 1 enclosures: Separate into compartments by means of partitions at 1.8 m maximum centres.

Equipment on doors: Set out in a logical manner in functional unit groups, so it is accessible without the use of tools or keys.

6.3.8.5 Metering

Provide metering to the incoming and/or outgoing ways of each switchboard as documented within this specification and shown on design drawings/ schedules.

6.3.8.6 Segregation

General: Segregate BCA emergency equipment from non-emergency equipment by means of metal partitions designed to prevent the spread of a fault from non-emergency equipment to emergency equipment.

6.3.8.7 Enclosure Construction

Fabricate from sheet metal of rigid folded and welded construction. Obtain approval for non-welded forms of construction.

Material: 1.6 mm thick metallic-coated sheet steel.

Coating class:
Indoor assemblies: Z200.

Outdoor assemblies: Z450.

Equipment mounting panels
General: To support the weight of mounted equipment.

Metallic panels: Construct from □ 3 mm thick metal with heavy metal angle supports or plates bolted or welded to enclosure sides.

Non-metallic panels: Provide non-metallic panels selected to suit the weight of the mounted equipment and design the mounting structure for stability and stiffness.

Non-metallic boards: To IEC 60893-1.

Equipment fixing
Spacing: Provide 50 mm minimum clearance between the following:

Busbars for lifts, fire services and building emergency services.
General installation services, busbars and equipment.

Mounting: Bolts, set screws fitted into tapped holes in metal mounting panels, studs or proprietary attachment clips. Provide accessible equipment fixings which allow equipment changes after assembly commissioning.

Installation: For lightweight equipment, provide combination rails and proprietary clips.

Earth continuity
General: Strip painted surfaces and coat with corrosion resistant material immediately before bolting to the earth bar. Provide serrated washers under bolt heads and nuts at painted, structural metal-to-metal joints.

Construction

Lifting provisions: For assemblies with shipping dimensions exceeding 1800 mm high x 600 mm wide, provide fixings in the supporting structure and removable attachments for lifting.

Supporting structure: Provide concealed fixings or brackets to allow assemblies to be mounted and fixed in position without removing equipment.

Floor-mounting: Provide mild steel channel plinth, galvanized to class Z600, with toe-out profile, nominal 75 mm high x 40 mm wide x 6 mm thick, for mounting complete assemblies on site. Drill M12 clearance holes in assembly and channel and bolt assemblies to channel. Prime drilled holes with zinc rich organic primer to APAS-2916.

6.3.8.8 Cable entries

Provide cable entry facilities within assembly cable zones for incoming and outgoing power and control cabling. Provide sufficient clear space within each enclosure next to cable entries to allow incoming and outgoing cables and wiring to be neatly run and terminated, without undue bunching and sharp bends.

Cover and gland plates

Cover plates: Provide 150 mm maximum width cover plates butted together and covering the continuous cable entry slot.

Gland plates: Provide removable gland plates fitted with gaskets to maintain the degree of protection.

Materials: 1.5 mm thick steel, 5 mm thick composite material or laminated phenolic. 6 mm thick brass for MIMS cables and cable glands.

6.3.8.9 Bus trunking system entry

Provide entry plates with close tolerance cut-out to accommodate busbars, fitted with a flange bolted and sealed to assembly enclosure to maintain assembly IP rating. Earth busway enclosure to assembly protective earth conductor. Fit busway flanges at assembly manufacturer's premises and retain for transportation.

6.3.8.10 Doors and covers

Provide lockable doors with a circuit card holder unless enclosed in cupboards.

Comply with AS/NZS 3000 clearance requirements.

Door layout

Maximum width: 900 mm.

Minimum swing: At least 90º.

Door stays: Provide stays to outdoor assembly doors.

Adjacent doors: Space adjacent doors to allow both to open to 90º at the same time.

Door construction

Provide single right angle return on all sides and fit suitable resilient sealing rubber to provide the documented IP rating and prevent damage to paintwork.

Provide corrosion-resistant pintle hinges or integrally constructed hinges to support doors. For removable doors, provide staggered pin lengths to achieve progressive engagement as doors are fitted. Provide 3 hinges for doors higher than 1000 mm. Provide restraining devices and opposed hinges for non lift-off doors.

Door hardware: Provide the following:

- Corrosion resistant lever-type handles, operating a latching system with latching bar and guides strong enough to withstand explosive force resulting from fault conditions within the assembly.
- Dual, edge mounted, corrosion resistant T handles with provision for key locking cylinder.
- Captive, corrosion resistant knurled thumb screws.
- Fit suitable resilient sealing rubber to provide the required IP rating.
- Incorporate cylinder locks in the latching system. Key alike, 2 keys per assembly.

Door mounted equipment: Protect or shroud door mounted equipment and terminals to prevent inadvertent contact with live terminals, wiring, or both.

Earthing: Maintain earth continuity to door mounted indicating or control equipment with multi-stranded, flexible earth wire, or braid of equal cross-sectional area, bonded to the door.

Covers

Maximum dimensions: 900 mm wide and 1.2 m2 surface area.

Fixing: Fix to frames with at least 4 fixings. Provide corrosion-resistant acorn nuts if the cover exceeds 600 mm in width. Rest cover edges on the cubicle body or on mullions. Do not provide interlocked covers.

Handles: Provide corrosion resistant D type handles.

Escutcheons

General: For doors enclosing circuit breakers, provide escutcheon plates as barriers between operating mechanisms and live parts.

Escutcheon plates

Provide plates or removable covers with neat circuit breaker toggle cut-outs allowing interchangeability of 1, 2 and 3 pole circuit breakers. Provide corrosion-resistant lifting handles or knobs. Provide unused circuit breaker toggle cut-outs with blanking in-fill pole covers.

Maximum dimensions: 900 mm wide and 1.2 m2 surface area.

6.3.8.11 Factory finishes

Standard: To AS 2700.

Apply protective coatings to internal and external metal surfaces of assembly cabinets including covers, except to stainless steel, galvanized, electroplated, or anodised surfaces and to ventilation mesh covers.

Finish coats: Thermoset powder coating to APAS-0155/1 or two-pack liquid coating of APAS-2971 primer and proprietary or epoxy acrylic full gloss spray finish to Factory finishes schedule.

Factory finishes schedule:

Mounting structure (brackets) To match enclosure
Enclosure Indoor assemblies: Orange X15
Outdoor assemblies: Avocado green G34
Assembly interior: White
Escutcheons Removable equipment panels: Off white Y35
Doors To match enclosure
Plinths Black

6.3.8.12 Busbars

Provide main circuit supply busbars within assemblies, extending from incoming supply terminals to the line side of protective equipment for outgoing functional units and for future functional units. Type: Multi-pole proprietary busbar assemblies or busbar systems, verified for short circuit capacity and temperature rise-limits by type tests.

High conductivity hard drawn tinned copper bar with arrised edges, sufficient to supply the capacity of the switchboard when filled, with neutral bus bars of the same current rating and size as phases and joints, terminations and fixings accessible. Arrange to safely withstand possible maximum prospective fault currents. Support on synthetic resin moulded type insulators, panels and cleats. Fully lap joints, finished electro-tinned, coated with acid free petroleum jelly and bolted together with high tensile cadmium plated steel bolts, washers, nuts and lock-nuts.

Standards:

- AS/NZS 3439.1
- AS 3768,
- AS 3865
- AS 4388.

Submissions: Submit design calculations of non-type tested or non-proprietary busbar assemblies.

Definitions
Incoming busbars: Busbars connecting incoming terminals to line side terminals of main switches.
Main circuit supply busbars: Busbars connecting incoming functional unit terminals, or incoming busbars where no main switches are included, to outgoing functional unit terminals or outgoing functional unit tee-offs.

Tee-off busbars: Busbars connecting main busbars to incoming terminals of outgoing functional units.

Support:
Sufficient to withstand thermal and magnetic stresses due to maximum prospective fault currents.
Support material: Non-hygroscopic insulation capable of holding busbars at 105°C.

Custom-built Busbar construction:

Material: Hard-drawn high-conductivity electrolytic tough pitched copper alloy bars, designation 110.

Temperature rise limits - active and neutral conductors:

Maximum rated current temperature rise limits: 65 □ 1.5ºC by type test or calculation to AS 3768 or AS 4388.

Maximum short-circuit withstand current temperature rise limits: 160ºC by calculation to AS 3865.

Cross section: Rectangular with radiused edges.

Proprietary busbars:
Type: Multi-pole proprietary insulated busbar assemblies or busbar systems, verified for short circuit capacity and temperature rise-limits by type test.

Phase sequence:
General: For main busbars and connections to switching devices, set-out phase sequence for phases A, B and C, from left-to-right, top-to-bottom and front-to-back when viewed from the front of the assembly.

Colour coding:

General: Provide 25 mm minimum width colour bands permanently applied to busbars at 500 mm maximum intervals with at least one colour band for each busbar section within each compartment.
Active busbars: Red, white and blue respectively for the A, B and C phase.

Neutral busbar: Black.

MEN link: Green-yellow and black.

Protective earth busbar: Green-yellow.

Current carrying capacity:

Active conductors: Take into account thermal stresses due to short circuit current, assuming magnetic material enclosures located indoors in well-ventilated rooms and 90ºC final temperature.
Neutral conductors: Size to match incoming neutral conductor current carrying capacity.

Protective earth conductors: Size for at least 50% of the rated short circuit withstand current for 100% of the time duration.

Tee-off busbars current rating

For individual outgoing functional units: Equal to maximum frame size rating of the functional unit.
For multiple functional units: Equal to the diversity factors of AS 3439.1, based on frame size rating.

MEN links:

MEN links > 10 mm2 in cross-section: Bolted removable busbar links stamped MEN LINK, located in the incoming compartment, between neutral and earth busbars.

Fault current limiters:

General: Rate busbars connected to fault current limiters to 100% of the indicated fault current limiter circuit breaker frame size or fuse base rating.
Busbar links:

For current transformers, provide removable busbar links □ 450 mm long.

Pre-drill the main circuit supply busbar for future extensions and extend busbar droppers into future functional unit locations.

Cable connection flags:

General: Provide and support busbar flags for equipment with main terminals too small for cable lugs. Provide flags sized to suit cable lug termination, with current rating of at least the maximum equipment frame size.
Phase isolation: Provide phase isolation between flags where the minimum clearance distances phase-to-phase and phase-to-earth are below the component terminal spacing.

Future extensions:

General: Pre-drill the main circuit supply busbar for future extensions and extend busbar droppers into future functional unit locations.
Jointing:

Type: High tensile steel bolts, washers and nuts, with lock nuts or locking tabs. Do not use tapped holes and studs or the like for jointing current carrying sections.

Custom-built busbar insulation:

Active and neutral busbars and joints: Select from the following:
Polyethylene: At least 0.4 mm thick with dielectric strength of 2.5 kV r.m.s for 1 minute, applied by a fluidised bed process in which the material is phase coloured and directly cured onto the bars.

Close fitting busbar insulation mouldings at least 1 mm thick.

Heat shrink material: Only on rounded edge busbars.

Taped joints: Apply non-adhesive stop-off type tape, coloured to match adjacent insulation and half lapped to achieve a thickness at least that of the solid insulation.

Damaged insulation: Repair damaged insulation before energising.

6.3.8.13 Neutral links and earth bars

To AS/NZS 3000 and AS/NZS 3439.1. Brass and or copper bar with tunnel type terminals for cables up to 6mm2 and stud type cable lugs for others.

Links:

Assembly capacity > 36 poles: Provide neutral links and earth bars at the top and bottom of the circuit breaker section.

Assembly capacity □ 36 poles: Provide links and bars at the point of entry of incoming supply cables.

Mounting: Mount neutral links on an insulated base.

Control circuits: Provide separate neutral links and earth bars.

Labels: Provide labels for neutral and earth terminals.

Cables > 10 mm2: Provide bolts or studs.

6.3.8.14 Internal wiring

0.6/1 kV copper cables with V-90HT insulation where directly connected to active and neutral busbars. Identify power and control cables at both ends with neat fitting ring type ferrules agreeing with record circuit diagrams. Mark to AS/NZS 4383. Terminate control cables and motor control circuits in tunnel terminals or, if necessary, provide suitable palm type lugs and correct crimp tool. Provide slotted trunking.

Cable interconnections

General: For the main circuit supply, provide cable interconnections as follows:

1.5 mm2 internal cables, with minimum V75 insulation rating with stranded copper conductors rated to AS/NZS 3008.1.1. Provide cables with current ratings suitable for the internal assembly ambient air temperature and for temperature rise limits of equipment within the assembly.

Run cables clear of busbars and metal edges.

Provide cables capable of withstanding maximum thermal and magnetic stresses associated with relevant fault level and duration.

Run cables neatly. Provide slotted trunking sized for future cables or tie at 150 mm maximum intervals with ties strong enough to withstand magnetic stresses created at the specified fault current. Do not provide adhesive supports.

Ensure wiring for future equipment can be installed without removal of existing equipment.

Identify power and control cables at both ends with neat fitting ring type ferrules agreeing with record circuit diagrams. Mark to AS/NZS 4383.

Terminate control cables and motor control circuits in tunnel terminals or, if necessary, provide suitable palm type lugs and correct crimp tool.

For equipment mounted on hinged doors run cables on the hinge side to avoid restricting the door opening. Bundle cables with spiral wrap PVC.

If recommended by device manufacturers, provide shielded wiring.

Adjacent circuit breakers: If suitable proprietary multi-pole busbar assemblies are available to link adjacent circuit breakers, do not provide cable interconnections.

Cables > 6 mm2

6.3.8.15 Terminations:

Tunnel terminals: Single cables.

Other connection points or terminals: 2 cables.

Supports:
Spacing at enclosure: 200 mm from a termination.
Spacing generally: 400 mm.

Capable of withstanding forces exerted during fault conditions.

Single core cables rated 300 A: Do not provide ferrous type metal cable saddles.

Terminate marked cables for connection to external controls in correspondingly marked terminals within the assembly.

Control and indication circuits:
General: Provide conductors sized to suit the current carrying capacity of the particular circuit.
Minimum size: 1 mm2 with 32/0.2 stranding.

Cable colours:

General: Colour code wiring as follows:

- A phase: Red.
- B phase: White.
- C phase: Blue.
- Neutral: Black.
- Earthing: Green-yellow.

Terminations
Outgoing Circuits: Connect direct to the circuit breaker terminals.
Shipping breaks: Provide terminal blocks for interconnecting wiring on each side of shipping breaks.

6.3.8.16 Assembly installation

To NZBC G9/VM1, AS/NZS 3000, AS/NZS 3008.1.2 and relevant Electrical Codes of Practice.

At the earliest opportunity set-out the position and sizes of holes, recesses and chases as necessary for the accommodation of the electrical services for the complete electrical installation. Arrange for those trades affected to carry out this work during construction or afterwards by cutting out and making good.

Before making inter-panel connections, fix assemblies and metering equipment enclosures into position, level and plumb.

Secure firmly plumb and level in position with masonry screws or bolts. Cut entry holes by machine saw or machine punching without distortion. Leave edges smooth, and neatly cover exposed metal with a matching anti-corrosive coating. Secure free-standing cubicle type switchboards on a supporting base of mild steel channel sections bolted rigidly in place. Apply seismic restraint measures to NZS 4219.

Mount all switchboard equipment on fixing rails or insulating panels within the cabinet, with only toggles, indicators, handles and dials protruding and all to enable easy access for adjustment, replacement and maintenance. Ensure any unit can be installed or can be replaced without disturbing adjacent units. Set out equipment on doors in a logical manner in function groups, accessible without use of key or tool.

Provide fixings in the supporting structure and removable attachments for lifting. Provide mild steel channel plinth for floor mountings, galvanised to class Z600, with toe-out profile, nominal 75mm high x 40mm wide x 6mm thick, for mounting complete assemblies on site. Drill M12 clearance holes in assembly and channel and bolt assemblies to channel.

6.3.8.17 Assembly entries

Cable entries:

Provide cable entry facilities for incoming and outgoing power and control cabling, to allow cables to be neatly run and terminated, without undue bunching and sharp bends.

Do not run cables into the top of weatherproof assemblies.

Single core cables rated > 300 A: Pass separately through non-ferrous gland plates. Do not use metal saddles.

Provide removable aluminium gland plates fitted with gaskets to maintain the degree of protection.

6.3.8.18 Cable enclosures:

Continue cable enclosures to or into assemblies and fit cable entry plates so that the IP rating of the assembly and the fire rating of the cable are maintained. Neatly adapt one or more cable entry plates, if fitted, to accept incoming cable enclosure. Provide the minimum number of entry plates to leave spare capacity for future cable entries.

6.3.8.19 Cable supports:

General: Support or tie mains and submains cables within 200 mm of terminations. Provide cable supports suitable for stresses resulting from short circuit conditions.

6.3.8.20 Bus trunking system entry:

Provide entry plates with close tolerance cut-out to accommodate busbars, fitted with a flange bolted and sealed to assembly enclosure to maintain assembly IP rating. Earth busway enclosure to assembly protective earth conductor. Fit busway flanges at assembly manufacturer's premises and retain for transportation.

6.3.8.21 Circuit Charts

For all assemblies, provide circuit charts of minimum size 200 x 150mm, with type written text showing the following as-installed information:

Submain designation, rating and short-circuit protective device.

Outgoing circuit numbers and circuit breaker current ratings, cable sizes and type and areas supplied.

Mounting: Mount schedule cards in a holder fixed to the inside of the assembly, protect with hard plastic transparent covers.

6.3.8.22 Single Line diagramns

Provide single-line diagrams for main and submain assemblies

Format: Non-fading print, at least A3 size, showing the situation as installed.

Mounting: Enclose in a non-reflective PVC frame and wall mount close to assembly.

6.3.8.23 Marking and Labelling

Identify the origin of all wiring by means of legible proprietary machine printed labels. Provide durable labels fitted to each core and sheath, permanently marked with numbers, letters or both to suit the connection diagrams.

Identify multicore cables and trefoil groups at each end with durable non-ferrous tags clipped around each cable or trefoil group.

Label the switchboard assembly in conformance with AS/NZS 3439.1 including the following:

- Size and type of all incoming and outgoing mains and submains.
- Emergency operating procedures.

Lettering heights:

- Isolating switches: □ 5mm.
- Switchboards, main assembly designation: □ 25mm.
- Switchboards, outgoing functional units: □ 8mm.
- Switchboards, sub assembly designations: □ 15mm

Danger, Warning and Caution notices

Provide warning notices on the front cover near the main switch or local main switch and on rear covers, indicating live busbars.

To prevent accidental contact with live parts, provide warning notices for equipment on assemblies not isolated by main switch or local main switch. Provide warning notices stating that assemblies may be energised from the stand-by supply at any time if applicable.

6.3.8.24 Completion

At completion tighten busbar joints, cable terminations and connections. Vacuum clean dust and debris from the interior and wipe down and polish exterior surfaces.

6.3.8.25 Maintenance

Standard: To AS 2467.

Carry out the following maintenance:

- Rectify faults, make adjustments and replace consumable and faulty materials and equipment within 24 hours of notification.
- Monthly inspections and maintenance work to maintain the assembly, including battery systems.
- Replace damaged, cracked or marked elements.

6.3.8.26 Distribution Boards

Assembly designation

6.4 SWITCHBOARD COMPONENTS

6.4.1 Responsibilities

General: Provide switchboard components as follows and to the Schedules.

6.4.1.1 Cross references

As well as the following section, conform to the following:

- General requirements.
- Switchboards

6.4.1.2 Statutory authority's equipment

Liaise with the supply authority with regard to the installation and coordinate with their protective and control equipment.

6.4.1.3 Submissions

Submit technical data for all components to be used.

6.4.1.4 General Requirements

Selection: To comply with the requirements of AS/NZS 3000 clause 1.9 and Section 2.

Rated duty: Uninterrupted.

Rated making capacity: fault level at assembly incoming terminals.

Rated breaking capacity (peak): rated full load current (RMS) at assembly incoming terminals.

Utilisation category: To AS 60947.1 clause 4.4.

Circuits consisting of motors or other highly inductive loads: At least AC-23.

Other circuits: At least AC-22.

Coordination: Provide protective devices which fully grade and coordinate for short circuit current, over-current, let through energy and earth faults.

6.4.2 Equipment Selection

6.4.2.1 Switch-isolator

Standard:

- AS 60947.1
- AS/NZS 3947.3.
- AS 60947.4.2.
- Poles: 3.

Operation: Independent manual operation including positive ON/OFF indicator.

Provide facility for padlocking in the 'Off' position.

Shrouding: Effective over range of switch positions.

Rated breaking capacity: □ rated full load current.

6.4.2.2 Fuse-switch units

Standard:

- AS 60947.1
- AS/NZS 3947.3.

- AS 60947.4.2.

Poles: 3.

Operation: Provide an extendable operating handle. Independent manual operation including positive ON/OFF indicator.

Provide facility for padlocking in the 'Off' position.

Provide 3 phase sets of high rupturing capacity (HRC) fuse links.

6.4.2.3 Fuse links

Standard:

- AS 60269.1,
- AS 60269.2.0
- AS 60269.2.1.

Enclosed, high rupturing capacity type mounted in a fuse carrier, breaking range and utilisation category:

Distribution/general purpose: gG

Motors: gM

Fuse-holders: Mount fuse-holders so that fuse carriers may be withdrawn directly towards the operator and away from live parts. Provide fixed insulation which shrouds live metal when the fuse carrier is withdrawn.

Barriers: Provide barriers on both sides of each fuse link, preventing inadvertent electrical contact between phases by the insertion of screwdriver.

Spare fuse links: Provide 3 spare fuse links for each rating of fuse link on each assembly. Mount spares on clips within the spares cabinet.

Spare fuse holder carriers: Provide 3 spare fuse holder carriers for each size of fuse holder carriers on each assembly. Mount spares on clips within the spares cabinet.

Busbar mounted fuse holders: Provide fuse carriers with retaining clips, minimum fuse holder 32 A.

Provide 3 spare cartridges of each type and rating used, including fault current limiting fuses, in a labelled panel adjacent to the main switchboard. To be isolated when switch contacts are open.

6.4.2.4 Wiring Systems - LV Cables

Unarmored Cables

LSOH insulated and unsheathed cables drawn into conduit and trunking
LSOH insulated cables shall be manufactured to AS/NZ5000.1

Cables shall only be drawn into a conduit system when it is complete, permanently fixed and thoroughly swabbed out. The cables shall be looped progressively from point to point and joints will not be permitted. Cables for different voltage bands shall not be installed in the same conduit and trunking systems unless specifically stated in project particular information.

The installation of cables in any conduit shall be in accordance with manufacturer's instructions and AS/NZS3000 and 3008. Cables shall be installed in conduit and trunking, however cables in conduit shall occupy no more than 65% of the available space and in trunking, no more than 55%.

Cables shall be drawn in such a manner that it is possible to withdraw any number from the conduit without disturbing the remainder. Wire pulling lubricant shall not be

used.

The ER reserves the right to require all cables pulled in with any lubricant to be removed and replaced and conduits cleaned internally. LSOH insulated and sheathed cables Insulated and sheathed cables shall be installed on either cable tray, cable basket or trunking. Cables may also be clipped direct to building fabric as well as concealed within the building fabric in accordance with AS/NZS3000.

Please note that where concealed in the building fabric, the depth of cables and method of mechanical protection may introduce the need to protect the circuit by either RCD or RCBO.

The installation of cables shall be in accordance with manufacturer's instructions and AS/NZS3000.

Armoured Cables (Including SWA)

XLPE/SWA/LSF cables shall be manufactured to AS/NZ5000.1. Single core cables shall have non-magnetic armour, such as aluminium wire or strip.

Where cables are buried direct in the ground or laid in ducts, they shall be installed and covered in accordance with the AS/NZS3000 and 3008.

Where cables are installed on cable ladder, tray, basket, or fixed directly to the building fabric, they shall be securely fixed in accordance with AS/NZ3000 and 3008. Where cables are exposed to direct sunlight or extremes of temperature, they shall be provided with suitable containment or solar shading as appropriate.

The following shall be applied for the fixing of cables, (unless stated in the particular specification;

Vertical
up to 35mm sq – Stainless Steel Tie wraps
Over 35mm sq Fire rated cable – Steel Cable Cleats
Over 35mm sq cables LSFZH (for non-fire applications)

Horizontal up to 35mm sq – Stainless Steel Tie wraps
Over 35mm sq cable – to be confirmed in the particular specification depending on fault levels

Flexible Cables and Cords
All flexible cables shall comply with AS/NZS5000.2 and shall be 450/750V insulated and sheathed in normal temperature situations, with various other insulation and sheath properties.

The minimum conductor size shall be 1.5mm2. In addition to those flexible cable types listed under general requirements, the following flexible cables may be used in the appropriate situation and subject to authorisation by the ER.

The application of the above temperature and constructional features of cables shall be to suit the relevant item of electrical equipment and its operational temperature 75^{o}C.

Where an earthing conductor is required for the earthing of metalwork in apparatus and luminaires, it shall be contained within the flexible cord.

2.5 Soft Skin Fire Performance Cables

Soft skin fire performance cables are those types capable of continuing to operate when exposed to fire. All soft skin cables used on the project shall comply with BS 7629 and BS EN 50200. All cables shall have insulation complying with BS EN 50265-2-1.

Emergency Lighting cables shall be compliant with AS/NZS3008 and shall be rated to WS52W. Where cables using solid inner cores are used, these cables shall be installed without kinks. Any kinked cables shall be replaced throughout their length.

Each termination shall be complete with suitable gland and shroud. Cables shall be supplied by the same manufacturer throughout the project when used on a common system.

Care shall be taken when terminating soft skin cables to ensure cores are not compressed together.

ELV Cables for Data and Communication use

Cables for general data and communications use shall be in accordance with the operational requirements of the system to which they are installed. Where cables run in the proximity of LV cables, they shall have insulation to the same standard. Where ELV cables are installed in areas of high moisture, extremes of temperature or exposed to direct sunlight, they shall be protected by suitable containment.
DALI cables shall be CAT 6 LSFOH.

All cables shall be installed in accordance with AS/NZS3008.

For specific Communications Cables, such as CCTV, CIS, Clocks, RADIO, Security , etc see the Communications Specifications and Schedules.

Cable Installation & Support
All distribution and final circuit cabling shall be installed, fixed to structure or supported on a cable support system complying with the manufacturers recommendations, and AS/NZS3000.

Cable Glands

All cable glands and terminations shall maintain the IP rating and integrity of the enclosure they terminate into. Unless otherwise specified elsewhere, mechanical cable glands shall be brass. Where proprietary forms of gland made of nylon or similar plastics material are available, they may be used with unarmoured cables. All cable glands shall be provided with a 'Banjo' earthing ring

All cables shall be identified at each gland and termination as specified elsewhere.

Cable Jointing and Terminations

All HV joints and terminations shall be made by qualified cable jointers, using jointing materials, components and workmanship recommended by the cable manufacturer and jointing accessory manufacturer. The manufacturer's instructions shall be followed at all times.

Where LV systems are concerned, these joints (where necessary) may be air insulated, with jointing carried out by suitably qualified electricians. Cable ends shall be cut immediately prior to jointing or terminating. Cables left unconnected for more than 24 hours shall be sealed to permanently prevent the ingress of moisture. All XLPE and LSF sheathed cables shall be sealed using proprietary shrink on end caps.

All necessary precautions shall be taken to ensure that strands are not damaged when stripping cable cores. Strands shall be twisted together and mechanically secured at terminations. Under no circumstances shall the number of strands be reduced at any termination.

Prior to jointing or terminating, the armour of all armoured cables shall be cleaned. Where connections are made to equipment and switchgear without integral cable clamping terminals, insulated compression lugs shall be used for bolted terminal connections.

For core sizes 10mm2 and above, all compression connections to components shall be made using tools that cannot be released unless the correct degree of compression has been achieved.

Core terminations shall be securely bolted via lugs to equipment using washers and proprietary shake-proof devices.

The bunching of more than two cores at clamping terminals or bolted connections shall not be permitted.

All cables shall be marked at each end at both sides of penetrations or transits and at any joints to provide adequate identification.

At all joints and terminations all cores, including multi-core spare cores shall be connected. Any unused core of multi-core cables shall be bonded at both ends to earth.

All compression joints for copper conductors shall comply with relevant standards.

Cable Installation

Cables shall be run neatly on the surface by means of cleats or on cable ladder rack or tray, or laid in floor trenches or drawn into ducts or buried in the ground, as indicated by the ER.

Cable routes shall be agreed with the Appointed Representative prior to commencement of work.

Cables shall be run at least 150mm clear of plumbing and mechanical services and below heating and hot water pipework. Where this cannot be achieved, an alternative shall be proposed, and approved by the appointed representative.

Cables passing through structural floors or walls shall have galvanised sleeves, wrapped with a non-combustible tape and grouted in position.

Cables shall be installed in accordance with good installation practice. Where separate CPCs are used, they shall be steel tie wrapped to the SWA feeder cable to that particular circuit.

Take all necessary precautions to prevent damage to cables during installation. Where cables are installed in situations where works by others are incomplete, take all reasonable precautions to protect the cables against damage arising from the execution of such other works.

In the event of damage to the sheath or armouring of a cable, the cable shall be replaced throughout its entire length.

All cables shall run directly from point to point without joints. Where this is not practical cable joints can be used, but shall be agreed with the ER.

Three-phase groups of single-core cables carrying alternating current shall be laid, in trefoil formation and touching each other. Where this is not possible, the disposition to be adopted shall be agreed with the ER before installation is commenced.

All cables shall be pulled into position in such a manner as to avoid any damage whatsoever to the cable or its sheath. Cables shall wherever possible, be pulled directly from the top of the drum, which shall be supported throughout the operation in such a manner that it is completely free to rotate.

Where circumstances make removal of the cable from the drum before pulling into position unavoidable, the cable shall be laid out neatly on a smooth clean area of ground completely free of debris or anything likely to cause damage to the cable. In such cases, ‘figure-eights’ shall be avoided wherever possible, and care shall be taken to avoid subjecting the cable to twisting.

An adequate number of cable rollers, each of which shall be undamaged and completely free to rotate, shall be used to support the cable during pulling, in such a manner that no part of the cable can touch the ground, the trench bottom or sides, or the walls of buildings.

Cables shall not be dragged over concrete or other surfaces.

The number and positioning of rollers at bends in the route shall be such as to ensure that the minimum bending radius for the cable is not approached.

Cables shall, wherever possible, be pulled into position by hand, using an adequate number of operatives suitably positioned along the length of the cable.

Winches whether power driven or hand operated and other mechanical aids shall only be used with the prior authorisation of the ER.

Wherever possible, cables which are intended to be winched into position shall be fitted by the manufacturer with a suitable pulling eye, firmly attached to all of the conductors, before being dispatched to site.

Whenever a winch or similar appliance is used, an approved tension gauge shall be fitted into the haulage line between the winch and the cable. The pulling tension must at all times be within the limit advised by the cable manufacturer, which shall be communicated in writing to the ER before the operation is commenced.

Cable stockings, when used, shall be of an approved pattern and the correct size, with swivel eye, in perfect condition, and shall be fitted with care to avoid damage to the cable sheath.

When a cable stocking has been used on a XLPE or LSF sheathed cable and the sheath, after removal of the stocking, shows signs of having been stretched, the cable shall be left for 30 minutes to recover. At the end of this period, if the sheath has not completely returned to its original position, the cable end shall be cut back by an amount equal to the length of the stocking plus 300mm, then immediately resealed.

During the course of pulling operations, the cable shall not be allowed, under any circumstances, to twist or rotate about its longitudinal axis because of excessive pulling tension or for any other reason.

Whenever the length and arrangement of a cable run is such that excessive tension would be likely to be needed to nose-pull the cable into position, the continuous bond method shall be employed. A wire pulling bond equal in length to twice the cable length, to which the cable shall be securely attached at intervals not greater than 1.8 metres.

Whenever a cable is cut, for whatever reason, the cut ends of both portions shall be immediately re-sealed. LSF and XLPE cables shall be sealed by means of an approved plastic cap embracing the armour wires and outer sheath.

All cable drums shall be handled with care to ensure that they are not damaged. All handling shall be carried out using sufficient and adequate plant and equipment.

All empty cable drums shall be stacked neatly in such a manner as not to obstruct access to, or about, the site or the operations of other trades.

Empty cable drums shall be removed promptly from the site and, in any case, not more than seven days after the cable has been removed from them. At no time shall more than three empty drums be stored on the site unless the ER has agreed otherwise.

Any cable joints shall be enclosed in a permanent joint chamber with removable cover in accordance with the requirements for draw-in pits.

Any work carried out requiring the use of split ducts shall be carried out in such a manner as to permit future cable withdrawal.

In rising ducts open to access, all non-armoured cables shall be protected against mechanical damage by the installation of a 300mm high mild steel ‘kick-shield’ suitably fixed at floor level. The ‘kick-shield’ to be of a suitable robust nature and treated against corrosion.

Any fixings or supports that are to be installed within Heritage protected areas shall be agreed with the Heritage advisor prior to the installation.

Identification of Cables

Except in the case where it is terminated in full view on to a clearly 6-11abelled switch, starter, distribution board or similar piece of apparatus, or on to a motor or other item of equipment the function of which is evident, each and every cable end shall be provided with an approved means of identification. In particular, this requirement shall apply to all cables terminating on the back, or in the base, of a cubicle type or similar switchboard or control panel and in any case where the function of the cable is not immediately obvious.

The means of identification shall be one or other of the following, or an approved alternative:
An engraved plastic label securely fixed to the cable sealing box (the cable sealing box must not be drilled or damaged however).

A proprietary cable identification method with numbered/lettered ferrules on a label fixed to the cable.

A label; produced on a proprietary labelling machine, onto an LSOH fire retardant material.

Self-adhesive embossed plastic labels will not be accepted as permanent. The cores of all control cables shall be individually identified at terminations, by means of approved plastic ferrules bearing indelible characters, in accordance with the numbering on the relevant wiring diagrams.

All cables run above ground shall be identified by means of engraved or stamped plastic label at intervals not exceeding 30 metres. The labels shall bear details of the cable size, number of cores, function, and reference.

6.4.2.5 Auto-transfer switches (ATS)

Standards

- AS 60947: Low-voltage switchgear and control gear
- AS/NZS 3947: Low-voltage switchgear and control gear
- AS/NZS 3439: Low-voltage switchgear and control gear assemblies
- IEC 60947-6-1 Low-voltage switchgear and control gear construction
- AS/NZS3010: Generator Installation Standards

Generally

Mount ATS in separate compartment within switchboards and allow necessary ventilation in accordance with the ATS manufacturers requirements.

Manufacture

All ATS shall be of the same manufacture i.e. ASCO or equal approved

Function of the Auto- transfer switch

Each ATS will receive power from two energy sources. In normal operating mode, each transfer switch will supply power to the applications located downstream, starting with the selected source, which is treated as the preferred one.

ATS

All new ATS shall be Automatic Open Transition Transfer Switch type (break-before-make) 415V, 50Hz, 3 Pole (no switching of neutral conductor), complete with a Group 5 Microprocessor control panel.

Construction

ATS shall be housed in a painted, folded sheet steel enclosure(s), fitted with hinged door(s) for access to wiring and equipment. All steelwork shall be thoroughly degreased and treated with rust-proofing primer and undercoat prior to finishing with approved finish, semi-gloss acrylic lacquer or equal. Provide spare space within enclosure for 10% future relays.

Colour

Externally – As per the existing switchboard.
Internally – As per the existing switchboard.

Operation & Control

Automatic Transfer Sequence

- Operation: Break in supply when transferring from the preferred source to the alternative, and a break in supply when transferring from the alternative supply to the preferred supply.
- Operating sequence: Controlled by a either a touch screen or a four-position control selector switch with the following functions:-
- Automatic: Automatic source 1 and source 2 transfer with adjustable source preference option.
- Manual: All automatic control sequences disabled. Switches remain in current or selected position when switched to manual.
- Emergency/Test: Selected source failure simulation by interrupting one phase of selected source supply sensing relay (start signal to emergency generator will be initiated if interface is required) and forcing automatic transfer to alternative active source. After an adjustable time delay, the ATS will transfer back to the original source emergency when the supply is healthy.
- OFF: Both sources of supply isolated.
- Source preference: ATS to have the ability to select the preferred source as either supply path one or two.

Operational Logic

- Automatic sequence: Source 1 (the switchboards matching transformer number) as the active preferred source:
- Source 1 available and source 2 not available: source 1 supply is active.
- Source 1 available and source 2 supply becomes available: source 1 supply remains active.
- Source 1 becomes unavailable: source 1 switch remains active until source 2 is available.
- Source 2 is available and source 1 is unavailable: - Source 1 becomes inactive and source 2 supply path becomes active after a time delay, adjustable 0-5 min, set at 1 sec.
- Source 2 is available and source 1 becomes available: - source 2 becomes inactive and source 1 supply path becomes active after a time delay, adjustable 0-30 min, set at 5 minutes.

Manual Switch Operation

- Provision shall be incorporated for manual operation of both sources of supply with mechanical interlock inhibiting the paralleling of supplies.

- Incorporate clear labels and instruction plates on equipment to identify the manual control facility and operation.
- Provide Mechanical interlocking of control relay used to energise motor operations.
- Provide electrical interlocking between an alarm switch in the switch and closing circuit to prevent switch reclosing on to a fault.
- Bypass operation & configuration

Equipment

Equipment requirements including ratings shall be sized to the match the rating of the upstream MCCB as shown on electrical schematic drawings.

Type

Class PC: ATS that is capable of making and withstanding, but is not intended for breaking short-circuit currents.

Relays

Control relays subject to both supply authority and generation voltages shall be rated for 500 Volts rms to allow for out of sequence imposition of both supplies on contact assembly.

Poles

4 Pole with 100% rated neutral.

Rated Short Circuit Making Capacity

50 kA

Utilisation Category

AC-33A.

Nature of current	Utilization category		Typical applications
	Frequent operations	Infrequent operations	
Alternating current	AC-31A	AC-31B	Non-inductive or slightly inductive loads
	AC-33A	AC-33B	Motor loads or mixed loads including motors, resistive loads and up to 30 % incandescent lamp loads
	AC-35A	AC-35B	Electric discharge lamp loads
	AC-36A	AC-36B	Incandescent lamp loads
Direct current	DC-31A	DC-31B	Resistive loads
	DC-33A	DC-33B	Motor loads or mixed loads including motors
	DC-36A	DC-36B	Incandescent lamp load

Logic Panel

Provide separate compartment for control logic relays, etc.

Labelling

Fit engraved label adjacent control selector switch with clear information on the function of the ATS in each control position. The label shall also include instructions for manual operation of switches and resetting after trip operation where applicable.

Voltage Sensing Relays

- Control circuit shall incorporate voltage sensing (phase failure) relays for both supply paths to initiate automatic operation and where applicable, provide a signal to start emergency generator.
- Voltage sensing shall have adjustable settings for Undervoltage and Overvoltage up to 20% voltage fluctuation either way referencing 400V on both supply paths.

Source 1 Voltage Relay (NVR) – Supply A

Single-phase voltage and frequency sensing with adjustable pick-up and drop-out. Set drop-out for control sequence initiation at 70% and pick-up at 90% nominal mains voltage.

Souce 2 Voltage Relay (NVR) – Supply B

Single-phase voltage and frequency sensing with adjustable pick-up and drop-out. Set drop-out for control sequence initiation at 70% and pick-up at 90% nominal mains voltage.

Indication

- "Closed/Open" status of both switches shall be clearly indicated by visible flags or indicating lights.
- The transfer switch nameplate to be mounted on the front so that it is visible when the switchboard door is opened.

Remote Status

- Provide a set of C/O contacts, wired to a terminal strip for remote indication of switch status and active path via a hard-wired signal.
- Provide a Modbus communications module to allow all alarm and indication from ATS.

Control Circuit Fuses

- Provide HRC fuse links and fittings to protect control circuits.

Controls and Indicators

- Flush mount in door to logic compartment.

Busbars

- Switches shall be interconnected by busbars, rated for specified current rating and fault level. Provide labelled terminals or busbar flags for connection of circuits; preferred path "Transformer X supply", alternative path, “Transformer 8 supply”. Busbars and terminations shall be phase colour coded with neutral as black.
- Earth: Provide earth bar.
- Testing & Quality Assurance
- Testing: ATS to be factory tested ensuring proper operation of the individual components and correct overall sequence of operation to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with this specification.

Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.

The ATS manufacturer to be certified to ISO 9001: 2000 International Quality Standard.

6.4.2.6 Static Transfer Switches (STS)

Generally

STS shall comprise of a power semiconductor to transfer between loads. The STS shall be in a separate enclosure from the switchboard/DB of same form and IP rating and allow necessary ventilation in accordance with the STS manufacturers requirements.

The technical requirements are based on a STATYS series of SOCOMEC brand hardware, however the contractor shall also propose an equal or similar approved from other reputable manufacturers.

Note sizes and ratings shall be based on the upstream MCCB protective device, as shown in the electrical schematics.

Operating Principle

Two sources of energy will supply power to delicate items of hardware

Each source will be capable of being standalone and of being installed in separate places.
The energy from each source will be distributed separately up to the static transfer system.

Function of the Static transfer system

Each static transfer system will receive power from two energy sources.

In normal operating mode, each static transfer system will supply power to the applications located downstream, starting with the selected source, which is treated as the preferred one.

Choosing the preferred source

The choice of preferred source is made by the operator and can be altered by the operator at the front panel (control panel) on the transfer system, or remotely from a PC.

This operation can be performed without having to pass via the maintenance by-pass, without unplugging the electronic unit and without any modification to the wiring. This operation will never require the electronic module to be shut down, nor any prior intervention via the maintenance by-pass. If several static transfer systems are being used, the preferred source may be different for each module.

Principle of automatic transfer

The quality of voltage at the output end of the static transfer system is monitored continuously.
If the voltage from the preferred source fails (dips or disappears), an immediate and automatic transfer takes place to the auxiliary source, with no interruption to the power supply to any of the hardware.
When operating a system from its auxiliary source (following a manual transfer), and in the event of that auxiliary source failing, an automatic transfer will take place to the preferred source.

Security of transfer

The automatic or manual transfer is permitted whenever defined conditions for synchronous transfer are in place: sources within phase, voltage and frequency tolerance limits. The transfer is carried out without source overlapping.

To be able to function with non-synchronized sources, it must be possible to configure the transfer system.

For any asynchronous automatic transfer with sources that are out of phase, with or without authorization for manual mode (the lock-down of manual mode imposes a need to wait for synchronization of the sources before any transfer can take place)

For a 'flying' transfer (this operating mode is used whenever the source phases diverge). In which case the transfer will take place as soon as the sources return to within the defined tolerance limits.

Separation of forms of use

In the event of a downstream short circuit, the transfer module locks down its switching function. This prevents the fault from spreading to another source, and avoids any risk of reciprocal interference between forms of use, i.e. applications.

Transfer on surplus power

In the event of any prolonged period with surplus power in the system, it shall be possible to configure the hardware to lock down the transfer, or to perform a transfer on another track after making use of the surplus power capacity of the track in service.

After automatic switching to the auxiliary track, the system can be configured in different ways (i.e. there is a choice).

Either an automatic reboot on the preferred source as soon as it has returned to normal status (after a configurable timed delay).

Or an automatic reboot to the first source to return to within tolerance limits, followed by a possible return to the preferred source (after a configurable timed delay).

Or without an automatic reboot, in this case the return to preferred source will be performed by the operator.

Availability

The systems comprise internal failure-tolerant circuits with a signalling feature to indicate loss of redundancy.

- An electronic protection ensures the service continuity in the event of failure of the management system.
- Each track has a dedicated, standalone monitoring board for the control/management of each power supply.
- Power supply to the electronics is linked to each of the sources and redundant.
- The cooling systems are monitored continuously and redundant.
- The status of the power components on the active as well as the passive circuit is monitored continuously. Depending on the type of malfunction and the circuit affected, transfer is prohibited or is immediately enabled with no possibility of return.

To obtain a very high level of reliability, in addition to the redundancy features listed above, all hardware units shall incorporate the following items:

- The system includes a redundant micro-controller via two separated boards.
- The power supply of control/management interfaces is redundant on each control/management board of the power circuits
- Dual redundant electronic power supply

Maintenance

To facilitate maintenance:
The hardware is designed with a box that can be unplugged, which allows work to be carried out without shutting down the powered applications.

This plug-in box comprises all the functions - control electronics and power electronics.
The fixed frame does not comprise any components that could be affected by faults, e.g. relays, electronic switches, electromechanical contactors.

To assure continuity of power supply during maintenance periods, the system has an integrated double maintenance by-pass built into the fixed frame which enables the output to receive power directly from one of the two sources, which the operator is free to choose.

The system can be switched from 'normal' to 'maintenance by-pass' mode without interrupting any of the applications.

The power box cannot be unplugged unless the maintenance by-pass switch is in 'maintenance' position on one of the two sources.

Technical Requirements

The minimum characteristics that each automatic transfer module is required to have are listed below:

- Voltage with neutral:3-phase, 400 V
- Permitted variation in voltage at RMS input: ± 10 % (configurable)
- Tolerance in relation to temporary shorts at input: ± 25 % (configurable)
- Input frequency: 50 Hz
- Frequency range: ± 2 Hz (configurable from ± 0.5 to ± 5 Hz)
- Overload: 1 hour at 110%, 10 min at 125 %, 150% 2mins, 200% at 20seconds
- Permissible peak factor: up to 3.5

Grounding Connections

The system for grounding/earthing this installation shall be suitable for a MEN earthing configuration.

To assure compatibility with the neutral operation and the type of distribution for neutral, shall be:

3-phase, 3 wires arrangement without neutral,

LV Cable connection terminals for input and output of STS shall be suitable for at least up to 50mm^2 copper conductors.

The guards comply with the class defined in standard CEI 62310-3 :

Class CB – the 3-phase devices that protect against short circuits and overvoltages are to be integrated at the input end of 3-phase static transfer systems.

The STS is to be equipped in accordance with standard CEI 62310-1 by a sensor system that detects any return of electrical power to one of the sources. This enables the upstream circuit protector (not supplied) to open in the event of a return of electrical power.

An operational shutdown function can be enabled in response to external information (contact) or from the control panel (password-protected).

Controls

To make the system easier to operate, the front panel of every static transfer system must be equipped with a control panel.

The control and monitoring functions are performed by microcontroller.

A test mode enables the system to be checked for correct operation of the display panel and of the LEDs.

The control and monitoring panel provides access to system functions.

From the automatic transfer system using buttons.
Preferred source selection
Transfer on source 1 or 2

Screen display of statuses (minimum)

- Status of sources 1 and 2
- Synchronization status of sources
- Preferred source selection
- Output powered by source 1 or 2
- Transfer impossible.
- Operation on maintenance bypass 1 or 2
- General alarm (minimum)
- An event log records different items of historical information

Screen display of measurements, relating to both inputs and output:

- Voltage
- Frequency
- Phase shift of sources
- Utilization level (global and by terminal)
- Phase(s) and neutral currents
- Peak/crest factor
- Power factor
- Power kVA / kW

Configuration

- The main parameters can be configured by operators:
- Preferred source selection
- Automatic reboot and timed delay
- Automatic retransfer of timing function
- Password for controls
- Password for configuration
- Power detection parameters (adaptable to the quality of the sources)

Communication

The statuses, measurements, monitoring and control functions can be accessed remotely in different ways:

- Inverter contacts, zero-potential, for alarm and status reports
- Ethernet connection, network (LAN – WAN)
- Modbus TCP
- SNMP connection
- Automatic sending out of an e-mail whenever an alarm is triggered

- HTML web page (http)
- RS 485

Quality and Standards

The manufacturer must be certified to ISO 9001 version 2000.
The hardware must be compliant with applicable standards, especially in relation to

- IEC 62310-1
- EN 50022
- IEC 62310-3
- IEC 60364-4
- IEC 62310-2 (class C2)
- IEC 60529
- IEC 60950
- IEC 60439-1
- CE MARKING

Environmental

Degree of protection IP 31 (minimum) excluding third party enclosure
Forced ventilation as per the manufacturers requirements

Replacement Parts

The supplier must undertake to supply replacement parts for a minimum period of ten years from the date of delivery of the installation.

Warrantee

The hardware shall be guaranteed (parts and labor) on site for a period of one year following the date of delivery.

6.4.2.7 Air Circuit Breakers - Open Frame Type

Standard:

- AS 60947: Low-voltage switchgear and controlgear
- AS/NZS 3947: Low-voltage switchgear and controlgear
- AS 60269: Low-voltage fuses
- AS/NZS 3133: Air break switches

Type

Open construction, withdrawable, 3 pole.

Rated Thermal Current

Continuous current rating applicable to the unit when installed within the specified enclosure.

Rated Short Circuit Breaking Capacity

Not less than the switchboard fault level.

Protection System

Solid state protection relay with adjustable instantaneous and inverse time/current trip settings, earth fault protection, arc detection, with indication of trip unit operation.

Closing Operation

Trip-free, stored energy spring type closing mechanism.

Initiation: Pushbutton Remote controlled solenoid.

Spring Charging: Motor operated.

Opening Operation
In addition to other releases specified, provide a mechanical push-button release for opening.

Status
Contact position shall be clearly indicated by mechanically operated flags.

Auxiliary Contacts
Provide auxiliary control N/O and N/C contacts, rated operational current 20 A at 230 V 50 Hz. Provide not less than one spare normally open and one spare normally closed contact.

Mounting
Mount the circuit breaker on a withdrawable carriage with racking gear for positively fixing the unit into any one of three positions as follows:

- Connected;
- Test/Isolated;
- Disconnected.
- Housing: Mount each circuit breaker in separate, segregated compartment.
- Auxiliary contacts: Shall remain connected in the Test/Isolate position.
- Interlocking: Prevent the circuit breaker from being racked in or withdrawn unless it is in a tripped condition and ensure the circuit breaker cannot be closed unless located in either the 'connected' or 'test/isolate' position. Stored energy devices shall be automatically discharged by any racking operation.
- Shutters: Provide automatic shutters, with facility for padlocking, covering busbar and incoming/outgoing circuit connection.
- Earthing: Provide an earthing connection between the withdrawable carriage and the switchboard earth busbar which will make before and break after all other contacts on the circuit breaker carriage.
- Equipment: Supply racking handles with each switchboard.

Locking
Provide a facility to padlock the circuit breaker in the open position.

Key Interlocks
Facilities for Castell Key interlocks shall be incorporated. Provide where specified.

Door Interlocking
Unless the door serves only as a cover, provide a means of preventing a compartment door being open whilst the circuit breaker is in the closed position.

Abnormal Operations
Provide a means to prevent the following incorrect operation in service:

- Slow closing or opening of the contacts;
- Hand closure, if springs fail;
- Release of charged springs whilst the contacts are closed.

Maintenance Facility
Provide a means of slow closing the circuit breaker for inspection, and adjustment when disconnected. Supply a set of tools, necessary for installation, servicing, and removal for each switchboard.

6.4.2.8 Moulded Case Circuit Breakers

Standard:

- AS 60947.1
- AS 60947.2.
- AS 2184

Operation:
Independent manual operation including positive ON/OFF indicator.
Provision to allow breaker to be locked in the 'Off' position.

Mount circuit breakers so that the ON/OFF and current rating indications are clearly visible with covers or escutcheons in position. Align operating toggles of each circuit breaker in the same plane.

Utilisation category (to AS 60947.2):

Final sub-circuits category: Category A.

Mains and submains: Category B.

Trip settings:
Set as documented, seal, and label.

Trip units:
Adjustable thermal, fixed magnetic or electronic trip unit, current limiting and isolation facility.
Connect circuit breakers with interchangeable and integrally fused trip units so that trip units are not live when circuit breaker contacts are open.

6.4.2.9 Miniature circuit breakers

Standard:

- AS/NZS 60898.1
- AS 3111
- AS 60947.2

Utilisation category (to AS 60947.2):

Final subcircuits category: Category A.

Mains and submains: Category B.

Operation:
Independent manual operation including positive ON/OFF indicator.

Mounting:
Mount circuit breakers so that the ON/OFF and current rating indications are clearly visible with covers or escutcheons in position. Align operating toggles of each circuit breaker in the same plane.
Fixed thermal magnetic type, minimum 6kA rated. Ratings and details as per distribution board schedules.

6.4.2.10 Residual current Operated Circuit Breakers

Standard:
AS/NZS 3190.

Integral non-overload protection type: To AS/NZS 61008.1.

Integral overload protection type: To AS/NZS 61009.1.

Modular type: To AS 60947.2.

Mounting: Comply with Moulded case and miniature circuit breakers.

Install RCD protection to AS/NZS 3000 and with AS/NZS 3190

Type: A

Tripping ensured for:

Residual sinusoidal alternating current

Residual pulsating direct current

Maximum tripping current: 30 mA.

For domestic installations, install 30mA RCD protection at the distribution board for all final sub circuits to control socket outlets and lighting except for fixed or stationary cooking equipment, to AS/NZS 3000.

For installations in high risk areas (as defined in AS/NZS 3000), install 30mA RCDs at the distribution board for areas not covered in Domestic installations, or using fixed wired RCD protected socket outlets in areas that may represent increased risk of electric shock to the user:

- Wet areas: bathrooms, laundries, kitchens.
- Near pools and water features.
- Where intended for use with cleaning equipment.
- Hand-held tools subject to movement in use, i.e. work-shops, garages.

6.4.2.11 Circuit breaker integral protective relays

General: Provide integral protective relays which provide for tripping in the event of relay operation, and for manually resetting. Provide operation indicators with a set of change over voltage free alarm contacts, for connection to an alarm circuit.

Mounting: Integral type: Readily accessible for viewing and adjustment with doors and covers in position.

Mounting: External type: Flush.

Standard: AS 60947.6.2.

6.4.2.12 Current transformers (protection)

Standard:

- AS 60044.1

Requirements – as follows or to the relay manufacturer's requirements.

Type: Cast resin encapsulated window type with busbar clamping devices.

Class: 5P

Rated short time current: At least the short time current equivalent to the assembly fault level.

Rated short-time: At least the maximum time setting of the related protective relay. Minimum 1 s.

Rated primary current: Equal to assigned current rating of the associated functional unit.

Rated secondary current: 5A. Connect star point to earth.

Interposing transformers: Provide as recommended by the protective relay manufacturer.

Characteristics: Conform to the recommendations of the protective relay manufacturer.

Test links: Provide test terminals and current transformer secondary shorting links in accessible positions within instrument panels. Provide a set of DIN-type rail mounted test links, consisting of screw clamped slide links and earth links, for each current transformer group.

Installation: Install transformers to permit easy removal.

Removable links: Provide removable links of minimum lengths for transformers fitted on busbar systems.

Markings: Mount transformers in the assembly enclosure, so that polarity markings and nameplate details are readily viewed right side up without removing the transformers.

6.4.2.13 Current transformers (metering)

Standard

Measurement current transformers: To AS 60044.1

Provide test links for connection of calibration instruments and meters and for shorting of current transformer secondaries.

Energy meters, maximum demand meters, ammeters and protection relays: Provide with rail-mounted links consisting of screw-clamped slide links and an earth link.

Those for the network utility operator equipment to be supplied by the electricity retailer or metering company.

For energy and demand meters provide rail-mounted potential test studs or plug connections next to associated current transformer links. Provide at least one set of test studs for each compartment.

Accuracy classification:

Energy measurements: Class 0.5M.

Indicating instruments: Class 3.

Ratings

Rated short time current: At least the short time withstand current equivalent of the circuit in which the transformer is installed.

Rated primary current: At least equal to the current rating of the functional unit.

Secondary windings: Rated at 5 A, burden of 0.4 □ (10 VA) with star point earthed.

If practice, use cast resin encapsulated window-type with busbar clamping devices. Otherwise wound-primary type with mounting feet.

Installation

Install transformers to permit easy removal.

Provide removable links of minimum length for transformers fitted on busbar systems.

6.4.2.14 Surge Protection

Standards

Assemblies connected to the MEN earthing system: To AS/NZS 4070 Category II.

Assemblies not connected to the MEN earthing system: To AS/NZS 1768 (Int) Category C.

IEC 61643 class I surge protection devices fitted to main switch board, with visual indication of status of transient detection and one set of normally closed 'dry' contacts indicating occurrence of a surge transient and level of protection remaining.

IEC 61643 class II surge protection devices fitted to distribution boards not able to withstand transient overvoltages exceeding class 1 protection let-through residual levels.

IEC 61643 class III surge protection to switched socket outlets or sensitive detection equipment if required.

Surge protection for IT equipment

Supply and install a surge filter to IT equipment as detailed below:

Surge Filter Specification

Device Type Surge Filter
Nominal Operating Voltage Un 220 – 240Vac Ph - N @ 50/60Hz
Max Continuous Operating Voltage Uc 385Vrms, as per IEC 61643 requirements
Operating time < 1ns
Power distribution systems: TN-C-S (MEN)
Primary surge protection rating Ph-N 100kA 8/20µs single shot surge capacity
Secondary surge protection rating Ph-N 50kA 8/20µs single shot surge capacity
N – E protection100kA 10/350µs or 150kA 8/20µs
Protection Modes Transverse and common mode

Inductor Non-saturating, low pass, power and noise filtering
Capacitor type Self healing polypropylene
Surge counter 7 Digit electro-mechanical display

Current crest factor 3:1
Voltage drop < 2V at full load
Efficiency 99%
Overload / short circuit protection In-line circuit breaker
Performance: Typical let-through voltage < 600V
Filter 3dB point Approx 6000Hz.
Standards (Primary and secondary) IEC 61643-1, Meets UL1449 Ed 3 requirements
Standards (N - E): IEC 61643-1
Surge withstand: Cat. A,B and C surge tests ANSI/IEEE C62.41 and AS 1768
Protection status indication Status indication, and remote alarm contact
Enclosure Metal enclosure with durable polyester powder coat finish, Wall mounted
Operating temperatures 0 to +50°C, 0 – 95% humidity 1
Warranty: 5 Years manufacturer’s warranty

Primary protection

Provide shunt connected metal oxide varistors at assembly incoming supply terminals, on the line side of incoming functional units.

Surge Rating: Imax ≥ 150 kA per phase to neutral.

Surge Rating: Imax ≥ 100 kA neutral to earth if remote from the MEN earthing system.

Residual Voltage: Up < 800 V.

Visual Indicator: Provide visual indication of SPD status and life visible from the switchboard front panel.

Alarm contacts: Provide one set of normally closed ‘dry’ contacts indicating occurrence of a surge transient.

Enclosure and installation: House SPD in a metal enclosure and protected with a suitable rated circuit breaker or 63A HRC fuse.

Secondary protection

Provide metal oxide varistors or zener diode surge protection to assembly in-built equipment and to semi-conductor components which are not able to withstand transient overvoltages exceeding primary protection let-through residual levels. Provide shunt connected metal oxide varistor based SPDs between each phase and neutral and a gas discharge tube between neutral and earth at assembly incoming supply terminals, on the line side of incoming functional units and upstream of RCD devices.

Surge Rating: Imax ≥ 50 kA per phase to neutral.

Surge Rating: Imax ≥ 20 kA neutral to earth.

Residual Voltage: Up < 800 V.

Visual indicator: Provide visual indication of SPD status and life.

Alarm contacts: Provide one set of normally closed 'dry' contacts indicating status.

Enclosure and installation: House SPD in a metal enclosure and protected with a suitable rated circuit breaker or 32A HRC fuse. Connecting lead lengths should not exceed 300mm.

Combined primary and secondary protection

Provide series connected surge filter comprising metal oxide varistor based primary SPDs, a low pass LC filter and secondary metal oxide varistor based SPDs.

Surge Rating: Imax ≥ 150 kA per phase to neutral primary protection.

Surge Rating: Imax ≥ 100 kA neutral to earth if remote from the MEN earthing system.

Residual Voltage: Up < 600 V.

Visual indicator: Provide visual indication of SPD status and life.

Alarm contacts: Provide one set of normally closed 'dry' contacts indicating status.

Enclosure and installation: House SPD in a metal enclosure and protected with a suitable rated circuit breaker equal to or less than the load current rating of the SPD.

6.4.2.15 Instruments and meters

Provide digital power meter with amp, volts, power factor, kW, kVar, kVA and maximum demand per phase.

All meters to have pulsed output for connection to remote monitoring and/or BMS system as necessary.

Standards:

General purpose electronic induction watthour meters: To AS 62053.21.

General purpose induction watthour meters: To AS 1284.1.

Socket mounting system: To AS 1284.4.

Kilowatt hours meters to AS 1284.1.

Tariff meters used for collecting revenue to be Electricity Governance Rules (EGR) compliant and to IEC 61036.

Accuracy:

Indicating Instruments and accessories: ≤ Class 1.5.

Thermal maximum demand indicators: Class 3.

Electricity meters: Class 0.5.

Power factor meters, phase angle meters and synchroscopes: 2 electrical degrees maximum error.

Transducers: Class 0.5.

Mounting

Flush mount meters on hinged panels.

Labels

If associated exclusively with one phase, label meters RED, WHITE, or BLUE as applicable.

Protection devices

Meter potential protection devices: Group together behind associated meter cover or hinged door, preferably next to current transformer test links.

If necessary for transducer operation, provide auxiliary supply. Connect outputs to dedicated rail-mounted isolating type terminals.

Ammeters

Type: Digital instantaneous meter with maximum, minimum, average readings

Overscale: For ammeters subject to motor starting currents, overscale to at least 5 x full load current.

Selector switches: 4-position type with positions designated R/W/B/OFF. Mount under or beside relevant ammeters.

Maximum demand indicators

General: Provide a meter in each phase with 15 minute response time. Provide for sealing the reset mechanism. Provide a combination 3-point indicator consisting of an instantaneous red ammeter pointer, a red maximum demand slave pointer with external reset facility, and a white maximum demand pointer.

Instantaneous type: Combined type with bi-metal maximum demand ammeter element and moving iron instantaneous ammeter element.

Thermal type: Combined type with bi-metal maximum demand ammeter element.

Voltmeters

Type: Digital with instantaneous, maximum, minimum and average outputs

Selector switches: 7-position voltage transfer type for measurement of phase-to-phase and phase-to-neutral voltages with off. Mount under or next to relevant voltmeters.

Wattmeters and varmeters

General: Suitable for balanced 3 phase, 4 wire loads. Connect to measurement transducers.

Hours-run meters

General: 6 figure (minimum), horizontal linear digits dial with last digit read-out in 0.1 hour increments.

Watthour meters

Type: digital with pulsed output

3-phase metering: Polyphase meters suitable for balanced 3 phase, 4 wire loads.

Current rating: To suit load and overload conditions. Provide direct connect meters suitable for current range of 15 to 100 A and meters with current transformers suitable to 5 A secondary.

Register: Provide a direct reading register of the large figure type. Mark on the scale the metering transformer ratios and the multiplying factor applied to the meter constant.

Covers: Seal main covers.

Frequency meters

Digital type, Graduated in 0.1 Hz increments.

Synchroscopes

General: Continuously rated, rotating vane type movement, with spring loaded bearings and silicon fluid dampening, positive and negative arrows, black pointer and 12 o'clock marking.

Scales: 360□.

Phase angle meters

General: Provide for 3 phase, 4 wire balanced loads. Digital type meter.

Scales: 0.5 leading to 0.5 lagging.

6.4.2.16 Contactors

Standard:

- To AS 60947.4.1.

Type: Enclosed, block type, air break, electro-magnetic.

Poles: 3pole unless stated otherwise.

Full load current of the load controlled.

≥ 16 A.

Mechanical durability: 10 million cycles to AS 60947.4.1.

Electric durability:1 million operations at AC-22 to AS 60947.4.1.

Mount with sufficient clearance to allow full access for maintenance, removal and replacement of coils and contacts, without the need to disconnect wiring or remove other equipment.

Provide auxiliary contacts with at least one normally-open and one normally-closed separate contacts with rating of 6 A at 230 V a.c., utilisation category: AC-1.

If the number of auxiliary contacts exceeds the number which can be accommodated, provide separate slave relays.

6.4.2.17 Control devices and switching elements

Standards:

- AS 60947.1
- AS 60947.5.1.
- AS/NZS 3947.3

Switching elements:

- Electrical emergency stop device with mechanical latching function: To AS 60947.5.4.
- Electromechanical control circuit devices: To AS 60947.5.1.
- Proximity switches: To AS 60947.5.2.

Rotary switches

General: Cam operated type with switch positions arranged with displacement of 60º.

Off position: Locate at the 12 o'clock position. Test positions must spring return to off position.

Switches to have the facility to be locked in the 'Off' position.

Rated operational current: At least 6 A at 230 V a.c.

Escutcheon plates: Provide rectangular plates securely fixed to the assembly panel. Identify switch position and function.

Time switches

Provide readily accessible means of adjustment. Provide operational settings which are clearly visible when switch cover is fitted.

To incorporate the following features:

- 365 day operation.
- Mains failure operation: 100 hour minimum operating capacity.
- Contact rating: 16 A at 230 V a.c.
- Dial: Digital with day, hour and minute display.
- Quartz crystal time base
- Day omitting device
- 24 hours minimum battery operated reserve
- Manual on/auto/off over-riding switch
- ± 1 hour capability for summer/winter time change, switch operated
- Automatic adjustments for daylight saving

Control relays

- Standards: To AS 60947.5.1.

Solid state electronic type time delay relays, continuously rated at 10 amps to AS 60947.5.1, with silver contacts, surge suppression on coils and have 1 spare set of normally open and normally closed contacts.

Suitable for continuous operation. Provide relays selected in conformance with the Control relay selection table.

Construction: Plug-in types. Receptacle bases with captive clips which can be operated without using tools.

Contact elements: Electrically separate, double break with silver alloy, non-welding contacts.

Configuration: For standard relays, provide assemblies with 2 sets of contacts and expandable to 8 sets of contacts in the same assembly. Provide at least one normally-open and one normally-closed contact.

On site conversion: Provide contact blocks readily convertible to either normally-open or normally-closed contacts.

Control relay selection table

Relay type	Minimum mechanical life (million operations)	Base	Minimum contact rating	Inter-changeable	Minimum number of contact elements
1	5	Plug-in	1.25IL	Yes	2
2	10	Plug-in	5 A at 240 V	Yes	2
3	10	Fixed mounting	5 A at 240 V	Yes	4

Time delay relays

Adjustable range: Adjustable over the full timing range with timing repeatability within □ 12.5% of nominal setting.

Electronic relays: Incorporate light emitting diodes indicating energisation states of relays.

Pneumatic relays: Provide sealed chamber type with internal circulating air with linear calibrated time adjustment.

Synchronous relays

Provide synchronous motor drive type relay fitted with anti-stalling device which protects gearing during normal operation.

Phase failure relays

Provide separate solid-state phase failure relays which release at the following:

- < 85% of normal voltage.
- Single phase failure.
- Reverse phase sequence after an appropriate time delay.
- Sensing circuit: To reject induced voltage spikes and disturbances with frequencies other than 50 Hz.
- Back-up protection: Provide high rupturing capacity fuses to each phase.

Plug in relays

Continuously rated at 10 amps, with silver contacts non welding and surge suppression on coils with 11 pin circular contact configuration and LED indication of coil activation. Use spring clip retainers when mounted in a horizontal plane. Include adjustable time delay if required.

Push-buttons

Type: Oil-tight, minimum 22 mm diameter, or 22 x 22 mm.

Rated operational current: At least 4 A at 240 V a.c.

Emergency stop devices with mechanical latching: To AS/NZS 3947.5.5.

Marking: Identify functions of each push-button. For latched STOP or EMERGENCY STOP push-buttons, provide label with instructions for releasing latches.

6.4.2.18 Semiconductor controllers and contactors

Provide semiconductor controllers and contactors rated for the characteristics of the controlled load.

Standard: To AS/NZS 3947.4.3.

6.4.2.19 Controller device interfaces

Provide interfaces between equipment and control systems including the following:

- Programmable logic controllers.
- Metering systems.
- Building management systems.

Standards:

- AS 62026.1
- AS/NZS 62026.2
- AS/NZS 62026.3
- AS/NZS 62026.5

Actuator sensor interface: To AS/NZS 62026.2. Provide control system components with an actuator sensor interface. The actuator sensor interface may be integrated into field devices, or be used in separate modules.

Devicenet: Provide control system components with a devicenet connection based controller-device interface, suitable for use on a Controller Area Network to AS/NZS 62026.3.

Smart distributed system (SDS): Provide control system components with a SDS controller-device interface, suitable for use on a Controller Area Network to AS/NZS 62026.5.

Seriplex: Provide a Seriplex interface and communications system between single or multiple controllers and control circuit devices or switching elements.

6.4.2.20 Indicator lights

Standard:

- AS 60947.5.1.

Panel mounted indicators: LED; minimum 22 mm diameter or 22 x 22 mm. Lamps shall be changeable from front of panel without removing the holder.

Neon indicators: 240 V, 12 mm diameter with in-built resistor.

LED indicators: 12 or 24 V as necessary, in corrosion-resistant bezel, nominal 5 mm diameter.

Press-to-test:

Compartments/subsections with < 5 indicating lights: Provide each indicating light with a fitted integral press-to-test lamp actuator.

Compartments/subsections with □ 5 indicating lights: Provide a common press-to-test lamp push-button.

6.4.2.21 Indicating counters

Provide the following:

At least 6 digits.

Digits at least 3.5 mm high.

Continuous duty rated.

Non-reset type.

500 V surge diverters.

6.4.2.22 Alarm annunciators

- Provide the following:
- Labelled annunciator illuminated windows, to indicate status and alarm conditions.
- Lamp test acknowledge-mute and reset individual push-buttons.
- Audible alarm and associated logic circuitry.

Mode of operation, provide the following functions:

- Fault conditions: To initiate flashing of appropriate annunciator lamps and sounding of audible alarms.
- Operation of acknowledge and mute buttons: To silence audible alarms and change annunciator lamps to the steady state on condition.
- Window: To extinguish only when fault condition has been cleared and alarm reset push-button has been activated.
- Subsequent alarms on other inputs: To reactivate the audible alarm and flash the appropriate annunciator lamp.
- Resetting: After correction of the fault condition, provide on-site choice of either automatic resetting or manual resetting at the annunciator panel.
- Type: Extra-low voltage, solid state, flush mounted, window type.

Lamps:

Provide annunciators with 2 extra-low voltage lamps per window.

Rated voltage of lamps105% of the annunciator system voltage.

Replacing: Changeable from front of panel without affecting condition of annunciator.

Vibration: Provide lamps which do not disconnect due to vibration.

Provide an extra-low voltage power supply for the alarm annunciator.

Background colours: White for status monitoring, red for alarms and shutdown functions.

6.4.2.23 Extra-low voltage transformers

General: Provide the following:

- Centre tap on secondary winding.
- Primary and secondary windings wired out on opposite sides of transformer case.
- Primary and secondary windings separated by means of an earthed screen wired out to an insulated terminal.
- Transformer rating ≥ 125% of maximum output load, taking account of degree of ventilation and ambient temperature within assembly, and supplied load.
- Finish: To match assembly.

6.4.2.24 Door mounted Equipment

Protect or shroud door mounted equipment and terminals to prevent inadvertent contact with live terminals, wiring, or both.

Maintain earth continuity to door mounted indicating or control equipment with multi-stranded, flexible earth wire, bonded to the door.

6.4.2.25 Marking and labelling

Provide and install labels including control and circuit equipment ratings, functional units, notices for operational and maintenance personnel, incoming and outgoing circuit rating, sizes and origin of supply and kW ratings of motor starters.

Provide and install a printed label under each controller, switch and circuit breaker on distribution boards. List the rating of each circuit. Clearly define functions on labels.

Label isolating switches and outlets to identify circuit origin.

Designation labels: For other than main assemblies, provide designation label stating source of electrical supply. Identify separate sections of enclosures.

Assembly controls: Label controls and fault current limiters, including the following:

- Circuit designation for main switches, main controls and submains controls.
- Details of consumers mains and submains.
- Incoming busbar or cable rating to first tee-off.
- Fuse link size.
- Labels on assembly interiors: Provide labels for equipment within assemblies. Locate so that it is clear which equipment is referred to, and so that lettering is not obscured by equipment or wiring.
- Moulded case circuit breakers: If circuit breaker manufacturer's markings are obscured by operating handle mechanisms or motor operators, provide additional markings open to view on, or next to, the circuit breaker.
- Arrestors: Label each group of primary arrestors, stating their purpose and the necessary characteristics.
- Busbars: If polymer membrane coating is used without further insulation, provide warning notices on the front cover near the main switch or local main switch and on rear covers, indicating that busbars are not insulated.
- Fault current limiters: In assembly sections containing fault current limiter fuses provide caution notices fixed next to the fault current limiters, stating that replacement fuse links are to match the installed fuse link ratings, make and characteristics. Provide separate label stating make and fault current limiting fuse ratings.
- Externally controlled equipment: To prevent accidental contact with live parts, provide warning notices for equipment on assemblies not isolated by main switch or local main switch.
- Stand-by power: Provide warning notices stating that assemblies may be energised from the stand-by supply at any time.
- Anti-condensation heaters: To prevent accidental switching off, provide caution notices for anti-condensation heaters.

- Insulation and shrouding: For insulation or shrouding requiring removal during normal assembly maintenance, provide danger notices with appropriate wording for replacement of insulation shrouding before re-energising assemblies.
- Positioning: Locate notices so that they can be readily seen, next to or, if impracticable, on busbar chamber covers of functional units and behind the front cover of functional units. Provide circuit identification labels in the cabling chamber of each functional unit, located next to external terminations.

6.4.3 Tripping Battery

6.4.3.1 Requirement

Provide a dc. supply for main switchboard circuit breaker tripping from a battery, charged by a constant voltage type battery charger suitable for connection to a 240 V 50 Hz supply, and designed for fully automatic operation.

6.4.3.2 Performance

The system shall be capable of ten consecutive circuit breaker trip operations, each of 0.5 second duration, at 1.0 second intervals, with a minimum discharge current of 4 A. The battery shall be capable of meeting this performance when in a 50% discharge condition and whilst maintaining a minimum terminal voltage of 80% of the rated voltage at the completion of the ten operations.

6.4.3.3 Battery Charger

Circuitry: Solid state, incorporating a smoothing network to give an output wave form with maximum 5% ripple voltage. Provide automatic boost and float charge functions with current limiting adequate to ensure maximum battery life and rated performance. Provide facilities for manual boost and test.

Settings: Float and boost voltages and current limit shall be adjustable within cabinet.

Transients: The maximum design transient shall not exceed 70% of the component manufacturer's peak inverse ratings.

Instruments and controls: Conveniently group instruments, controls and indicators for ease of operation.

AC input protection: Moulded case circuit breakers. Unless otherwise specified, the outgoing tripping supply shall not be protected.

6.4.3.4 Trip Circuit Supervision

Provide trip circuit supervision relay to monitor tripping supply voltage and continuity of trip relay circuit. If a fault is detected the supervision relay shall immediately trip the circuit breaker or system to an inherently safe mode and raise an alarm.

Provide common alarm output to the EMS, refer EMS section and points list.

6.4.3.5 Location

The following tripping batteries shall be provided.

Tripping Battery A – feeding Main Switchboard ‘A’

Tripping Battery B – feeding Main Switchboard ‘B’

Circuits

Each tripping battery shall have suitable circuits to power each Main switchboard.

6.5 LIGHTING

6.5.1 Project requirements

Provide lighting to the development as documented herein and as scheduled and shown on drawings.

This section relates to the supply, fixing and testing of all light fittings and lamps as shown on the drawings, or otherwise specified or scheduled.

Provide new, undamaged luminaires complying with the relevant Standards, Codes and Regulations. Ensure work is electrically safe and installed to NZBC G9/VM1, AS/NZS 3000 and relevant Electrical Codes of Practice.

The requirements of this specification for lamps, ballasts and luminaire control equipment over-ride the specifications inherent in the selection of a particular make and model of luminaire.

6.5.2 Related Sections

Conform to the following work-sections:

- General requirements.
- Low voltage power systems.
- Scope and associated sections

6.5.3 Standards

The following standards shall apply to the supply, installation, testing and commissioning of the lighting installation:

- Air-handling luminaires: To AS/NZS 60598.2.19.
- EMC compliance: To AS/NZS CISPR 15.
- Energy efficiency for ballasts and lamps: To AS/NZS 4783.2.
- Fixed general purpose luminaires: To AS/NZS 60598.2.1.
- Floodlights: To AS/NZS 60598.2.5.
- Harmonic limits: AS/NZS 61000.3.2.
- Luminaires, general requirements and tests: To AS/NZS 60598.1.
- Luminaires: To AS/NZS 60598.1.
- Luminaires for swimming pools: To AS/NZS 60598.2.18.
- Luminaires for use in clinical areas of hospitals and health care buildings: To AS/NZS 60598.2.25.
- Luminaires with built-in transformers for filament lamps: To AS/NZS 60598.2.6.
- Portable general purpose luminaires: To AS/NZS 60598.2.4.
- Recessed luminaires: To AS/NZS 60598.2.2.

- Road lighting luminaires: To AS/NZS 1158.6.
- Radio interference limits: To AS/NZS CISPR 15.
- Minimum energy performance standards (MEPS):
- To AS/NZS 4783.2

6.5.4 Energy Efficiency

The lighting installation shall be designed to comply with the energy efficiency requirements as described in NZS 4243: Part 2:2007. Luminaires shall be selected to meet the minimum power density limits set out in the standard. Lighting power density limits specified for luminaires shall include the total power (Watts) for the installed system, including all losses.

6.5.5 Interpretations

Abbreviations

For the purposes of this work-section the abbreviations given below apply.

- CCT: Correlated colour temperature.
- CRI: Colour rendering index.
- DALI: Digital addressable lighting interface.
- EEI: Energy efficiency index.
- ELV: Extra low voltage.
- ILCOS: International lamp coding system.
- PLC: Programmable logic controllers.
- SBC: Small bayonet cap.
- SES: Small Edison screw.

6.5.6 Definitions

For the purposes of this worksection the definitions given below apply.

- Control system: A lighting control system comprising a combination of some or all of the following:
- Automatic sensing and control components.
- Timers.
- Manual overrides.
- Programming using a computer interface.
- Proprietary luminaires: Luminaires available as a catalogue item.
- Custom-built luminaires: Luminaires manufactured to order.

6.5.7 Submissions

6.5.7.1 Technical data

Submit technical data for each of the following:

- Luminaires
- Lamps
- Ballasts
- Power factor correction equipment
- Lighting control systems.
- All accessories.

6.5.7.2 Shop drawings

Refer to the general requirements section for the requirements for submission, review and provision of final shop drawings.

Supply drawings required for co-ordination of the work. Confirm overall dimensions. Design to fit the available space with clearances required by the relevant standards and guidance.

Include details of control panel construction, description of materials and finishes, general arrangement of equipment and method of support, wiring diagrams and schematics of control circuits including interfaces, size and wording of labels, manufacturer's name and catalogue number of standard equipment.

6.5.7.3 Samples

Submit samples of all luminaires and accessories. Only those samples that have been approved in writing may be used.

6.5.8 Proprietary luminaires

Provide proprietary luminaires complete with lamps, luminaire control equipment, lighting control equipment, diffusers, and accessories as documented.

All luminaries shall conform to the following requirements (unless stated otherwise):

- Electronic control gear to MEPS (AS/NZS 4783.1 and AS/NZS 4782.2) requirements
- One ballast per lamp
- 0.95 or greater lagging power factor, capacitors to AS 61048 and AS 61049
- No light leaks
- Low harmonics to AS/NZS 61000.3.2
- Low glare
- Compliance with AS/NZS 60598
- Sound thermal and acoustic design.
- All luminaries shall be supplied complete with all mounting and housing equipment.

- The electrical Contractor shall be responsible for providing all required fittings and accessories required for fixing all luminaires to the building fabric.
- All luminaires shall be provided with proprietary lamp holders for the lamp type specified.
- All luminaires shall be selected such that noise and vibration is not noticeable.

6.5.9 Fluorescent Luminaires

Conform to the following standards:

6.5.9.1 Fittings:

- AS/NZS 60598.1
- AS/NZS CISPR 15,
- AS/NZS 4251.1,
- AS/NZS 61000.6.1,
- AS/NZS 60155,
- AS/NZS 60901
- AS/NZS 60598,

6.5.9.2 Ballasts:

- AS/NZS 60929
- AS/NZS 61347.2.8
- AS/NZS 61347.2.3
- AS/NZS 60921,
- An Energy Efficiency Index (EEI) to Minimum Energy Performance Standards (MEPS) set out in AS/NZS 4783.2:
- B1 for ferromagnetic
- A2 for electronic
- A1 for dimmable electronic

6.5.9.3 Capacitors:

- AS 3168, or
- AS 2644 as appropriate.

Lamps: T8 (26mm dia) or T5 (16mm dia) triphosphor type complying with IEC 60081 publication of a rated life of 7,500 hours minimum.

- Starters to AS/NZS 60155.

6.5.9.4 Control gear to:

- AS/NZS 61347.2.3

- AS/NZS 60929.

Fluorescent lamps of length 550mm or greater to AS/NZS 4782.2. Lamp efficacy to meet the requirements of Class R.

6.5.10 Discharge Luminaires

Conform to the following standards:

6.5.10.1 Fittings:

- AS/NZS 60598.1
- AS/NZS CISPR 15
- AS/NZS 4251.1
- AS/NZS 61000.6.1
- AS/NZS 60598

6.5.10.2 Discharge lamps:

- IEC 60188
- IEC 60192
- IEC 60662
- IEC 61167
- AS/NZS 60968
- AS/NZS 60969

6.5.10.3 Control gear:

- AS/NZS 61347
- AS/NZS 60923

6.5.11 Lamps

6.5.11.1 Standards

All lamps used shall conform to the following standards:

Fluorescent

- AS 4782.1
- AS 4782.2.

High pressure mercury vapour: To IEC 60188.

High pressure sodium vapour: To IEC 60662.

Incandescent: To AS 2325.

Low pressure sodium vapour: To IEC 60192.

Self ballasted lamps: To AS/NZS 60968 and AS/NZS 60969.

Single capped fluorescent lamps: To AS/NZS 60901.

Tungsten halogen: To IEC 60357.

6.5.11.2 Fluorescent lamps

All fluorescent lamps shall conform to the following requirements:

- Cathodes: Low resistance.
- Bi-pin caps: Standard.
- Lamps, conventional: 26 mm, colour corrected temperature 4000 K.
- Lamps, low energy: 16 mm, colour corrected temperature 4000 K.
- Colour rendering index: At least Ra 84.

6.5.11.3 Incandescent lamps

Type: Tungsten filament for general lighting service, rated 250 V.

Bulb finish: Internally frosted.

Lamp cap type table

Lamp rating	Cap type
100 W	Bayonet (B22), medium Edison screw (E27), small Edison screw (E14), or small bayonet
> 100, 200 W	Medium Edison screw (E27) or bayonet (B22)
> 200 W	Goliath Edison screw (E40/45)

6.5.11.4 Light Emitting Diodes:

General

Refer to the luminaire schedule for LED lighting types.

LED Packages

LED packages used in LED systems on this project must comply with the following criteria:

- All white LEDs must use Transparent Substrate or Sapphire Substrate
- White LEDs shall have a colour temperature that lies within the range of 4500K and 6500K. LEDs operating outside this colour range will not be accepted. White LEDs fitted shall have a colour temperature range not exceeding +/- 500K of the nominal colour temperature. (e.g. 6000K +/- 500K)
- The LED system manufacturer must be able to provide evidence that the LED packages used in their system do not infringe on any patents relating to the respective LED technology.

LED System Efficiency

- White LED systems must produce a minimum of 20 lumens per watt including LED driver losses.
- High Output cable based White LED systems must produce a minimum of 21 lumens per watt including LED driver losses.

LED System Electrical Performance

- Apart from the initial connection of the LED driver to the LED string, there shall be no other system critical connections in the LED string such that if they were to fail would cause all LEDs beyond that point of failure to stop illuminating. Plugs and Sockets and or soldered wire connections between circuit boards will not be accepted.
- LED systems must be provided with a proprietary LED driver designed specifically for use with the proposed LED system.
- LED Drivers must comply with C-Tick Certification.
- LED drivers must have inbuilt short circuit and overload protection re-settable by cycling the input power off then back on. Fuse protection will not be accepted.
- The LED system shall be designed and configured to ensure that at no time will the LED packages be driven at or above their maximum rated current.
- The LED driver must operate the LEDs using true DC current.

LED Surface Brightness

The surface brightness shall not be less than 300cd/m2. The manufacturer shall ensure that sufficient LEDs meeting the requirements above are provided together with efficient design to meet this requirement.

LED System Mechanical Performance

- The LED system must have an integrated heat sinking system
- The LED system including the LED Driver shall have an operating ambient temperature range from minus 25C up to +60C.
- The LED system shall be clearly labelled to indicate LED Bin Codes for brightness and colour.
- The LED system MUST be clearly labelled with the manufacturing date code to enable warranty claims to be assessed if the need arises.

LED lifetime.

LED lifetimes specified below are based on LED system performance not just LED package performance. LED system manufacturers must be able to provide evidence of system lifecycle testing to substantiate any LED lifetime claims.

- White LEDs must have a minimum rated life of 35,000 hours based on 70% lumen maintenance.
- High Output White LEDs must have a minimum rated life of 50,000 hours based on 70% lumen maintenance

LED System Warranties

All LED system warranties shall be based on the assumption that the LEDs will be operating continuously i.e 24 x 7. The LED System manufacturer must provide a written warranty statement that includes confirmation that the warranty period covers continuous LED operation for the duration of the stated warranty period.

- White LED systems must have a minimum warranty period of 4 years.
- LED Drivers, transformers and Power Supplies must have a minimum warranty period of 5 years
- Upon request the LED system supplier shall supply the manufacturer warranty statement that summarises and qualifies all of the warranty conditions.

6.5.12 Ballasts

Provide ballasts for lighting systems selected to be compatible with the lamp and control method.

Provide Tridonic Atco one-4-all electronic ballasts for all fluorescent luminaires.

Standard: To AS/NZS 61558.1

Conform to the following requirements:

- Current total harmonic distortion: < 15%.
- Number of ballasts: Provide separate ballasts for each lamp.
- Reactive fluorescent lamp ballasts, to:
- AS/NZS 60921
- AS/NZS 61347.2.8.
- Ballast performance measurement – fluorescent lamps
- To AS/NZS 4783.1.
- Provide quick-connect terminals or wiring, suitable for the operating temperature close to the ballast.
- Discharge lamp ballasts
- High-pressure mercury vapour, low-pressure sodium vapour, high-pressure sodium vapour and metal halide type, to:
- AS/NZS 61347
- AS/NZS 60923
- Metal halide type:
- 150 W: Reactors or electronic controlgear.
- > 150 W indoor: To the lamp manufacturer's recommendation.
- > 150 W outdoor: To the lamp manufacturer's recommendation.
- Ignitors: Provide ignitors which cut out when lamp ignites.

6.5.13 Power factor correction

Provide power factor correction on all luminaires to a minimum power factor of 0.95 lagging.

Capacitors shall be manufactured and installed to:

- AS 61048
- AS 61049.

6.5.14 Integral fuses

Provide integral fuses for high intensity discharge (HID) lamp ballasts with suitably rated fuse links to AS/NZS 60598.1 complete with carrier and base and spare fuse.

6.5.15 Wiring

Flexible cords

Provide recessed luminaires with an external 1.5 m length of 0.75 mm2 3-core V75 (minimum) PVC/PVC flexible cord, connected to a 10 A 3-pin moulded plug to AS/NZS 3112.

Other fittings flexible cord cross sectional area: 1 mm2.

6.5.16 Accessories

All lighting accessories shall be from the same manufacturer and of the same range to match all small power accessories used in that area.

6.5.17 Lighting outlets

Pin arrangement: Standard: 3 flat pin with looping terminal.

6.5.18 Lighting switches

Provide light switches as documented. 16 amp 230 volt mechanism to AS/NZS 3133, mounted under a moulded polycarbonate flush plate ganged under a common plate for multiple switches on the same circuit and by separate plates for multiple switches on separate circuits. To AS/NZS 3000 for damp or exterior situations.

6.5.19 Switch Panels

To accommodate switches to separate circuits and phases and flush mounted within a metal wall box with selected colour powder coated or stainless steel flush plate 2.5mm thick. Switches individually secured within a mounting plate behind the flush plate. Provide internal barriers between phases. Engrave the flush plate to indicate the use of each switch. Permanently label circuit numbers on back of plate.

6.5.20 Key switches

Proved key switches as documented.

Run-on timer switches

Proved run-on timer switches as documented.

Delay: Adjustable to 20 minutes.

6.5.21 Dimmer switches

Mounted with adequate ventilation suitable for remote control and incandescent loads as required and incorporating solid state controls. Provide voltage control to incandescent loads with adjustable lower limits of the output voltage.

Dimmers controlling electronic transformers to be leading or trailing edge type as required to suit the type of load.

Remote control station to include switches to control power supply, potentiometers to control voltages from the respective dimmers, flush mounted behind a common flush plate.

Standard: To AS/NZS 60947.5.2.

6.5.22 Daylight switches

Provide integral photo electric switch units as documented. Weatherproof plug-in sensor head and receptacle base type suitable for switching the controlled lighting systems at an adjustable

illuminance. Incorporate a time delay to prevent operation during transient lighting conditions, and shield to avoid other artificial lighting sources operation.

Performance:
Adjustable between 50 and 1000 lux.
Time delay: > 2 minutes.
Illumination differential: > 50 lux.

6.5.23 Motion detector switches

Provide HPM Legrand PIR and dual technology wall switches/motion sensors as described in the scope sections of this document.

Provide movement detectors which cover designated areas as documented.

Combined passive infrared and ultrasonic type, 90-360 degree range with selectable timer on or off to IEC 60669.2.1.

Standard: To AS 2201.3.
Type:
Passive infra-red/ultrasonic dual technology for general open areas.
Microwave for long-range (>10m) detection.

6.5.24 Manual time delay switches

Proved manual time delay relay switches as documented.

Type: Pneumatic.

Duration: Adjustable between 5 minutes and 15 minutes.

Provide Indicator light, activated when artificial illumination is ‘off’.

Photo-electric switches

Provide integral photo electric switch units as documented.

6.5.25 Movement detector switches

Provide movement detectors which cover designated areas as documented.

Standard: To AS 2201.3.

6.5.26 Ceiling Roses

White plastic mounting base with screwed cover, manufactured to AS/NZS 3113. Terminal type. Cylindrical section TPS for suspended fittings.

6.5.27 Installation

Install to the luminaire manufacturer's requirements in correct orientation for light output, complete with lamps, also suitable for location and application. Apply seismic restraint measures to NZS 4219 and fix through linings to structure or framing. Provide additional nogs, trim and packing if required. Use protective gloves when handling reflectors or lamps.

Locations shown on the drawings are the actual location, but subject to verification for final height and position. Allow for up to 2 metres of movement at first fix.

6.5.27.1 Supports

Install luminaires on proprietary supports by means of battens, trims, noggings, roses and packing material.

6.5.27.2 Cabling

Run cabling concealed, using conduit, chases and penetrations located as provided previously and to AS 2293.1 and the Electricity (Safety) Regulations 2010.

6.5.27.3 Recessed Luminaires

Recessed luminaires installed in trimmed opening to NZ ECP 54. Clearances from insulation and building elements to NZ ECP 54.

6.5.27.4 Surface mounted luminaires

Fit packing pieces to level luminaires and prevent distortion of luminaire bodies. Provide packing strips to align end to end luminaires.

Fixing: Provide 2 fixings at each end of fluorescent luminaires. A single fixing at each end in conjunction with 1.6 mm backing plates may be used for narrow luminaires.

6.5.27.5 Exterior Luminaires

Seal to maintain IP rating suitable for location and application. Seal all building fabric penetrations to maintain weather tightness.

6.5.27.6 Suspended Luminaires

Supports:

Rigid tube/rod as per the lighting suppliers proprietary system

Levelling: Adjust the suspension system length so that the lighting system is level and even.

Horizontal tolerance: □ 3 mm between luminaires within the one space.Light fittings in a suspended grid ceiling must be fixed to the grid, fittings over 10kg must be supported from the structure.

No chains or wires permitted for suspension of light fittings.

Connect luminaires to a plug socket outlet.

6.5.27.7 Extra Low Voltage Lighting

Use electronic transformers for ELV lamps, one transformer per lamp. Locate to manufacturer's requirements and as close as practicable to the lamp. Ensure transformers and rear of light fittings are adequately ventilated and clear of any thermal insulation, to NZECP 54.

6.5.27.8 Final Connection

Take fixed wiring directly into fitting terminals, use heat resistant sleeves where subject to excessive heating. Where specified in public areas and BoH areas connect luminaires to a plug/socket arrangement, if IP rated use flexible cord glanded into fitting to maintain IP rating.

6.5.27.9 Recessed luminaires

Connect recessed luminaires to a plug socket outlet.

6.5.27.10 Lighting tracks

Locate associated low voltage transformers within 600 mm of the track.

6.5.28 Completion

Verify the operation of all luminaires. Replace lamps which have been in service for a period greater than 50% of the lamp life as published by the lamp manufacturer.Replace damaged, cracked or marked elements.

Leave units and fittings clean and in full working order. Leave work to the standard required by following procedures. Ensure work is operating correctly, with equipment clean, luminaires and control systems operational as specified.

6.5.29 Schedules

Luminaire schedule

Refer to the Luminaire schedule associated with this specification for details of all luminaires.

6.5.30 Lighting Controls

6.5.31 General

Provide a lighting control system as detail below including all equipment, testing and commissioning for a complete and functioning system including the following,

6.5.32 Shop drawing submission

- Tech Data submission
- Graphic display submissions including touch screens, themes, layouts, buttons etc,
- After hours testing and commissioning
- After hours site inspection by Auckland Transport
- Training
- Interfacing with other systems, EMS, security, emergency lighting, etc.

6.5.33 Functional description

6.5.33.1 Clipsal Dalicontrol lighting control system performance and technical requirements:

The lighting controls scope of work is based upon maximum flexibility and maximum control. It provides a digital lighting system that can typically be reconfigured without the need to re-wire, while providing control and status down to the individual ballast.

The lighting control system shall be a DALI (Digital Addressable Lighting Interface) system with DALI controlled fixtures and DALI controllers throughout the interior space. The lighting controllers, ballasts, transformers, drivers, and other electronic control gears and devices shall fully comply with the DALI standard (IEC 62386) enabling devices from multiple manufacturers to be used in the system.

DALI Lines shall be linked on an Ethernet network utilising DALICONTROL din-rail mount BM-DALI Line Controllers from Clipsal to provide computer control, configuration and analysis as well as occupant control from computers in their workstations and offices.

The lighting system must provide manual control, scheduled occupancy control, automatic occupancy control and daylight harvesting to dim down the electric lighting in response to daylight admittance.

The lighting controls shall utilize time schedules, occupancy sensors, light sensors and switches to control the lighting in the interior spaces on each floor. The overall intent is to provide electric light only when the space is occupied and to provide as little electric light as is necessary to achieve the required light level for the work plane.

The Line Controllers are to automatically monitor the status of all ballasts on the DALI Lines and to provide the tools to identify and replace ballast and lamp failures. Line controllers shall be din-rail mount type.

The successful tenderer is to engage a qualified Clipsal Platinum Integrator trained in DALI and the DALICONTROL lighting system, to program and commission the system. Allow for all costs associated with this engagement in the Tender submission. Provide a commissioning program.

6.5.33.2 System Description

The DALI lighting control system shall consist of multiple DALI Lines linked to form a building-wide solution intelligent BM-DALI Line Controllers connected on an Ethernet network.

As DALI is a distributed control system all DALI Line Controllers, DALI Group Controllers and other DALI Electronic Control Devices must co-exist enabling devices from different manufacturers to be mixed and matched to provide maximum flexibility now and in the future. Controllers must not interfere with each other in compliance with the DALI standard (IEC 62386).

The DALI system shall be capable of incorporating DALI Electronic Control Gears (ECGs) from multiple vendors including:

- Ballasts for linear and compact fluorescent lamps
- Transformers for low voltage fittings
- LED Drivers including RGB devices
- Control Gear for high pressure discharge lamps
- Relay and Output Modules
- Blind Controllers
- Future DALI ECGs from various manufacturers

The system shall be capable of incorporating a wide range of DALI Electronic Control Devices (ECDs) from multiple vendors including those shown in the list below. These should include but not be limited to wall and ceiling controls, occupancy sensors and light level sensors.

- BM-DALI Line Controllers
- Group Controllers
- Room Controllers
- Partition Controllers
- Occupancy Sensor Interfaces
- Light Sensor Interfaces
- Remote Controllers
- LCD Controllers and Touch Panels
- Access Controllers and Security Panels

- Audio Visual Systems
- SMS/Email Communications modules
- Future DALI ECDs and controllers from various manufacturers

6.5.33.3 Wiring and Installation

All light fittings shall wired in compliance with the DALI Standard.

A single DALI Line has the following constraints:

- The maximum cable length using a cross-section of 1.5mm2 is 300m.
- The maximum number of addressable DALI units is 64.
  (Devices that take a DALI short address such as ballasts, transformers, emergency lighting units, etc.)
- The maximum permitted line current is 250mA.
- The sum of the current consumptions of all the DALI units from the DALI Line must not exceed the nominal current of the DALI power supply used.
- The DALI voltage range at the DALI power supply must be between 11.5V and 22.5V; a typical DALI

6.5.33.4 Line Controllers

The BM-DALI Line Controllers shall link the distributed DALI Lines onto an Ethernet network to provide a building-wide DALI system. The Line Controllers provide configuration, monitoring, control, reporting and maintenance functions.

The Line Controllers shall operate independently and must continue to process local inputs and schedules when disconnected from the Ethernet network. The controllers must not be reliant on a server or other control system in order to operate.

The Line Controllers shall provide scheduling of DALI groups for scheduled occupancy, sequencing for override timers and effect lighting.

The Line Controllers shall provide local intelligence and features including:

- Integrated real time clock with automatic daylight savings adjustment and leap-year correction.
- Integrated sunrise/sunset support based on site location (latitude and longitude).
- Automatic Time Schedules to control groups for scheduled occupancy with support for holiday exceptions.
- 16 multi-function digital inputs for pushbuttons and sensors including occupancy sensors and daylight sensors and for integration with access control and security panels.
- 2 digital outputs for additional control and interlocking to external equipment such as fans and blinds.
- Up to 32 configurable sequences for override sequences, mood and effect lighting.
- Up to 32 configurable command lists for advanced control and effects.
- Support for two DALI Lines (up to DALI 128 ballasts).

- Zone control whereby groups on different DALI Lines are controlled together as one entity.
- An in-built web server for status and error reporting of DALI Line, ballast and lamp failures. The status shall include lamp hours.
- DALI Emergency testing and reports.
- Local processing. In the event of network failure or disconnection from the Ethernet network the Line Controller is to continue to run automatic time schedules and sequences and process inputs independently.
- Computer monitoring and configuration. The Line Controller shall allow configuration, monitoring and analysis from computers on the Ethernet network.
- Computer control. The Line Controller shall allow occupants to control their local lighting using their computers on the network.
- Line controllers shall respond to a global 'panic' network message. Once in panic mode, the load controllers shall turn all circuits to 100% until they receive an 'un-panic' message. The system shall not obey any other network messages whilst in panic mode.
- Line controllers shall monitor the network for loss of communications by listening for a network watchdog message. When a load controller has not heard a network watchdog message for a user-defined period of time (loss of communications), the load controller must revert to one of the following load conditions:
    - All circuits full on
    - All circuits off
    - All circuit to previous condition prior to communication loss
    - All circuits to a specific preset

The BM-DALI Line Controllers shall be located in the switchboard with their associated DALI line power supplies.

6.5.33.5 Line Controller Inputs and Input Profiles

The Line Controller inputs shall provide manual control through the use of switches and pushbuttons, occupancy control using motion detectors and daylight harvesting using light sensors. The inputs are also used for integration with remote controls, security panels and access control systems.

The Line Controller shall provide:

- 16 integral digital inputs for use with switches, pushbuttons, occupancy sensors, light sensors etc.
- Multi-group functionality so that one input can control multiple DALI Groups. An input is not to be limited to a single group.
- Dynamic Input Profiles that enable an input to operate differently for Normal-hours and After-hours operation.
- Examples of uses for this functionality include but are not limited to:

Wall-plate Pushbutton

- Office Hours: Single button dimmer
  After Hours: Toggle MAXIMUM/OFF with dimming override sequence

- (30 min 75%, 5 min 50%, 5 min 25%, 5 min OFF)

Wall-plate Pushbutton – After Hour cleaners

- Office Hours: Single button dimmer
  After Hours: Toggle 60%/OFF with override sequence
- (25 min MINIMUM, 5 min OFF)

After hours Occupancy sensor

- Office Hours: disabled (lights are scheduled ON
  After Hours: 30 minute Override Sequence
- (MAXIMUM, 20 min 50%, 5 min 25%, 5 min OFF)

Occupancy sensor with variable override

- Office Hours: 60 minute Override Sequence
  After Hours: 30 minute Override Sequence
- Toilet occupancy – reed switch
- (Toilet lights are scheduled on to MINIMUM)
  Office Hours: MAXIMUM, 15 min MINIMUM
  After Hours: 30 minute Override Sequence

The inputs shall provide different functionality based on a condition.

For example, in a partitioned room a wall-plate switch is to control the partitioned area when the partition is closed and the whole area when the partition is opened.

6.5.33.6 Automatic Time Schedules

In order to cater for scheduled occupancy of the building the Line Controllers shall include an integrated real-time clock and automatic schedule control.

The Line Controller shall provide:

- An integrated real-time clock to allow automatic time schedules to be run independent of the Ethernet network.
- The real-time clock shall provide automatic daylight savings adjustment and leap year correction.
- Sunrise/sunset support based on site location. Schedules shall be provided with a configurable offset to allow lighting to be controlled relative to dusk and dawn.
  eg. Sunrise + 20 minutes
  Sunset – 30 minutes
- Active Periods where a timer can be configured to fire only within a defined date range.
  eg. From June 1 to Aug 31.
- Custom time schedules shall be configured for an absolute time
  eg. Office Open, Monday to Friday at 8:30am
  Cleaners lights, Thursdays at 8:00pm
- Repeat timers
  eg. Run façade lighting sequence every 30 minutes from 7pm until 11pm

- Time schedules shall be configured to include or exclude holiday periods. Holiday periods are to be configurable for one or more days and are to be able to be selected as perpetual (eg. January 1, every year)
- Scheduled actions shall include all DALI arc levels (eg. 80%), DALI indirect commands (eg. GOTO MAXIMUM, RECALL SCENE2), Sequences (eg. 50%, 5 mins 25%, .5 mins OFF) and Command Lists.
- Configuration of the time schedules is to be completed from a computer over the Ethernet network.

6.5.33.7 Sequences

Control sequences shall provide multi-step override timers and mood and effect lighting.

Examples of uses for sequences include:

Override sequence 30 mins 75%, 5 mins 50%, 5 mins 25%, 5 mins OFF

Delayed exit button Goto 50%, 5 mins MINIMUM, 5 mins OFF

Façade color mixing variations in red, green, blue over time

Mood lighting SCENE1, 20 sec SCENE2, 30 sec SCENE3, 40 sec SCENE4

The Line Controllers shall store 32 sequences of up to 8 steps where each step consists of a configurable time delay and action. Longer sequences are to be achieved by linking sequences.

Sequences shall be activated by a Time Schedule, from an Input or by Computer/PDA/Touch Screen via the Ethernet network.

Configuration of the sequences is to be completed from a computer over the Ethernet network.

6.5.33.8 Command lists

Command Lists shall provide a series of actions to different groups in response to a timer or input. An example of a command list is may be to provide a structured shutdown of all lighting when the building is secured.

- The Line Controllers shall be able to store 32 Command Lists of up to 8 steps where each step consists of a target ballast, group or zone, a configurable time delay and an action. Longer command lists are to be achieved by linking command lists.
- Command Lists shall be activated by a Time Schedule, from an Input or by Computer/PDA/Touch Screen via the Ethernet network.
- Configuration of the Command Lists is to be completed from a computer over the Ethernet network.

6.5.33.9 Warning Message

Where the software alerts the user to lamp failure or other required maintenance it shall also display a warning message that the luminaire must be electrically isolated at the distribution board as the local light switch will not isolate power to the luminaire.

6.5.33.10 Computer control

In order to get the most out of the lighting control system it is advantageous to provide individual occupants with the ability to adjust the lighting parameters.

It is therefore a requirement of the Line Controller to accept commands from computers connected to the Ethernet network.

The group of ballasts to be controlled is to be configurable.

6.5.33.11 Head End Computer

Provide a desktop computer for the complete control of the system and the monitoring and logging of data recorded from the system. Locate the computer in the Engineering bunker basement level.

The computer shall be an industrial quality PC with a minimum capacity of:-

- 3.06GHz Intel Core 2 Duo
- 4GB memory, with allowance for future expansion (ie. 2x2GB with 2 spare slots, not 4x1GB with no spare slots)
- 1x500Gb hard drive in a RAID-5 configuration, including 'hot-swap' capability
- ATI Radeon graphics card with 256MB
- 101 key wired keyboard and mouse
- 2 x 19"LCD flat screen monitor, both 2560 x 1440 resolution
- CD-RW/DVD+-RW/ 4 x USB2 / 2 x IEEE 1394 Fire wire
- 1Gb network card
- Current MS Windows Operating System including all service packs and updates as at date of handover
- MS Office (current version), including Word and Excel - this allows graphs etc to be copied, used etc.
- Colour laser printer

This computer will also have the emergency lighting software installed on it by the Emergency Lighting Contractor.

Status and Error Information

The Line Controllers shall monitor the connected DALI Lines and provide status and error information for DALI Lines, ballasts and lamps.

The status and error information shall be available on web pages served by the integrated webserver in the Line Controller. This means that only a web-browser is required by maintenance or operations staff to monitor the system.

The Line Controller shall monitor and track lamp hours for connected luminaires. If the DALI ballast does not support lamp hours then the Line Controller is to provide the tracking.

Maintenance and Ballast Replacement

The Line Controller shall monitor the connected DALI Lines and provide status and error information for DALI Lines, ballasts and lamps. The maintenance software shall identify a faulty ballast and address and reconfigure the replacement ballast with a simple point and click operation.

All group, scene and configuration settings shall be restored to the DALI ballast.

Wallplates

Wallplates with push-to-make switches shall provide the occupant with manual control of the workspace lighting. The switches shall be configurable so that they can issue different DALI commands depending on the usage requirements of the space. The switches shall be connected to

either the BM-DALI Line Controller or a DALI controller equal to the DALIcontrol DCDALIO-0402 from Clipsal.

Uses of the switches include but are not limited to the following:

- Toggle button, eg. On|Off
- Single button dimmer, eg. On|Off and Up|Down
- On and Up button
- Off and Down button
- Scene button, eg, Scene 1
- Multi-scene button, eg Scene1, Scene2, Scene3, Off

Note that some buttons will require an override sequence for after hours operation.
The locations of the required wallplates are shown on the design drawings.

Occupancy Sensor Interface

The DALI occupancy sensor interface is used to control a group of ballasts depending on the occupancy of an area as determined by occupancy sensors. The interface is to operate with one or more occupancy sensors that provide a contact closure output.

The group of ballasts to be controlled is to be configurable allowing the space to be reconfigured or modified without changing the fixture wiring.

The lighting level activated when the sensor detects a change in occupancy is to be configurable to match the use of the space.

Refer to lighting layout plans for zoned corridors and other zoned spaces. Each zone shall operate as one group i.e any of the individual occupancy sensors in that zone shall initiate all of the lighting in that zone.

Light Sensor Interface

The DALI light sensor interface is used to control the level of a group of ballasts depending on the light level of an area as determined by a light sensor. The light sensor interface is typically used to control a group of ballasts adjacent to a row of windows.

The group of ballasts to be controlled is to be configurable allowing the space to be reconfigured or modified without changing the fixture wiring.

When the group is on the light level is raised or lowered depending on whether the light level determined by the light sensor is above or below the setpoint.

DALI Output Modules

The DALI Output Modules are required to provide ON/OFF control for non-dimmable loads such as fixed output electronic ballasts, incandescent lamps, fans and motors. The modules are to accept DALI commands over the DALI Line allowing modules to be placed adjacent to the load to be controlled.

The DALI Output Modules may require an external relay to control the load and are to be provided as indicated on the design drawings. Typically, relay output modules shall be provided for external non-DALI light fittings, discharge lighting and illuminated signage.

Floor Layout Graphic Display

The computer shall display a luminaire layout of each floor, based on the final sub-Contractor as-installed drawings. The display shall provide the following,

- show the DALI address of each luminaire
- Show the groups the luminaire is currently assigned to,
- Updated the shown groups as the luminaires are allocated to new groups,
- Show the programming sequences and time scheduling parameters for all areas
- Show all DALI sensors, switches, push buttons, controllers etc. along with their addresses and group assignments.

6.6 EMERGENCY LIGHTING AND EXIT SIGNAGE

6.6.1 Responsibilities

Supply, install, test and commission a single point emergency evacuation lighting system, as shown on the drawings, or otherwise specified or scheduled. This includes, emergency evacuation lighting, exit signs, single point battery systems, centralised battery systems.

Exit signs and emergency lights shall be as specified on the luminaire schedule.

6.6.2 Cross references

Conform to the following associated work-sections:

- General Requirements
- Electrical general requirements.
- Low voltage power systems.
- Lighting
- Luminaire Schedule

6.6.3 Standards

Comply with the following documents:

- NZBC F6/AS1 - Lighting for emergency evacuation
- NZBC F8/AS1 - Signs
- NZBC G9/VM1 - Electricity
- AS/NZS 3000 - Electrical installations (known as the Australian/New Zealand Wiring Rules)
- AS 2293.1 - Emergency escape lighting and exit signs for buildings - System design, installation and operation
- AS/NZS 2293.2 - Emergency evacuation lighting for buildings - Inspection and maintenance
- AS 2293.3 - Emergency escape lighting and exit signs for buildings - Emergency escape luminaires and exit signs
- AS/NZS CISPR 15 - Limits and method of measurement of radio disturbance characteristics of electrical lighting and similar equipment (CISPR 15:2000, MOD) Residential, commercial and light industry

- Electricity (Safety) Regulations 2010

6.6.4 Design

Design the emergency and exit lighting system to the project fire report, the New Zealand Building Code and AS 2293.1. Provide details of compliance to NZBC F6/AS1.1.7 for Building Consent application.

6.6.5 Submissions

6.6.5.1 Samples

Submit samples of all luminaires and exit signs.

6.6.5.2 Technical data

Submit technical data for each type of luminaire and exit sign including the following:

- Maximum luminaire spacing for a given mounting height.
- Luminaire classification to AS 2293.3.
- Type test data

For central systems include:

- Central battery and charger performance test reports, including discharge and charging characteristics.
- Details of central monitoring and testing facility
- Construction details and layout of power source.
- Details of room or enclosure housing the power source, including ventilation requirements, wiring method and cable types.

6.6.5.3 Certificate of Compliance

Provide a certificate of compliance to the requirements listed in the general requirements section. Provide a log book to AS/NZS 2293.2.

6.6.5.4 Shop drawings

Supply drawings required for co-ordination of the work. Confirm overall dimensions. Design to fit the available space with clearances required by the relevant standards and guidance.

Refer to the general requirements section for details of shop drawings.

Submit the following:

- Construction details, overall dimensions and wiring arrangement for each custom built luminaire and exit sign.
- Details of the central monitoring and testing facility, including:
- Construction details and layout of the power source.
- Details of room or enclosure housing the power source, including ventilation requirements.
- Details of wiring method.

6.6.6 Signage

Exit signs single/double sided, ceiling/wall/suspended mounted with arrows as indicated on the drawings. Label and sign size to NZBC F8/AS1: Signs.

6.6.7 Duration of operation

Design the emergency lighting fittings and exit signs for a minimum 2hr duration under full load.

6.6.8 Single-point System (Existing systems)

6.6.8.1 Non-maintained self-contained exit sign

Single fitting with LED lamp, long life high temperature NiCad batteries and charger to AS 2293.3 with lamp only energised when under test or power fail condition.

6.6.8.2 Maintained self-contained exit sign

Single fitting with LED lamp, long life high temperature NiCad batteries and charger to AS 2293.3 with lamp energised at all times.

6.6.8.3 Sustained self-contained exit sign

Single fitting with 2 fluorescent lamps, long life high temperature NiCad batteries and charger to AS 2293.3 with 1 lamp only energised at all times (or switched) with the other lamp energised when under test or power fail condition.

6.6.8.4 Non-maintained self-contained emergency light

To AS/NZS 2293.2 and AS 2293.3, with long life high temperature NiCad batteries and lamp only energised when under test or power fail condition.

6.6.8.5 Batteries

Type: nickel-cadmium batteries capable of operating each lamp at its rated output continuously at least 2 hours during completion tests and 1.5 hours during subsequent tests.

Batteries to have a minimum life of 3 years under normal operating conditions at an ambient temperature of 25°C, subject to charging and discharging at 6 monthly intervals. Batteries to be indelibly marked with date of manufacture.

6.6.8.6 Luminaire Construction

Visual indicator lights: Provide a red indicator, readily visible when the luminaire is in its operating location, which indicates that the battery is being charged.

Inverter system: Provide protection of the inverter system a against damage in the event of failure, removal or replacement of the lamp, while in normal operation.

Local test switches: Provide a momentary action test switch, accessible from below the ceiling, on each luminaire to temporarily disconnect the mains supply and connect the battery to the lamp.

6.6.8.7 Power supply

Provide an un-switched active supply to each luminaire and exit sign, originating from the test switch control panel.

6.6.8.8 Common test switches

Provide a common test switch to AS/NZS 2293.1:2005 at each local distribution board which disconnects main supply to the luminaires and tests for discharge performance. The test twitch shall energise the emergency lights and exit signs (by disconnection of the emergency lighting supply) and then to automatically reset controls and revert to normal operating mode after a maximum of 2 hours.

6.6.9 Materials - central systems

Central System Luminaires

LED luminaires with inverters and transformers to operate lamps from the central power supply to AS 2293.3. To operate on 48V AC/DC power supply.

6.6.10 Monitoring systems

Supply and install, test and commission a monitoring system to AS/NZS 2293.1:2005 that will monitor the general lighting supply to each area, and activate the emergency lighting to that area upon loss of mains supply. Refer to the schematic drawings for further details.

6.6.11 Marking and labelling

Label each luminaire with a unique identifying number and record the number and luminaire location in a schedule included in the emergency evacuation lighting operation and maintenance manual. The label must be permanently fixed, indelible and readable at a distance of 1 m.

6.6.12 Installation

Refer to the Lighting section for details of installation requirements for lighting systems.

Install to AS 2293.1 and NZBC F6/AS1. Ensure work is electrically safe. Verify installation to NZBC G9/VM1: Electricity, by compliance with AS/NZS 3000 and the relevant Electrical Codes of Practice.

6.6.13 Testing and Commissioning

Carry out tests, including out-of-hours tests, to demonstrate the emergency and evacuation system's performance. Include the following:

- Test components for correct function and operation.
- Demonstrate illumination performance on site, to at least the level stated in the manufacturer's performance specification for that device.
- Test operation of battery discharge test and control test switch functions, including discharge and restoration.
- Demonstrate system functions under mains fail condition.
- Demonstrate operation of the battery and charger including a full discharge/recharge over the designated time.
- On completion of the installation carry out a discharge check to the procedure in AS/NZS 2293.2.
- Before commissioning, ensure mains supply has been continuously connected for at least 24 hours.
- Ensure the system is operating correctly, with equipment clean and luminaires and testing facilities operational as specified.

6.6.14 Maintenance

Carry out the 6-monthly procedures before practical completion and again before the end of the maintenance period.

Emergency evacuation lighting: To AS 2293.2.

Carry out general maintenance on the emergency lighting system as described in the Lighting section.

6.6.15 Schedules

Refer to the luminaire schedule accompanying this specification for details of all emergency luminaires.

6.7 ELECTRICAL MANAGEMENT SYSTEM (EMS)

6.7.1 General

6.7.1.1 Design Intent:

The design intent of the Electrical Management System (EMS) system is to provide the facility and maintenance staff of Britomart station with convenient, accurate and timely access to information to ensure:

- Reliable, safe, and efficient use of Britomart station's electrical infrastructure and equipment.
- Opportunities to increase energy efficiency levels within the CRL through the use of useful and accurate information.
- Energy cost can be allocated to the stations internal departments and third parties such as building tenants.
- A computerised EMS will be used to collect electrical infrastructure equipment data and present this data as information in the format of real-time diagrams and reports.
- Monitoring and control of LV switchgear, UPS and batteries

Lighting control and emergency lighting monitoring shall be via dedicated individual software applications.

6.7.2 Scope

Provide an Electrical Management System (EMS). The scope shall broadly cover the following items:

- EMS Server (hardware, operating software, application software) to collect, serve and store EMS data.
- EMS Clients (application software) to provide users with access to the EMS data in the form of real time diagrams and reports.
- Metering installations connected to the EMS Server for incoming electrical supplies and billing metering.
- Metering installations connected to the EMS Server for incoming supplies to all main switchboards, specified outgoing electrical supplies on main switchboards and distribution boards as indicated.
- Virtual metering installations connected to the EMS Server for all departments;

- EMS Server interfaced to electrical equipment, typically:

Primary and secondary LV electrical network;

UPS and batteries;

Power factor correction equipment;

Harmonic filtration equipment;

Lifts;

Escalators;

Load-shed equipment

- Wiring from terminal strips to EMS system;
- High level interface with BMS and SCADA systems;
- Wiring from meters to EMS equipment for onward connection to provided RJ45 outlets;
- Equipment to set to work the EMS system;
- Factory acceptance testing of other trades controllers to ensure interfaces are compatible;
- Commissioning of the EMS system in stages, typically:

EMS system stand alone

EMS system integrated with working plant

EMS system against commissioned station

- Training, operations manuals, maintenance documentation, installed drawings.
- The communications link between the EMS head end to the fibre network shall use Ethernet TCP/IP as a transport protocol.
- Web based interface

A serial backbone network will not be accepted.

6.7.3 Compatibility & Arrangement

EMS compatibility: compatible with all EMS field devices, Nominated field equipment, EMS head end equipment and EMS software.

EMS arrangement: drawings and specification show the arrangement of the EMS system and should any specific manufacturer/product integrate a number of the EMS devices or other platforms, alternative will be accepted as long as they fully compliant with this specification and agreed with the managing Contractor. Any alternative offer shall have a written statement of full compliance, and any deviations shall be listed as applicable.

EMS Commercial off The Shelf Software (COTS): The EMS software shall be available as commercial off the shelf software. The software shall only be modified using as fully supported by original manufacturer and using supported tools to develop and implement the EMS.

The subContractor will not use custom software to implement the system or ‘hack’ some COTS software as this will result in an ‘orphan’ system. Orphan systems will introduce a number of risks such as future upgrade compatibility, ongoing support limitation and no/limited support from the OEM.

6.7.4 Interfacing & Liaison

The topic of system/component interface security will be addressed.

As an example use a special OPC Tunneller to reduce the number of open ports to one (1) on two servers connected via OPC (based on Microsoft DCOM).

All interfaces will consist of the following components as per the OSI model. Note that Ethernet TCP/IP does not rigidly meet the OSI layers as per RFC 3439.

- Layer 1: Physical layer – defines the electrical and physical specifications for the devices i.e. will the interface be via copper, optical fibre, what form factor the connector will be, etc.
- Layer 2: Data link layer – defines the functions and procedures to transfer data between the systems and detect/correct errors that may occur in the physical layer. Examples include 802.3 and 802.1Q (VLAN)
- Layer 3: Network layer – defines the functions and procedure to transfer data a host on one network to a destination on another network. These are basically the routing protocols i.e. IPv4
- Layer 4: Transport layer – provides transparent transfer of data between end uses. Examples include TCP (Transmission Control Protocol) and UDP (User Datagram Protocol)
- Layer 5: Session layer – provide the functions to control dialogues between computers. TCP provides part of this functionality as it performs session check pointing and recovery.
- Layer 6: Presentation layer – provides the functions to transform the data into a format that the application accepts.
- Layer 7: Application layer – defines the protocols and methods for the process to process communications i.e. the application protocols such as Modbus.

In summary, for two systems to be interfaced they must be connected to the same network, support the connection of their computers together, and then the two applications must be able to communicate using the same protocol.

To use a lay man example for two people (systems) to connect and communicate you need:

- A telephone with the correct type of plug to connect to the telephone network i.e. Fibre Optic, CAT 5
- A telephone with the correct data link technology i.e. Ethernet
- A telephone with the correct network technology i.e. IP
- A telephone with the correct transport technology i.e. TCP
- A telephone with the correct session technology i.e. SIP
- A telephone with the correct CODEC i.e. G.711

The two people need to talk the same language i.e. English

6.7.4.1 Britomart communications Interface & liaison

The Britomart system listed above requires interfacing with the communications subContractor and any required liaison for connections and termination points on the communications backbone shall be allowed to set the system to work.

6.7.4.2 Britomart Electrical Equipment Interface & liaison

The Britomart EMS system to be interfaced with the specified electrical equipment and any mapping of signals that are required to be monitored/controlled on the EMS shall be included and liaison with the different equipment manufacturer's and subContractors to be allowed to set the system to work. Electrical equipment includes LV switchgear monitoring and control, UPS monitoring, metering monitoring and data gathering/analysis.

6.7.4.3 Britomart BMS Interface & liaison

The Britomart EMS system to be interfaced with the Britomart BMS and mapping of signals that are required to be monitored/controlled by the BMS as set out in the mechanical specification.

Connections from Britomart EMS to the Britomart BMS shall be physically via a fibre with high level interfacing. All required programming to map the Britomart BMS information to be included and interfacing with the Britomart BMS sub-Contractor to be allowed to set the system to work. The physical high level interface point for the Britomart EMS system and the Britomart BMS is within the allocated CPO B1 control room and all required BMS signals to be mapped onto the EMS system as described within the BMS mechanical specification.

6.7.4.4 Britomart SCADA Interface & liaison

The Britomart EMS system to be interfaced with the Britomart SCADA system via mapping of signals that are required to be monitored/controlled by the EMS as set out in the Station Control specification.

Connections from Britomart EMS to the Britomart SCADA system shall be physically via a fibre with high level interfacing and low-level interfacing in the field via I/O terminals. All required programming to map the Britomart EMS information to be included and interfacing with the Britomart SCADA subContractor to be allowed to set the system to work. The physical high level interface point for the Britomart EMS system and the Britomart SCADA is within the allocated CPO B1 control room and all required EMS signals to be mapped onto the SCADA system as described within the Station Control specification.

6.7.5 Interface Factory Testing

6.7.5.1 Requirement

Provide factory testing of all sub-Contractors controllers to ensure the interfaces are all compatible with the EMS system prior to installation on site.

Method

Obtain from all sub-Contractors the controllers they propose to use to interface to the EMS system. Connect them together and demonstrate the interfaces work for all protocols used.

Advise the managing Contractor if the protocols used by the controllers are not compatible.

Provide a report to the Managing Contractor demonstrating the test procedure and the results.

Note there is no requirement to build a complete points interface test model for the Britomart.

6.7.6 EMS Requirements

Provide all terminal strips, wiring access, control relays, interposing relays, voltage free contacts, transducers, power sources, interconnection facilities addressable devices and the like, all suitably sized and labelled to provide the required interface to the EMS.

Each switchboard (MSB) shall have a separate control section where all the EMS points and control equipment shall be housed. EMS subContractor to liaise with switchboard subContractor to allow sufficient space within the switchboard.

From the EMS points, equipment shall be provided to link the EMS points back to the EMS head end via the communications cabling. JR45 outlets will be provided by the communications subContractor for the EMS subContractor to connect to.

6.7.6.1 Points Schedule

Refer to the Station Control specification for EMS and SCADA points schedule. Provide wiring to terminal strips and equipment for signals shown on the point's schedule.

Terminations

Labelled DIN rail mounted modular terminals with isolation facilities. Terminals shall be logically grouped with space for 30% additional terminals and shall be segregated from all other wiring. RS 232C connections shall be via a 25 pin D type connector wired from the terminals.

Schedule: For each terminal strip provide a typed schedule listing points including description of signal, function and type of signal.

6.7.6.2 EMS Control Voltage

Devices suitable for: 24 volts DC,

6.7.6.3 EMS Digital Inputs

Application: Event recording of status of alarms, system changeovers and the like.

Initiating Device: Voltage free changeover contact.

Contact Rating: 5A resistive, 2A inductive.

6.7.6.4 EMS Data Inputs

Application: High level data input from energy meters, circuit breakers and relays.

RS 232C to manufacturer's protocol, and transmission rate.

6.7.7 Metering installations

6.7.7.1 Introduction

Each metering installation shall consist of the following components

- A current transformer.
- A voltage transformer if the voltage exceeds the meter's voltage input specifications.
- Secondary wiring from the current transformer and voltage transformer to the meters.
- A meter
- A data logger internal or external to the meter, external data loggers can be located local or remote from the metering installation site
- A communication interface supporting the read/write access to real time, alarm/event, logged data, and configuration parameters by the EMS Server and Clients.
- Test links and fusing

- Hardware lock for metering installations of electrical connection points to external parties to the hospital.
- Auxiliary electricity supply to the meter.
- Testing and inspection.
- Management, maintenance, and auditing.

The EMS shall consist of the following metering installations:

- Incoming supplies to all main switchboards and retail/tenancy meters (Meter type: IMSB)
- Specified outgoing supplies on main switchboards (Meter type: OMSB)
- Distribution boards as indicated (Meter type: DBM)

Callibrate and certify the meters in the factory before delivery to site. Provide certificates as evidence.

Refer to the Station Control specification and associated EMS/SCADA points schedule for metering information required to be monitored by the EMS system.

Meter type: IMSB, Class .5 metering (Billing metering)

The following devices shall be class 0.5 and have 5MB of on-board memory storage capability.

- MSB A – main incomer.
- MSB B – main incomer
- Retail meters
- Tenancy meters

Meter to include the following metered values:

- Current (Per-Phase, Neutral, 3-Phase average, % unbalanced);
- Voltage (L–L Per-Phase, L-L 3-Phase average, L–N Per-Phase, L-N 3-Phase average, % unbalanced);
- Real Power (Per-Phase, 3-Phase total);
- Reactive Power (Per-Phase, 3-Phase total);
- Apparent Power (Per-Phase, 3-Phase total);
- Power Factor – True (Per-Phase, 3-Phase Total);
- Power Factor – Displacement (Per-Phase, 3-Phase Total)
- Frequency;
- THD (Per-Phase, Current and Voltage);
- Energy (Real kWh, Reactive kVarh, Apparent KVAh);
- Reactive Energy by Quadrant
- Demand Current Per-Phase, actual and peak;

- Demand Real Power 3-Phase total, actual and peak;
- Demand Reactive Power 3-Phase total, actual and peak;
- Demand Apparent Power 3-Phase total, actual and peak;
- THD - Voltage (Per-Phase, Line to Line, Line to Neutral);
- THD - Current (Per-Phase, Neutral);
- Power Factor;
- Operating time (suitable for usage analysis).

Sampling: continuous sampling at a minimum of up to 32 samples/cycle, simultaneously on all voltage and current channels

Minimum & maximum values:

- Voltage L-L
- Voltage L-N
- Current
- Power Factor
- Real Power Total
- Reactive Power Total
- Apparent Power Total
- THD Voltage L-L
- THD Voltage L-N
- THD Current
- Frequency

Minimum & maximum recorded values: record the following attributes:

- Min/Max. Value
- Phase of recorded Min/Max

Minimum and maximum value display: available via communications and display.

- Class: comply with IEC62053-22 Class 0.5S for Real Energy and IEC62053-23 Class 2 for Reactive Energy.
- Voltage accuracy: 03% from 50 to 227 V.
- Current accuracy: 0.4% from 1 to 6A.
- Power accuracy: 0.5%
- Frequency Accuracy: ±0.2 % from 45-65 Hz
- Maintaining accuracy: No annual calibration to maintain accuracy

- Input/Output: 2 Digital Inputs and One Digital Pulse Output
- Upgrades: field upgrade the firmware in the Power Meter to enhance functionality via the communication connection
- Power control: 100-415 VAC, +/-10%, 5VA; 50 to 60Hz. Or 125-250 VDC, +/-20%, 3W.
- Communications: RS-485 Modbus protocol with a 2-wire connection at speeds up to 19.2 kBaud.
- Display: LCD, anti-glare and scratch resistant with full setup from the screen.
- Software interface: Product suitable for interface with EMS head end software

Provide hardware lock on all revenue meters with installation and commissioning by a suitable competent person.

Meter type: OMSB & DBM, Class 1 or 2 energy metering

Meter to include the following metered values:

- Current per-phase
- Neutral current
- Voltage, phase-to-phase & phase-to-neutral
- Real Power (kW), per phase & three-phase total
- Reactive Power (kVAR), per phase & three phase total
- Apparent Power (kVA), three phase total
- Power Factor (true), three-phase total
- Real Energy (kWh)
- Operating time (suitable for usage analysis)
- Accuracy: 0.5% of reading for voltage and current, to 1% for power.
- Class: class 1 according to IEC62053-21 or IEC61036 for energy measurements.
- Display: Visual indication for current, voltage and power.
- Communications: RS485 port, Modbus RTU protocol, up to 19 200 bauds or a pulse output for active or reactive energy metering. All information to be made available via the communications port.
- Impulse withstand voltage: 6kV.
- Software interface: Product suitable for interface with EMS head end software

6.7.8 EMS Head End

6.7.8.1 General

Provide a complete electrical monitoring system to record the power quality, overall power consumed, power consumed in nominated sections of the installation as shown on the single line diagrams and in

the schedules. Monitor sag and swell characteristics of the supply and provide waveform capture for future evaluation of power quality characteristics.

Log and record the information on a dedicated PC loaded with Data Acquisition and Analytical software.

Retrieve the information from all indicated devices via Ethernet communications, with modbus master functionality receiving data from slave metering devices.

The work station shall be located in the control/monitoring room on basement level 1

Design the system such that specific data may be viewed, via the web, off site by selected personal with the appropriate passwords.

Connect each field requiring power to a UPS power supply.

Connect the head end PC to a UPS power supply.

6.7.8.2 Head End Computer

Provide a desktop computer for the monitoring and logging of data recorded from the system. Locate the computer in the Engineering bunker basement level.

The computer shall be an industrial quality PC with a minimum capacity of:-

- 3.06GHz Intel Core 2 Duo
- 4GB memory, with allowance for future expansion (ie. 2x2GB with 2 spare slots, not 4x1GB with no spare slots)
- 3x1TB hard drive in a RAID-5 configuration, including ‘hot-swap’ capability
- ATI Radeon graphics card with 256MB
- 101 key wired keyboard and mouse
- 2 x 19”LCD flat screen monitor, both 2560 x 1440 resolution
- CD-RW/DVD+-RW/ 4 x USB2 / 2 x IEEE 1394 Fire wire
- 1Gb network card
- Current MS Windows Operating System including all service packs and updates as at date of handover
- MS Office (current version), including Word and Excel - this allows graphs etc to be copied, used etc.
- Colour laser printer

6.7.9 EMS Software

6.7.9.1 General

Software:

- web-enabled monitoring system intended to monitor an entire electrical distribution infrastructure, from incoming utility feeds down to low voltage distribution points.
- designed to monitor, manage energy consumption and control distribution throughout an electrical network, whether within a single facility or across a number of facilities.

The software shall be a standard product based on a successful, proven software platform.

Key features:

- Data acquisition for metering devices, sensors, and other intelligent electronic devices
- Power Quality analysis (including harmonics, and voltage and current sinusoids)
- Graphical displays of information
- Reporting tools with standard reports
- Interactive historical data analysis
- Power Factor monitoring and control
- Interoperability with disparate devices and systems through OPC Client and OPC Server
- Third Party Device Integration through Modbus RTU and Modbus TCP protocols such as UPS systems.
- Support real-time data display and control actions for multiple users for applications such as sub-metering, load monitoring / shedding, real-time pricing and generator control
- Expansion of system through distributed I/O servers

6.7.9.2 Power Monitoring Software Components

Web enabled, user friendly, suitable for operation on the computer workstations, to provide a robust, reliable and secure data network.

Support easy integration of other third party intelligent electronic devices (IED's).

Power Monitoring Software: core components operating as services in Windows operating systems consisting of:

- Connection Manager - to manage connection request for all power monitoring system components
- Log Server – provides power monitoring system historical data storage and retrieval
- DDE Server – enables inter-application distribution of power monitoring system data
- Site Server – manages interactions between local and remote power monitoring system components
- Network Router – to manage data traffic between servers in the power monitoring system
- Virtual Meter – provide system-wide aggregation, control and mathematical analysis of power monitoring data
- Query Server – to provide client access to live and archived databases
- Alert Monitor – to receive alarm information generated by exception from metering devices outside of normal polling cycle

6.7.9.3 Data Storage and Data Sharing

Data storage/retrieval application: autonomously retrieve from any or all devices in the power monitoring network and provide the following abilities:

- Interrogate and download logs of interval data stored onboard metering devices.
- Interrogate and download logs of alarm and event data stored onboard metering devices.

- Interrogate and download logs of waveform capture data stored onboard metering devices.
- Interrogate and download logs of alarm and event data stored onboard circuit breaker control units.
- Interrogate and download logs of interval data generated by the software system (software-based logging).
- Interrogate and download logs of alarm and event data generated by the software system (software-based alarming).
- Automatically re-arm the waveform recorders, upon upload of information.
- Automatically detect downstream devices that are Modbus-mastered on metering devices, and store logged data in the database associated to a unique name for each downstream source.
- Detect unknown measurement quantities provided by devices in the network, and automatically generate appropriate database references for those quantities without user intervention.
- The database shall have the capability to record all information to 1ms precision.
- Provide a facility to archive, trim, and backup the database on demand, or on a schedule.
- Provide a facility to view historical data from archived databases
- Support user initiated changes to the database, with the following abilities:

Support on-line changes

Suffer no interruption to its operation while changes are being made

Requires no restart once the configuration has been performed.

6.7.9.4 User Interfaces

Provide at a minimum the following types of graphical user interfaces:

- Graphical Display interface
- Historical Reporting interface
- Device Configuration interface
- Network Configuration interface

Provide levels of user security:

- View – The viewer shall be permitted to view information. No change privileges allowed
- User – Same as View, but is able to initiate control functions
- Controller – Same as User, but is able to initiate communications
- Operator – Same as Controller, but is able to modify configurations
- Supervisor – Same as Operator, but is able to administer security privileges

6.7.9.5 Graphical Display Interface

Provide the ability to create, view and control a graphical representation of the monitoring system, including electrical one-line diagrams, facility maps, plan views, floor layouts, equipment representations, mimic displays and UPS status that would be typically found from an off the shelf UPS remote diagnostics software.

Provide the ability to display real-time information from the monitoring system within the graphical displays, including numeric values, status values and historical information stored in the database.

The screens shall show all parameters which are available from the individual remote devices by device, including but not limited to all metered values, load status, alarm status, energy data, device position and/or status, device data logs, waveform capture, sag/swell events, etc. In addition, the screens shall be capable (if allowed by the end user) of providing for suitable tripping, closing, and opening of appropriate remote devices.

Allow unlimited screens and unlimited screen penetration to lower-level detailed screens.

Provide the following screens as standard in the software (if supported by the device):

- Real-time device information (e.g. line to line and line to neutral voltage and current readings for all power meters in a line diagram format).
- Event logs
- Alarm logs
- Historical trend plots
- Real-time trend plots
- Waveform capture display with zoom in/out capability
- Harmonic analysis display
- Phasor display
- Time-of-use display
- Power quality display
- I/O status display
- Setpoint and setup display
- Device log and setup display
- One-click access to device logs, including long-term min/max, voltage, current, power, frequency and power factor trending.
- Flicker

Provide the following capabilities for ad-hoc historical analysis:

- Ability to view and trend all time-series historical data stored in the database
- Ability to view all alarm and event information stored in the database
- Ability to view and analyse waveform capture data stored in the database, including visualization of voltage and current sinusoids, histograms of harmonics, and phasor diagrams.
- Allow the user to set an unlimited number of individual computer alarms for all monitored parameters, such as setting low and high alarm levels for voltage, current, motor run time, etc. Alarm levels shall be independent of device built-in alarm levels.
- Display the analog value that caused the alarm on the alarm screen (time and date stamped), and log same information to the event file.

- Provide fully customizable alarm/event log where unlimited log views can be created by the user in real-time for organizing, filtering and prioritizing different alarms (e.g. UPS Alarms, Critical Alarms, General Alarms, All Alarms, etc.).

The alarm displays to provide customised alarm annunciation in the form of:

- playing of any .wav file
- loop the playback of any .wav file until the operator acknowledges the alarm
- Flashing of the program header in the Windows Taskbar
- Launching of a command line application
- Activate the output of any power monitoring devices or control point
- Message box pop-up
- Have the ability to create, edit, save and view diagrams with the following features:
- Support graphic characters, symbols and pictures
- Ability to import graphic object libraries from other Windows graphical applications
- Create user configured system diagrams
- Ability to display a number of diagrams simultaneously
- Ability to modify display formats
- Ability to use animation, including changing shape, flashing symbols and AVI files
- Support Grouping windows
- Hot Spots – for control functions and to open diagrams giving multilevel hyper linking between diagrams
- Have the ability to automatically generate a hierarchical graphical representation of all devices in the power monitoring network with a single mouse-click.
- Provide configurable poll rates for real-time data values.

Web Enabled Capabilities:

- provide access to information using an interface that provides the same look and feel as the user display interface software.
- Diagrams created in the user display interface software shall automatically be rendered as a page, viewable to clients over the web. No programming shall be required.

When viewing historical data, it shall provide the following capabilities:

- Selectable date range
- Selectable data parameter to chart
- Zoom, pan, and scroll the drawing to any desired magnification
- Able to de-select parameter on chart

Able to modify the following:

- Chart type (each selected parameter)
- Chart colour (each selected parameter)

Export chart in the following formats:

- Bitmap
- Jpeg
- GIF
- Full graphical chart editing capabilities providing at a minimum, titles, legends, axis, 3D.
- Exporting data in text, XML, or HTML formats

6.7.9.6 Device Configuration Software

The device configuration software:

Provide the ability to interrogate and graphically display the onboard configuration of metering devices including:

- metered quantities that are logged to onboard interval data logs
- alarm and event conditions and logging to onboard event logs
- waveform capture logs
- the size and behaviour of all onboard logs
- Ability to customize the onboard functions of metering devices using graphical configuration tools
- Ability to customize the functions of the software-based virtual meter using graphical configuration tools

Toolbox with all supported functional modules for the specific device type and shall provide:

- Quick link to specific modules
- Display the number of modules currently in use.
- Graphically represent the device configuration and linkages
- Ability to upload device templates to other devices
- The device template shall be capable of being saved for future use.
- Provide standard Windows functionality. I.e. Copy/Paste.
- Users without appropriate security login credentials shall only be capable of viewing device configuration

6.7.9.7 Network Configuration Software

Network Management:

Shall provide a graphical interface with the following abilities:

- Add and remove devices in the power monitoring network
- Paste device name and address information from Microsoft Excel

- Provide an automated mechanism to name any number of devices based on a user-defined naming scheme
- Add and remove IO servers in the power monitoring network
- Edit advanced communication properties for devices including timeouts, delays,
- Display a visual indication to the user of the mandatory fields to add a new device
- Associate devices into a hierarchy using a group name
- Manually connect and disconnect serial, Ethernet, modem and Ethernet gateway sites
- Enable and disable devices and sites in the power monitoring network without interruption to other devices or sites.
- Provide a fully configurable connection schedule for any site
- Provide a diagnostics viewer to monitor:
- Communication request/response and error rates, and timeouts
- Log acquisition services
- Provide a view of system diagnostic events

Database Maintenance Tool:

- Include an integrated database management tool that is designed specifically to manage the databases of the power monitoring and control system.
- The database maintenance tool shall require a login window and security to prevent unauthorized use of the tool
- The database maintenance tool shall provide backup, archiving and trimming functionality. At a minimum, the tool shall:
    - Provide start and end date for operation
    - Be capable of copying data to another database and / or trimming the data from the existing database

Be capable of selecting any or all of the following type of logs for the required operation:

- Data logs
- Event logs
- Waveform logs

- The database maintenance tool shall provide the capability to attach and detach databases.
- The database maintenance tool shall provide the ability to configure alarms on the database, including the ability to email an alarm if the database size exceeds a configured value.

User Administrator Tool:

Provide a user administration tool with the following abilities:

- Allow users to view the current list of user names and their level of security.
- Add, remove, modify users and level of security

- Any modification requires the supervisor password

Modbus Device Importer Tool:

- user Modbus device importer tool providing a graphical interface for specifying Modbus register information for devices that are not natively supported by the power monitoring software.
- quick edit function to easily duplicate and edit register information.
- multiple register formats
- ability to define scaling, multiplier, and offset registers for any other register.
- support data entry of registers in either decimal or hexadecimal format.
- support the creation of text labels for enumerated values.
- support the ability to add a named device type to the power monitoring system network database in order to create instances of the Modbus device.
- provide the ability to associate a template graphical display with the device type.
- provide the ability associate Modbus registers with user-specified measurement quantities.
- provide a facility to validate the Modbus device profile and alert the user to validation errors such as: duplicate registers.

6.7.9.8 Reporter

Power Monitoring Software: provide a reporting tool to view historical data in pre-formatted report templates.

Reports: based on Microsoft Excel

Custom reports: able to be created using Visual Basic for Applications (VBA).

Reporting tool: provide the following features:

- Report generation user configurable on event, on a schedule, or manually activated.
- Ability to export to HTML, printer, or network folder
- Ability to distribute reports via email using Microsoft Outlook
- Ability to validate for duplicate or missing data
- Standard report templates as follows:
    - Energy and Demand report that utilizes a user-defined Time-of-Use schedule with tariff rates for On-Peak and Off-Peak
    - Load Profile report with a trend chart peak demand indication

Each default report shall provide the following options:

- Summary aggregation of data from the selected devices
- Individual device information
- Raw data

- graphical interface to create and manage multiple Time of Use (TOU) schedules.
- provide the ability to define multiple tariffs including energy cost rates per kWh, kVARh, and kVAh, and demand charges per kW, kVAR, and kVA.
- provide the ability to define off-peak and on-peak times.
- support the ability to define cost in any currency, including dollars, pounds, Euro, etc.

6.7.9.9 Communications Subsystems

Communications Subsystems: support multiple communications network topologies including:

- Direct serial communications on an RS-485/RS-232 network using ModbusRTU or ION protocol.
- Ethernet/TCP connections from the software using ModbusTCP protocol through the use of an Ethernet-to-serial gateway using to devices using any protocol supported by the gateway and converted to ModbusTCP.
- Ethernet/TCP connections from the software using ION protocol through the use of an Ethernet-to-serial gateway to serial devices using ION protocol.
- Connection to external OPC servers compliant with the OPC DA 2.x specification.
- Provide time-synchronization signals over an Ethernet network with 16ms accuracy.

6.7.9.10 Operating Environment

Software: Microsoft Windows 7 business operating system.

Use: Microsoft SQL Server database.

Support: deployment of the system in a distributed IT environment utilizing a dedicated database server and a dedicated application server.

Distributed configuration: allow a configurable TCP port for communications between the application server and database server.

6.7.9.11 Billing reporting

Billing: provide an automatic billing output such that the supporting information from metering will be clearly displayed to enable verification of electricity from the supply transformers and retail outlets.

Required software outputs (electrical):

- Total electrical demand (Britomart and CPO);
- Britomart demand;
- Balance of electricity.
- Total kWh consumption per retail outlet and upper tenancys

The metering head end shall be arranged graphically to calculate all metering and the final arrangement of the layout and display shall be agreed with the Britomart station representative.

Reporting requirements:

- Provide aggregate load profile reports, trend analysis on any measured parameter, including demand, predicted demand, graph multiple load profiles derived from multiple metering points with system wide usage patterns over the specified date range, including timestamps and peak usage.

- Energy profiling and related costs to each substation, feeder, process, along with other usage profiles to show energy reduction and the ability to create virtual metering within the software is required. The graphical design interface shall have the ability to automatically generate a hierarchical graphical representation of all devices in the power monitoring network with a single mouse-click.
- Provide a reporting tool to view historical data in pre-formatted report templates via a web browser. All reports shall be based on Microsoft Reporting Services Technology and to allow custom reports to be created using Microsoft Business Intelligence Studio or similar platform. The reporting tool shall be able to provide automated report generation based on event, on a schedule or manually initiated. The reporting tool shall provide both standard and customized reports.

Standard template reports to include but not limited to:

- Energy Consumption Report
- All energy consumption reports which include at least energy cost report, energy period over period report, and energy by shift report. This includes the ability to define Time of Use Schedule or a Flat Rate using a graphical interface. Reports or trends, where applicable can be generated and compare them daily, weekly, monthly, or yearly. These reports shall also include the ability to define rollup interval as Day, Week, Month or Year.
- Power Quality Report
- Reports include 100ms report, IEC 61000-4-30 report and CBEMA evaluation.
- Energy Demand Report
- Reports include both power and demand.
- Non-electrical (Water, air, gas, steam) Report.
- Reports generated by calculated pulse counts collected from measuring devices such as PLCs, digital input/output devices and sensors.
- Other type of reports: Trend reports, tabular reports, system configuration report, alarm and event history report.
- Trend reports shall allow values for multiple measurements and multiple devices to be viewed in the following methods:
- Line Chart
- Pie Graph
- Bar Chart
- Column Chart
- Smooth Line Chart
- Stacked Column Chart
- Stacked Bar Chart

Customised report templates to include the following ability to provide but not limited to:

- Aggregated Energy Consumption Reports

- Individual and total energy reports measured or calculated from multiple points/ grouped devices formed as sites, building floor levels, maps, geographical area etc.
- This report to follow local energy reporting as so far as virtual zoning of the following:
- Floors
- Areas
- Dedicated tenant areas
- External
- Lifts
- Aggregated Demand Reports
- Individual and total demand reports measured or calculated from multiple points/grouped devices formed as sites, building floor levels, maps, geographical area etc.

6.8 UNINTERRUPTIBLE POWER SUPPLY (UPS)

6.8.1 General:

Refer to the scope section and Appendix UPS schedule in this specification for UPS ratings and requirements of the UPS and Battery systems.

6.8.2 Standards:

The following standards are referred to in this Section:

- AS/NZS 3000:2011 Electrical Installations.
- AS 2676.2 Guide to the installation, maintenance, testing and replacement of secondary batteries in buildings - Sealed cells
- AS 3011.2 Electrical installations - Secondary batteries installed in buildings - Sealed cells
- AS 62040.2 Uninterruptible power systems (UPS) - Electromagnetic compatibility (EMC) requirements
- AS 62040.3 Uninterruptible power systems (UPS) - Method of specifying the performance and test requirements
- AS 2184 Low voltage switchgear and controlgear - Moulded-case circuit-breakers for rated voltages up to and including 600 V a.c. and 250 V d.c.
- AS/NZS 60269 Part 2 Low-voltage fuses - Supplementary requirements for fuses for use by authorized persons (fuses mainly for industrial application) - Sections I to VI: examples of types of standardized fuses
- AS 4029.2 Stationary batteries - Lead-acid - Valve-regulated type

6.8.3 Manufacturer

The supplier is to be capable of proving that he has a broad experience in the area of UPS and provide proof that he has already supplied equipment of the equivalent type and brand which has been in operation for at least three years in the Auckland region.

The UPS's shall be of established, standard design of a type installed in a significant number of installations in NZ and for which spare parts and service are readily available. It shall be suitable for unattended operation.

6.8.4 Submission

Submit the following documentation to the Managing Contractor for review

- UPS technical data to AS62040.3
- Calculated input power factor and harmonic content
- Heat load data of the UPS.

6.8.4.1 Drawings

Provide workshop drawings for approval before commencing manufacture. Drawings shall show:

- General arrangement of equipment and dimensions;
- Details of battery enclosure/stand and battery cabling;
- Plan of room showing equipment and clearances;
- Weights of all items.
- Functional block diagram
- Layouts with details of connections and cable termination locations
- Interfacing point of connection/control with the EMS
- Functional description and drawings of the by-pass interlocking arrangement.

6.8.5 Function

The UPS system shall isolate the load from any mains power transient or longer term disturbance in voltage or frequency, and shall supply conditioned power to the load for the specified period of time after input supply failure.

6.8.5.1 UPS Redundancy

Where there are multiple UPS modules serving Life Critical loads i.e. emergency lighting and comms power (as per the electrical schematics), each UPS module and batteries shall be able to support the load for both outgoing switch panels of the failed UPS. For the emergency lighting systems 2no static switches shall be configured to switch between UPS modules to provide an interrupted power supply. For the UPS comms power, local static switches shall be located at each of the local distribution boards to switch between UPS modules.

6.8.5.2 Load

The UPS systems shall operate within limits when supplying the load. The UPS shall offer the following service duty:

- Electrical equipment with battery backup supporting emergency lighting, DC supplies, switched mode power supplies and uninterruptable power supplies;
- IT servers including blade servers;
- Communications network switching devices;
- Largely single phase electronic equipment load with high harmonic current content.

6.8.5.3 Earth and Neutral Connections

Connect the UPS output neutral to the bypass ("Mains 2") neutral in the UPS equipment. Connect the UPS module earth bar to the supply circuit earth.

All neutral current carrying conductors and components (switches, etc.) shall be rated for not less than 180% of the associated active conductor.

6.8.5.4 Phase Rotation

Take care to connect all input supplies and output to maintain correct phase rotation. Check on-site prior to connecting load.

6.8.6 Requirements

The UPS shall be self-contained and be capable of safe, unattended operation.

The equipment shall comprise the following:

- Rectifier/Battery Charger;
- Inverter;
- Battery and Stand or Enclosure;
- Battery Monitoring;
- DC isolation points for each string of batteries;
- Synchronous Static Bypass Switch;
- Internal Manual Maintenance Bypass Switch;
- Castell key interlocking with the external maintenance bypass;
- All necessary associated equipment, protection devices and controls including isolating switches, circuit breakers, instruments, alarms and displays.

Further to UPS performance requirements details are provided in the table below:

Element	Standard/ Reference
Input voltage distortion	THVD < 5% and TVD < THVD + (1.05 x THVD) for on site location. No individual harmonic > 3% Note that further mitigation may be required at the UPS to meet Supply Distribution Company requirements at the PCC (Point of Common Coupling).
Input voltage	400V 3 phase (nominal) -20%, +10%
Output voltage	400V 3 phase sinusoidal
Load current crest factor	3:1
Output frequency:	50 Hz (nominal) ± 1%
Voltage output stability	0 to full load ± 0.5% (Regulation) Balanced to 50% unbalanced load ± 1%
Transient voltage:	50% Full load step ±8%
Performance	Loss of AC Input ±5% Return of AC Input ±5% Transfer between UPS and bypass (and vice versa) ±8% Recovery response time to 95% in 50ms, to nominal in 100ms
Phase displacement:	Balanced load (all values) 120 ±1% 50% unbalanced 120°C±3°C
Bypass	Static by-pass: Provide an automatic, no-break, integral static by-pass switch with automatic reset, to transfer the load automatically to the by-pass supply when the UPS output characteristics are outside the designated limits (can be short time rated if automatically transfers to continuously rated bypass switch, without a break). Less than or equal to 5m/s change-over for restoration of supply Maintenance by-pass: Provide a manual by-pass switch to manually transfer the load to the mains supply, bypassing the UPS and the static by-pass switch.
Overload capabilities	125% UPS rated load for at least 10 minutes 150% UPS rated load for at least 1 minute
Efficiency	Greater than or equal to 92% under the following conditions: Operating at full load and part load i.e. 100, 75, 50 and 25% The module is operating at the nominally rated load and power factor. The battery is fully charged and floating on the system. The input voltage is within the specification. The load power factor is between unity and 0.8 lagging.
Input current limiter	Limit input current to 125% of the full rated load current.
Rectifiers/chargers	Totally solid state 12 pulse providing direct current to the inverter unit and the battery. Waveform characteristic: 12 pulse bridge rectifier, or better, for all connected loads (e.g. discontinuous conduction through parallel connected phase shifted 6 pulse rectifiers is not acceptable). Use semiconductor bridge, connected to the input through a series inductance to rectify the AC input and pass through an LC inline filter connected to the DC Bus.
Battery chargers	Restore the battery from discharge to approximately 80% charge within eight hours, 95% within a further 12 hours after mains restoration following a full battery discharge, while maintaining full inverter load.

Element	Standard/ Reference
	DC ripple: Less than 2% RMS, under all conditions.
Inverters	Synchronisation: With the static bypass line provided the static bypass line remains within +/- 0.5% or 1% (selectable) of the nominal frequency. Rate of change of output frequency: Less than 0.1 Hz per second.
Batteries	Sealed lead-acid, recombination type, to be rated at 25°C, relative humidity 90% (minimum). Load transfer module (LTM's): Voltage tolerance: configurable up to ± 20% Frequency tolerance: configurable up to ±10% Admissible overload: 10sec 200% 2min 150% Short circuit capability: 20 to 60 In Three phase nonlinear loads capability: neutral rating 1.7 In Harmonic compensation: In built harmonic compensator for elimination of load-generated harmonics Minimum life expectancy of 10 years (3 year warrantee and 7 years pro-rata)

System	Back-up Time
Master clock system	90 min
CCTV	90 min
PIDS	90 min
PA	90 min (plus up to 24 hours quiescent)
Critical and essential communications systems	90 min
Critical operational room lighting and power	90 min
EWIS	90 min
Staff and emergency radio systems	90 min
Digital voice recorder systems	90 min
Main control system	90 min
Station control system	90 min
UPS and selected plant room ventilation systems	90 min
Station and tunnel emergency lighting	90 min
Fire services communications systems	90 min

6.8.6.1 Service and Repairs

All components shall be easily replaced. Controls shall be solid state type mounted on plug-in circuit cards. Control system shall include a self-diagnostic facility and display and facilities shall be provided for remote indication of status and alarms.

6.8.6.2 Housing

Equipment shall be housed within a floor mounted, painted, sheet steel, cubicle with anchor bolt to the floor or wall. Access to all equipment and terminals shall be by means of hinged doors or removable panels.

Access: All installation, testing and maintenance shall be available by means of front access only, preferably via hinged, lockable doors.

Cable Entry: Provide gland plates for input and output cables in top of cabinet.

Safety: Provide insulating shrouds and internal barriers to permit safe access for setpoint adjustments, testing and limited maintenance with equipment live.

6.8.6.3 Corrosion Protection

Protect all equipment including transformers, frame and cubicle metalwork against the effects of corrosion.

6.8.6.4 Cubicle Ventilation

To maintain component cooling, provide air inlet louvres and ventilation fans. The number of fans shall be such that the failure of one will not cause the system to shut down. Provide vents for cooling air inlet through low level louvred openings in cabinet.

6.8.6.5 Over temperature Protection

Protect equipment against overheating due to excessive ambient temperature or failure of cooling fans. The load shall be automatically transferred to static bypass in case of over-temperature. Temperature sensors shall be fitted to all critical equipment. All cooling fans per module to be arranged in a redundant configuration.

6.8.6.6 Circuit Protection

Provide over-current protection at the following locations:

- Rectifier input.
- Inverter input.
- Inverter output.
- Static switch input.
- Unit output.

6.8.6.7 Protective Devices

Circuit breakers: Units to have a fixed setting or be calibrated for function, then permanently sealed.

Fuses: HRC type or fast acting fuses suitable for protection of solid state devices where applicable.

Identification: Clearly label each device with rating and function.

6.8.6.8 Monitoring

Provide facilities, test points or sensors on the UPS equipment to enable:

- monitoring of waveforms to facilitate testing and fault finding;
- measurement of critical voltages;
- measurement of hot spot temperatures;
- measurement and monitoring of other critical parameters.

6.8.7 Performance

6.8.7.1 Fault Rating

Input circuit protection equipment shall be capable of withstanding and isolating the prospective fault current of the supply switchboard.

The UPS shall be sized such that it will clear the largest downstream Circuit Protective Conductor when operating on battery, i.e. where no normal or essential supplies are present.

6.8.7.2 Electromagnetic Interference

Provide adequate measures to limit electromagnetic interference.

6.8.7.3 Protection

Provide protection against damage or faults due to following conditions and ensure that load is isolated from their effects:
Supply over-voltage and under-voltage;
Transient supply voltage surges;
Sudden changes in load.

6.8.7.4 Harmonic Suppression

Limit the harmonic content of input current by providing a 12 pulse rectifier.

6.8.7.5 Ambient Conditions

Equipment shall operate normally and within specified tolerances over full load range under the following conditions:

- Temperature: 0°C to 40°C
- Humidity: 95% RH

See Clause "Battery Rated Output" for ambient conditions applicable to battery capacity.

6.8.7.6 Voltage Adjustment

The equipment shall be suitable for operation at the present Australian Standard voltage. All necessary facilities shall be provided to adjust to this voltage for input and output to achieve +10 and -6% of 230/400V.

6.8.8 Rectifier/Charger

6.8.8.1 Requirement

Units shall comprise solid state, high reliability, sealed components to provide regulated DC power to start and run inverter unit and charge batteries.

6.8.8.2 Features

The unit shall incorporate:

- input circuit breaker;
- soft start feature which limits inrush current at switch on to the normal maximum input current;
- fast acting fuses to protect power semiconductors except where circuit breaker provides adequate protection;
- automatic voltage regulation within limits acceptable to inverter input and to maintain battery in a charged condition;

- rated to supply full system output via inverter and simultaneously charge batteries after full emergency discharge period;
- battery charging current shall be adjustable in the range 1/10 to 1/15 of rated discharge current or otherwise as recommended by battery manufacturer;
- current limiting to prevent damage in case of low battery volts or short circuit;
- output filter to limit ripple current into battery to 3% peak to peak of charging current;
- monitoring of DC output arranged to transfer inverter to battery and switch off rectifier/charger if output is not within tolerance;
- battery charge current inhibit, signalled by closing of a remote set of voltage free contacts connected to terminals provided in unit to limit UPS input current when emergency generator is supplying unit.

6.8.9 Inverter

6.8.9.1 Requirement

The Inverter shall be capable of providing the specified quality output power while operating from any DC source voltage (rectifier or battery) within the specified; DC operating range.

The modular design of the UPS module shall permit easy removal of each phase of the Inverter and DC electrolytic capacitors without removal of any other assembly.

Uninterrupted manual transfers shall be initiated from the control panel. Uninterrupted manual transfers to Bypass and from Bypass shall be possible with the Inverter logic, without using the emergency bypass control logic or the static switch.

During manual transfers to bypass mode, the Inverter must verify proper Bypass operation before transferring the critical load to the Bypass. Where Insulated Gate Bi-polar Transistors (IGBTs) are featured they shall be arranged in a three-leg, pulse-width-modulation (PWM) design with a minimum switching speed of 4500 HZ. Protection circuitry shall be included which prevents the IGBTs from sourcing current in excess of their published ratings.

6.8.10 Synchronous (Static) Bypass Switch

6.8.10.1 Requirement

Unit shall comprise an AC static switch with automatic bypass contactor or circuit breaker rated for continuous operation at rated output.

6.8.10.2 Features

The static switch control system shall incorporate:

- Synchronous transfer of load without interruption from inverter output to bypass supply, and in reverse direction, automatically or by manual control.
- Automatic transfer to bypass if load current exceeds safe overload rating of inverter.
- Automatic transfer to bypass in the event of inverter malfunction.
- Protection to inhibit transfer in either automatic or manual mode if voltages and phase angles of inverter output and bypass supply differ to a degree which would cause system output to deviate beyond specified limits.

- Automatic transfer of load from bypass to inverter output when inverter output and system load are within normal operating limits, after transfer to bypass has been initiated by an abnormal condition.
- Inverter in parallel operation with mains bypass supply limited to a maximum of one second or otherwise as stipulated by Supply Authority.

6.8.11 Manual Bypass Switch

6.8.11.1 Requirement

The Bypass shall serve as an alternate source of power for the critical load when performing maintenance on the UPS module or when a failure prevents operation in Normal mode.

The Bypass shall consist of a naturally-commutated static switch, for high-speed transfers, and wrap-around switchgear.

The maintenance bypass shall be ‘castel’ key interlocked with the external manual bypass.

The modular design of the UPS module shall permit removal of the static switch without removal of any other assembly.

The static switch shall only be necessary for controlling emergency make before break transfers.

The Bypass shall feature the following transfer and operational characteristics:
Uninterrupted transfers to Bypass shall be automatically initiated for the following conditions:

- Output overload period expired
- Critical bus voltage out of limits
- Over temperature period expired
- Permissible level of battery discharge
- UPS module failure.

Uninterrupted automatic retransfer shall take place whenever the Inverter is capable of assuming the critical load. Uninterrupted automatic retransfers shall be inhibited for the following conditions:
When transfer to Bypass is activated manually or remotely

In the event of multiple transfer-retransfer operations the control circuitry shall limit “cycling” to three (3) operations in any ten minute period. The fourth transfer shall lock the critical load on the Bypass source.

6.8.11.2 Rating

Switch shall be rated to carry at least 150% of UPS rated output.

6.8.12 Instrumentation and Controls

6.8.12.1 Requirement

A control panel shall be provided to give a clear indication at all times of the state of the system and components and to permit manual control and isolation and identification of faulty equipment.

6.8.12.2 Mounting

Flush mount panel in cabinet at a convenient height.

6.8.12.3 Characteristics

The controls shall be simple to operate and indications and alarms shall be easy to read and interpret. The control panel may utilise conventional pushbuttons and selector switches, labelled as required with LED indicators to display operating and alarm conditions, alternatively a keypad with LCD display and menu with prompt commands may be used.

6.8.12.4 Features

Shall include:

Mimic diagram of system with visual indication of state of principal components;
alarm conditions displayed until reset after condition has gone;
audible alarm with mute facility to signal any abnormal condition;
provision for connection of remote summary alarm signal;

Controls shall include:

- start/stop;
- manual control of synchronous bypass;
- load disconnect;
- alarm reset;
- indications shall include:
- mains on;
- rectifier on;
- load on inverter;
- load on bypass (synchronous or maintenance);
- input voltage;
- input current;
- output voltage;
- output frequency;
- output current, kW, kVA;
- battery current charge/discharge;
- battery voltage;

Alarm indications shall include:

- mains input supply out of tolerance;
- fault indication for each main component;
- battery discharging;

- load on bypass;
- inverter/bypass supply not synchronized;
- stop imminent (battery near minimum);
- battery discharged/UPS shutdown;
- battery over-voltage;
- battery circuit breaker open;
- battery under-voltage;
- overload;
- over-temperature;
- fan failure;
- output voltage outside tolerance.

6.8.12.5 Battery Protection

Automatic protection of battery against over discharge, irrespective of system load shall be provided. The cut-off voltage at which the UPS is automatically shut down shall be programmable as a function of the discharge rate.

6.8.12.6 High Level Interface

Each UPS module and system shall incorporate facilities including cable sockets for connection of cables to the EMS system using Modbus protocol.

Refer to the Station Controls and SCADA specification, EMS points schedule, EMS sections of this specification and Electrical schematic drawings for SCADA and EMS interfacing requirements.

All necessary interfacing to be allowed to set the UPS systems to work on the EMS and SCADA systems.

6.8.12.7 Alarm Log

Alarm conditions shall be logged in a non-volatile or battery backed memory in sequential order with clear indication of date, time and condition. The logged data, up to memory limit, shall be retrievable at any time.

6.8.12.8 Automatic Battery Discharge Test Facility

The system to incorporate an automatic facility to periodically discharge and test the battery. The system shall adjust rectifier output for a present period so that the major load is supplied by the battery. The interval between automatic discharges shall be programmable. Test results shall be automatically logged.

6.8.12.9 Fault Diagnostics

The control circuit cards shall incorporate LED's or other features which facilitate fault finding. The control system shall produce comprehensive alarm message, indications or codes which are referenced in the Maintenance Manual. The manual shall indicate appropriate action to rectify any fault based on the indicated fault diagnosis.

6.8.12.10 Remote Monitoring

The following remote monitoring shall be provided in the form of volt-free changeover Contacts compatiable with the existing station system:

- UPS Fault (common alarm)
- UPS fan fault
- UPS overload
- Static Bypass switch operation
- Static Bypass mains fault
- Rectifier fault
- Rectifier mains fault
- Battery operation
- Battery time available (programmable)
- Battery under-voltage
- Battery temperature high
- Battery disconnected
- Battery Charge and discharge Current
- Load Output
- External manual bypass operation
- Common Fault Alarm to the Fire Alarm System

6.8.12.11 Monitoring & Control Components

The following components shall provide monitor and control capability with the EMS:

- Micro-controller driven circuitry:
- Monitor Panel with status indicators
- Alarm and metering display
- Building alarm monitoring
- Input circuit breaker
- Inverter and bypass contactors
- RS-232 (EIA/TIA-232) and RS-485 communication ports
- RJ45 (TCP/IP) network connection.

6.8.13 Battery

6.8.13.1 Requirement

Provide a battery bank comprising high performance, valve regulated, maintenance free, lead acid batteries incorporating:

- high impact resistant plastic containers;
- high pressure relief vents;
- low resistance, corrosion proof inter-cell connections;
- matched lead calcium plates;
- insulating shrouds over all connections with holes for insertion of meter probes;
- labels on each battery stating date of manufacture/date of putting into service;

- design and construction for minimum 10 year warranty;
- 90 minute battery autonomy time at beginning of life for critical life-safety, 3 hours for critical loads .

6.8.13.2 Manufacturer/Supplier

The battery shall be manufactured by an organisation with an established history of manufacturing reliable batteries and an established and reliable sales and service organisation shall be present in NZ.

6.8.13.3 Rated Output

Specified emergency period shall be provided at 25°C and a manufacturer's guarantee shall be provided that this capacity will be achieved at the end of a 10 year period after Date of Practical Completion. Initial capacity post initial battery recharge shall provide not less that 25% reserve post the specified emergency period which is 30 minutes.

6.8.13.4 Warranty and Guarantee

The battery supplier shall guarantee to replace any faulty batteries at no charge for a period of up to 3 years from Date of Practical Completion. Replace any faulty batteries for a period of up to 10 years after this date on a pro-rata cost basis. A written statement from the battery manufacturer or supplier, specific to this project shall be provided to support this warranty and guarantee provisions.

6.8.13.5 Enclosure/Stand

Battery bank shall be complete with multi-tier ventilated enclosure/stand maximum 2 m high, arranged for easy testing and replacement of batteries and designed to suit space allowed.

The installation shall be as follows:

- batteries arranged in 2 rows per tier, access from both sides;
- battery locations sequentially numbered and labelled;
- acid resistant, powder coated finish, bolted steel panel and frame construction;
- designed to spread load on floor with special base to distribute load over slab under false floor;
- designed to occupy minimum room area;
- earthed.

6.8.13.6 DC Cables

Interconnecting cables shall be flexible with bolted connections to terminal posts and shall be arranged to minimise overall resistance. Provide Red (+ve) and Black (ve) colour coding at terminations.

Parallel Strings: Where parallel battery strings are installed the interconnecting cables of each string shall be rated for full load current to allow for failure of one string. Each parallel string shall be housed in a separate enclosure and the individual strings shall be fitted with fuses in each leg and a full load rated isolator.

6.8.13.7 Battery Circuit Breakers

Shall be provided and shall:

- isolate battery bank in event of a fault;

- be mounted in a prominent position and labelled to approval.

6.8.14 Maintenance

6.8.14.1 Requirements

During Defects Liability Period, promptly attend site and rectify any defects when advised by the Managing SubContractor and in addition, make regular visits at no more than 3 monthly intervals for routine checking and maintenance. Provide a written report after each visit.

6.8.14.2 Routine Maintenance

Work carried out on 3 monthly visits as a minimum shall include:

- attention to any items advised;
- checking of fault and alarms log and attention to any relevant items;
- check and record all parameters displayed on control panel;
- check that displays, indicators, etc., including all remote items are working;
- by arrangement, carry out transfer to bypass and return switching operation;
- by arrangement, carry out a battery discharge test.

6.8.14.3 Battery Check

Prior to Final Completion, carry out a battery discharge test and measure and record individual battery voltages during test. Note any anomalies and replace any batteries which display poor performance.

6.8.15 Tools, Test Equipment and Spares

6.8.15.1 Requirement

Provide a set of recommended tools and spares together with such test equipment as necessary for regular maintenance of the installation.

6.8.15.2 Items

Shall include but shall not be limited to:

- A spanner to suit cell connections;
- Spare fuse cartridges, 3 of each size and type fitted;
- Spare indicator lights, 3 of each type fitted.

6.8.16 Staff Training

6.8.16.1 Requirement

Train the site staff in the maintenance and operation of the system. The manuals shall be discussed and explained during the training sessions.

6.8.16.2 Time

Training shall take place at an agreed time after testing and commissioning. At least two separate training sessions shall be provided.

6.9 CABLE DUCTS AND DRAWPITS

All cable ducts shall be formed from 100 or 150 diameter minimum single or composite multi-duct systems as shown on the Electrical Drawings. Ducts shall be laid in continuous lengths with integral joints and shall form a watertight system to prevent the entry of ground water into the duct system.

Ducts shall be Marley system or equal approved and installed to the manufacturer's recommendations.

Ducts shall be rigid uPVC to AS/NZS2023 and carry Bureau Veritas Licence number 2297 complete with vehicle loads, encasement, concrete and draw pits, fittings etc. to make a composite system. All duct routes shall be shown on the installer's drawings and agreed on site with the Principle Contractor's Appointed Representative prior to installation.

Cable ducts shall only each contain single distribution cable (with any associated pilot or control cables), but for final LV circuiting and ELV systems such as comms, SCADA etc., multiple cables may be drawn into a duct, so long as the cables do not take up more than 50% of the duct section, the cables can easily be withdrawn and the effect of grouping is allowed for in the current rating of the cables.

All duct and tape colours and identification shall comply with AS/NZS3000 specific requirements.

Abandoned ducts are sometimes used for other purposes. Ensure systems are fully identified and traced out before any work is carried out. Ducts shall be laid to be self-draining to the cable pits and a drainage connection shall be made to the surface water drainage system.

Ducts shall be kept clear of gas and water pipes, drains, sewers and electrical plant.

In order to allow the use of 'tapping' machines on gas and water mains that may be adjacent wherever possible at least 150mm clearance shall be given to these and any other services. No clearance shall be less than 25mm where services cross, the minimum clearance shall be 50mm.

Ducts shall be laid to provide the minimum cover and spacing specified. Ducts shall be laid and supported on a minimum 100mm layer of compacted sand or shingle prior to backfill. Where it is necessary to deflect from a straight line or to vary the depth, as in passing from footway to carriageway or in entering an underground chamber, a lateral set not exceeding 25mm in a length of 750mm or a vertical set not exceeding 25mm in a length of 1.5 metres shall be given to the joints.

The Main Contractor's ER shall be in attendance to supervise the installation of the underground ducts during the appropriate stages of construction prior to backfill and concreting. Ducts shall be plugged or capped before and after each test. uPVC plugs or caps shall be inserted at the ends of each section of duct to prevent entry of soil or stones.
Ducts shall be cleared in the presence of the Main Contractor's ER with a mandrel not smaller than the internal diameter of the duct minus 12.5mm followed by a circular wire brush 12.5mm greater in diameter than the duct just before any cables are drawn in.

Draw pits where speficied (temporary Plaza works) shall be of standard modular type sytem, sized as per the electrical drawings and shall be light weight and easy to install on site. It shall be constructed from non PVC material i.e. cast aluminium or concrete and be suitable to be casted directly into contcrete with suitable bedding as per the manufacturers requirements.

Draw pits shall watertight once installed and also have the flexibility to allow various ducts diameters to enter and exit the pit. All duct openings shall be water tight to prevent ground water from entering the installation.

Draw pit covers shall shall support weights of upto load classification Class D in accordance to AS3996. Lid covers shall be flush with the ground and fully removable with the use of a suitable lifting aid/tool. Covers shall also be specified with an recess infill to allow the matching of the surrounding floor finishes. Draw pits shall be supplied from a reputable manucturer such as SIKA 'Pathway' range or similar approved and locally manufactuered.

Draw-pits of a depth exceeding 900mm shall be fitted with step irons or a prefabricated steel access ladder in accordance with BS EN 13101-2002 or AS/NZS equivalent. The step irons/ladder shall be fixed with stainless steel masonry anchors or cast-in fixing systems. Access ladders or step irons to be located for easy access into the draw pit.

After all cables have been installed, both duct ends shall be sealed using mastic or expanding foam to form a vermin, gas, water and fire barrier. The fire rating of the seal shall be as necessary to match the fire rating of the local building structure. Spare ducts shall be sealed with end caps and mastic to form a vermin, gas, water and fire barrier.

Cables shall be identified where they come into and out of ducts and all labels shall be legible and visible after duct sealing is complete.

6.10 HERITAGE CONSIDERATION (CPO)

Where Services are located in very sensitive areas, and come under Heritage, special care shall be sort from the architect and design team, to ensure the correct installation is employed. The detail shall be sort from the particular drawings pertaining to these areas, and will not for the standard approach as detailed in this section.

6.11 POWER FACTOR CORRECTION (PFC) AND HARMONIC FILTERING EQUIPMENT

6.11.1 General – Power Factor Correction

Power factor correction equipment shall be suitable for operation from the supply voltage and frequency, including the tolerances specified elsewhere.

6.11.1.1 Requirement

Power factor correction equipment shall be provided to correct the power factor to the value in the particular specification.

The complete power factor correction equipment assembly shall comply with all applicable requirements of this specification and shall incorporate adequate provision for connection to the general earth system.

Power factor correction equipment intended to be applied centrally or to specific groups of motors shall comprise a sufficient number of capacitor units to make up the specified capacitance, accommodated in a suitable cabinet or in a series of modular cubicles assembled together to form a composite unit, together with a control relay, switching equipment, protective fuses and means of isolation, all assembled and connected to as to control automatically the switching 'on' and 'off' of the capacitors in response to changes in the load power factor.

Each assembly and all of the equipment within it shall be so arranged that every item of apparatus is readily accessible for adjustment where this may be necessary, and for maintenance.

Each assembly shall be complete with incoming isolating switch of appropriate rating, HRC fuses, a set of insulated copper bus-bars rated for the total capacitive load, suitably rated contactors for the automatic switching of the capacitors in stages and a suitable control relay of approved design.

Capacitors shall be of an established, proven design and two copies of type-test certificates shall be submitted to the Appointed Representative for comment. Each capacitor unit shall comprise a balanced three-phase system of capacitors.

Each capacitor stage shall be protected by BS EN 60269 fuses (or AS/NZS equivalent) and be switched by a separate, block type contactor rated for capacitor switching duty (BS EN 60947-4-1).
Capacitors shall be self-healing type to IEC 60831-1.

Capacitors shall consist of elements wound from metallised polypropylene film, vacuum processed and encapsulated in hermetically sealed containers. Each capacitor shall have overpressure operated disconnect fuse elements, in addition to overcurrent protection.

Capacitors shall be provided with discharge resistors to achieve full discharge within 60 sec. of disconnection. Capacitors shall have low loss per kVAr and be rated for a line current not less than 1.3 times the rated current. 50kVAr steps shall be used.

Means shall be provided to identify a failed capacitor or bank of capacitors. Units of equal capacitance shall be interchangeable.

Space shall be left in the power factor correction equipment for the installation of detuning reactors should their use prove necessary in the future.

The control relay shall be suitable for operation from the current transformer(s) installed for the purpose; within the main low-voltage switchboard, (by the panel manufacturer) as shown on the drawings.

A microprocessor based reactive power controller connected to EMS shall be provided to control switching of the capacitor banks and allow rotation of use of the banks to uniformly distribute usage.

The controller shall ensure:

- Automatic disconnection of all capacitors in the event of mains failure, with a two minute delay before re-connection
- Target power factor setting adjustable, and set at the initial power factor as required within the particular specification to correct to unity
- Time delay between switching of stages to ensure capacitors are sufficiently discharged before re-energisation and to prevent hunting
- Push button operated manual override incorporating time delay as above
- Adjustable switching programmes
- Incorporate normally open volt-free contacts for BMS indication of common alarm
- Visible LED indication of capacitor stages
- Shrouding and large, clearly visible warning labels shall be provided within the
- enclosure to warn personnel of the need to discharge the equipment prior to any work.

Cable glands or sealing boxes shall be provided for the connection of incoming supply and control cables as specified.

6.11.2 General - Harmonic Filters

Active power Quality Filters shall be provided in the MCC Panels where required to be protect against damage from harmonic currents.

All Harmonic currents shall be cancelled at the MCC panel or at the source where no MCC panel is installed. Any further equipment required will be provided in the main switchboards after installation, when all the equipment is installed and running and accurate measurements provided.

6.11.2.1 Requirement

If Harmonic filters are required they shall comply with the below specification.

The Active Filter Type module for neutral current and line current filtering, rated at “00” Amps per phase shall monitor all three phases of the low voltage line current in real time, and process the measured harmonics by means of a multi-Digital Signal Processor (DSP) system and microcontroller.

The filter to be capable of operating on a 3 or 4 wire system as required. The control of the power modules and associated reactors shall be such that harmonic currents are generated in anti-phase those to be attenuated; and injected into the source of supply to the filter so that the harmonic currents flowing in the line are reduced to the programmed levels.

The system shall be operated under closed loop control via 3 –c.t.’s (1 per phase:class 1.0; 15VA; 5-Amp secondary); measuring both the system and the Active Filter loads, and shall have a maximum response time of not more than 40 milliseconds.

The control system shall be such that the Active Filter cannot be overloaded. Simultaneous filtering shall be provided for 15 individual harmonics, which shall be individually programmable per harmonic up to the 50th harmonic in line with G5/4 requirements. The degree of filtering shall be programmable; for each harmonic, in Amps, as a percentage of the line current fundamental, or as a percentage of the total line RMS current, as selected by the programmer. The Harmonic attenuation factor to be better than 97%.

The operating power factor of the active filter shall be programmable over the range 0.6 inductive to 0.6 capacitive. Both fixed and dynamic reactive power consumption shall be available for selection by the programmer.

Each Master Filter to be complete with a PQF Manager which is a graphical user interface and offers direct control, programming, monitoring capabilities without a PC, communication facilities and detailed fault and event logging with real time stamp.

The filter to be of a modular design and capable of controlling up to 4 units of equal rating in parallel. The Active Filter shall be housed in a forced air-cooled enclosure to IP30 and to be complete with its own integral cable entry spreader box for bottom cable entry.

6.12 COMMUNICATIONS

6.12.1 General

Provide a passive telecommunications cabling network system as follows and as documented in the preliminary, general, scope and technical sections of this specification.

In the situation where there is a conflict of compliance between the AS/NZS codes or detail in this specification, clarification shall be confirmed by the tendering Contractors prior to closing of the tender period.

6.12.2 System description

Provide the following as documented:

- Network connections (existing site campus)
- Building distributors
- Backbone cabling
- Telecommunications outlets
- Patching of telecommunications (copper and fibre optic)
- Comms room racks and associated equipment

6.12.3 System performance

- Category 6/6A UTP
- Application class to AS/NZS 3080 clause 6.3: E.
- Balanced system to AS/NZS 3080 clause 7 (data): Category 6.
- Balanced system to AS/NZS 3080 clause 7 (voice): Category 6.
- TIA/ETL-568-B.2-10
- IEEE 802.3ba
- EN 50173-1:2992 Information Technology – Generic Cabling Systems – Part 1: General Requirements and Office Areas.
- Fibre system components type: ST/ To be confirmed by client.

6.12.4 Cross references

Conform to the following associated work sections:

- Scope of works and associated sections
- Cable support and duct systems

Refer to specification appendices and drawings for further details of the voice and data installation requirements.

6.12.5 Standards

The system shall be provided to meet the following standards:

- All structured cabling works shall be installed in strick compliance with the Auckland Transport Business Technology (BT) Communications Cabling Infrastructure specifications and the latest applicable TE Connectivity, Enterprise Networks warranty specification
- AS/NZS 3084 - Telecommunications installations - Telecommunications pathways and spaces for commercial premises
- AS/NZS 3000 Electrical installations (known as the Australian/New Zealand Wiring Rules)
- AS/NZS 3085.1 - Telecommunications installations - Basic requirements
- Cabling products to:
- AS/ACIF S008
- AS/NZS 3080 - Telecommunications installations - Integrated telecommunications cabling systems for commercial premises

Installation of commercial cabling to:

- AS/ACIF S009
- AS/NZS 3080
- AS 3084
- SAA HB29
- SAA HB243

6.12.6 Interpretation

For the purposes of this works section the abbreviations given below apply.

- EMC: Electromagnetic compatibility.
- EMI: Electromagnetic interference.
- EMR: Electromagnetic radiation.
- RU: Rack unit.
- CES: Communication earth systems.
- TRC: Telecommunications reference conductor.

6.12.7 Submissions

6.12.7.1 Technical data

Submit technical data including the following:

- System design parameters: Performance
- Voice and/or data transfer rate
- Cable type and characteristics
- Segregation requirements for EMI/EMR
- Maximum length of cables
- Cross-connect type and characteristics
- Cross-connect block
- Patch cords
- Fibre optic terminations
- Patch panel module
- Cable management for racks
- Rack
- Fly leads
- Submit all technical data with the tender return for approval of all equipment by the client.

6.12.7.2 Samples

Submit samples for approval of telecommunications outlets and all telecommunication accessories, cabling, connectors, cable basket etc.

6.12.7.3 Shop drawings

Submit showing the following:

- Layouts of equipment racks.
- Cross-connect layout.
- Cabling diagram for complete system.
- Cable management system.

6.12.7.4 Certification

Submit certification for the completed installation showing conformance with the requirements as documented herein.

6.12.7.5 Log Books

Submit log books for each distribution frame with details of cable terminations and provisions for recording cable, line and jumper information. Identification and labelling, and record documentation to AS/NZS 3085.1.

6.12.8 Network Connection

Provide and install lead-in cabling as described in the scope and associated sections of this specification.

6.12.9 System Components

All system components (distributors, cabling and outlets), where possible, to be of a common manufacturer and every component to meet the required level of performance.

6.12.9.1 Distributors

Wall mounted cable distributor or rack mounted 8-pin modular patch fields for incoming voice cables (1 pair terminated per jack) and outgoing outlet field cables (4 pair terminated per jack). Provide rack space and check that power outlets are provided and suitably located. Provide cable management rings and jumper bars. Minimum 25% spare space capacity in each field and overall rack capacity.

6.12.9.2 Equipment racks

Provide and install equipment racks and associated equipment as described in the scope and associated sections of this specification.

All fly leads shall be provided and installed by the client.

Modular connector patch panels

Terminate directly to the modular connector. Terminate Patch cord ends with appropriate registered jacks.

6.12.9.3 Optical fibre termination panels

Provide fibre optic cable break out trays at each group of fibre optic cable terminations. Neatly loom cables and lay stripped cables into the break out tray. Ensure that cables are secured by the sheath and that there is no stress on the fibre optic cores.

Fibre optic connectors shall be of the bayonet type, specification to be agreed by the client.

6.12.9.4 Cable management

Provide a record book at each cross-connect. Secure log books in each distribution frame records holder.

Provide Identification, labelling, and record documentation to AS/NZS 3085.1.

6.12.9.5 Cables

Copper:

- Standard: To AS/ACIF S008.
- Balanced system cables: UTP.
- Cat6 UTP

Fibre:

All specifications to be presented to and confirmed by the Contractor

- Standard: To IEC 60793-2.
- Default type: 6 core multimode OM3 50/125 mu

- Length: Provide V1000mm spare at each end.
- Component type: LC

External:

- Standard: Water penetration resistance to IEC 60794-1-2.

6.12.9.6 Telecommunications outlets

Quantities and locations as drawn. Allow to move up to 2 metres prior to installation. Confirm all locations prior to installation. Mount at 300mm above finished floor level unless noted otherwise. Mount aligned with electrical socket outlets where present, separated at 100mm centres. Mount on Category 6 compliant skirting trunking where indicated.

Requirements:

- Outlets: Provide RJ45 8 way modular jacks.
- Standard: To AS/ACIF S008.
- IEC 60603-7-4/5
- Electrical performance – Cat6 UTP
- Pinouts: T568B to AS/NZS 3080.
- Mounting: Flush mount.
- Style, material and colour of plates: To match adjacent power and switch plates.
- 100 ohm balanced category 6 - multiple outlets on common faceplates.

6.12.10 Installation

Communications cabling installation to be carried out by competent workers experienced with the materials and in the techniques specified and accredited to work on the proposed manufacturer's system.

Install all equipment to the manufacturer's requirements.

Comply with AS/ACIF S009. Conceal all cables. Support all cables clear of hot and sharp surfaces without placing unnecessary strain on the cables or terminations. Earthed or insulated high tensile catenaries or cable trays in ceiling/floor cavities. Cable trays for greater than 24 cables in a common route. Cables run parallel to power cables separated by 300mm and cross at right angles with segregation. Do not share cable supports or penetrations with other services.

Backbone cable:

- From demarcation point to distributor or enclosure. Multi-pair voice grade (Category 3), terminate one pair per jack.
- From distributor or enclosure, to PABX. Multi-pair voice grade (Category 3), terminate one pair per jack.

Horizontal cable: 4 pair 100 ohm balanced Category 6 UTP, per outlet, terminate 4 pair per jack.

Crossover: Install cables neatly and without crossovers between cables.

Loom size: Loom cables into groups not exceeding 50 cables, and hold looms in place using reusable cable ties at least 20 mm wide. Do not exert compressive force on the cables when installing cable straps.

Cable separation:

- For safety: To AS/ACIF S009, and by at least 300 mm.
- Electromagnetic interference(EMI): To AS HB29.
- Fluorescent luminaires: Maintain a clearance of □ 300 mm.
- External cables: To ACIF C524.

6.12.11 Earthing System

Provide a communication earthing system (CES) to AS/ACIF S009 and SAA HB29.

Provide an earth bar within each distributor and connect to the local CET in accordance with SAA HB29.

Interconnections: Verify that there are no interconnections between the lightning protective earthing system and the telecommunications earthing system.

Labelling and Colour Coding

6.12.12 Testing

At completion test to manufacturer's requirements and provide a certified copy of the results. Correct or replace any sub-standard items and re-test.

6.12.12.1 Standards

- Testing of balanced cabling systems: To AS/NZS 3087.1.
- Testing of patch cords: To AS/NZS 3087.2.
- 100% of the installed cables must be tested. Tests to AS/NZS 3080 in conformance with SAA HB29.

Include the following:

Basic Link and Channel transmission tests including the following:

- Wire map.
- Length.
- Attenuation.
- NEXT.
- ACR.
- Propagation delay.
- Delay skew.
- Power sum NEXT.
- Power sum ACR.
- ELFEXT.

- Power sum ELFEXT.
- Return loss.
- Optical fibre cable: Carry out Basic Link transmission tests including the following:
- Length.
- Attenuation.

6.13 SECURITY SYSTEM (ACCESS CONTROL AND INTRUDER DETECTION)

6.13.1 General

Provide a security, access control and monitoring system as follows and as documented in the preliminary, general, scope and technical sections of this specification.

In the situation where there is a conflict of compliance between the AS/NZS codes or detail in this specification, clarification shall be confirmed by the tendering Contractors prior to closing of the tender period .

6.13.2 System description

Provide the following as documented:

- Gallagher 6000 security and access control system (as a minimum requirement)
- Equipment and functionality as described in this section and scope sections of this document

6.13.3 Cross references

Conform to the following associated work sections:

- Scope of works and associated sections
- Cable support and duct systems
- CCTV and Security technical section

Refer to the security, comms and electrical drawings for security device locations, comms and further details of the security and access control system.

6.13.4 Standards

- All structured cabling works shall be installed in strick compliance with the Auckland Transport Business Technology (BT) Communications Cabling Infrastructure specifications and the latest applicable TE Connectivity, Enterprise Networks warranty specification
- Equipment design and manufacture: To AS 4428.4.
- System design, installation and commissioning: To AS 1670.4.

6.13.5 Technical data

Submit all technical data with the tender return for approval of all equipment by the client.

Submit technical data including the following:

6.13.5.1 Samples:

General: Submit samples of the following:

- Door contacts and reed switches.
- Key or card readers
- Electric mortice locks and door release devices.
- Duress alarm switches.
- Access control cards and tokens
- Detection devices.
- Activation devices

6.13.5.2 Records:

- General: Submit records to AS 2201.1.
- Licence: Submit copy

6.13.5.3 Shop drawings

General: Submit shop drawings showing the following:

- Block diagram of all systems.
- Panel layouts and dimensions.
- Power supply requirements.
- Wiring access necessary for door frames.
- Cut out dimensions.

6.13.5.4 Certification

Submit certification for the completed installation showing conformance with the requirements as documented herein.

6.13.5.5 Log Books

Submit log books for each distribution frame with details of cable terminations and provisions for recording cable, line and jumper information. Identification and labelling, and record documentation to AS/NZS 3085.1.

6.13.5.6 As-builts and Manuals

Refer to general and scope sections for requirements.

6.13.6 System

This specification calls for the supply, installation and commissioning of a complete, integrated security system in accordance with appropriate local and international standards; and the technical and performance criteria set out in this document.

This specification covers:

- Access Control
- Intruder Alarm System (door alarms and monitoring)
- Alarms Management
- Card, token and wrist band programming

The system is to be supplied with all equipment, hardware, software, cabling and ancillary services as required to provide an integrated system complete and functional in all respects. The tenderers are to familiarise themselves with all matters related to such requirement and to account for such in the tendered price.

Other security system components not included in this specification shall be fully integrated with this access control system.

It is the responsibility of the tenderer to obtain clarification of all matters in which doubt exists as to the exact intent of this document or in which a conflict appears to have arisen. Such information must be obtained prior to the closing and lodging of tenders.

The response shall clearly detail all pricing for components, cabling, installation, engineering, training, commissioning, setting to work, and 24 months comprehensive warranty.

The tenderer must include as part of the tender submission a complete, clause-by-clause response.

6.13.6.1 Product Competence

The successful tenderer will be required to demonstrate their competence to supply, install, commission and maintain the product line proposed in the tender submission as follows:

Provide a letter of reference from the product manufacturer confirming the tenderers status with the manufacturer advising:

- Exclusive or non-exclusive agreement to provide the system in the geographical territory for this specific project.
- The tenderer will be fully supported by the manufacturer in meeting the requirements of this specification.

The tenderer shall provide evidence of competency in carrying out the following areas of work:

- System design
- Installation management
- System configuration
- System commissioning
- System maintenance

When working on the system, each employee of the successful tenderer shall be required to carry an identification card issued by the product manufacturer showing evidence of current manufacturer factory training; indicating the level of training as defined above.

6.13.6.2 Functional Overview

The system shall provide comprehensive access control and intruder alarm functionality; allowing multi-site configuration able to be managed by one or more of the connected sites.

The system shall provide a means to control access through nominated doors having electric locking door status monitoring and token access control readers. Access rights associated with a presented access token shall be checked for validity based on token or identifier, access area, access time and any other access management function defined in this specification; as stored in intelligent field controllers. Access shall be granted or denied, dependant on the access privilege. Access rights shall be programmed in a variety of ways to allow flexibility as defined elsewhere in this specification.

The system shall monitor the condition of inputs. The system shall be able to be programmed to apply a variety of conditions to the way in which these inputs are monitored and shall enunciate the condition of such inputs in accordance with such programming.

The system shall provide a fully functional intruder alarm system including entry and exit delays where intruder detection sensors are connected to system inputs. The Intruder Alarm Systems component shall be fully integrated with the Access Control aspects of the system. It shall be possible to set (secure) or unset (unsecure) areas from any access control reader associated with an area, access control reader with keypad, Remote Arming Terminal, or as required from defined central control locations.

The system shall be OPC (Alarms and Events) and OPC (Data Access) enabled using Microsoft COM and DCOM enabling integration of event data with other third party OPC enabled automation and business systems.

The system shall allow data exchange with other applications using XML protocols for schedule changes, and card record changes.

All system communications must be totally integrated with either existing or new LAN/WAN networks. Tenderers must make themselves familiar with the specific requirements for this project.

Connection to Intelligent Field Controllers (IFCs) shall be achieved using cabling supporting Ethernet and TCP/IP protocols. The network connection must be on-board the IFC. Interface transceiver units (Ethernet to RS485, RS232 etc) are not acceptable.

Remote IFCs not permanently connected to the network can be connected via a PSTN service, using TCP/IP protocols.

Connection from the remote IFC to the server shall be either via dialup to an Internet Service Provider (ISP) using encrypted TCP/IP; and then via an approved firewall through into the IT environment or via dialup directly to a RAS connection on the Server.

All system software upgrades shall be downloadable through the network to the IFC.

All data communication internal to the system on the TCP/IP network between IFC's and between IFC's and the Server shall be encrypted using symmetrical session keys and an industry-standard encryption algorithm to a minimum of 128 bit AES. Session keys shall be changed on a regular basis at intervals no longer than 24 hours.

Communication authentication shall use 1024 bit RSA keys.

The system shall report all events to the operator(s) as configured and shall produce and maintain a log of all system events, alarms and operator actions.

The system shall provide a means for an operator to extract information relative to the event log and system configuration and produce this information in the form of printed reports, screen displays or ASCII files.

The system shall provide for a Windows based User Interface with Site Plans and interactive icons representing the location and real-time status of Access Control, and Alarm Monitoring equipment.

The system shall provide emergency evacuation reporting.

The system shall be designed and manufactured by a reputable company who shall be certified under the ISO 9001:2000 quality procedures.

All equipment shall have the following approvals:

- FCC Part 15
- CE approval BS EN 50130-4 Alarm Systems Electromagnetic Compatibility (Immunity)
- CE approval BS EN 55022 Emissions
- UL294 Access control
- UL1076 Burglar Alarms
- CSA C22.2 No. 205
- ULC-ORD-C1076

Encoders and readers shall also meet:

- CE ETS 300 683 Short Range Devices
- C-Tick AS/NZS 4251 Generic Emission Standard
- C-Tick RFS29

The system software shall be written in a fully structured, fully validated and commercially available language that provides a strictly controlled development environment.

The user interface for operational management of site security shall be developed using Microsoft .net and Windows Presentation Foundation (WPF) development tools.

Comprehensive backup and archiving facilities shall be incorporated as an integral part of the system software.

The system shall include system divisioning suitable for multi-tenanted buildings. Operators shall only be able to access those parts of the system which fall within their division and operator privileges.

IFC's must support peer to peer communications for input and output communications between IFC's. Systems that require the main server for communications between panels are unacceptable.

6.13.6.3 System Servers and Workstation Hardware

The servers for the permanent works shall be located in the B1 CPO CER room or ATBT data centres.

The workstation equipment shall support the Microsoft Windows environment as described in this section.

Where this document refers to 'central control' or 'workstation control', it is referring to the workstation in the existing east end control rooms and remote site-wide central security control room.

The server installation shall support 64 bit operating system.

The operating system used by the system server shall be manufactures latest release (Microsoft Windows, Linux, etc):

Workstations shall support multi-monitor operation, allowing an operator to set up one or more monitors for each workstation.

Where a workstation is configured for a lower resolution, dragging the view onto a higher resolution monitor shall cause the view to resize, taking advantage of the higher resolution.

Manual Deployment using installation media shall also be supported.

It shall be possible for an operator to run a workstation solely from files stored on and run from a USB memory device and without requiring any pre-installation of software on the PC.

6.13.6.4 System requirements

The system shall be in commercial operation with the same or similar configuration as detailed in this specification and shall be available for inspection. A reference list of such similarly configured systems and details of contact persons shall be submitted with the tender response.

The system described in this specification must have the following capacity as a minimum:

- Graphical Site Plans: Unlimited
- Access Readers: Unlimited
- Fully Supervised 4 state Alarm Inputs: Unlimited
- Output relays: Unlimited
- Access Control Zones: Unlimited
- Schedules per day: 100
- Schedule categories: 50
- Holiday days: 30
- Operators: Unlimited
- Concurrent Operator Sessions: Unlimited
- Cardholders: Unlimited
- Cardholder Issue Levels:15
- Cardholder Personal Data Fields: 64

The system architecture shall be a tiered system consisting of:

- Two installations of the head-end software application operating on computer servers and operator workstations;
- Intelligent Field Controllers (IFC's) managing the system in a distributed intelligence format;
- Semi-intelligent subunits (outputs, inputs, readers, etc) which rely on IFC's to function.

6.13.6.5 Operator Workstation And System Management Software

The system shall use the Microsoft Windows© operating system as defined previously. The version of Microsoft Windows shall be a currently supported version.

The system database shall be a version of Microsoft SQL Server appropriate for the system size required. The version of Microsoft SQL Server shall be a currently supported version as defined previously.

The system shall be OPC enabled in accordance with the current OPC specification for OPC (Alarms and Events) and OPC (Data Access).

The system shall automatically log and time/date-stamp all events within the system including intruder alarm set/unset events, access control events, operator actions and activity.

The control software shall be easy to use, make extensive use of menus and windows and require a minimum of operator training to operate the system proficiently. Systems requiring a program language approach to configure the system will not be accepted.

The control must be capable of receiving simultaneous alarm signals from a number of remote locations, without loss or excessive delay in their presentation to the operator. Any authorised operator should be allowed to acknowledge, view and/or process an alarm from any screen.

The control shall be fitted with a real time clock, the accuracy of which shall be preserved over the period of main power supply failure. Synchronisation between the central control and Ethernet connected IFCs shall be automatic, not requiring operator intervention.

Operator selection of processing tasks shall be via menu selections. Authorised Operators shall be able process alarms, produce reports and modify database records without degrading system performance.

The following is the minimum operational and monitoring facilities required. The ability to:

- Program either a group or individual card readers with access control parameters, without affecting other card readers.
- Program the access criteria for individual Cardholders or groups of Cardholders.
- Store at least 64 non-access control data fields for each cardholder. The names of these “Personal Data” fields shall be user definable.
- Authorise or de-authorise a Cardholder in the system with the result reflected immediately throughout all readers in the system.
- Enable a “Card Trace” against selected Cardholders so that an alarm is raised each and every time that cardholder presents their access card or token.
- Pre-program holidays so that different access criteria apply compared to normal working days. The system must have a capacity to set at least 30 holiday days.
- Recognise and manage regional holiday requirements
- Define as many access zones as there are card readers fitted.
- Allow or disallow individual Cardholder access to any one, or group of card readers, in real time.
- Log all system and operator activity to hard disk as they occur.
- Program alarm response instructions into the system so that these are presented to the Operator when processing an alarm event.
- Enable an Operator to enter messages against alarm events.
- Override (temporarily) a Cardholder’s, or group of Cardholder’s, pre-programmed access criteria.

The workstation control shall display a one-line plain language event message for every activity event (alarm or otherwise) occurring in the system. All activity logged shall be time and date stamped to the nearest second (hh:mm:ss). On having the appropriate operator authorisation it shall be possible to drill

down into the properties of each component that makes up that event for future details. The event message shall advise:

- Time of event

- Action
- Successful or unsuccessful
- If the transaction is unsuccessful, the reasons for the denial.

This includes but is not restricted to the following items:

- All card attempts
- All door alarms
- All operator activity including log on, log off, alarm response messages and any alteration of system data files
- All alarm monitoring activations
- All communications link failures.
- Time schedules for different “day types” shall be configurable.
- Regional holidays shall be configurable to allow for regional variations.
- The system shall provide a detailed operator help file. This help file shall provide operators with text, audio and video help instructions and tutorials.

The system shall allow for searching of items configured within the system based on the following:

- Item characteristics
- Related items
- Times related to events including the item

6.13.6.6 Multiple Server Connectivity

Systems based on multiple servers installed at several locations shall be supported.

Alarms and events from all servers shall be able to be displayed on any or all of the system workstations.

The cardholder database shall be automatically replicated to all servers as a “global” entity.

Replication of cardholder changes shall occur as changes are made and not batch processed.

Communication between servers shall be peer to peer.

The multiple server environment shall allow for evacuation reports for each site on the multiple server system to be generated on one server, for one or more remote servers.

Operator views and access privileges shall follow the same rules across multiple servers as apply within a single server.

Security system items configured on existing servers shall automatically be recognised by any servers added to the multiple server group. Likewise system items configured on the server(s) being added shall be automatically recognised by the existing multiple server group.

Use of software interface modules, custom written, to connect servers into a multiple server configuration shall not be permitted.

Manual or script re-entry of data for existing servers into any new servers being added to the multiple server group shall not be permitted.

Synchronisation of data across all servers shall be automatic, real-time function not requiring operator intervention or initialising.

Should c`ommunication be lost between two or more servers, the individual servers shall continue to function independently and shall resynchronise all changes made whilst off line automatically.

Should a conflict occur resulting from two items being created in two or more servers whilst servers are off line then an alarm shall be raised when the servers are re-joined advising of the conflict.

Should an existing record be modified in two or more servers whilst the servers are off line then on reconnection, the modifications shall be carried out in time order of the modifications.

6.13.6.7 Graphical User Interface

Configuration Graphical User Interface:

- The system access shall be via a Graphical User Interface (GUI)
- All functionality shall be managed via the GUI
- Drop-down menus shall be provided to select all configuration functions.
- System items (hardware items and software items) shall all have an associated properties menu to allow item configuration.
- Configuration or operation using scripting or other forms of text-based programming will not be accepted.

Operator User Interface

In addition to the User Interface defined above, the Operator User Interface shall be provided as follows:

- Full screen, user configurable Viewers, designed specifically for the task and the information needs of the operator.
- Alarm management
- Cardholder management
- Monitor Site
- The system shall allow customised viewers to be created.
- The Operator User Interface shall be fully configurable by an operator with authorisation to configure Viewers.

Each Viewer shall consist of a Navigation Area and a Panel Area, as detailed below.

- The navigation area shall provide a list of system information associated with the specific viewer.
- It shall be possible to select and order the columns of data associated with alarm and cardholder viewers.
- Incremental searching shall be provided based on preselected data columns for cardholder viewers.
- Selection of a line item in the navigation area shall cause the associated tile data to be populated.
- Alarm Viewer headers shall display the number of unprocessed alarms for each alarm.

- One or more data Tiles shall be provided to display detailed data associated with the navigation area item selected.
- Tiles shall be able to be created based on a range of default Tiles provided for this purpose.
- Each tile shall be configurable with the required data fields as determined by the tile's function.
- Tiles shall be maximised by single click operation.
- When a Tile has been maximised, other Tiles shall remain visible in a film-strip format, allowing single click to restore them.
- Where applicable, minimised tile icons shall display dynamic content.

6.13.6.8 Site Plans and Site Plan Icons

It shall be possible to manage and monitor alarms, overrides, the general status of site items and open doors through the Graphical User Interface with the use of interactive real time dynamic site plans and icons.

Site plan usage shall support touch-screen technology.

All site plans stored on the control PC's shall be automatically updated if amended at any of the networked workstations.

External drawings shall be imported into the system from external drawing software.

The ability to import at least the following drawing formats shall be supported:

- BMP
- WMF, EMF
- JPG
- GIF

It shall be possible to assign icons to system functions and place these at any position on a site plan.

Provision for drawing lines and areas to form "objects" shall be available. These objects shall be able to be associated with system items allowing system item status to be visually indicated by the object.

It shall be possible to place free text onto a site plan.

Site plans shall be "nested" allowing a single action (mouse click on a current site plan icon) to move from one site plan to another.

The following functions should, as a minimum, be able to be executed by clicking on Site Plan icons:

- View the current status of a Door, Input or Output.
- Monitor and acknowledge an Alarm
- Open an access controlled door
- Move from one plan to another plan
- Override an alarm, access or perimeter fence zone state.
- Display the properties of the item.

Icon names shall user the item name by default but a short name shall be selectable if available.

The size of the Icons shall be scalable.

A pre-designed set of icons covering basic access control functions shall be provided.

It shall be possible to design and load icons from external software for use in the system.

It shall be possible to design macro buttons to reside on siteplans. On activation, macro buttons must be capable of performing multiple overrides for any site items simultaneously.

It shall be possible to click and drag over an area within a site plan or individually select items on a site plan in order to override their state in one action.

It shall be possible to search for, select and navigate through available site plans within a single window (tile) and to view, move backward or forward through the list of recently visited site plans.

6.13.6.9 Field Hardware

The IFC shall be the main controller in the field. The head-end application shall communicate directly with all IFC's in the system.

Each IFC shall be intelligent in that in the event of failure of power or communications to the central control, for whatever reason, the system shall continue to allow or deny access based on full security criteria.

The IFC shall store on-board all the security and access parameters to operate completely independently from the central control server. Systems that rely on the central control PC for access decisions will not be considered.

The IFC shall "concentrate" activity data and immediately transmit it to the central control server computer.

Should communications fail with the central control, each IFC shall be capable of buffering up to 80,000 events.

All events shall be time-stamped at the IFC at the time of occurrence.

The IFC shall transfer buffered events to the central control automatically when the communications link is re-established.

The IFC shall be capable of storing up to 500,000 card records with associated access criteria.

The ratio between stored events and stored cardholders shall be configurable for each IFC to allow site requirements to be configured in accordance with specific site needs (more cardholders or more events per IFC).

The system shall monitor input circuits and enunciate whether the circuit is in Normal, Alarm, Open Circuit Tampered or Short Circuit Tampered as separate conditions.

A configurable range of end of line resistor values shall be supported as a software function to support pre-existing input circuits when required.

The use of any circuits using other than dual 4k7 end-of-line resistors must be approved by the consultant.

The IFC shall include tamper protection for the front and the back of the panel. The front panel shall be tamper protected for door open, and the rear of the panel to detect if the panel has been removed from the wall. These shall use optical tamper detection. Mechanical tamper devices are not acceptable.

The IFC shall incorporate an ARM 9 processor with at least 256 Megabytes of non-volatile FLASH EEPROM. The IFC shall incorporate boot code in a protected sector of the flash memory. For software upgrades, all system software shall be downloaded from the central server over the network

The IFC shall support direct download via USB to allow local upgrade of the IFC.

The upgrade process shall only accept authenticated downloads via the USB port.

The IFC shall operate from a separate battery backed 13.6V DC supply.

The IFC shall continue to operate for at least 24 hours in the event of a mains supply failure

The system shall be capable of automatically detecting and reporting a power failure, low battery and battery not connected.

IFCs shall automatically restart and resume processing following a power failure

IFCs shall be fitted with "watchdog" hardware and software to provide automatic detection and restart should the processor lock up.

The IFC shall contain its own real time clock. The clock shall be synchronised with the central control's clock at least once per hour. The accuracy shall be such that the time difference between IFC's shall not vary more than 0.5 second at any time

The IFC shall be allocated to a time zone appropriate to the IFC location

The IFC shall have an on board Ethernet (TCP/IP) connection and driver for communications with the central control supporting 10BaseT and 100BaseT operation.

The IFC shall support 100/1000BaseT

The IFC shall be fitted with 2 Ethernet ports providing alternate communication capability.

The IFC shall be provided with a pre-configured IP address to allow off-line initial configuration via a web browser application.

The IFC shall support DNS (Domain Name Server) operation to obtain an IP address.

Should the primary DNS not be available, the IFC shall be able to automatically establish contact with a secondary or tertiary DNS.

Should excessive network broadcast traffic occur (resulting from a ping attack or similar), an alarm shall be generated.

All communications between the IFC and the system PC shall be encrypted TCP/IP using 256 bit AES.

Communications shall be on-line and monitored for interruption.

The IFC shall include one RS 232 multi-communications port.

The IFC shall include one USB2.0 port.

The IFC shall support remote site dial-up.

Remote communication between the IFCs and the remote devices shall use the switched telephone network circuits.

Incoming connection shall be via an ISP service.

Outgoing connections via modems connected to the customer LAN are not permitted, however dial-out directly from the Server is allowed provided the modem is fixed to "non-answer" mode.

It shall be possible to view the IFC status and configuration for commissioning and diagnostic purposes without the use of the central server software or other proprietary software. This may be achieved by the use of conventional WEB based browser. In high security applications, it must be possible to disable this feature at the IFC.

The IFC shall support logic functionality by way of configurable Logic Blocks.

The IFC logic functionality shall be able to be run independent of the central control system being online.

The following items shall be useable as inputs to Logic Blocks:

- Physical Input states
- Output states (both physical and logical)
- Door states
- Other Logic Block states

Up to 10 Logic Block input items shall be configurable in ”AND” or “OR” combinations to cause an output to operate. Up to 10 “AND” or “OR” rules shall be configurable for each item.

The Logic Block output shall be able to be configured as an internal (virtual) output.

The Logic Block output shall be able to be assigned to an external output.

The Logic Block output shall be able to be assigned as an input on one or more other logic blocks.

The Logic Block output timing shall be configurable to at least the following:

- Delay on
- Delay off
- Latched
- Pulse time
- Maximum on time
- Explicit

The IFC Logic Block output shall be able to trigger actions across multiple IFCs, independent of the centralcontrol system being online.

A separate alarm message shall be transmitted to the central control for at least the following alarm conditions. The alarm message shall be displayed in plain language text:

- Tamper
- Tamper Return to Normal
- Unit Stopped Responding
- Card error
- Maintenance Warning
- Alarm Sector State Change
- User Set
- User Unset
- Card Trace
- Wrong PIN
- Access Denied
- Duress
- Zone Count Maximum

- Zone Count Minimum
- Door Open Too Long
- Forced Door
- Door Not locked
- Power Failure
- System Reboot.

The IFCs shall communicate with and control the following equipment:

- Token or biometric access readers
- Card access readers with PIN keypads
- Alarm monitoring Input/Output panels and equipment
- Alarm response equipment

Any failure of a token or biometric reader unit and its communications with the IFC shall be raised immediately as a high priority alarm and shall not cause the IFC or other associated hardware to stop working correctly.

The IFC shall communicate with remote devices (token and biometric readers, alarm equipment, elevator readers) using a fully encrypted data communications protocol. Unencrypted ASCII text or similar data transmissions are not acceptable.

All communications between the IFCs and the remote devices must be check-digit coded to protect data from manipulation during transmission.

All communications links between the IFCs and the remote devices shall be monitored such that an alarm is raised at the central control if the data being transmitted is corrupted or tampered with in any way.

Communication between IFC's and readers and other "downstream" devices shall support Generic Wiegand connections protocol, supporting up to 9999 bit Wiegand format

Wiegand formats shall be configurable, allowing for:

- Number of bits
- Facility/site code bits
- Card number bits
- Parity bit configuration

Communication between IFC's and downstream devices shall support a high speed protocol of at least 1Mbit/second.

The data Communication sessions between IFC's and devices shall use certificate exchange protocols using keys have a minimum strength of 256 bit elliptical encryption.

Data communication between IFC's and devices shall use a minimum of 128 bit AES encryption.

The high speed communication circuit shall support at least 20 individual devices on each circuit.

Each device connected to the circuit shall report its serial number to the IFC, for identification and assignment for a specific function.

Each IFC shall support up to 10 high speed communication protocol electrical circuits.

6.13.6.10 Access Control, Security Alarm And I/O Programming

The system shall provide complete flexibility and be capable of programming an unlimited combination of access control, security alarm and I/O parameters subject only to performance and memory limitations within the IFC.

For ease of programming Cardholders shall be grouped into access groups sharing the same access criteria.

Cardholders may be assigned with an extended door unlock time, as may be required by cardholders with a disability.

It shall be possible to assign an individual cardholder to an access group on a temporary basis with predetermined start and finish times.

During the period of temporary access, the cardholder shall have the rights of the group to which they have been assigned in addition to any permanent access rights they may have been assigned.

The access group property page shall display both permanent and temporary access members with the status of temporary members shown as:

- Pending (with the start and finish times)
- Active
- Expired

Any cardholder or access group in the system shall be able to be programmed to have access to any combination of controlled doors in the system with each period of access for each door controlled to withinthe nearest minute.

The IFC shall check entry based on ALL of the following criteria:

- Correct facility code
- Authorised card in database
- Correct issue number
- Authorised door / access zone
- Authorised time of day
- Valid card holder competencies (refer to Section 13)
- Correct PIN (If PIN entry is required)
- Double entry (anti-passback, anti-tailgating or escort modes).

Anti-passback mode shall be able to be configured in any of the following modes:

- Disallow second access to an area if a valid exit has not previously been registered and generate an alarm (hard anti-passback).
- Allow second access to an area if a valid exit has not previously been registered but generate an alarm (soft anti-passback).
- Exclude specific Access Groups from the rules defined in (a) and (b) above.

Anti-passback rules shall be able to be reset by either:

- Automatically after a preset period after valid entry.
- Automatically at a standard time each day
- Automatically on exit from site
- Manually as an over-ride.
- Must support Global Anti-passback allowing multiple access zones to be linked for the purpose of anti-passback, across multiple IFC devices utilising encrypted peer-to-peer communications.
- The IFC's shall not rely on the server for anti-passback operation. Global anti-passback shall work across multiple IFCs, even should the server be off line.

Anti-tailgate mode shall be able to be configured in any of the following modes:

- Disallow exit from an area if a valid access has not previously been registered and generate an alarm (hard anti-tailgate).
- Allow exit from an area if a valid access has not previously been registered but generate an alarm (soft anti-tailgate).
- Exclude specific Access Groups from the rules defined in x.7(a) and x.(b).

Anti-tailgate rules shall be able to be reset by either:

- Automatically after a preset period after valid entry.
- Automatically at a standard time each day
- Manually as an over-ride.
- The IFC's shall not rely on the server for anti-tailgate operation. Global anti-anti-tailgate shall work across multiple IFCs, even should the server be off line.
- Every incorrect PIN attempt shall be notified at the central control as an alarm condition.

Each reader shall be capable of automatically switching the access mode at a door at different times of theday, based on control parameters received from the central control. The following access criteria modes are required:

- Free access: Door is unlocked, no card entry required.
- Secure access: Door is locked, a successful card attempt is required for valid entry. Door re-secures after access attempt.
- Secure + PIN access: Door is locked, a successful card and correct PIN number attempt is required for valid entry. Door re-secures after access attempt.
- Override from reader: Members of certain access groups shall be able to change the access and PINs mode of the door at certain times.
- Dual Authorisation: Access is granted when two different but legitimate cards are presented within a given time frame.
- Escort: A second card is required to be presented from a cardholder who is nominated in the "Escort Access Group".

- Shared PIN Number: The system Operator determines what the PIN number will be and programs this into the system. Access is allowed through the door when the correct 4 digit PIN is pressed followed by the “Enter” key.

Cardholder access reporting to the central control and logging in the audit trail shall be configurable in two modes:

- Only when there has been a successful presentation of a valid access card or token AND the door open sensor has detected that the door has actually been opened.
- Whenever there has been a successful presentation of a valid access card irrespective of if the door has been opened.

Readers with integrated PIN pads, or fingerprint readers using identification, shall provide an “Entry under Duress” facility.

Duress shall be initiated by the cardholder either by the addition of a unique number to their PIN number, or by incrementing the last digit of their PIN number by one. Duress on fingerprint readers shall be initiated by the cardholder presenting their pre-enrolled duress finger.

There must be NO indication of a Duress entry at the reader.

A high priority “Duress Alarm” shall be displayed at the central operator station.

It must be possible to configure the system such that duress or other selected critical alarms pop to the front of the display, ensuring immediate operator attention. The existence of other incoming alarms shall be visible to the operator but must not interrupt their current task.

Zone counting shall be available to provide real-time counting of cardholders in access zones.

The result of the number of cardholders in the zone being outside of the specified range(s) shall generate an event or an alarm.

The minimum and maximum numbers of cardholders in a zone before an event is generated shall be configurable.

It shall be possible to set up a “grace time” in seconds to allow the zone count to be outside the minimum within the mid-range or outside the maximum number of cardholders, without generating an event.

It shall be possible to assign a specific message for each of the below minimum, mid-range or above maximum conditions.

It shall be possible to set up the system to prohibit one cardholder being allowed in a zone by:

- Requiring two valid but different cards to access a zone should the zone count reports zero cardholders in the zone;
- Requiring one card to access a zone should the zone count report two or more cards in the zone;
- Requiring one card to exit from a zone should the zone count report three or more cards in the zone;
- Requiring two valid but different cards to exit from a zone should the zone count report two people present;
- Prohibiting exit from a zone and generate an alarm if the zone count reports one person present.

It shall be possible to increment and decrement zone counting based on logical inputs not related to access events.

6.13.6.11 Identity Analytics - Competencies

Competencies shall be cardholder-based assignable attributes, used to determine if the cardholder is allowed access to specified areas based on factors relevant to the cardholder. The factors may be based on authority or skill levels or similar.

Multiple competency attributes may be assigned to one or more cardholder records.

Each competency will assume one of 4 different states:

- Active - The competency is currently valid for the cardholder.
- Expiry due - The competency is currently valid for the cardholder but will expire in a specified period.

A configurable message shall be displayed advising the cardholder that the competency is about to expire.

- Expired - The competency has been assigned to the cardholder but has expired.
- Disabled - The competency, is temporarily disabled (or overridden) for the cardholder.

A field shall be provided to store the reason for disabling a competency.

The competency states shall be configurable as “soft” allowing access but generating an alarm; or “hard” denying access, should a competency requirement not be met.

Each competency shall be individually set per cardholder

A field shall be provided to store the reason for disabling a competency.

Competencies shall be configured as required per access zone.

It shall be possible to exempt specific access groups from the requirement to meet specific competencies.

Denied access due to an invalid or missing competency shall be displayed to the user at the door reader.

Access permission based on competency criteria must be determined at the IFS, independent of the Server being on line.

The reason for denied access due to an invalid competency shall be displayed on the door reader or keypad.

Advanced warning of a cardholder’s competency about to expire shall be sent to the individual and/or other nominated persons.

Notice of a cardholder’s competency expiry shall be sent to the individual and/or other nominated persons.

A consolidated report detailing competency expiry warnings for cardholders shall be sent via email to the associated manager.

6.13.6.12 Pre-programmed Override Macros

To allow for making changes to the system configuration on demand, it shall be possible to pre-configure the required changes and assign them to a macro command.

An operator shall be able to initiate the macro (to carry out the changes) via either a menu item or by a site plan icon.

Macro assembly must be by the use of GUI features such as drop down lists and drag-and-drop techniques. The use of script language to write macros is not acceptable.

Macro's shall be able to be initiated on a time schedule.

Macro's shall be able to execute command line actions.

Up to 300 character variables shall be able to be specified for each command line.

Each Macro shall be able to contain multiple command line entries.

The configuration and execution of command line Macros shall be user account name and password protected. These user names and passwords shall be obscured on entry, and transmitted and stored at the central command system server in an encrypted format.

6.13.6.13 On-Line Door control

Access control for a door shall allow for the following features:

- Access reader
- Emergency release switch input

Egress control for a door shall allow for the following features:

- Exit reader
- Push button request to exit
- Emergency exit break-glass

Push button request to exit shall record the exit in the event database.

When requested by a valid means of access or egress, the door shall unlock for a preset period, after which the door shall relock.

If access or egress is completed prior to the preset time expiring, then the door shall relock immediately the door has closed.

The period of unlock shall be extended should a cardholder be a member of an access group where extended entry time is required.

Entry and exit methods referred to above shall each record the event in the event database.

The door shall be monitored for both door open/closed and door unlocked/locked using concealed monitor switches appropriate for the door installation.

Where the door is a double door, the inactive door leaf shall also be monitored for door open/closed and door unlocked/locked. The inactive leaf door monitor switches may be connected as part of the active door leaf monitoring.

It shall be possible to configure the door in a way that generates a forced door alarm should the door be unlocked and/or opened without reference to the system.

Should a door be left unlocked or open after a preset time, an alarm shall be generated reporting the condition.

The door open/unlocked warnings shall provide an audible warning at the door.

It shall be possible to disable the reader audible warning.

It shall be possible to generate the audible warning via a relay connected elsewhere in the system.

Should a valid request to access a door be generated and access not taken, it shall be possible to ignore the request (not record it as an entry event) and automatically re-secure the door after a preset time.

When a valid access through a door is undertaken, the door shall immediately re-secure on re-closing.

It shall be possible to “lock-down” an Access Zone by assigning an input condition to the access zone.

When the input is operated, all doors in the access zone shall go to secure mode

It shall be possible to assign specific cardholders the right to access a zone when the access zone is locked, whilst refusing access to all other cardholders.

It shall be possible to create an interlock relationship between a group of doors. Up to 20 doors shall be included in any interlock group.

It must be possible to configure interlock groups via GUI ”drag and drop” functionality, without the requirement to write scripted logic.

The system shall support a challenge or video verification mode as specified below:

- When a card is presented at a reader, images from the cardholder database (as many as required) shall be displayed in the challenge window.
- Associated with the images, it shall be possible to display a video image from one or more assigned cameras.
- In challenge mode it shall be possible to view a site plan showing the location and status of the controlled entry point and nearby items.
- In challenge mode it shall be possible for the operator to view the status of the cardholder’s cards and competencies for the purpose of informing the cardholder, at the time of entry, if any expiries are imminent.
- Specific personal data shall also be able to be displayed, associated with the cardholder (name details, department etc).
- Associated with a challenge entry, the selection and layout on screen of cardholder images, cardholder personal data, cardholder card or competency status, site plans or video images must be configurable using simple drag and drop, or click and drag techniques to resize or reposition information.

The challenge made shall be configurable to either:

- Automatically grant access to a valid card. In this case the system shall be able to display the current access decision (granted or denied) to the challenge operator.
- Require operator intervention to grant access to a valid cardholder.

Should a second challenge be requested while an unanswered challenge remains in the system, the second and subsequent challenges shall queue automatically awaiting response.

It shall be possible for an operator to view waiting challenge events and to select and process challenge events within the queue in any order they choose.

The system shall allow challenge events to be managed from a single full-screen view per operator or multiple filtered views, as dictated by the customer.

6.13.6.14 System Integration

The system shall support OPC (OLE for Process Control) Alarms and Events protocol to provide an open interface to allow integration with Building and Facilities Management, and Management Information Systems.

The OPC (Alarms and Events) interface shall allow third party OPC clients to register to receive the security system's alarms and events.

When an alarm is processed, the OPC Alarms & Events client shall send an event processed message back to the security system to process the alarm on the security system.

The system shall support OPC (OLE for Process Control) Data Access protocol to provide an open interface to allow the status of system components to be reported to an external OPC (Data Access) client.

The OPC Interface shall allow third party OPC (Data Access) clients to generate system component overrides including but not limited to alarm zone and access zone overrides.

The system shall provide an XML interface to allow for the import, export, and synchronisation of data in an ongoing basis from other applications directly into the Cardholder database both an on-line real time manner or in a batch oriented approach. A developer's kit shall be readily available to allow for easy implementation.

The system shall provide an XML interface to allow for updating access control schedules from other applications directly into the system configuration database both an on-line real time manner or in a batch oriented approach. A developer's kit shall be readily available to allow for easy implementation.

An Application Programming Interface (API) shall be available to allow 3rd party systems to be integrated into the system.

The API shall be managed at the IFC level, to allow inputs from the 3rd party system to be managed as system inputs, and to allow the IFC to directly trigger actions in 3rd Party systems.

Access via OPC or XML shall be managed as "operator events" and logged accordingly.

A facility shall be provided in the system to allow for the real-time export of any alarm or event information to 3rd party systems via customisable strings for the purposes of controlling the 3rd party application.

The system shall support accepting events from one or more 3rd party applications and displaying these and their status' in the event and/or alarm windows.

Events from 3rd party systems shall be managed in the same way as inputs connected directly to the IFC's.

6.13.6.15 Access Control Readers

The technology for the Access Control Readers will be specified in accompanying sections. When required, these readers shall meet the following specification:

The following features shall apply to both 125 kHz and Mifare technologies:

The Card only reader option shall include an audible beeper and red/green LEDs, to provide feedback to users.

The beeper shall give different beeps to indicate:

- Access granted
- Access denied.

2nd card required when dual card authorisation or escort mode is programmed.

A steady red LED shall indicate door secure.

A flashing red LED shall indicate access denied.

A steady green LED shall indicate door free access.

A flashing green LED shall indicate access granted.

Readers must comply with at least IP68 environmental protection rating.

Readers must comply with an impact rating of at least IK07

A vandal resistant enclosure having an impact rating of at least IK08 rating shall be provided in external locations and in secure areas.

Vandal covers shall be fixed to the wall surface using tamper-resistant screws.

Vandal covers shall have bevelled edges to limit the ability for persons use the reader as an aid to climbing the building.

All external surfaces shall be bevelled and without protruding parts to meet anti-ligature requirements.

Readers shall generate a heartbeat signal to enable the IFC to identify lost communications and thereby generate an alarm.

The reader must accept a message from the IFC to advise that the data from reader to IFC has been received and to consequently stop sending the card data.

Each reader shall be identified independently at the central control by means of a unique plain language descriptor. The central control plain language descriptor shall be at least 60 characters in length.

Where a PIN pad is specified, the reader shall include:

- A PIN pad fully integrated with the reader.
- Backlit PIN pad
- backlit LCD display indicating:
- Card required
- PIN required
- Access denied
- Intruder alarm set
- Intruder alarm unset
- Free access
- 2nd card required

The PIN pad shall include:

- Standard 0 to 9 digit keys
- CE (clear entry)
- IN (enter key)

- Three function keys (F1, F2 and F3)

Where Mifare technology is specified:

- Card Serial Numbers (CSN's) shall only be used as the access card identifier when approved by the consultant.
- The reader shall read the card identifier from any of Sectors 1 to 15 as programmed, using the MAD address to identify the specific sector
- Readers shall support enhanced encryption as described later in this specification.

6.13.6.16 Access Reader Self-discovery and Communication

Readers shall be individually serialized.

When connected to an IFC, the serial number of the reader shall be reported at the system server.

Once assigned to a function within an IFC, if any attempt is made to substitute readers in the field without authorization, an alarm shall be generated.

Data communication rate between IFC's and readers shall be at least 1Mbit/second.

Communication sessions between IFC's and readers shall use certificate exchange protocols using keys have a minimum strength of 256 bit elliptical encryption.

Data communication between IFC's and readers shall use a minimum of 128 bit AES encryption.

6.13.6.17 Access Cards and Tokens

The access token technology for this project shall match the reader technology as specified separately but in association with this specification.

Access cards shall be of standard credit card size, being no larger than CR-80 and shall be direct printable using a dye-sublimation print process or be capable of accepting an adhesive label printed through such a process.

All cards shall meet ISO standards.

As well as CR80 sized cards, vehicle tokens and key-ring transponders shall also be provided.

The access token data shall include:

- Support for up to 2008bit card numbers

Where a proprietary card number format is offered, the card format shall include:

- A unique facility (site) code not used for any other system worldwide.
- A unique cardholder identification number at least 7 digits long.
- An issue level for each card number to allow for replacing lost cards without reducing the card database size. Up to 15 levels of issue levels shall be supported.
- The access control token shall uniquely identify the cardholder to the access control system.
- Access control information shall be stored on or in the access token in a secure format, as described in below sections.
- Transmission of data between the proximity access token and the proximity reader shall be in a secure format as described below.
- Access control encoding data shall not be displayed on the access card or token.

- There shall be barriers employed to prevent the deciphering of access control data stored on the card using any readily available equipment.
- There shall be barriers employed to prevent the copying or altering of access control data stored on the card using any readily available equipment. The Tenderer shall document the barriers used.
- Cards and access tokens shall be able to be encoded by the supplier according to the client's specifications, made known at the time of order. Cards and tokens supplied with manufacturer determined card numbers will not be acceptable.
- It shall be possible to encode cards and tokens to allow operation of a user defined Personal Identification Number (PIN) in association with the card requirement, with the card still supplied ex stock as defined above.
- Allowance shall be made for the supply of encoding software and hardware to the Client to enable encoding of their own cards and/or tokens on site.
- The system shall provide facility to encode cards or tokens in batches of user definable quantity.

6.13.6.18 Mifare Plus Technology

The cards shall incorporate Mifare Plus technology.

The card number must be a number specifically coded onto the card. It shall not be the card serial number (CSN).

The card data encoded shall use a secure sector authentication level of security to protect against card cloning. 128bit AES encryption shall be used.

The Mifare Plus "S" variant shall be provided.

The encoded card data shall incorporate data consisting of:

- The assigned card number.
- A site-specific key consisting of 32 hexadecimal characters.
- The 32 hexadecimal key shall optionally be sourced from a customer specified key-safe.

Card encoding shall be an integral part of card production. Refer to relevant section below.

It shall be possible to specify the card sector where the card number is stored.

The sector unlock key and the Mifare MAD unlock key shall be user definable.

Where multiple reader technologies are deployed, as defined in sections covering other technologies, single pass card encoding shall be used.

6.13.6.19 Cardholder Management

The cardholder database shall be structured so that the name field is the master field for each record. A background unique identifier may be used as the key field for each record but this must not be required by an operator to identify a cardholder. Use of the card number as the key field is not acceptable.

Each IFC shall cater for the number of cardholders as defined above.

The system must allow at least 15 Issue Levels per card or token. This must deny access and raise an alarm to the operator when a wrong issue level is presented to a reader.

Cardholders must be able to be issued with more than one access token of different description and different number (i.e. access card, biometric identification and vehicle token) whilst maintaining only one cardholder record in the database.

Encoding and printing cards shall be properties of the cardholder record.

The options for encoding and printing shall be:

- Print card
- Encode print
- Print and encode card

Access groups shall be linked to cardholders by both assigning access groups to cardholders or cardholders to access groups.

At least 64 user-definable “Personal Data” fields shall be provided which may be selectively reported on.

Personal Data Fields shall be able to be set up as either:

- Text User data may be entered.
- Text List User selects text from a pre-prepared list of text strings.
- Numeric User must enter numeric data.
- Date Calendar dates may be entered based on the workstation date format.
- Default Value The field has a default value assigned.
- Image The field may only contain an image to the field.
- Email/Mobile The field contains an email address or mobile number to be used for notifications.

Personal data Fields shall also be able to be configured as:

- Required field Data must be entered.
- Unique Values Data must be unique from all other card records.
- No default Value Default value disabled.

Personal data fields shall support rules to ensure data accuracy. Examples: @ in email addresses; employee codes are in the correct format.

A notes/memo field shall be available, associated with each card record.

The notes field shall support word-wrap, insert, delete, cut, copy and paste functions.

It shall be possible to “group” or “filter” cardholders for the purposes of editing access, generating reports and assigning operator privileges.

The following information fields shall optionally be displayed on the Cardholder editing window:

- The date when a cardholder record was created.
- The date when the record was last modified.

For ease of programming Cardholders shall be grouped into access groups sharing the same access criteria and default personal data fields.

It shall be possible to enter an automatic expiry date/time for the card.

It shall be possible to automatically expire cards that have not been used for a predetermined period of inactivity of up to 999 days.

It shall be possible to allocate start and end dates and times for an Access Groups access to a particular access zone.

Access shall have start and end dates and time to within one minute.

The system shall be capable of importing database information, on selected cardholders, from other systems and be capable of exporting that cardholder's data, either with or without controlled alteration or amendment, to other databases.

The system shall support the capability to allow bulk changes to card records. It shall be possible to carry out the following changes as a bulk change:

- Delete selected cardholder records.
- Change personal data fields
- Change card details.
- Change access options
- Change the system division the records are assigned to.

A bulk change shall be able to be saved and scheduled to run at a later time.

A window shall be provided to show details of created, saved, edited, pending, successful and failed bulk changes.

A personal user code (4 or 6 digit) shall be a property of the cardholder record to allow alarm setting and unsetting.

System operator management shall be a property of the cardholder record.

A change history record associated with each cardholder record shall list all changes made to a cardholder record, including details of who made the changes.

The system shall support an event trail for the cardholder which details recent card usage events for the cardholder as well as operator events which have modified the cardholder record. The number of prior events to be shown or prior length of time to be covered shall be configurable. The system shall allow different prior length of time / number of prior events to be displayed for different operators.

The system shall allow an operator to search for a cardholder by entering any part of their first and/or last name, in any order and separated by a space if using both. After three characters have been entered the system shall automatically return matching results and filter these dynamically as the operator continues to type.

The system shall allow the cardholder search fields and search results to be configurable. The system shall allow different operators to use and see different search fields and search results for the purpose of cardholder administration tasks.

The system shall allow the information returned for a cardholder and visible to the operator to be configurable and include any sub-section of the total information stored in the cardholder record (e.g. personal data, cards, access groups, competencies, biometric information etc). Different operators shall be able to view different sub-sections of the cardholder information.

The system shall allow design of different screen layouts for the purpose of cardholder administration, for use by different operators.

The system shall allow cardholder information to be viewed and updated in one screen.

Configuring operators shall, subject to the required privileges, be able to design single screen cardholder management viewers adapted for the specific screen resolution of the operator(s) who will use the viewer, to ensure best use of available screen real-estate.

The system shall provide tools to maximise, on screen, specific cardholder details when required. Maximising an area and returning to standard layout must both be single-click actions.

The system shall allow all cardholder administration functions to be managed solely via keyboard.

6.13.6.20 System Operator Management

Operators shall be members of operator groups.

Operator establishment and maintenance shall be limited to assigned Senior Operators.

It must be easy to define operator privileges for a group of operators and it must be easy to add an operator to the group.

Operator access to the system is to be restricted by means of an operator identifier and individual password.

Passwords shall be managed by using either non-restrictive or force password changes. Forced changes shall include options for:

- Minimum password length greater than 8 characters.
- Mixed case characters
- Mixed alpha and numeric characters
- Change password after a defined period of up to at least 365 days.
- Remembering and rejecting at least 8 previously used passwords.

The system shall also support Mifare card logon.

Each operator shall have the authority to alter his own password, but not that of other operators

Automatic logoff shall occur after a preset time of up to at least 60 minutes of operator inactivity.

It shall be possible to configure the system to only allow one logon per operator.

It must be possible to allow or deny Operators access to system menu functions, including viewing of Cardholder Personal Data fields, Personal Notes and Images.

It must be possible to restrict Operator access to Cardholders based on system division.

It shall be possible to assign different access rights for each division an operator is required to access. For example, “advanced user” for division 1; “view only” for division 2; and “no access” for division 3.

Any menu option not available to an Operator should be either greyed out or not visible.

6.13.6.21 Input and output circuit functionality

Input circuits shall be connected to the IFC as described in “Field Hardware”.

Inputs from detection devices covering the same region for control purposes are to be grouped into alarm zones. Alarm zones can be in any one of four states and shall handle alarms differently depending of the state. The first two shall be defined as set (armed) and unset (disarmed). The names of the other states shall be able to be defined at the central control for other purposes such as maintenance testing.

Alarm priorities can be assigned to any of the four input states.

The system shall provide entry and exit delays for the setting and unsetting of alarms.

The entry delay shall be configurable from 0 to 5 minutes in steps of one second.

An optional audible warning must sound during the entry delay (from the time that the alarm occurs to the time that the Zone state is changed). It must be possible to designate specific card readers and remote arming terminals to sound entry delay warning beeps. Selected output relays should also be able to be operated during the entry delay period allowing suitable sounders to be connected at required locations.

An exit delay is to be provided to groups of inputs so that a change of state of an exit delayed zone is delayed by the exit delay period, which can be adjusted, from 5 seconds to 5 minutes in steps of one second.

An optional audible warning must sound during the exit delay (from the time that the alarm occurs to the time that the zone state is changed). It must be possible to designate specific card readers and Remote Arming Terminals to sound exit delay-warning beeps. Selected output relays should also be able to be operated during the exit delay period allowing suitable sounders to be connected at required locations. This applies to both manually and automatically changing the state of a zone in the case of automatically changing the state of a zone the exit delay and audible warning gives people working late in the building time to unset the alarms or leave the building.

The system shall include Alarm Escalation as an event. The new event shall correspond to the original alarm, but may have a different (usually higher) priority, and may require a different set of alarm relays to operate.

Escalated alarms shall be able to be displayed in a Window specifically provided for this purpose.

Alarms shall be able to be escalated under the following conditions:

- Escalate if alarm not acknowledged after (X) seconds
- Escalate if in inactive state for (X) seconds
- Escalate if zone contains (X) alarms
- Escalate if two event from same point within (X) seconds.
- Escalate if two events from different points in same zone within (X) seconds

It shall be possible to have automatic time based setting and unsetting of alarms.

It shall be possible to configure the system such that events (such as a card swipe or operation of a key switch connected to an input) can change the state of a zone.

Authorised cardholders shall be allowed to set and unset alarm zones by:

- Operation of the Card plus PIN reader as an alarm panel.
- Presenting a valid access card to a card reader associated with the alarm zone, twice within a nominated time period (double card badging).

It shall be possible to set and unset multiple alarm zones from a Remote Arming Terminal.

All alarm occurrences shall be presented at the central control within 4 seconds of their occurrence at the remote field device.

All Alarm events shall be viewable from an Alarm Stack.

It shall be possible to view all alarm events by clicking on interactive Site Plan icons that, because of their changing audible and visual states, indicate the presence of alarms.

All alarm events arriving at the central control shall be "time stamped" with the time they occurred and the time they were logged at the central control.

All alarm events shall have a user definable alarm priority assigned. A minimum of 8 alarm priority levels plus non-alarm event and ignored shall be provided.

It shall be possible to assign a different audio warning sound to each alarm priority.

Incoming Alarms shall be presented in the Alarm stack according to their assigned priority with the highest level at the top. Alarms with the same priority shall be presented in time order.

The priority of Alarms in the alarm stack shall be identifiable by a user definable colour.

Identical consecutive alarms that occur within a predefined time span shall be report as a single alarm with the number of occurrences reporting as a flood alarm quantity.

The Central control must be able to control the actual priority assigned to any alarm activation throughout the day. This means any alarm activation may be programmed as "Low Priority" during office hours and "High priority" at all other times.

It shall be possible to nominate an Input (e.g. Smoke, Fire or Gas detection) as an “Evacuation Input” in which case certain doors within the Site will revert immediately to Free Access.

Operators shall be required to complete 2-stage alarm processing as:

- Acknowledge Alarm.

An Acknowledged alarm shall remain in the alarm stack and be easily identified as having been acknowledged but not yet processed.

The central control shall record in the hard disk activity log that the operator has acknowledged the alarm. An alarm is “acknowledged” by the operator selecting the “Acknowledge” button in the alarm-viewing window.

A second alarm from the same source as the acknowledged alarm shall be indicated as a new alarm.

- Process Alarm.

A Processed alarm shall clear from the Alarm Stack.

The central control shall record in the hard disk activity log that the operator has processed the alarm. An alarm is processed by the operator selecting the Process button that is displayed in the alarm viewing window.

The system shall allow an operator to multi-select contiguous or non-contiguous alarms in the list in order to add a note, acknowledge or process all selected alarms in one action.

The alarm list shall support mandatory fields of alarm time, alarm priority and alarm state.

The system shall allow a suitably privileged operator to configure any of the following additional fields to be visible in the alarm list and to configure their order:

- full alarm message
- related cardholder name
- acknowledging operators name
- alarm zone
- alarm source
- related access zone

- event type
- event group
- division of the alarm source
- count (occurrences of alarm)

It must be possible for an operator to sort the alarm list by any of the available fields.

The system shall display a summary of alarms, by priority, which is visible to the monitoring operator at all times and updated dynamically as new alarms occur or existing alarms are actioned.

The alarm summary shall indicate if there are any unacknowledged alarms for a given priority.

The system shall allow configuration of filtered alarm lists. Alarm lists shall be filterable based on any combination of selected divisions, escalation status or alarm priority.

The system shall allow different information to be configured and displayed to a monitoring operator based on the type of alarm.

Door Open Too Long alarms must display selected and configurable information (including, as an example, the photo and contact details) for the person who left the door open (last successful access).

Cardholder related alarms shall automatically display recent events and selected information (name, photo, personal details etc.) for the person causing the alarm.

An active alarm shall not be able to be finally processed and cleared from the Alarm Window until the cause of the alarm has been removed and the alarm condition has returned to the normal state.

Pre-programmed alarm instructions shall be available for the operator to provide instructions for acknowledging and processing each alarm.

Alarm Instructions shall have the following features:

- Default Alarm Instructions shall be able to be programmed and automatically applied to all events of a common type e.g. all wrong PIN events applicable to all readers.
- Individual Alarm Instructions shall be able to be programmed and applied to individual alarm events.
- A table of contact names, phone numbers or other frequently used volatile information shall be available when programming Alarm Instructions, and applied to Alarm Instructions from a pick list.
- When items in the pick-list are updated, the linked Alarm Instructions shall automatically update.

The alarm instruction text shall be able to be formatted using common text formatting features including but not limited to:

- Bold, italic and underline
- Text colours
- Left, centre and right justified.
- Bulleted text
- Standard Microsoft Windows font types and sizes.

It shall be possible to copy and paste Alarm Instructions between alarm events.

The Alarm window shall allow the operator to enter a comment. Such comment will be date/time stamped by the system, and recorded against that alarm event in the audit trail.

When required, a pre-defined list of alarm responses shall be available for operators to select the appropriate response to an alarm. The alarm responses shall be user configurable to suit site requirements.

Keyboard function keys (F1 to F8) shall be mapped to the first 8 alarm response messages to automatically insert the associated message as required.

The system shall provide relay output facilities that are system activated in response to alarm activations. Relay functions required are:

- Activate and latch a relay in response to an alarm. Relay to remain latched until alarm processed.
- Activate a relay for pre-set "pulse" time. The relay to release after the "pulse" time lapses.
- Relay activation to "mirror" or “follow” the alarm input activation.

The system shall incorporate relay outputs that can be activated according to time schedules, rather than alarm event. These outputs may be used to control lighting, heating, or to electronically lock or unlock non-monitored doors.

6.13.6.22 Notifications

Specific event and alarm messages shall be able to be configured to be sent to nominated users via either email or SMS message.

It shall be possible for persons receiving alarm messages to be able to acknowledge the alarms via email or SMS message.

It shall be possible to send notification of imminent card or competency expiry to an individual, their manager or other nominated person. Refer also to Sections 13 and 39.

A comprehensive filtering feature shall be provided to manage notification information transmission.

6.13.6.23 Audit Trail

The Server hard disk shall be used to record all system activity for archiving purposes. It shall not be possible to alter archived data.

Every system activity event along with all details, including but not limited to the following list, shall be time stamped with the time of occurrence to the nearest second and shall be recorded in the system activity log for archiving:

- All access attempts (allowed and disallowed).
- Alarm events.
- System events.
- Operator activity.

The central control shall provide an on-line facility to archive system data and event records to an archive file to free hard disk space for further activity logging

The archive process shall be initiated by either manual operation or automatically by time.

It shall be possible to nominate the number of days of data that shall remain on the server subsequent to an archive process.

It shall be possible for an operator to view filtered event trails, e.g. for filtered for selected site items.

6.13.6.24 Reports

The central control shall provide historical reporting capabilities from the following sources of information:

- System activity data
- Cardholder access data
- Cardholder Personal Data fields
- Site configuration and setup data.

The report generation feature shall be easy to use and based on a “wizard” style of parameter selection and preparation. The wizards shall provide features to simplify report generation by incorporating selections such as report for “yesterday”, “last week”, “last month” etc. This is for the purpose of quickly generating recurring, standard format, reports.

The parameters for producing the report must be fully user definable and must be capable of searching on any cardholder or access event criteria.

It shall be possible to automatically produce the reports listed in this clause. The methods available to generate the report(s) are defined in previously:

- Activity Any site activity.
- Evacuation Last known location of all cardholders on site.
- Exception Unprocessed alarms, un-acknowledged alarms and doors temporarily overridden from secure to free

The report shall be generated by any of the following means, as may be required by the operator:

- Operator running a macro.
- An alarm event trigger.
- On a recurring schedule.

The central control shall generate and format reports in "background". This means the operator must be able to process alarms, alter database parameters and perform other system changes while the report is being generated. Report generation must continue if the operator decides to perform any other task

The central control shall have a screen preview function, so that reports can be previewed on-screen before they are printed

It shall be possible to email reports to nominated people or groups of people.

Report formats shall be able to be saved for future use.

The central control shall have a "printer spooler" so that reports can be printed at any network-supported printers connected to the system.

The central control shall have a printer queue facility to enable reports to be queued if the target printer is off-line, busy, not connected or faulty.

The central control shall be able to produce voltage reports for electrified fencing perimeter security voltage monitoring.

Visitor management reporting shall provide reports as follows:

- Visitor status (expected, on site, departed).

- Planned visits.
- Past visits (who visited who, who escorted a visitor).

6.13.6.25 Communications & Diagnostics

The central control shall automatically restart full and complete processing after a power failure.

The central control shall provide a full diagnostic performance log to enable system engineers to monitor system performance in the event of a system malfunction.

The diagnostic performance log shall be stored in a separate file on hard disk from all other data files.

The diagnostic performance must be available without shutting down or "freezing the system".

The central control shall provide on-line system diagnostic facilities which enable authorised operators or systems engineers to monitor and then tune the system performance (communications network performance tuning, for example).

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