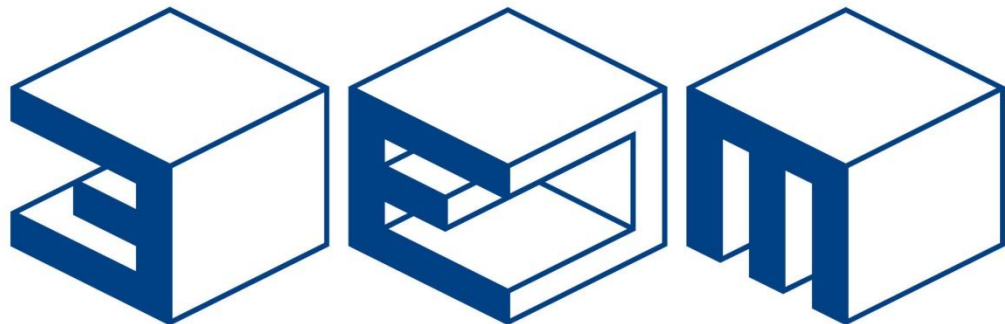


Waroona Community Precinct Big Shed For

MCG Architects

Revision	Description	Date
0	Issued for Tender & CDC	21/02/2025



ELECTRICAL ENGINEERING CONSULTANTS

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0901 ELECTRICAL SYSTEMS**1 GENERAL****1.1 RESPONSIBILITIES****General**

The extent of work covered by these documents includes the supply, delivery, installation, testing, commissioning and subsequent maintenance as detailed in this specification and on the accompanying drawings.

Provide materials, labour, cartage, tools, plant, appliances, accessories and fixings necessary for the proper execution of the works, together with all minor and incidental works. The following list identifies the work to be undertaken by the Contractor. The listed items are not intended to limit or exclude any items required by the contract documents. This electrical specification is a conforming electrical specification, **NO ALTERNATIVES SHALL BE ACCEPTED.**

Any enquires regarding the requirements of the tender documents during the period prior to the close of tenders should be referred to **3em Engineering Consultants**, telephone **04 9999 2191**

The work shall include, but not be limited to:

- Liaison with Western Power to provide headworks and incoming services (**excluded**)
- LV switchboards
- Utility power consumption metering (**excluded**)
- LV mains and submains cabling
- Cables trays and other cable support systems
- Earthing systems
- Transient protection equipment
- General power distribution
- Power and controls to mechanical / hydraulics equipment
- Provision of conduit access to enable installation of services by others
- Lighting (Electrical contractor shall include in writing that they comply with the tender selection of the luminaire schedule and provide the luminaire data sheets of all the lighting fixtures which was selected for this project (refer to drawing E000) as part of the tender and construction price).
- Emergency lighting
- Solar PV Array with inverter and associated cables, circuit breakers and isolators.
- Voice and data communications infrastructure (**excluded**)
- CCTV system (**excluded**)
- Access control system (**excluded**)
- Intruder detection system (**excluded**)
- Hardwired smoke and heat detectors AS3786 (if required by NCC/BCA code standard)
- Commissioning
- As Built drawings and maintenance handbooks
- Maintenance during the defects period
- **The electrical contractor shall contact the electrical consultant during tender / pricing a week (7 days) before submission of his tender / pricing to ensure all items are correct and included for the respective project.**

NBN guides for electrical contractors with trained suppliers that can assist, following the link below:

- o <https://www.nbnco.com.au/develop-or-plan-with-the-nbn/new-developments/design-build-install>

EXCLUSIONS

The following work is not included and does not form part of this Trade Section:

- Application and liaison with Telecommunications Carrier for phone lines.
- Provision of PABX, Telephone Handsets, including external handset programmed as "Intercom" or Payphone.
- Provision of additional ISDN/PSTN links.
- Provision of hubs, PC's, printers or other active equipment.
- Baluns, adaptors.
- Rendering walls after chasing in of conduits
- Control wiring for air conditioning and final connection from isolators.
- Control wiring for roller shutter doors and final connection from isolators.
- Control wiring for louvres / windows and final connection from isolators.
- Supply of soft wiring starters and supply and installation of power modules in workstation system.
- White goods such as ovens, fridges, microwaves and the like.

Electrical performance

Supply system: 400 V, 3-phase, 4-wire, 50 Hz.

Performance criteria: Meet the performance criteria, as documented.

Fault level protection: To withstand the prospective fault level of the incoming supply at the equipment location.

Site electricity supply

Responsibilities: Provide site electricity supplies as documented. Connect project electrical facilities to the network distributor's external site electricity supply.

Low voltage supplies

Low voltage transformer output supply: To AS/NZS 3000 and the network distributor's requirements.

Low voltage protection: Provide low voltage short circuit and overload protection at the transformer secondary supply using fault current limiting circuit breakers with adjustable overload and short circuit current setting features. Alternatively, if approved by the network distributor, where no secondary output protection is provided, provide appropriate sized high voltage protection on the incoming supply to transformers.

Low voltage circuit breakers: Include full discrimination and cascade protection and grade with the incoming transformer supply protection system and the downstream site protection devices.

Switchboards

Responsibilities: Provide main switchboard(s) and local distribution boards as documented and to the requirements of the following worksections:

- *Switchboards – proprietary.*

Electrical protection equipment: Include all necessary electrical protection equipment, electrical components and the local network distributor's tariff metering equipment to the requirements of the *Switchboard components* worksection.

Large switchboards: Manufacture switchboards of module sizes to allow access and manoeuvrability through the project site and into switchrooms.

Overload and fault protection on all submains: Provide circuit breaker protection equipment coordinated to allow cascade and discrimination protection between upstream and downstream cable protection devices to AS/NZS 3000.

Electricity distributor's low voltage service protective device: To AS/NZS 3000, the network distributor's requirements and the supply authority Service and Installation rules.

For service protective devices > 100 A: Provide fault current limiting circuit breakers with adjustable overload and short circuit current facilities and full discrimination and cascade protection between the incoming supply protection systems and the downstream protection systems, if required.

Electrical cable systems

Responsibilities: Provide the following cabling systems:

- Power cables: Provide cable systems as documented and to the requirements of the *Low voltage power systems* worksection.

- Communications cables: Provide cable systems as documented and to the requirements of Australian Communications and Media Authority (ACMA) and the *Telecommunications cabling* worksection.

Provide separate cable systems for communications and sound systems. Do not use any part of the power system cable support systems.

Lighting

Responsibilities: Provide lighting systems as documented and to the requirements of the following worksections:

- *Lighting.*
- *Emergency evacuation lighting.*

Proprietary equipment: If proprietary equipment is selected by the contractor, the requirements of this specification override the specifications inherent in the selection of a particular make and model of accessory.

1.2 PRECEDENCE

General

Worksections and referenced documents:

- The requirements of other worksections of the specification override conflicting requirements of this worksection.
- The requirements of the worksections override conflicting requirements of their referenced documents.
- The requirements of the referenced documents are minimum requirements.

1.3 CROSS REFERENCES

General

Requirement: Conform to the following worksection(s):

- *Demolition by Architect.*
- *Cable support and duct systems.*
- *Low voltage power systems.*
- *Switchboards – proprietary.*
- *Lighting.*
- *Emergency evacuation lighting.*

1.4 REFERENCED DOCUMENTS

General

Requirement: Conform to the *General requirements* worksection.

1.5 STANDARDS

General

Electrical services: To AS/NZS 3000 unless otherwise documented.

Electrical installations

Designing to the win: To SAA HB 301.

Selection of cables: To AS/NZS 3008.1.1.

Degrees of protection (IP code): To AS 60529.

EMC: To AS/NZS 61000.

Rotating and reciprocating machinery noise and vibration: Vibration severity in Zone A to AS 2625.1 and AS 2625.4.

Telecommunications systems: To AS/CA S008, AS/CA S009, AS/NZS 3080, SAA HB 243 and SAA HB 29.

1.6 CONTRACT DOCUMENTS

General

Requirement: Conform to the *General requirements* worksection.

1.7 INSPECTION

General

Requirement: Conform to the *General requirements* worksection.

1.8 SUBMISSIONS

General

Requirement: Conform to the *General requirements* worksection.

Certification

Certification: Submit certification that the plant and equipment submitted meets the requirements and capacities of the contract documents except for departures that are identified in the submission.

Technical data

Submissions: Submit technical data for all items of plant and equipment.

Data to be submitted: Include at least the following information in technical submissions:

- Assumptions.
- Calculations.
- Model name, designation and number.
- Capacity of all system elements.
- Country of origin and manufacture.
- Materials used in the construction.
- Size, including required clearances for installation.
- Certification of compliance with the applicable code or standard.
- Technical data schedules corresponding to the equipment schedules in the contract documents. If there is a discrepancy between the two, substantiate the change.
- Manufacturers' technical literature.
- Type-test reports.

2 PRODUCTS

2.1 GENERAL

General

Requirement: Conform to the *General requirements* worksection.

2.2 ELECTRICAL ACCESSORIES

General

Responsibilities: Provide accessories as documented and to the requirements of the *Low voltage power systems* worksection.

Proprietary equipment: If proprietary equipment is selected by the contractor, the requirements of this specification over-ride the specifications inherent in the selection of a particular make and model of accessory.

Uniformity: Provide all accessories and outlets located in close proximity of the same manufacture, size, finish and material.

Default finish: Select from the manufacturers' standard range.

As Constructed Drawings

The As Constructed Drawings shall be completed as follow:

- Within one week of Practical Completion, provide as constructed drawings as computer data in Autocad Version 2020 format on USB mass data storage device in PDF and DWG format in addition to two sets plotted on 80gsm A1 size bond paper and two sets plotted on 80gsm A3 size bond paper.
- Use the same size drawings, border, title block, line types, line thickness and fonts as the contract drawings.

- Mark up plans as conduits / cable trays / pits are installed, clearly indicating dimensions of all conduits / cable trays and pits with their respective alignments and depths prior to back filling trenches and concealment of conduits / cable trays work.
- During the progress of the works provide the As Constructed drawings for sighting by the Superintendent or his representative to ensure that all changes or deviations are satisfactorily recorded.
- A draft copy of the Operating and Maintenance manual complete with all draft 'As Constructed' drawings and including an index of the proposed content of the manual must be submitted for approval, at least one week prior to Practical Completion. A written statement shall be issued by the Contractor, verifying the accuracy of the information contained within the final completed manuals.

Operation and Maintenance Information

The manuals shall be complete with:

- Separate identified sections within the manual.
- List of suppliers and sub-contractors used, including key personnel names and mobile phone numbers.
- Manufacturers literature on all fixed equipment installed
- Comprehensive schedule of all light fittings including, description of light fitting (as per contract documents), manufacturer's catalogue number, lamp rating (including colour temperature, beam angle etc.)
- Specific operating instructions for all equipment and systems
- Shop drawing – switchboard, etc
- Block diagram of power consumption meter tree, detailing meter tag names and meter numbers.
- Manufacturers literature on fuses, isolators, circuit breakers, etc, including trip settings where appropriate
- Operating instructions for automated equipment, designed to be understood by non-technical personnel
- Discrimination study.
- Copies of all reports, certification and test results conducted on the project.
- Copies of all equipment warranties.
- Recommended service schedules for all systems installed

Provide separate log books and/or binders for:

- Emergency lighting
- Fire Detection

The following sections shall be included as a minimum within the manual:

- Contact Register
- Earthing systems
- Transient protection equipment
- LV switchboards – shop drawings
- Transient protection equipment – manufacturers literature
- Lighting – luminaire "cut sheets"
- Emergency lighting – test results, as constructed plans
- Test records and commissioning certificates

3 EXECUTION

3.1 GENERAL

General

Requirement: Conform to the *General requirements* worksection.

3.2 WORK ON EXISTING SYSTEMS

Demolition

General: Decommission, isolate, demolish and remove from the site all existing redundant equipment including minor associated components that become redundant as a result of the demolition.

Breaking down: Disassemble or cut up equipment where necessary to allow removal.

Recovered materials: Recover all components associated with the listed items. Minimise damage during removal and deliver to the locations documented.

Existing electrical systems

Condition of existing systems:

- If the existing condition does not conform to the requirements in the contract documents, submit proposals to rectify the deficiencies with related costing, time and other impacts.
- Subject to the rectification works on existing systems, achieve the performance in the contract documents.

3.3 SWITCHBOARDS

General

Fixing wall mounted switchboards: Fix direct to wall framing for framed wall constructed walls and to masonry or concrete walls.

Fixing floor/wall mounted switchboards: Fix to floor plinths and direct wall framing for framed wall constructed walls and to masonry or concrete walls by suitable fasteners.

Fixing floor mounted island switchboards: Fix switchboard to floors plinths by suitable fasteners able to withstand seismic events nominated in the project documents.

Seismic sensitive projects

Fixing wall and wall/floor mounted switchboards: Fix only to building structural elements or to steel framing fixed to structural elements. Do not fix to masonry infill panels.

3.4 SUPPORT OF PLANT AND EQUIPMENT

Support of roof mounted plant and equipment

Platforms: If a horizontal platform is required, or the area of the plant and equipment is extensive, obtain the advice of a professional engineer for the documentation of a suitable platform.

Balustrades: If balustrades or screening are required, obtain the advice of a registered architect.

Roof level support: If any of the following apply to roof level support, obtain the advice of a professional engineer:

- The total load from any unit of plant or equipment exceeds 500 kg.
- The load from a unit of plant or equipment to any single support point exceeds 100 kg.
- The average loading of plant and equipment over the area extending 1 m on all sides beyond the plant and equipment exceeds 25 kg/m².

Sloping roofs:

- Roof slope $\geq 10^\circ$: Adopt the roof material manufacturer's documented installation procedures, or seek the advice of a professional engineer.
- Roof slope $< 10^\circ$: Provide appropriate continuous supporting members, compatible with the roof material, laid parallel to the span of the roof sheeting. Extend the continuous support members in both directions to the first purlin or joist that is > 1 m from the face of the plant or equipment it supports.

Support of ground level plant and equipment

Ground level:

- If the ground slope is $\geq 15^\circ$ or the area of the plant and equipment is extensive, obtain the advice of a professional engineer for the documentation of a suitable slab or platform.

- In all other cases, provide proprietary plastic or concrete supports installed with falls that achieve a raised, impervious and water shedding bearing surface.

Balustrades: If balustrades or screening are required, obtain the advice of a registered architect.

0902 ELECTRICAL INSTALLATION AND DESIGN**1 GENERAL****1.1 RESPONSIBILITIES****Design**

Design parameters: As documented.

Fault protection: Automatic disconnection to AS/NZS 3000 clause 2.4.

Maximum demand: Calculation method to AS/NZS 3000 Appendix C.

Electrical performance

Supply system: 400 V, 3-phase, 4-wire, 50 Hz.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following worksection(s):

- *Demolition by Architect.*
- *Cable support and duct systems.*
- *Low voltage power systems.*
- *Switchboards – proprietary.*
- *Lighting.*
- *Emergency evacuation lighting.*

1.3 STANDARDS**General**

- Electrical services: To AS/NZS 3000 unless otherwise documented. The electrical contractor shall contact the electrical consultant during tender / pricing a week (7 days) before submission of his tender / pricing to ensure all items are correct and included for the respective project.

Electrical installations

Design guide: To the recommendations of SAA HB 301.

Selection of cables: To AS/NZS 3008.1.1.

Degrees of protection (IP code): To AS 60529.

EMC: To AS/NZS 61000.

Telecommunications systems: To AS/CA S008, AS/CA S009, AS/NZS 3080, SAA HB 243 and SAA HB 29.

1.4 CONTRACT DOCUMENTS**General**

Requirement: Conform to the *General requirements* worksection.

1.5 INSPECTION**General**

Requirement: Conform to the *General requirements* worksection.

1.6 SUBMISSIONS**General**

Requirement: Conform to the *General requirements* worksection.

Certification

General: Submit the following:

- Certification of conformance with AS/NZS 3000, for electrical services.
- Certification of conformance with the applicable code or standard.

- Telecommunications cabling: Submit product and installation certification for the installation.

Samples

Lighting: Submit samples of all luminaires and accessories complete with lamp, control gear and three core flex and plug.

Emergency evacuation lighting: Submit samples of all luminaires and exit signs.

Shop drawings

Lighting: Submit shop drawings for the following:

- Lighting columns.
- Lighting column mounting bases.
- Non standard fixing brackets.

Telecommunications cabling: Submit shop drawings showing the following:

- Layouts of equipment racks.
- Cross-connect layout.
- Cabling diagram for complete system.
- Cable management system.

Technical data

Submissions: Submit design and technical data for the electrical services, all items of plant and equipment. Include at least the following information in technical submissions:

- Assumptions.
- Calculations, including maximum demand calculations.
- Capacity of all system elements.
- Country of origin and manufacture.

Lighting: Submit technical data for the following:

- Luminaires.
- Lamps.
- Ballasts.
- Power factor correction equipment.
- Lighting control systems.
- All accessories.
- Manufacturers' technical literature.
- Materials used in the construction.
- Model name, designation and number.
- Single line diagram(s), including fault levels at switchboards, cable size and type.
- Size, including required clearances for installation.
- Switchboard layouts.
- Technical data schedules corresponding to the equipment schedules in the contract documents. If there is a discrepancy between the two, substantiate the change.
- Type-test reports.

Telecommunications cabling: 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.

Emergency evacuation lighting: 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.

Tests

Lighting efficacy: Confirm the efficacy of the following by a photometric test, carried out for the applicable CCT, from a NATA approved laboratory:

- Light-emitting diode luminaires.
- Light-emitting diode lamp replacement modules.

1.7 WORK ON EXISTING SYSTEMS

Demolition

General: Decommission, isolate, demolish and remove from the site all existing redundant equipment including minor associated components that become redundant as a result of the demolition.

Breaking down: Disassemble or cut up equipment where necessary to allow removal.

Recovered materials: Recover all components associated with the listed items. Minimise damage during removal and deliver to the locations documented.

Existing electrical systems

Condition of existing systems:

- If the existing condition does not conform to the requirements in the contract documents, submit proposals to rectify the deficiencies with related costing, time and other impacts.
- Subject to the rectification works on existing systems, achieve the performance in the contract documents.

2 LOW VOLTAGE POWER SYSTEMS

2.1 RESPONSIBILITIES

General

General: Provide low voltage power systems, as documented.

2.2 SYSTEM DESCRIPTION

Network supply

General: Liaise with the electricity distributor and provide network connection, as documented.

Program: Schedule the works and statutory inspections to suit the construction program.

Prospective fault current: Determine, from the electricity distributor, the prospective fault current and fault protection requirements.

Distribution system

General: Provide power distribution system elements, as documented.

2.3 SURGE PROTECTION DEVICES (SPD)

General

Responsibilities: Provide surge protection devices as documented and where required to protect sensitive electrical equipment.

Surge protection devices (SPD)

General: Where nominated in the document, provide all mode metal oxide varistor based series connected SPD to protect final equipment in racks and cabinets.

Standard: To AS 4262.1 and AS 4262.2.

Surge Rating: $I_{max} \geq 20$ kA per phase.

Residual Voltage: $U_p < 600$ V.

Visual indicator: Provide visual indication of SPD 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.

2.4 SITE ELECTRICITY SUPPLY

General

Responsibilities: Provide site electricity supplies as documented.

Consumers Mains

Selection: Provide consumers mains, associated services and all necessary fault and overload current protection equipment to AS/NZS 3000 Section 3, the local electricity distributor's standards, the local Service and Installation Rules and as documented.

Protected consumers mains: Provide short circuit and overload protection, where required by the network distributor.

Metering

Retail: Provide metering to the requirements of the principal, the selected electricity retailer and the electricity distributor.

Surge protection devices (SPD)

General: Provide surge protection as documented.

2.5 WIRING SYSTEMS

Selection

General: Provide wiring and site cable reticulation systems appropriate to the installation conditions and the function of the load. Include the following:

- Underground services.
- Above-ground services.
- In-building services.

Type: Re-wireable system.

Neutral conductors: Same size as the corresponding active conductors. Rate the neutral conductor size for the maximum harmonic currents.

Cable support system: To AS/NZS 3000.

2.6 POWER CABLES

Standards

Polymeric insulated cables: To AS/NZS 5000.1.

Aerial cables: To AS 1746.

Cable

General: Provide multi-stranded copper cables.

Default insulation: V-75.

Default sheathing: 4V-75.

Minimum size: Conform to the following:

- Lighting subcircuits: 1.5 mm².
- Power subcircuits: 2.5 mm².
- Submains: 6 mm².

Voltage drop: Provide final subcircuit cables within the voltage drop parameters set by the route length and load.

Fault loop impedance: Provide final subcircuit cables to satisfy the requirements for automatic disconnection under short-circuit and earth fault/touch voltage conditions.

Underground residential distribution (URD) systems: To AS/NZS 4026.

Colours

Cables: 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.

Cable Installation

Standard: Classifications to AS/NZS 3013.

Handling cables: Report damage to cable insulation, serving or sheathing.

Stress: Make sure 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 and/or in pits.

Extra-low voltage circuits: Individual wiring of extra-low voltage circuits: Tie together at regular intervals.

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 legible indelible marking.

Submains and final sub-circuits

Installation: Provide the following:

- Cables with diameter less than 13 mm: Run in conduit, cable ducts or support on cable trays or ladders.
- Cables for lighting systems: Run in conduit, cable ducts, suspend on catenary systems or support on cable trays or ladders.
- Inaccessible concealed spaces: Install cable in UPVC conduit.
- In roof spaces: Install cable below heat insulation and sarking. If not protected from high ambient roof space temperatures by thermal insulation, derate the cables to AS/NZS 3008.1.1 Table 27, for an assumed ambient temperature of 55°C.
- In accessible ceiling voids: Support and enclose cables on ceiling surfaces or ceiling suspension systems.
- In walls filled with bulk thermal insulation: Install cables in PVC conduit.
- In metal stud framed walls: Install cable using TPS cable allowing rewirability. Bush all knock-outs in steel framing to prevent cable damage. Earth metal stud frames to the electrical earthing system.
- On horizontal cable trays or ladders: Fix cables using proprietary nylon cable ties or straps, cable saddles or clips at 2000 mm intervals.
- In vertical cable risers: Fix cables using proprietary nylon cable ties or straps, cable saddles or clips at 1000 mm intervals.
- Plant rooms: Install cable in heavy duty UPVC conduit or on tray, cable ladder or in duct.

2.7 EARTHING SYSTEMS

Earthing systems

Standard: Provide a protective earthing system with a multiple earth neutral (MEN) connection to AS/NZS 3000 and as documented.

Earth electrodes

General: Provide electrodes to AS/NZS 3000 clause 5.3.6.

Bonding

General: Provide equipotential bonding to AS/NZS 3000 clause 5.6.

Earth and bonding clamps

General: Provide proprietary earthing and bonding clamps.

Standard: To AS 1882.

2.8 ELECTRICAL ACCESSORIES

General

Selections: Provide accessories, as documented.

Style: Provide accessories of the same style and from the same manufacturer.

Socket outlets

Standards:

- General: To AS/NZS 3112.
- Industrial: To AS/NZS 3123.

Plastic switched socket outlets

Type: Integral switched socket outlet.

Material: High impact plastic.

Size: Standard single gang.

Colour: White electrical.

Current rating: 10 A.

Pin arrangement: Mount outlets with the earth pins at the 6 o'clock position.

Mounting configuration: Horizontal.

Ironclad socket outlets

Type: Integral switched socket outlet.

Material: Diecast metal or cast iron.

Size: Standard single gang.

Colour: Grey.

Current rating: 10 A.

Pin arrangement: Mount outlets with the earth pins, at the 6 o'clock position.

Weatherproof socket outlets

Type: Integral switched socket outlet.

Material: High impact plastic.

Size: Standard single gang.

Colour: Grey.

Current rating: 10 A.

Pin arrangement: Mount outlets with the earth pins, at the 6 o'clock position.

Combined RCD switched socket outlets

Type: Integral RCD unit with double switched socket outlet.

Material: High impact plastic.

Size: Standard single gang.

Colour: White electrical.

Current rating: 10 A.

RCD trip current: Conform to the following:

- General light and power: 30 mA Type II to AS/NZS 3190.
- Patient treatment areas: 10 mA Type I to AS/NZS 3190 as documented in the project documents.

Pin arrangement: Mount outlets with the earth pins, at the 6 o'clock position.

Multi-switch socket outlets on grid mounted panels

Type: Separate switch and socket outlets grid mounted on propriety or custom designed panels.

Material: As documented.

Colour: As documented.

Panel finishes: As documented.

Current rating: 10 A.

Plugs – 230 volt

General: Provide plugs with integral pins of the insulated type to AS/NZS 3112.

230 volt combination switch and permanently connected cord outlet

Type: Three terminal flush mounted switch and flex-lock insert assembly.

Material: High impact plastic.

Size: Standard single gang.

Colour: White electrical.

Current rating: 10 A.

Neon Indicator: Provide neon indicator, where nominated in the project documents.

Flex-lock assembly: Match and securely grip the size and type of flexible cable to be used.

Mounting configuration: Horizontal.

Permanently connected equipment

General: Provide final subcircuit to permanently connected equipment, as documented.

Isolation: Provide isolating switch adjacent to equipment.

Control: Provide Toilet exhaust fan control ((shall be provided with a switched active from dedicated channel of lighting control motion sensor – set run on time as per mechanical engineers design drawings) via a motion sensor (B.E.G. model PD3N-2C – two channel) and run on/off timer (refer to the Mechanical Engineers drawings for requirements).

Control: Provide Kitchen exhaust fan control via a timer run on/off (refer to the Mechanical Engineers drawings for requirements).

Coordination: Coordinate with equipment supplier.

Wall/ceiling mounted equipment: Conceal final cable connection to equipment.

Isolating switches

Standard: To AS/NZS 3133.

Emergency stop switches

Standard: To IEC 60947-5-5.

3-phase outlets

Standard: To AS/NZS 3123.

Type: Surface mounted integral switched socket outlet with flap lid on the outlet.

Material: High impact plastic.

Size: To suit current rating and pin configuration nominated in the project documents.

Colour: Grey.

Current rating: 5 pin, 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.

Installation

General: Install accessories and conceal cabling in walls in conformance with the following:

- 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: Flush wall box, with thermoplastic insulated cables in conduit run in cavity and tied against inner brick surface, or thermoplastic sheathed cables run in cavity.
- Stud partition: Flush plate secured to proprietary support bracket or wall box.
- Fire walls: Flush wall box, with conduit built into wall. Provide additional fire protection around wall boxes, where necessary to maintain fire rating.

Location: Confirm final location of all outlets and equipment on site, before installation.

Spacing from adjacent horizontal surface: ≥ 75 mm to the centre of accessory socket.

Default mounting heights to centre of accessory plate:

- GPO / DPGO Outlets: 300 mm (standard unless otherwise nominated).

GPO / DGPO Outlets: General Purpose outlets shall be located not less than 600 mm nor more than 1100mm above the plane of the finished floor and not less than 500mm from internal corners” AS1428.1-2009 – Section 14.2 (Paragraph 2) (for UAT rooms).

- Light switches and Ceiling fan controls: 1100 mm (standard unless otherwise nominated).
- Light switches, GPO's and Ceiling fan controls: 1500 mm (for Childcare buildings - projects).

Flush mounting: Provide flush mounted accessories, except in plant rooms.

Common face plates: Mount adjacent flush mounted accessories under a common faceplate.

Restricted location: Do not install wall boxes across junctions of wall finishes.

Surface mounting: Proprietary mounting blocks.

Installation of ceiling mounted accessories

Connections for appliances: Provide flush mounted outlets on the ceiling next to support brackets.

Mounting: Mount appliances independent of ceiling tiles and suspended ceiling suspension system. Fix directly to concrete slab or to roof structure above ceiling.

Connections for fixed equipment: Provide concealed permanent connections.

Fixing: For equipment and appliances heavier than 30kg, provide support through the suspended ceiling to the building structure. Brace appliances that have excessive bending moments, are heavy or vibrate, to prevent horizontal movement, e.g. operating theatre shadowless lights.

2.9 MECHANICAL ELECTRICAL POWER AND CONTROLS

Power supplies and control for toilet exhaust

Standard: Provide an isolator for each toilet exhaust fan (shall be provided with a switched active from dedicated channel of lighting control motion sensor – set run on time as per mechanical engineers design drawings) and connect via a motion sensor (B.E.G. model PD3N-2C – two channel) (recessed / surface mounted to ceiling) and set run on / off timer as prescribed on mechanical drawings. Electrical contractor shall include in tender price for the supply and installation of power (isolators) and controls (via a motion sensor and run on/off timer, contactor, relay, ect.) and liaise and refer to the mechanical consultant drawings for correct controls and equipment to be provided. No additional variation will be approved.

2.10 MARKING AND LABELS

Where flush plates, light switch panels and other items of equipment are to be labeled or engraved, they shall be machine engraved in upper case lettering filled with black pigments to approval.

Switchplates and socket outlet plates shall be marked to identify phase and circuit number. The identification shall be provided by means of inedible ink positioned so as to be concealed by the cover plate when in position.

Provide IPA markers to IP44 and IP56 rated devices with circuit numbers coloured to the appropriate phase colour. Install the IPA markers centrally at the bottom of the device.

Provide labels as nominated on drawings.

Labels shall be:

- Laminated plastic engraved to approved size, wording and design, clearly indicating the function and/or circuit designation of the component
- Of white background white with black machine engraved lettering for general items
- Of red background with white machine engraved lettering for safety purposes (eg DANGER and FIRE SERVICES labels)
- Provided with bevelled edges.
- Fixed by drilling and tapping at a minimum of at least two points. Self-tapping screws, adhesive application or otherwise methods of fixing are NOT acceptable.
- Not be fixed to removable covers and lids.
- Of 5mm minimum lettering height.

3 SWITCHBOARDS – PROPRIETARY

3.1 RESPONSIBILITIES

General

General: Provide proprietary switchboards for the following, as documented:

- Main switchboard.
- Distribution boards.

Switchboard manufactures

General: Provide 4 tender / construction switchboard prices from the following selected switchboard manufactures list:

- Price Trandos Engineering.
- PGS Industries Inc.
- ARC Electrical Switchboards.
- Ray Brooks Switchboards.
- CPE Switchboards.
- HAHN Electrical.
- EATON.
- POPE Electrical.
- Universal Switchboards.
- Denco Industries

The electrical contractor can offer alternative switchboard manufacturers (during Tender stage), but will require approval 7 days prior to the closing tender date from the electrical consultant.

The electrical contractor and switchboard manufacturer shall refer to all Western Power design drawing(s) regarding this project during tender and prior to shop drawing, manufacturing and installation of the SMSB and confirm all SPD (quantity), SPD settings fault kA rating, meter type, CT's type, ect. are correct and compliant as per the Western Power design drawing and Western Power single line drawing / Western Power standards.

3.2 STANDARDS

General

Standards: To AS/NZS 3000 and AS/NZS 61439.

3.3 GENERAL

Enclosure

Default material: Metallic-coated sheet steel.

Separation

Default: Form 1 or Form 2 or Form 3b as documented.

Metering

Retail: Provide metering to the requirements of the principal, the selected electricity retailer and the electricity distributor.

Private: Provide private metering, as documented.

Busbars

General: Incorporate proprietary insulated busbar systems for the interconnection of isolators, circuit breakers and other circuit protective devices.

Spare capacity

Default spare poles: $\geq 20\%$.

Surge diversion

General: Provide surge protection as documented.

Earthing

General: Provide for the connection of the communications earth terminal (CET) at switchboard earth bar to AS/CA S009.

Doors

General: Provide lockable doors with a circuit card holder unless enclosed in cupboards or in an area which is not readily accessible to the public.

IP rating

Default rating: IP44 minimum.

Weatherproof: IP56 minimum.

Finishes

Exterior and Interior: To the manufacturer's standard colour.

Supporting structure

Assemblies:

- Wall mounted: $\leq 2 \text{ m}^2$.
- Floor mounted: $> 2 \text{ m}^2$.

Ventilation

General: Required to maintain design operating temperatures at full load.

Cable entries

General: 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. Do not run cables into the top of weatherproof assemblies.

Single core cables: Pass separately through non-ferrous gland plates. Do not provide ferrous metal saddles.

Cable enclosures

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.

Cable supports

Cable supports: Support or tie mains and submains cables within 200 mm of terminations. Provide cable supports suitable for stresses resulting from short circuit conditions.

4 SWITCHBOARD COMPONENTS

4.1 RESPONSIBILITIES

General

Responsibilities: Provide switchboard components as follows and as documented.

Statutory authority's equipment

General: Liaise with the electricity distributor regarding the installation and coordination of their metering, protection and control equipment.

4.2 PRODUCTS

General

Selection: Conform to the requirements of AS/NZS 3000 clause 1.7 and AS/NZS 3000 Section 2.

Rated duty: Uninterrupted.

Rated making capacity (peak): $\geq 2.1 \times$ fault level (r.m.s.) at assembly incoming terminals.

Utilisation category: To AS 60947.1 clause 4.4 and the recommendations of Annex A.

- Circuits consisting of motors or other highly inductive loads: At least AC-23.
- Other circuits: At least AC-22.

Coordination: Select and adjust protective devices to discriminate under overload, fault current, and earth fault conditions.

Enclosure: IP4X minimum.

4.3 OVERLOAD AND FAULT PROTECTION GENERALLY

General

Requirement: Provide overload and fault protection devices including full discrimination and cascade protection and grade with the electricity distributor's incoming supply protection system and the downstream site protection devices.

4.4 SWITCH-ISOLATOR AND COMBINATION FUSE-SWITCH UNITS

Standard: To AS 60947.1 and AS/NZS 3947.3.

Operation: Independent manual operation including positive ON/OFF indicator.

Shrouding: Effective over range of switch positions.

Fault make/fault break switch-isolators

Rated breaking capacity: To AS/NZS 3947.3 Table 3.

Rated short-time withstand current: To AS 60947.1 clause 4.3.6 and the manufacturer's recommendation to meet the prospective fault current conditions applying.

Rated short-circuit making capacity: To AS 60947.1 clause 4.3.6 and the manufacturer's recommendation to meet the prospective fault current conditions applying.

Rated short-circuit breaking capacity: To AS 60947.1 clause 4.3.6 and the manufacturer's recommendation to meet the prospective fault current conditions applying.

Load make/load break switch-isolators

Rated breaking capacity: To AS/NZS 3947.3 Table 3.

Rated short-time withstand current: To AS 60947.1 clause 4.3.5 and the manufacturer's recommendation to meet the current conditions applying.

Rated making capacity: To AS 60947.1 clause 4.3.5 and the manufacturer's recommendation to meet the current conditions applying.

Rated breaking capacity: To AS 60947.1 clause 4.3.5 and the manufacturer's recommendation to meet the current conditions applying.

Fuse links: Isolate when switch contacts are open. Provide 3 phase sets of high rupturing capacity (HRC) fuse links.

4.5 MOULDED CASE AND MINIATURE CIRCUIT BREAKERS

Moulded case breakers: To AS 60947.1, AS 2184 and AS 60947.2.

Miniature circuit breakers: Interrupting capacity classification to AS/NZS 60898.1 or AS/NZS 3111.

- For general building services: Type C.
- For motor protection: Type D.

Operation: Independent manual operation including positive ON/OFF indicator.

Trip type: Conform to the following:

- Moulded case breakers: Adjustable thermal, fixed magnetic.
- Miniature circuit breakers: Fixed thermal and fixed magnetic.

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.

Clip tray chassis: For miniature overcurrent circuit breakers provide clip tray assemblies capable of accepting single, double, or triple circuit breakers, and related busbars. Provide moulded clip-on pole fillers for unused portions.

Trip settings: Set for load requirements, seal, and label.

Interchangeable trip units: Connect trip units so that trip units are not live when circuit breaker contacts are open.

Fault current limiting circuit breakers: Select breaker frame sizes from one manufacturer's tested range of breakers to give cascade and discrimination protection within the switchboard and downstream switchboards as required.

4.6 ELECTRICITY DISTRIBUTOR'S SERVICE PROTECTIVE DEVICES

Requirement: Provide low voltage service protective devices to AS/NZS 3000, the electricity distributor's requirements and the supply authority Service and Installation rules.

For service protective devices > 100 A: Provide fault current limiting circuit breakers with adjustable overload and short circuit current facilities with full discrimination and cascade protection between the incoming supply protection systems and the downstream protection systems.

4.7 RESIDUAL CURRENT OPERATED CIRCUIT BREAKERS (RCDS)

General

Standard: To 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.

Type: Type II.

Default tripping current: 30 mA.

4.8 FUSES WITH ENCLOSED FUSE LINKS

General

Standards: To AS 60269.1, AS 60269.2.0 and AS 60269.2.1.

Fuses with fuse-links for the protection of semiconductor devices: To AS 60269.4.0.

Fuses with fuse-links used as fault current limiters: Co-ordinate fuse type and rating with the protection switchgear manufacturer's recommendation if used downstream of the fault current limiters. Provide labels adjacent to the fuse holder stating FAULT CURRENT LIMITER and fuse size.

Fuse links: 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 can 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.

4.9 CONTACTORS

General

Standard: To AS 60947.4.1.

Type: Enclosed, block type, air break, electro-magnetic.

Poles: 3.

Rated operational current: The greater of:

- 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.

Mounting: 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.

Auxiliary contacts: 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.

5 LIGHTING

5.1 RESPONSIBILITIES

General

Requirement: Provide lighting and control systems, as documented.

Minimum energy performance standards (MEPS)

General: To AS/NZS 4847.2, AS/NZS 4783.2, AS 4934.2.

Self ballasted lamps: To AS/NZS 4847.2.

5.2 STANDARDS

Standards

Energy efficiency for ballasts and lamps: To AS/NZS 4783.2.

5.3 PROPRIETARY LUMINAIRES

General

Requirement: Provide proprietary luminaires complete with lamps, luminaire control equipment, lighting control equipment, and accessories as documented. Provide lamps of the same type from the same brand and country of manufacture.

Self ballasted lamps: To AS/NZS 60968 and AS/NZS 60969.

5.4 ELV VOLTAGE TRANSFORMERS OR ELV SWITCH POWER SUPPLIES

General

Requirement: Provide separate ELV transformers for each ELV lamp.

Standard: To AS/NZS 4879.1, AS/NZS 4879.2 and AS/NZS 61558.1.

5.5 LIGHT-EMITTING DIODES (LEDS) LUMINAIRES

General

General: Provide light emitting diode (LED) luminaires, as documented.

Colour: CRI > 80.

CCT: 4000 K.

5.6 CONTROL GEAR ENCLOSURE

General: Provide controlgear support enclosure within the body of the luminaire, except where remotely mounted controlgear is documented or required by the manufacturer.

Enclosures and controlgear mounting assemblies: Provide heat dissipation facilities to dissipate heat from the luminaire.

Controlgear enclosure: Form a barrier against direct contact with live parts of the controlgear and the area of the luminaire containing the lamp and lamp support holders.

Separate controlgear enclosures: If separate controlgear enclosures external to the luminaire are required, conform to the above requirements.

Fixing: Screw fixed.

5.7 WIRING

Flexible cords

Recessed luminaires: Provide external flexible cord in conformance with the following:

- Length: ≥ 1.5 m.
- Cross sectional area: 0.75 mm^2 .
- Type: 3-core V75 (minimum) PVC/PVC, connected to a 10 A 3-pin moulded plug to AS/NZS 3112 or multi-pin plug, as documented.

5.8 LIGHTING CONTROL

General

Requirement: Provide the following as documented:

- Lighting switches.

- Motions sensors.

5.9 SUPPORTS

General

General: Install luminaires on proprietary supports by means of battens, trims, noggings, roses and packing material .

Suspended luminaires

Rods: Steel pipe suspension rods fitted with gimbal joints.

Chains: Electroplated welded link chain.

Levelling wire: Stainless steel.

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.

Surface mounted luminaires

General: Fit packing pieces to level luminaires and prevent distortion of luminaire bodies. Provide packing strips to align end to end luminaires.

Fixing: Conform to the following:

- Generally: Provide 2 fixings at each end of fluorescent luminaires.
- Luminaires less than 150 mm: A single fixing at each end in conjunction with 1.6 mm backing plates may be used.
- Provide battens and support for the fitting.
- Do not direct fix into plasterboard.

Recessed luminaries

General: Install recessed luminaries in trimmed openings in the suspended ceiling.

Standard: To AS 2946.

5.10 COMPLETION

General

Requirement: Before the date of practical completion carry out the following:

- Verify the operation of all luminaires.
- Adjust aiming and controls for all luminaires under night time conditions.
- Replace lamps which have been in service for a period greater than 50% of the lamp life as published by the lamp manufacturer.

6 EMERGENCY EVACUATION LIGHTING

6.1 RESPONSIBILITIES

General

General: Provide single point monitored emergency lighting and exit signs as documented.

6.2 SINGLE-POINT SYSTEM LUMINAIRES

General

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 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.

Common test switches: Provide a common test switch on the local distribution board which disconnects main supply to the luminaires and tests for discharge performance and automatically reverts to normal operating mode after testing.

Batteries

Type: Provide Lithium-ion batteries (LIION) capable of operating each lamp at its rated output continuously for at least 2 hours during commissioning tests and 1.5 hours during subsequent tests.

Battery life: At least 10 years when operating under normal conditions at an ambient temperature of between 10°C and 40°C and subject to charging and discharging at 6 monthly intervals.

Marking: Indelibly mark each battery with its date of manufacture.

6.3 SINGLE POINT SYSTEM

Power supply

General: Provide an unswitched active supply to each luminaire and exit sign, originating from the test switch control panel.

0911 CABLE SUPPORT AND DUCT SYSTEMS**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide cable support, trunking and duct systems, as documented.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following worksection(s):

- *Demolition by Architect.*
- *Cable support and duct systems.*
- *Low voltage power systems.*
- *Switchboards – proprietary.*
- *Lighting.*
- *Emergency evacuation lighting.*

1.3 INTERPRETATION**Definitions**

General: For the purposes of this worksection the following definitions apply:

- Cable support: Cable tray, cable ladder and cable mesh cable support systems.

1.4 SUBMISSIONS**Certification**

General: Submit structural engineer's certification for the following:

- Fabricated columns.
- Flange assemblies at the base of columns.
- Footings for columns.
- Rag bolt assemblies for column support.

Shop drawings

General: Submit shop drawings showing the following:

- Cable tray and trunking routes.
- 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.

Technical data

General: Submit technical data for the following:

- Ducted wiring enclosure systems.
- Cable support systems.
- Proprietary pits.
- Proprietary columns.
- Load calculations for aerial cable supports.

2 PRODUCTS

2.1 CONDUITS

General

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 and AS/NZS 2053.8.

Type

General: Rigid.

Sizes

Conduits: ≥ 20 mm.

Underground: ≥ 25 mm.

Conduits for telecommunications: ≥ 25 mm.

Fixings

Surface mounted: Double sided fixed.

In concrete slabs: Tie to structural steel.

Colour

Conduits generally: Light orange.

Telecommunications systems conduits: White.

Galvanized water pipe

Medium or heavy: To AS 1074.

2.2 METALLIC CONDUITS AND FITTINGS

General

Standards: To AS/NZS 2053.7 or AS/NZS 2053.8

Type

General: Steel conduit with medium protection outside and inside to AS/NZS 2053.7.

Exposed to dampness or moisture: Steel conduit with high protection outside and inside to AS/NZS 2053.7.

Laid underground: Steel water pipe with protection outside and inside to AS/NZS 2053.7.

Joining

Steel conduit: Screwed joints and ends.

Fixings

Saddles: Conform to the following:

- Internal: Zinc plated.
- External: Hot-dipped galvanized.

Corrosion protection

Steel conduits: Paint ends and joint threads with zinc rich organic primer to AS/NZS 3750.9.

2.3 NON-METALLIC CONDUITS AND FITTINGS

General

Standards: Non-metallic conduits and fittings: AS/NZS 2053.2, AS/NZS 2053.3, AS/NZS 2053.4, AS/NZS 2053.5 or AS/NZS 2053.6.

Solar radiation protection: Required for conduits and fittings exposed to sunlight.

Flexible conduit

General: Provide flexible conduit to connect with equipment and plant subjected to vibration. If required, provide for adjustment or ease of maintenance. Provide the minimum possible length.

Associated fittings

Type: Provide associated fittings of the same type and material as the conduit.

Wall boxes on UPVC conduits: Provide prefabricated earthed metal boxes, for special size wall boxes not available in UPVC.

Inspection fittings

General: Provide inspection-type fittings only in accessible locations and where exposed to view.

Joints

Type: Cemented or snap-on joints.

2.4 CABLE DUCT/TRUNKING**General**

Standards: To AS/NZS 4296.

Cable duct

Material: Metal.

Material finish: Metallic-coated to AS 1397 Grade G2, Coating Class Z275.

Construction: Solid.

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 1000 mm.

Proprietary trunking systems

General: Provide proprietary skirting duct (type AK150/50, AKS50, AKS50OC, CM50OC, CM50E or AKS50E, CM50EC or AKS50EC, CM50IC or AKS50IC, AK150/50/3 or AKS50/3) (2 compartment skirting duct, 150mm high x 50mm deep), wall duct, floor duct and service column systems, incorporating segregation, if used for multiple services. Provide rigid supports. Round off sharp edges and provide bushed or proprietary cable entries into metallic trunking.

Accessories: Provide proprietary fixings and mountings facilities for accessories and outlets.

Covers: Screw-fixed or clip-on type, removable only with the use of tools.

2.5 CABLE SUPPORT SYSTEMS**General**

System: Provide a complete cable support system consisting of the cable supports, brackets, fixings and accessories.

Standard: To NEMA VE-1.

Type tests: To NEMA VE-1.

Manufacture: Provide proprietary cable support, fittings and accessories from a single manufacturer for the same support system.

Selection: Select cable supports in conjunction with support system installation to achieve the loading and deflection requirements.

Spare capacity: $\geq 50\%$.

Support

Power cables: Conform to the following:

- Overhead suspension: Trapeze or centre rail structure.
- Wall supported: Wall bracket with full access from one side of the cable support.

Communications cables: Conform to the following:

- Overhead suspension: Single sided.
- Wall supported: Wall bracket with full access from one side of the cable support.

Dimensions: To the preferred dimensions nominated in NEMA VE-1.

Material finish: Metallic-coated to AS 1397, Grade G2, Coating Class Z275.

Covers: Provide ventilated flat covers to cable support systems installed in accessible locations.

2.6 CATENARY SYSTEMS**General**

Catenary systems: May be used within suspended ceiling spaces in lieu of cable tray and ladder systems.

Wire: Provide stainless steel or coated galvanized cable and couplings for catenary systems.

2.7 CABLE PITS**General**

Cable draw-in pits: Provide cable draw-in pits as documented. Sizes given are internal dimensions.

Proprietary cable pits

Pits ≤ 1200 x 1200 mm: Provide proprietary concrete or polymer moulded pits.

In situ construction

Pits > 1200 x 1200 mm: Provide either:

- Proprietary cable 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

General: 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

General: 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.

3 EXECUTION

3.1 GENERAL

Fire isolation

General: Provide fire stop sealing where electrical services pass through fire-rated walls, floors or ceilings.

Wall boxes in fire rated walls: Provide fire-rated barriers behind wall boxes in fire-rated walls if the integrity of the fire rating has been altered.

3.2 UNSHEATHED CABLES – INSTALLATION

General

General: Provide permanently fixed enclosure systems, assembled before installing wiring.

Draw wires: Provide draw wires to pull in conductor groups from outlet to outlet, or provide ducts with removable covers.

3.3 CONDUIT SYSTEMS – INSTALLATION

Inspection fittings

Location: Locate in accessible positions.

Draw cords

General: Provide 5 mm² polypropylene draw cords in conduits not in use.

Draw-in boxes

General: For conduits in accessible locations provide draw-in boxes as follows:

- In straight runs at > 30m: Spacing ≤ 30 m.
- At changes of level or direction.

Underground draw-in boxes: Provide gasketed covers and seal against moisture. Install in accessible pits.

Expansion

General: Allow for thermal expansion/contraction of conduits and fittings due to changes in ambient temperature conditions. Provide expansion couplings as required.

Rigid conduits

General: Provide straight long runs, smooth and free from rags, burrs and sharp edges. Set conduits to minimise the number of fittings.

Routes

Set out: If exposed to view, install conduits in parallel runs with right angle changes of direction.

Bends: Install conduits with no more than 2 right angled bends per cable draw-in run.

Concealed conduits: 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. Use large radius bends or elbows.

Overhead conduits in mechanical plant rooms: If overhead conduits service mechanical equipment installed on plinths in plant rooms, provide support and protection. Alternatively use cable support system.

Painting

Conduits exposed to view: Paint to match surrounds as documented.

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.

Parallel conduit spacing: ≥ 50 mm apart.

Conduits in mechanical plant room slabs: Avoid installation of conduits in plant room slabs (boiler rooms, mechanical plant rooms and tank rooms) if conduits and cables are likely to experience high temperatures, be subject to core hole drilling, drilling of large anchor bolt points or where exact plant locations are unknown at time slab is poured.

Minimum cover: The greater of the conduit diameter and 20 mm.

Construction joints: Provide sleeving over conduit to allow movement of the conduit across the joint due to any slab movement.

Fixing: Fix directly to the top of the bottom layer of reinforcing.

Conduits in hollow-block floors

Location: Locate conduits in the core-filled sections of precast hollow-block type floors.

Conduits in columns

Number and size of conduits in columns: As determined by the structural engineer.

Bends: Enter columns with radius sweep bends greater than or equal to 150 mm. Do not use elbows.

Chasing: Do not chase columns.

3.4 CABLE SUPPORT SYSTEMS – INSTALLATION

General

Standard: To NEMA VE-2.

Design: Support cable support systems as follows:

- Horizontal runs:
 - . Concealed cable support system: Provide supports at spacing which is less than length of cable support section.
 - . Visible cable support: Loaded deflection \leq span/200.
- Vertical runs: Support to manufacturer's recommendation, taking into account the weight of cables installed.

Fixing to building structure

General: Fix supports to the building structure or fabric with threaded rod hangers greater than or equal to 8 mm attached to hot-dipped galvanized U-brackets, or by means of proprietary brackets.

Cable fixing

General: Provide strapping or saddles suitable for fixing cable ties.

Bend radius

General: Provide bends with an inside radius at least 12 times the outside diameter of the largest diameter cable carried.

Cable protection

General: Provide rounded support surfaces under cables where they leave trays or ladders.

Clearances

Access: Provide at least 150 mm free space above and at least 600 mm free space on at least one side of cable tray and ladders.

From hot water pipes: > 200 mm.

From boilers or furnaces: > 500 mm.

Electromagnetic interference (EMI): Locate support systems for electrical power cabling and communication cabling to minimise electromagnetic interference.

3.5 CATENARY SYSTEMS – INSTALLATION

General

Anchoring: Anchor catenary systems to the structure. Do not fix to any part of a suspended ceiling system.

Design loads: Provide catenary systems designed to support the proposed load of the cables with a spare capacity of 50% loading.

Fixing: Fix cables to the catenary system so 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.

3.6 CABLES IN TRENCHES – INSTALLATION

Sand bed and surround

General: Conform to the *Service trenching* worksection.

Sand bed and surrounds: Provide at least 150 mm clean sharp sand around cables and conduits installed underground.

Sealing ducts and conduits

General: Seal buried entries to ducts and conduits with waterproof seals as follows:

- Spare ducts and conduits: Immediately after installation.
- Other ducts and conduits: After cable installation.

0921 LOW VOLTAGE POWER SYSTEMS**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide low voltage power systems, as documented.

Design

Fault protection: Automatic disconnection to AS/NZS 3000 clause 2.4.

Maximum demand: Calculation method to AS/NZS 3000 Appendix C.

1.2 PERFORMANCE**Network supply**

General: Liaise with the electricity distributor and provide network connection, as documented.

Programme: Schedule the works and statutory inspections to suit the construction programme.

Prospective fault current: Determine, from the electricity distributor, the prospective fault current and fault protection requirements.

Embedded generator supplies

General: Provide embedded generator supplies, as documented.

Distribution system

General: Provide power distribution system elements, as documented.

Metering

Retail: Provide metering to the requirements of the principal, the selected electricity retailer and the electricity distributor.

Surge protection devices (SPD)

General: Provide surge protection as documented.

1.3 CROSS REFERENCES**General**

Requirement: Conform to the following worksection(s):

- *Demolition by Architect.*
- *Cable support and duct systems.*
- *Low voltage power systems.*
- *Switchboards – proprietary.*
- *Lighting.*
- *Emergency evacuation lighting.*

1.4 STANDARDS**General**

Electrical design: To SAA HB 301.

Electrical equipment: To AS/NZS 3100.

Fire and mechanical performance classification: To AS/NZS 3013.

Selection of cables: To AS/NZS 3008.1.1.

Distribution cables: To AS/NZS 4961.

Testing

Standard: To AS/NZS 3017.

1.5 INTERPRETATIONS**Abbreviations**

General: For the purposes of this worksection the following abbreviations apply:

- RCD: Residual current device.

- SPD: Surge protection device.

Definitions

General: For the purposes of this worksection the following definitions apply:

- Embedded generator: Electricity generator connected to the local electrical distribution network.
- Extra-low voltage: Not exceeding 50 V a.c. or 120 V ripple-free d.c.
- Low voltage: Exceeding extra-low voltage, but not exceeding 1000 V a.c. or 1500 V d.c.
- High voltage: Exceeding low voltage.

1.6 SUBMISSIONS**Samples**

General: Submit samples of all visible accessories and equipment.

Cabling accessories: Submit switched socket outlets, light switch plates and other accessories.

Shop drawings

General: Submit shop drawings of the following:

- Cable routes.
- Busduct systems including routes, dimensions and connection details.

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.
- Discrimination and grading of protective devices.
- Prospective short circuit current automatic disconnection times.
- Earth fault loop impedance calculations for testing and verification.
- Certification of conformance to AS/NZS 3000, for electrical services.
- Stringing calculations for aerial cables.

Final subcircuits: May be treated as typical for common route lengths, loads and cable sizes.

Tests

Site tests: Submit results as follows:

- Installation: To AS/NZS 3000 Section 8 using the methods outlined in AS/NZS 3017.
- Connections to electricity networks: To AS 4741.

2 PRODUCTS

2.1 SITE ELECTRICITY SUPPLY**LV supplies from dedicated substations**

LV transformer output supply: To AS/NZS 3000 and the electricity distributor's Service and Installation Rules.

Requirements: Provide short circuit and overload protection at the transformer secondary supply using fault current limiting circuit breakers with adjustable overload and short circuit current setting features, if secondary output supply protection is required.

Circuit breakers: Include full discrimination and cascade protection and grade with the electricity distributor's incoming supply protection system and the downstream site protection devices.

Consumers Mains

Requirement: Provide consumers mains, associated services and all necessary fault and overload current protection equipment to AS/NZS 3000 Section 3, the local electricity distributor's standards, the local Service and Installation Rules and as documented.

Protected consumers mains: Provide short circuit and overload protection, where required by the electricity distributor.

2.2 WIRING SYSTEMS**General**

Requirement: Provide wiring and site cable reticulation systems appropriate to the installation conditions and the function of the load. Include the following:

- Underground services.
- Above-ground services.
- In-building services.

Type: Re-wireable system.

Neutral Conductors: Same size as the corresponding active conductors. Rate the neutral conductor size for the maximum harmonic currents.

Cable support system: Conform to the *Cable support and duct systems* worksection.

2.3 POWER CABLES**Standards**

Polymeric insulated cables: To AS/NZS 5000.1.

Aerial cables: To AS 1746.

Cable

General: Select multi-stranded copper cables.

Default insulation: V-75.

Default sheathing: 4V-75.

Minimum size: Conform to the following:

- Lighting sub-circuits: 1.5 mm².
- Power sub-circuits: 2.5 mm².
- Sub-mains: 6 mm².

Voltage drop: Select final subcircuit cables within the voltage drop parameters dictated by the route length and load.

Fault loop impedance: Select final subcircuit cables selected to satisfy the requirements for automatic disconnection under short circuit and earth fault/touch voltage conditions.

Underground residential distribution (URD) systems: Cables to AS/NZS 4026.

Distribution cables: To AS/NZS 4961.

Colours

Cables: 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.

2.4 ELECTRICAL ACCESSORIES**General**

Style: Provide accessories of the same style and from the same manufacture.

Socket outlets

Standards:

- General: To AS/NZS 3112.
- Industrial: To AS/NZS 3123.

Plastic switched socket outlets

Type: Integral switched socket outlet.

Material: High impact plastic.

Size: Standard single gang.

Colour: White electrical.

Current rating: 10 A.

Pin arrangement: Mount outlets with the earth pins at the 6 o'clock position.

Mounting configuration: Horizontal.

Ironclad socket outlets

Type: Integral switched socket outlet.

Material: Diecast metal or cast iron.

Size: Standard single gang.

Colour: Grey.

Current rating: 10 A.

Pin arrangement: Mount outlets with the earth pins, at the 6 o'clock position.

Weatherproof socket outlets

Type: Integral switched socket outlet.

Material: High impact plastic.

Size: Standard single gang.

Colour: Grey.

Current rating: 10 A.

Pin arrangement: Mount outlets with the earth pins, at the 6 o'clock position.

Combined RCD switched socket outlets

Type: Integral RCD unit with double switched socket outlet.

Material: High impact plastic.

Size: Standard single gang.

Colour: White electrical.

Current rating: 10 A.

RCD trip current: 30 mA Type II to AS/NZS 3190. Alternatively provide 10 mA Type I to AS/NZS 3190 as documented in the project documents.

Pin arrangement: Mount outlets with the earth pins, at the 6 o'clock position.

Multi-switch socket outlets on grid mounted panels

Type: Separate switch and socket outlets grid mounted on propriety or custom designed panels.

Material: As documented.

Colour: As documented.

Panel finishes: As documented.

Current rating: 10 A.

Plugs – 230 volt

General: Provide plugs with integral pins of the insulated type to AS/NZS 3112.

230 volt combination switch and permanently connected cord outlet

Type: Three terminal flush mounted switch and flex-lock insert assembly.

Material: High impact plastic.

Size: Standard single gang.

Colour: White electrical.

Current rating: 10 A.

Neon Indicator: Provide neon indicator, where nominated in the project documents.

Flex-lock assembly: Match and securely grip the size and type of flexible cable to be used.

Mounting configuration: Horizontal.

Installation couplers

Standard: to AS/NZS 61535.

Permanently connected equipment

General: Provide final subcircuit to permanently connected equipment, as documented.

Isolating switch: Locate adjacent to equipment.

Control: Provide Toilet exhaust fan control (shall be provided with a switched active from dedicated channel of lighting control motion sensor – set run on time as per mechanical engineers design drawings) via a motion sensor (B.E.G. model PD3N-2C – two channel) and run on/off timer (refer to the Mechanical Engineers drawings for requirements).

Control: Provide Kitchen exhaust fan control via a timer run on/off (refer to the Mechanical Engineers drawings for requirements).

Coordination: Coordinate with equipment supplier.

Wall/ceiling mounted equipment: Conceal final cable connection to equipment.

Isolating switches

Standard: To AS/NZS 3133.

Emergency stop switches

Standard: To IEC 60947-5-5.

3-phase outlets

Standard: To AS/NZS 3123.

Type: Surface mounted Integral switched socket outlet with flap lid on the outlet.

Material: High impact plastic.

Size: To suit current rating and pin configuration nominated in the project documents.

Colour: Grey.

Current rating: 5 pin, 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.

Appliances

Connection: Shorten lead to minimum length for plug connections.

Isolating Switches: To AS/NZS 3000.

2.5 MECHANICAL ELECTRICAL POWER AND CONTROLS**Power supplies and control for toilet exhaust**

Standard: Provide an isolator for each toilet exhaust fan (shall be provided with a switched active from dedicated channel of lighting control motion sensor – set run on time as per mechanical engineers design drawings) and connect via a motion sensor (B.E.G. model PD3N-2C – two channel) (recessed / surface mounted to ceiling) and set run on / off timer as prescribed on mechanical drawings. Electrical contractor shall include in tender price for the supply and installation of power (isolators) and controls (via a motion sensor and run on/off timer, contactor, relay, ect.) and liaise and refer to the mechanical consultant drawings for correct controls and equipment to be provided. No additional variation will be approved.

3 EXECUTION

3.1 SITE ELECTRICITY SUPPLY**General**

Electrical systems: Connect to the electricity distributor's supply, as documented and provide all equipment necessary to meet the electricity distributor's requirements.

3.2 EARTHING

Earthing systems

Standard: Provide a protective earthing system with a multiple earth neutral (MEN) connection to AS/NZS 3000 and as documented.

Earth electrodes

General: Provide electrodes to AS/NZS 3000 clause 5.3.6.

Bonding

General: Provide equipotential bonding to AS/NZS 3000 clause 5.6.

Earth and bonding clamps

General: Provide proprietary earthing and bonding clamps.

Standard: To AS 1882.

3.3 POWER CABLES

Cable installation

Standard: Classifications to AS/NZS 3013.

Handling cables: Report damage to cable insulation, serving or sheathing.

Stress: Make sure 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 and/or in pits.

Extra-low voltage circuits: Individual wiring of extra-low voltage circuits: Tie together at regular intervals.

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 legible indelible marking.

Submains and final sub-circuits

Installation: Provide the following:

- Cables with diameter less than 13 mm: Run in conduit, cable ducts or support on cable trays or ladders.
- Cables for lighting systems: Run in conduit, cable ducts, suspend on catenary systems or support on cable trays or ladders.
- Inaccessible concealed spaces: Install cable in UPVC conduit.
- In roof spaces: Install cable below heat insulation and sarking. If not protected from high ambient roof space temperatures by thermal insulation, derate the cables, to AS/NZS 3008.1.1 Table 27, for an assumed ambient temperature of 55°C.
- In accessible ceiling voids: Support and enclose cables on ceiling surfaces or ceiling suspension systems.
- In walls filled with bulk thermal insulation: Install cables in PVC conduit.
- In metal stud framed walls: Install cable using TPS cable allowing rewirability. Bush all knock-outs in steel framing to prevent cable damage. Earth metal stud frames to the electrical earthing system.
- On horizontal cable trays or ladders: Fix cables using propriety nylon cable ties or straps, cable saddles or clips at 2000 mm intervals.
- In vertical cable risers: Fix cables using propriety nylon cable ties or straps, cable saddles or clips at 1000 mm intervals.
- Plant rooms: Install cable in heavy duty UPVC conduit or on tray, cable ladder or in duct.

3.4 COPPER CONDUCTOR TERMINATIONS

General

General: 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

General: 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.

Alternative: Run cables in UPVC cable duct with fitted cover.

Identification: Provide durable numbered ferrules fitted to each core, and permanently marked with numbers, letters or both to suit the connection diagrams.

Spare cores: Identify spare cores and terminate into spare terminals, if available. Otherwise, neatly insulate and neatly bind the spare cores to the terminated cores.

3.5 ACCESSORIES

Installation

General: Install accessories and conceal cabling in walls in conformance with the following:

- 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: Flush wall box, with thermoplastic insulated cables in conduit run in cavity and tied against inner brick surface, or thermoplastic sheathed cables run in cavity.
- Stud partition: Flush plate secured to proprietary support bracket or wall box.
- Fire walls: Flush wall box, with conduit built into wall. Provide additional fire protection around wall boxes, where necessary to maintain fire rating.

Location: Confirm final location of all outlets and equipment on site, before installation.

Spacing from adjacent horizontal surface: ≥ 75 mm to the centre of accessory socket.

Default mounting heights to centre of accessory plate:

- Outlets: 300 mm.
- Switches and controls: 1100 mm.

Flush mounting: Provide flush mounted accessories, except in plant rooms.

Common face plates: Mount adjacent flush mounted accessories under a common faceplate.

Restricted location: Do not install wall boxes across junctions of wall finishes.

Surface mounting: Proprietary mounting blocks.

Installation of ceiling mounted accessories

Connections for appliances: Provide flush mounted outlets on the ceiling next to support brackets.

Mounting: Mount appliances independent of ceiling tiles and suspended ceiling suspension system. Fix directly to concrete slab or to roof structure above ceiling.

Connections for fixed equipment: Provide concealed permanent connections.

Fixing: For equipment and appliances heavier than 30kg, provide support through the suspended ceiling to the building structure. Brace appliances that have excessive bending moments, are heavy or vibrate, to prevent horizontal movement, e.g. operating theatre shadowless lights.

Installation couplers

Standard: To AS/NZS 3000 and AS/NZS 61535.

Location: Accessible.

3.6 TESTING

Site tests

Inspection: Visually inspect the installation to AS/NZS 3000 before testing. Submit record on a checklist.

Ventilation: Test and verify the installation to AS/NZS 3000 Section 8 using the methods outlined in AS/NZS 3017.

Electricity networks: Test and verify the connections to electricity networks to AS 4741. Record and submit the results of all tests.

Dummy load tests

General: If electrical tests are required and the actual load is not available, provide a dummy load equal to at least 75% of the design load.

3.7 SPARE PARTS**General**

Spare parts: As documented.

0941 SWITCHBOARDS – PROPRIETARY**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide proprietary switchboards, as documented.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following worksection(s):

- *Demolition by Architect.*
- *Cable support and duct systems.*
- *Low voltage power systems.*
- *Switchboards – proprietary.*
- *Lighting.*
- *Emergency evacuation lighting.*

1.3 STANDARDS**General**

Standards: To AS/NZS 3000 and AS/NZS 61439.

1.4 INTERPRETATION**Definitions**

General: For the purposes of this worksection the following definitions apply:

- Proprietary assemblies: Low voltage switchgear and controlgear assemblies available as a catalogue item, consisting of manufacturer's standard layouts and equipment.
- Fault current limiters: Circuit opening devices designed or selected to limit the instantaneous fault current.
- 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.

1.5 INSPECTION**Notice**

Inspection: Give notice so that inspection may be made of the following:

- Factory assembly completed, with busbars exposed and functional units in place.
- Assembly ready for routine testing.
- Assembly installed before connection.
- Assembly installed and connected.

1.6 SUBMISSIONS**Product data for proprietary assemblies**

General: 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.
- Paint colours and finishes.
- Access details.
- Schedule of labels
- Smoke seals to all doors of distribution boards.

Verification tests to the AS/NZS 61439 series: Submit verification test certificates from an Accredited Testing Laboratory for components, functional units and assemblies, including internal arcing-fault tests and factory test data, with evidence that the tests were carried out at not less than the designated fault currents at rated operational voltage. Assembly type testing to the AS/NZS 3439 series with test results that fulfil the requirements of the relevant parts of the AS/NZS 61439 series are acceptable as verification of the requirements of the AS/NZS 61439 series.

Tests

General: To AS/NZS 61439.

Type tests: Submit results, as follows:

- Type test certificates for components, functional units and assemblies including internal arcing-fault tests and factory test data.
- Testing facility: Accredited by a NATA registered testing authority.

Routine tests: Submit results, as follows:

- Assemblies: Electrical and mechanical routine function tests at the factory using externally connected simulated circuits and equipment.
- Dielectric testing: 2.5 kV r.m.s. for 15 s.

2 PRODUCTS

2.1 GENERAL

Switchboard connectors

Type: Front connected.

Enclosure

Default material: Metallic-coated sheet steel.

Separation

Default: Form 1 / Form 2 / Form 3b / Form 4a (as documented) to AS/NZS 61439.2.

Metering

Requirement: To the *Low voltage power systems* worksection.

Main switchboard main switches

Spare capacity: Provide at least 25% spare capacity in the ratings main switch/isolators.

Busbars

General: Incorporate proprietary insulated busbar systems for the interconnection of isolators, circuit breakers and other circuit protective devices.

Busbar fault rating: Rated to meet the prospective fault current for 1 second or a minimum rating of $\geq 18\text{kA/second}$, whichever is the greater.

Spare capacity

Default spare poles: $\geq 20\%$.

Main switchboard incoming busbar: $\geq 25\%$.

Surge diversion

General: Provide surge diversion as documented.

Earthing

General: Make provision for the connection of the communications earth terminal (CET) at switchboard earth bar to AS/CA S009.

Doors

General: Provide lockable doors with a circuit card holder unless enclosed in cupboards or in an area which is not readily accessible to the public. Smoke seals to all doors of distribution boards.

IP rating

Default rating: IP44 minimum.

Weatherproof: IP56 minimum.

Equipment layout

General: Position equipment to provide safe and easy access for operation and maintenance. Group devices by function.

Compartments: Separate shipping sections, subsections, cable and busbar zones, functional unit modules and low voltage equipment compartments using vertical and horizontal steel partitions which suit the layout and form of separation.

Equipment on doors: Set out in functional unit groups and to allow access without the use of tools or keys.

Form 1 enclosures: Separate into compartments with partitions at 1.8 m maximum centres.

Segregation

General: Segregate NCC emergency equipment from non-emergency equipment with metal partitions designed to prevent the spread of a fault from non-emergency equipment to emergency equipment.

BMS equipment: Accommodate extra-low voltage BMS equipment in a separate compartment.

Finishes

Exterior and interior: Orange X15 or the manufacturer's standard colour.

- Installed in cupboards, switchrooms and plant rooms: Orange X15 or the manufacturer's standard powder coated finish.
- Installed elsewhere: Orange X15, the manufacturer's standard powder coated finish or to the documented non-standard powder coated colour.

Supporting structure

Assemblies:

- Wall mounted: $\leq 2 \text{ m}^2$.
- Floor mounted: $> 2 \text{ m}^2$.

Ventilation

General: Required to maintain design operating temperatures at full load.

Tests

Requirement: To AS/NZS 61439.1.

3 EXECUTION

3.1 GENERAL**Fixing**

Requirement: Before making inter-panel connections, fix assemblies and metering equipment enclosures into position, level and plumb.

Cable entries

General: 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. Do not run cables into the top of weatherproof assemblies.

Single core cables rated $> 300 \text{ A}$: Pass separately through non-ferrous gland plates. Do not provide ferrous metal saddles. Minimise eddy currents.

Cable enclosures

Requirement: Continue cable enclosures to or into assemblies and fit cable entry plates so that the IP rating of the assembly and the fire-resistance level of the cable are maintained.

Cable supports

Requirement: Support or tie mains and submains cables within 200 mm of terminations. Provide cable supports suitable for stresses resulting from short-circuit conditions.

3.2 MAINTENANCE**General**

Standard: To AS 2467.

4 SELECTIONS**4.1 PROPRIETARY SWITCHBOARDS**

Proprietary switchboard schedule (Electrical Contractor / Switchboard Manufacturer to complete and submit with shop drawings)

	A	B	C
Location			
Nominal voltage (V)			
Rated frequency f_n (Hz)			
Earthing system			
Special service condition			
Enclosure material			
Enclosure colour			
Connection			
Main busbar current rating (minimum)			
Prospective short circuit current at supply terminals I_{cp} (kA)			
Form of separation (minimum)			
Protection against ingress of solid foreign bodies and ingress of water (IP rating)			
Limiting overall dimensions (width, height, depth) (mm)			
Maximum overall dimensions (width, height, depth) (mm)			
Maximum weight (kg)			
Type/Mounting			
Main isolator rated current (minimum)			
Provision for future circuits			
Surge protection			
Metering			
Provision for control equipment			

	A	B	C
Busbar insulation			
Provision for future busbar extension			

Additional AS/NZS 61439 characteristics schedule (Electrical Contractor / Switchboard Manufacturer to complete and submit with shop drawings)

	A	B	C
Electrical System			
Transient overvoltages			
Temporary overvoltages			
Additional on-site testing			
Short-circuit withstand capability			
Prospective short-circuit current in the neutral			
Prospective short-circuit current in the protective circuit			
SCPD in the incoming functional unit requirement			
Co-ordination of short-circuit protective devices including external short-circuit protective device details			
Data associated with loads likely to contribute to the short-circuit current			
Protection of persons against electric shock in accordance with IEC 60364-4-41			
Basic protection (protection against direct contact)			
Fault protection (protection against indirect contact)			
Installation environment			
External mechanical impact (IK)			
Resistance to UV radiation			
Resistance to corrosion			
Ambient air temperature – Lower limit			
Ambient air temperature – Upper limit			
Ambient air temperature – Daily average maximum			
Maximum relative humidity			

	A	B	C
Pollution degree (of the installation environment)			
Altitude			
EMC environment			
Installation method			
Stationary/Movable			
External conductor type(s)			
Direction(s) of external conductors			
External conductor material			
External phase conductor, cross sections, and terminations			
External PE, N, PEN conductors cross sections, and terminations			
Special terminal identification requirements			
Storage and handling			
Maximum dimensions and weight of transport units			
Methods of transport			
Environmental conditions different from the service conditions			
Packing details			
Operating arrangements			
Access to manually operated devices			
Location of manually operated devices			
Isolation of load installation equipment items			
Maintenance and upgrade capabilities			
Requirements related to accessibility in service by ordinary persons; requirement to operate devices or change components while the assembly is energised			
Requirements related to accessibility for inspection and similar operations			
Requirements related to accessibility for maintenance in service by authorized persons			

	A	B	C
Requirements related to accessibility for extension in service by authorized persons			
Method of functional units connection			
Protection against direct contact with hazardous live internal parts during maintenance or upgrade			
Current carrying capability			
Rated current of the assembly I_{nA} (amps)			
Rated current of circuits I_{nc} (amps)			
Rated diversity factor			
Ratio of cross section of the neutral conductor to phase conductors - Phase conductors up to and including 16 mm ²			
Ratio of cross section of the neutral conductor to phase conductors - Phase conductors above 16 mm ²			

0943 SWITCHBOARD COMPONENTS**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide switchboard components, as documented.

1.2 DESIGN**Statutory authority's equipment**

General: Liaise with the electricity distributor about the installation and coordinate with their protective and control equipment.

1.3 CROSS REFERENCES**General**

Requirement: Conform to the following worksection(s):

- *Demolition by Architect.*
- *Cable support and duct systems.*
- *Low voltage power systems.*
- *Switchboards – proprietary.*
- *Lighting.*
- *Emergency evacuation lighting.*

1.4 INTERPRETATION**Abbreviations**

General: For the purposes of this worksection the following abbreviations apply:

- ATS: Auto-transfer
- MSB: Main switchboard
- SPD: Surge protection device.

1.5 SUBMISSIONS**Technical data**

General: Submit technical data for all components.

2 PRODUCTS**2.1 GENERAL****General**

Selection: Conform to the requirements of AS/NZS 3000 clause 1.7 and AS/NZS 3000 Section 2.

Rated duty: Uninterrupted.

Rated making capacity (peak): $\geq 2.1 \times$ fault level (r.m.s.) at assembly incoming terminals.

Utilisation category: To AS 60947.1 clause 4.4 and the recommendations of Annex A.

- Circuits consisting of motors or other highly inductive loads: At least AC-23.
- Other circuits: At least AC-22.

Coordination: Select and adjust protective devices to discriminate under overload, fault current, and earth fault conditions.

Enclosure: IP4X minimum.

2.2 SWITCH-ISOLATOR**General**

Standard: To AS 60947.1 and AS/NZS 3947.3.

Poles: 3.

Operation: Independent manual operation including positive ON/OFF indicator.

Shrouding: Effective over range of switch positions.

Fault make/fault break switch-isolators

Rated breaking capacity: To AS/NZS 3947.3 Table 3.

Rated short-time withstand current: To AS 60947.1 clause 4.3.6 and the manufacturer's recommendation to meet the prospective fault current conditions applying.

Rated short-circuit making capacity: To AS 60947.1 clause 4.3.6 and the manufacturer's recommendation to meet the prospective fault current conditions applying.

Rated short-circuit breaking capacity: To AS 60947.1 clause 4.3.6 and the manufacturer's recommendation to meet the prospective fault current conditions applying.

Load make/load break switch-isolators

Rated breaking capacity: To AS/NZS 3947.3 Table 3.

Rated short-time withstand current: To AS 60947.1 clause 4.3.5 and the manufacturer's recommendation to meet the current conditions applying.

Rated making capacity: To AS 60947.1 clause 4.3.5 and the manufacturer's recommendation to meet the current conditions applying.

Rated breaking capacity: To AS 60947.1 clause 4.3.5 and the manufacturer's recommendation to meet the current conditions applying.

2.3 OVERLOAD AND FAULT PROTECTION GENERALLY

General

Requirement: Provide overload and fault protection devices, including full discrimination and cascade protection, and grade with the electricity distributor's incoming supply protection system and the downstream site protection devices.

2.4 FUSE-SWITCH UNITS

General

Operation: Provide an extendable operating handle.

Fuse links: Isolate when switch contacts are open. Provide 3 phase sets of high rupturing capacity (HRC) fuse links.

2.5 MOULDED CASE AND MINIATURE CIRCUIT BREAKERS

General

Moulded case breakers: To AS 60947.1, AS 2184 and AS 60947.2.

Miniature circuit breakers: Interrupting capacity classification to AS/NZS 60898.1 or AS/NZS 3111.

- For general building services: Type C.
- For motor protection: Type D.

Operation: Independent manual operation including positive ON/OFF indicator.

Trip type: Conform to the following:

- Moulded case breakers: Adjustable thermal, fixed magnetic.
- Miniature circuit breakers: Fixed thermal and fixed magnetic.

Isolation facility: Required.

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.

Utilisation category: Moulded case breakers:

- Final subcircuits category: Category A.
- Mains and submains: Category B.

Trip settings: Set as documented, seal, and label.

Interchangeable trip units: Connect trip units so that trip units are not live when circuit breaker contacts are open.

Fault current limiting circuit breakers: Select breaker frame sizes from one manufacturer's tested range of breakers to give cascade and discrimination protection within the switchboard and downstream switchboards as required.

2.6 ELECTRICITY DISTRIBUTOR'S SERVICE PROTECTIVE DEVICES

General

Requirement: Provide low voltage service protective devices to AS/NZS 3000, the electricity distributor's requirements and the supply authority Service and Installation rules.

For service protective devices > 100 A: Provide fault current limiting circuit breakers with adjustable overload and short circuit current facilities with full discrimination and cascade protection between the incoming supply protection systems and the downstream protection systems.

2.7 RESIDUAL CURRENT OPERATED CIRCUIT BREAKERS (RCBO)

General

Standard: To 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.

Type: Type II.

Default tripping current: 30 mA.

2.8 FUSES WITH ENCLOSED FUSE LINKS

General

Standards: To AS 60269.1, AS 60269.2.0 and AS 60269.2.1.

Fuses with fuse-links for the protection of semiconductor devices: To AS 60269.4.0.

Fuses with fuse-links used as fault current limiters: Coordinate fuse type and rating with the protection switchgear manufacturer's recommendation if used downstream of the fault current limiters. Provide labels adjacent to the fuse holder stating FAULT CURRENT LIMITER and fuse size.

Fuse links: 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 carrier 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.

2.9 CURRENT TRANSFORMERS (PROTECTION)

General

Standard: To AS 60044.1.

Type: Cast resin encapsulated window type with busbar clamping devices.

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: 5 A. Connect star point to earth.

Interposing transformers: Provide to the protective relay manufacturer's recommendations.

Characteristics: Conform to the protective relay manufacturer's recommendations.

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.

2.10 SURGE PROTECTION DEVICES (SPD)

General

Standard: To IEC 61643-11 and IEC 61643-12.

Installation: To AS/NZS 3000 Appendix F.

Primary protection

General: Provide shunt connected metal oxide varistor based SPDs between each phase and neutral at assembly incoming supply terminals, on the load side of incoming functional units.

Type I SPD

Surge Rating: $I_{max} \geq 150$ kA per phase to neutral.

Surge Rating: $I_{max} \geq 100$ kA neutral to earth if remote from the MEN earthing system.

Residual Voltage: $U_p < 800$ V @ 3 kA.

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 status.

Enclosure and installation: House SPD in a metal enclosure and protected with a suitable rated circuit breaker or 63A HRC fuse.

Type II SPD

Surge Rating: $I_{max} \geq 100$ kA per phase to neutral.

Surge Rating: $I_{max} \geq 100$ kA neutral to earth if remote from the MEN earthing system.

Nominal discharge current: 40 kA (8/20 μ s)

Residual Voltage: $U_p < 800$ V @ 3 kA.

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 status.

Enclosure and installation: House SPD in a metal enclosure and protected with a suitable rated circuit breaker or 63A HRC fuse.

Secondary protection

General: 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 load side of incoming functional units and upstream of RCD devices.

Type III SPD

Surge Rating: $I_{max} \geq 50$ kA per phase to neutral.

Surge Rating: $I_{max} \geq 20$ kA neutral to earth.

Residual Voltage: $U_p < 800$ V @ 3 kA.

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 300 mm.

Combined primary and secondary protection

General: Provide series connected surge filter comprising metal oxide varistor or triggered spark gap based primary SPDs, a low pass LC filter and secondary metal oxide varistor based SPDs.

Surge Rating: $I_{max} \geq 100$ kA per phase to neutral primary protection.

Surge Rating: $I_{max} \geq 100$ kA neutral to earth if remote from the MEN earthing system.

Residual Voltage: $U_p < 600 \text{ V @ } 20 \text{ kA}$.

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.

2.11 CURRENT TRANSFORMERS (METERING)

Standard

Measurement current transformers: To AS 60044.1.

Test links

General: 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.

Test studs

General: 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 0.5.

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 0.4Ω (10 VA) with star point earthed.

Type

General: If practicable, cast resin encapsulated window-type with busbar clamping devices. Otherwise wound-primary type with mounting feet.

Installation

General: Install transformers to permit easy removal.

Removable links: Provide removable links of minimum length for transformers fitted on busbar systems.

2.12 INSTRUMENTS AND METERS

Electricity meters (Watthour meters)

Standard:

- Socket mounting system: To AS 1284.4.
- Electronic: To AS 62053.21.

Electricity meters: Class 0.5.

3-phase metering: Polyphase meters suitable for balanced 3 phase, 4 wire loads.

1 or 2 phase metering: Single phase meters.

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.

2.13 CONTACTORS

General

Standard: To AS 60947.4.1.

Type: Enclosed, block type, air break, electro-magnetic.

Poles: 3.

Rated operational current: The greater of:

- 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.

Mounting: 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.

Auxiliary contacts: 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.

Slave relay: If the number of auxiliary contacts exceeds the number which can be accommodated, provide separate slave relays.

2.14 CONTROL DEVICES AND SWITCHING ELEMENTS

Standards

General: To AS 60947.1 and AS 60947.5.1.

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 60° .

Off position: Locate at the 12 o'clock position. Test positions must spring return to 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

Type: 7 day fully programmable with holiday override function.

Daylight saving switch: Required.

Mains failure operation: 100 hour minimum operating capacity.

Contact rating: ≥ 16 A at 230 V a.c. resistive load.

Construction: Provide readily accessible means of adjustment. Provide operational settings which are clearly visible when switch cover is fitted.

Dial: Digital with hour and minute display.

Override switch (manual): Required.

Control relays

Standard: To AS 60947.5.1.

Operation: 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.

Plug-in types: If required provide the following:

- Receptacle bases with captive clips which can be operated without using tools.
- Changeover type contacts to allow either normally-open or one normally-closed configuration.

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	1.25I _L	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 $\pm 12.5\%$ of nominal setting.

Electronic relays: Incorporate light emitting diodes indicating energisation states of relays.

2.15 CONTROL AND PROTECTIVE SWITCHING DEVICES OR EQUIPMENT**General**

Standard: AS 60947.6.2.

2.16 CONTROLLER DEVICE INTERFACES**General**

General: Provide interfaces between equipment and control systems including the following:

- Programmable logic controllers.
- Metering systems.
- Building management systems.

Standard: To AS/NZS 62026.1, AS/NZS 62026.2, AS/NZS 62026.3 and 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.

2.17 SPARES CABINET**General**

General: Provide a spares cabinet with main name plate, labelled shelves and non-lockable door. Size for storing racking handles, special tools, spare lamps, spare fuse links and other equipment necessary for satisfactory assembly operation.

Location: Either of the following:

- Incorporated into assembly enclosure.
- Wall mounted in main switchroom.

Finish: To match switchboard assembly.

3 EXECUTION**3.1 MARKING AND LABELLING****General**

General: Provide 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. Smoke seals to all doors of distribution boards.

Labels on assembly exteriors

Manufacturer's name: Required.

Assemblies: Label with essential markings.

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 consumer's mains and submains.
- Use different colours on labels to distinguish operational requirements such as normal operation, operation under fire or emergency conditions.
- Incoming busbar or cable rating to first tee-off.
- Fuse link size.

Labels on assembly interiors

General: 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.

Danger, warning and caution notices

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.

Schedule cards

General: For general light and power distribution assemblies, provide schedule cards of minimum size 200 x 150 mm, with typewritten text showing the following as-installed information:

- Submain designation, rating and short-circuit protective device.
- Light and power circuit numbers and current ratings, cable sizes and type and areas supplied.
- Mounting: Mount schedule cards in a holder fixed to the inside of the assembly or cupboard door, next to the distribution circuit switches. Protect with hard plastic transparent covers.

Single-line diagrams

Main and submain assemblies: Provide single-line diagrams.

Format: Non-fading print, at least A3 size, showing the system as installed.

Mounting: Enclose in a non-reflective PVC frame and wall mount close to assembly.

Marking cables

General: Identify the origin and cable size of wiring with legible indelible marking.

Identification labels: Provide durable labels fitted to each core and sheath, permanently marked with numbers, letters or both to suit the connection diagrams.

Multicore cables and trefoil groups: Identify multicore cables and trefoil groups at each end with durable non-ferrous tags clipped around each cable or trefoil group.

0951 LIGHTING**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide lighting and control systems, as documented.

Proprietary equipment

General: The requirements of this worksection for lamps, ballasts and luminaire control equipment over-ride the specifications inherent in the selection of a particular make and model of luminaire.

Minimum energy performance standards (MEPS)

General: To AS/NZS 4782.2, AS/NZS 4783.2, AS 4934.2.

Self ballasted lamps: To AS/NZS 4847.2.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following worksection(s):

- *Demolition by Architect.*
- *Cable support and duct systems.*
- *Low voltage power systems.*
- *Switchboards – proprietary.*
- *Lighting.*
- *Emergency evacuation lighting.*

1.3 STANDARDS**Standards**

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.

1.4 INTERPRETATION**Abbreviations**

General: For the purposes of this worksection the following abbreviations apply:

- CCT: Correlated colour temperature.
- CFL: Compact fluorescent lamps.
- CRI: Colour rendering index.
- DALI: Digital addressable lighting interface.

- EEI: Energy efficiency index.
- ELV: Extra low voltage.
- EMC: Electromagnetic compatibility.
- HID: High intensity discharge.
- ILCOS: International lamp coding system.
- LED: Light-emitting diode.
- PIR: Passive infra-red.
- PLC: Programmable logic controllers.
- RCD: Residual current device.
- UPS: Uninterruptable power supply.

Definitions

General: 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.
 - . Dimming systems.
 - . Motion detection sensors (Occupancy sensors).
 - . Computer interface for programming.
- Proprietary luminaires: Luminaires available as a catalogue item.
- Incandescent lamp: Lamps as covered in AS 4934.2 including both tungsten filament and tungsten halogen types.

1.5 SUBMISSIONS**Samples**

General: Submit samples of all luminaires and accessories complete with lamp, control gear and three core flex and plug.

Shop drawings

General: Submit shop drawings for the following:

- Lighting columns.
- Lighting column mounting bases.
- Non proprietary luminaires.
- Non standard fixing brackets.

Technical data

General: Submit technical data of the following:

- Luminaires.
- Lamps.
- Ballasts.
- Power factor correction equipment.
- Lighting control systems.
- All accessories.

Tests

Efficacy: Confirm the efficacy of the following by a photometric test, carried out for the applicable CCT, from a NATA approved laboratory:

- Light-emitting diode luminaires.
- Light-emitting diode lamp replacement modules.

2 PRODUCTS

2.1 PROPRIETARY LUMINAIRES

General

Requirement: Provide proprietary luminaires complete with lamps, luminaire control equipment, lighting control equipment, and accessories as documented. Provide lamps of the same type from the same brand and country of manufacture.

Self ballasted lamps: To AS/NZS 60968 and AS/NZS 60969.

2.2 ELV VOLTAGE TRANSFORMERS OR ELV SWITCH POWER SUPPLIES

General

Requirement: Provide separate ELV transformers for each ELV lamp.

Standard: To AS/NZS 4879.1, AS/NZS 4879.2 and AS/NZS 61558.1.

2.3 LIGHT-EMITTING DIODES (LEDS) LUMINAIRES

General

General: Provide light emitting diode (LED) luminaires, as documented.

Light-emitting diode luminaires

General: Light-emitting diode luminaires include integral LEDs, reflectors, lenses, heatsinks and drivers.

Performance: Provide LED luminous efficacy of the LED luminaire at normal operating temperature in its normal position and enclosure of > 60 lumens per watt.

Life of the LED in the complete luminaire: L70 to IES LM-80-2008, unless documented.

Colour: CRI > 80.

CCT: 3000K or 4000K as documented.

Light-emitting diode lamp replacement modules

Performance: Conform to the following:

- Reflector lamps: Provide luminous efficacy of the LED replacement modules at operating temperature in normal position and enclosure of > 40 lumens per watt where the quoted beam angle is the angle between the points of 50% of maximum luminous intensity.
- Linear fluorescent lamps: Provide luminous efficacy of replacement modules of > 80 lumens per watt.

2.4 CONTROL GEAR ENCLOSURE

General: Provide controlgear support enclosure within the body of the luminaire, except where remotely mounted controlgear is documented or required by the manufacturer.

Enclosures and controlgear mounting assemblies: Provide heat dissipation facilities to dissipate heat from the luminaire.

Controlgear enclosure: Form a barrier against direct contact with live parts of the controlgear and the area of the luminaire containing the lamp and lamp support holders.

Separate controlgear enclosures: If separate controlgear enclosures external to the luminaire are required, conform to the above requirements.

Fixing: Screw fixed.

2.5 WIRING

Flexible cords

Recessed luminaires: Provide external flexible cord in conformance with the following:

- Length: ≥ 1.5 m.
- Cross sectional area: 0.75 mm^2 .
- Type: 3-core V75 (minimum) PVC/PVC, connected to a 10 A 3-pin moulded plug to AS/NZS 3112 or multi-pin plug, as documented.

Other fittings: Provide external flexible cord in conformance with the following:

- Cross sectional area: $\geq 1 \text{ mm}^2$.

2.6 LIGHTING CONTROL

General: Provide the following as documented:

- Lighting switches.
- Motion sensors.

Manual controls

General: Provide manual control of luminaires into groups, zones and to individual devices, as documented.

Control wiring: To control system manufacturers' recommendation, with distinctive sheath colour.

Controllers and contactors: Provide controllers and contactors rated for the characteristics of the controlled load and to AS/NZS 3947.4.3.

Dimmer control: Provide electronic dimmer controls compatible with the lighting control system and as documented.

Direct current interface for proximity sensors and amplifiers: To AS/NZS 3947.5.6.

Controller interfaces: Provide interfaces between lighting control systems and other control systems as documented in the **Controller interface schedule**.

2.7 ACCESSORIES

General

Manufacturer: If of a similar finish, provide electrical accessories from the same manufacturer throughout the project and for interchangeability of subcomponents such as switch modules in wall plates.

Lighting outlets

Pin arrangement: Conform to the following:

- Standard: 3 flat pin with looping terminal.
- Luminaires with integral emergency light or special switching: If required, a 4 or 5 pin plug or a second lighting outlet plug of alternative pin configuration to differential the functions or supply.

Lighting switches

General: Provide light switches as documented.

Standard: To AS/NZS 3133.

Minimum: 10 A, 230 V a.c.

Key switches

General: Provide key switches as documented.

Run-on timer switches

General: Provide run-on timer switches as documented.

Delay: Adjustable to 20 minutes.

Dimmer switches

General: Provide integral dimmer/switch units as documented.

Proximity switches

General: Provide proximity switches as documented.

Standard: To AS 60947.5.2.

Daylight switches

General: Provide integral photo electric switch units as documented.

Performance: Adjustable between 50 and 1000 lux in internal applications and 2 to 100 lux in external applications

Time delay: > 2 minutes.

Illumination differential: > 50 lux.

Motion detector switches

General: Provide motion detection sensors which cover designated areas as documented.

Timer: Incorporate ON timers adjustable between 1 and 5 minutes minimum and 30 minutes and 2 hours maximum.

Control function: Provide manual/OFF/automatic control switch. If manual switches are used in association with motion sensors, wire the switch so that it can turn the lights OFF but not override the motion switch to turn the lights ON.

Standard: To AS 2201.3.

Type: Passive infra-red (PIR).

Manual time delay switches

General: Provide manual time delay relay switches as documented.

Type: Electronic.

Duration: Adjustable between 5 minutes and 15 minutes.

Indicator light: Required. Activated when artificial illumination is OFF.

3 EXECUTION

3.1 RE-USE OF LUMINAIRES

Modifications and refurbishing

General: Modify and refurbish existing luminaires to manufacturer's current recommendations. Test for conformance with current Australian Standards before returning to service. Provide test results.

Component replacement: Starter and lamp.

Diffuser: Clean.

3.2 SUPPORTS

General

General: Install luminaires on proprietary supports by means of battens, trims, noggings, roses and packing material.

Suspended luminaires

Rods: Steel pipe suspension rods fitted with gimbal joints.

Chains: Electroplated welded link chain.

Levelling wire: Stainless steel.

Levelling: Adjust the suspension system length so that the lighting system is level and even.

Horizontal tolerance: ± 3 mm between luminaires within the same area.

Surface mounted luminaires

General: Fit packing pieces to level luminaires and prevent distortion of luminaire bodies. Provide packing strips to align end to end luminaires.

Fixing: Conform to the following:

- Generally: Provide 2 fixings at each end of fluorescent luminaires.
- Luminaires less than 150 mm: A single fixing at each end in conjunction with 1.6 mm backing plates may be used.
- Provide battens and support for the fitting.
- Do not direct fix into plasterboard.

Recessed luminaires

General: Install recessed luminaires in trimmed openings in the suspended ceiling.

Standard: To AS 2946.

3.3 WIRING CONNECTION

Recessed luminaires

General: Connect recessed luminaires to a plug socket outlet.

Lighting tracks

General: For low voltage transformers located remotely from the track, size the cable between the transformer and the track to give a voltage drop of less than 5% between the transformer and the track at the rated current of the transformer.

3.4 ACCESSORIES

Installation

General: Install accessories and conceal cabling to the *Low voltage power systems* worksection.

3.5 COMPLETION**General**

Requirement: Before the date of practical completion carry out the following:

- Verify the operation of all luminaires.
- Adjust aiming and controls for all luminaires under night time conditions.
- Replace lamps which have been in service for a period greater than 50% of the lamp life as published by the lamp manufacturer.

0971 EMERGENCY EVACUATION LIGHTING**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide single point monitored emergency lighting and exit signs as documented.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following worksection(s):

- *Demolition by Architect.*
- *Cable support and duct systems.*
- *Low voltage power systems.*
- *Switchboards – proprietary.*
- *Lighting.*
- *Emergency evacuation lighting.*

1.3 STANDARDS**General**

System design, installation and operation: AS 2293.1.

Inspection and maintenance: To AS/NZS 2293.2.

Emergency escape luminaires and exit signs: To AS 2293.3.

1.4 SUBMISSIONS**Samples**

General: Submit samples of all luminaires and exit signs.

Shop drawings

General: For each custom-built luminaire and exit sign, submit the following:

- Construction details.
- Overall dimensions.
- Wiring arrangement.

Technical data

General: 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

General: Submit type test data.

2 PRODUCTS**2.1 SINGLE-POINT SYSTEM LUMINAIRES****General**

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 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.

Common test switches: Provide a common test switch on the local distribution board which disconnects main supply to the luminaires and tests for discharge performance and automatically reverts to normal operating mode after testing.

Batteries

Type: Provide Lithium-ion batteries (LIION) capable of operating each lamp at its rated output continuously for at least 2 hours during commissioning tests and 1.5 hours during subsequent tests.

Battery life: At least 10 years when operating under normal conditions at an ambient temperature of between 10°C and 40°C and subject to charging and discharging at 6 monthly intervals.

Marking: Indelibly mark each battery with its date of manufacture.

Charger design

3 EXECUTION

3.1 SINGLE POINT SYSTEM

Power supply

General: Provide an unswitched active supply to each luminaire and exit sign, originating from the test switch control panel.

Test switch

General: Provide a timed test switch at each distribution board.

Function: To energise emergency lights and exit signs and then to automatically reset controls after a maximum of 2 hours.

3.2 MARKING AND LABELLING

Labelling

General: Label each luminaire with a unique identifying number. Provide a label which is permanently fixed, indelible and readable at a distance of 1 m.

Emergency evacuation lighting schedule: Record the number and luminaire location in an emergency evacuation lighting schedule included in the operation and maintenance manual.

3.3 TESTS

General

General: 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 recommendations for performance 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.

Mains supply

General: Before commissioning, make sure mains supply has been continuously connected for at least 24 hours.

3.4 MAINTENANCE

General

Emergency evacuation lighting: To AS/NZS 2293.2.

Interval: Carry out the 6-monthly procedures before the date of practical completion and again before the end of the maintenance period stated in the *General requirements* worksection.

0991 ELECTRICAL MAINTENANCE**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide maintenance of the electrical systems, as documented.

Maintenance period: 12 months from the date of completion of commissioning of the systems.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following worksection(s):

- *Demolition by Architect.*
- *Cable support and duct systems.*
- *Low voltage power systems.*
- *Switchboards – proprietary.*
- *Lighting.*
- *Emergency evacuation lighting.*

1.3 STANDARD**General**

Electrical services: To AS/NZS 3000.

1.4 INSPECTION**Notice**

Inspection: Give notice so that an inspection may be held simultaneously with the last programmed maintenance visit.

1.5 SUBMISSIONS**Certification**

Annual certification: Inspect and certify all items required to be inspected annually under statutory requirements including, but not limited to, fire detection and alarms, emergency evacuation lighting and EWIS. Submit certification to the principal.

Maintenance records

General: Submit records of maintenance undertaken. If available, record in the schedules provided as part of the maintenance manuals.

Records: As a minimum, record the following:

- Date, time and name of person undertaking the task.
- Activities completed including operational and maintenance procedures.
- Materials used.
- Test results.
- Comments for future maintenance actions and notes covering the condition of the installation.

Mandatory maintenance records: Include mandatory maintenance record forms with completed project specific information.

Service visits: Record comments on the functioning of the systems, work carried out, items requiring corrective action, adjustments made and name of service operator. Obtain the signature of the principal's designated representative.

Log books: Record maintenance in the log book pages provided in the Operation and maintenance manuals to *General requirements*.

Periodic maintenance and performance report

General: Provide a report summarising the maintenance performed and the performance of the electrical services in the preceding period. Set out the report in a form that permits comparison with previous reports. Include the following as minimum requirements:

- Dates and number of site labour hours for programmed maintenance. Exclude travelling time.
- Dates, number of site labour hours and nature of work for corrective maintenance. Exclude travelling time.
- Dates and number of site labour hours for defects liability rectification if within the defects liability period. Exclude travelling time.
- Peak load and load profile for electrical power consumed, where metering equipment allows. Where no appropriate metering equipment exists, provide copies of electricity accounts from the electricity service provider.
- Results of recommissioning if scheduled for the period.

2 PRODUCTS**2.1 GENERAL****Selections**

Proprietary items: Select products, as replacement items, of the same make, model and type as those being replaced.

Substitutions: Where the existing product is no longer available, provide products with at least the same performance, energy profile and construction characteristics.

Light fittings and ballasts: If fluorescent tubes or ballasts change due to obsolescence, change should be to the betterment of the installation i.e. equal or lower energy consumption or ballast that improve lamp life, i.e. change to electronic ballasts.

3 EXECUTION**3.1 MAINTENANCE REQUIREMENTS****General**

Requirements: Provide all labour and material necessary to maintain the electrical installation, including all items commonly referred to as consumable.

Site control

General: Report to the principal's designated representative on arriving at, and before leaving the site.

3.2 CLEANING

General: Progressively clean the interior of components as they are installed. Inspect the interior of components on installation and remove obstructions.

Lighting fittings: Clean the interior of luminaires, including diffusers and louvers, annually for non-air conditioned buildings and every three years for air conditioned buildings. For large air conditioning buildings schedule areas of the building where a third of the fittings are cleaned each year.

3.3 CORRECTIVE MAINTENANCE**General**

Requirement: Respond to call outs for breakdowns or other faults requiring corrective maintenance. Rectify faults and replace faulty materials and equipment.

Remedial work: Carry out any remedial work, including temporary work, necessary to restore the systems to safe and satisfactory operation. Do not leave site until correct operation has been proven. Do not leave the plant in an unsafe condition.

Temporary work: Promptly replace temporary work with permanent rectification.

Response time

Period: Attend site for emergency service within the documented time period.

Calculation of response period: Response period starts at the time of notification to the contactor's nominated contact point.

Failure to respond

General: Should the contractor fail to respond to site within the period documented, the principal may, without incurring any liability or obligation and without limiting any other redress, engage persons other than the contractor to undertake emergency work on the systems. Fully reimburse the principal.

3.4 REGULAR MAINTENANCE**General**

Requirement: Make routine service visits. Service items of equipment in accordance with the maintenance schedules in the operation and maintenance manuals.

Notification of defects

Requirement: When defects in the installation are identified, notify the principal in writing.

All systems

General: Provide maintenance work including, but not limited to, the following:

- Attend to reported defects and complaints.
- Check for and repair corrosion.
- Remove rubbish and clean equipment.
- Thoroughly check for and rectify any unsafe conditions.
- Replace faulty or damaged parts and consumable components.
- Check anti-vibration supports, brackets and clamps, holding down bolts and flexible connections, for deterioration and for freedom of movement of assembly.
- Safety signs maintenance: To AS 1319.

Electrical general

Tasks: Perform the following tasks:

- Check for hot joints, burnt insulation and burnt contacts.
- Check electrical connections for tightness.
- Check operation of all electrical components and systems.
- Check indicating lights and replace defective lamps.
- Check overload settings.
- Check and report any changes to controls and wiring.
- Provide maintenance in accordance with manufacturer's recommended maintenance program.

Standards:

- Electrical equipment generally: To AS/NZS 3760.
- Switchboards: To AS 2467.

Switchboards

Standard: To AS 2467.

General: Carry out the following:

- Check for hot joints and burnt insulation. Carry out a thermal scan of joints and cable terminations by use of an infrared temperature detector or cameras and repair any joints showing high temperatures.
- 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.

Emergency evacuation lighting

Emergency evacuation lighting: To AS/NZS 2293.2.

Interval: Carry out the 6-monthly procedures before practical completion and again before the end of the maintenance period.

Fire detection and alarms

Operational and maintenance manual: To AS 4428.4 .

Maintenance and records: To AS 1851.

Routine service process and procedures: To AS 1851 clause 6.2.

Baseline data: Provide baseline data to AS 1851.

3.5 END OF MAINTENANCE PERIOD SERVICE**General**

General: Within a month of the end of the maintenance period, undertake all work scheduled to be carried out on an annual basis.

0995 ELECTRICAL SERVICES TENDER BREAKDOWN AND RATES
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1 GENERAL

I/We _____ hereby tender for the supply, installation, testing and maintenance of all work in accordance with the tender documents.

<u>Item</u>	<u>Tender Amount</u>
Liaison with Western Power to provide headworks and incoming services (excluded)	\$
LV consumer mains and submain cabling	\$
Cables trays and other cable support systems	\$
Earthing systems	\$
Transient protection equipment	\$
General power distribution boards (DB, ect) (<i>submit the 4 Switchboard Manufacturers quotes with your tender price to the electrical consultant</i>)	\$
Power to mechanical / hydraulics services equipment	\$
Provision of conduit access to enable installation of services by others	\$
Lighting (Supply light fittings, lamps and control gear)	\$
Lighting installation	\$
Emergency lighting	\$
Hardwired Smoke and heat detectors AS3786 (if required by NCC/BCA code standard)	\$
Solar PV Array and inverter with associate cables	\$
Commissioning	\$
As Built drawings and maintenance handbooks	\$
Maintenance during the defects period	\$
Site establishment costs	\$
Sub Total	\$
Goods & Services Tax (GST)	\$
TOTAL	\$

Our charge out rates including all allowances for supervision, overheads and profit, etc for additional works that may be requested by the Engineer are:

Unit Rates	Normal Time
Charge per hour per tradesman	\$
Charge per hour per assistant	\$
Charge per hour per apprentice	\$
Mark up on actual cost (including normal trading discounts) to the contractor of materials	%

SCHEDULE OF COMPLIANCE

(Initial relevant paragraph below and strike out the other.)

- (i) We confirm that the tender submission fully complies with the tender documentation.
- (ii) We confirm that the tender submission is not fully compliant with the tender documentation and varies from the requirements of the documentation as detailed upon the attached schedule:

Dated this Day of February 25

Name of Contractor:

Signed:Print Name:

Name of Witness:

Signed:Print Name: