

0901 ELECTRICAL SYSTEMS

1 GENERAL**1.1 AIMS****Responsibilities**

General: Provide electrical systems as documented.

Design Criteria

Design criteria associated with the installation are listed below:

Item	Design Criteria
Extreme ambient conditions under which all services and systems shall operate	50.0°C dry bulb maximum 24.0°C wet bulb maximum Full solar load -2.0°C dry bulb minimum.
Ambient conditions within air conditioned spaces under which all services and systems shall achieve full load performance	24.0°C dry bulb maximum 60% relative humidity maximum with humidity varying dependent on ambient and internal loads 20.0°C dry bulb minimum.
Ambient conditions within ventilated non air conditioned spaces under which all services and systems shall achieve full load performance	39.0°C dry bulb maximum 21.0°C wet bulb maximum 4.0°C dry bulb minimum.
Earth resistivity	100 ohm - metres nominal.
Earthing	2m earth stake, minimum, within poly pit
Maximum noise levels at adjoining property boundaries	Not to exceed levels specified for commercial properties and residential properties in the Environmental Protection Act.
Equipment balancing criteria - maximum allowable vibration levels (maximum peak to peak displacement mm)	All equipment not to exceed limits set in Australian Standard 1359 - Rotating electrical machines - General requirements and Australian Standard 2625 - Rotating and reciprocating machinery - Mechanical vibration.
Earthing systems:	
Protective earthing system	MEN earthing system in accordance with Australian Standard 3000 - Electrical installations (known as the Australian/New Zealand Wiring Rules)
Electricity supply	400/230 volts, +10%, -6%, 3 phase, 4 wire, 50 Hz in accordance with SA Power Networks Service Rules and Conditions of Supply. Design and utilise only systems and equipment to be capable of guaranteed rated performance on both present and future supply voltages.
Consumers mains	400/230 volt, 3 phase, 50 Hz supplies from the SA Power Networks transformer.

Item	Design Criteria
Metering	Retailer metering to minimise operating costs.
Electrical reticulation	In accordance with AS/NZS 3000 - Electrical installations (known as the Australian/New Zealand Wiring Rules)
Electrical capacities	Equipment and cable capacities calculated to achieve 30% spare capacity.
Electrical and communications Pits and Lid	In accordance with Australian Standard AS3996 Access covers and grates. Class B Covers, Grates and pit/lid combinations minimum in non-vehicle trafficable areas, Class D otherwise.
Smoke/Heat Detectors	In accordance with AS 1670 – Fire detection, warning, control and intercom systems – System design, installation and commissioning.
Voltage drop	Voltage drop at switchboards limited to 2.5% (maximum) of nominal LV supply voltage of 400 volt, 3 phase. Voltage drop at final distribution points limited to 5% (maximum) of nominal LV supply voltage of 400 volt, 3 phase.
Electromagnetic emission and immunity	In accordance with AS/NZS 61000.
Degree of protection (IP Code)	In accordance with AS/NZS 60529.
Illuminance levels	In accordance with the minimum requirements of the following:
Building interiors	<p>AS/NZS 1680.1 Interior and workplace lighting - General principles and recommendations</p> <p>AS/NZS 1680.2.1 Interior and workplace lighting - Specific applications - Circulation spaces and other general areas</p> <p>AS/NZS 1680.2.3 Interior and workplace lighting - Specific applications - Educational and training facilities</p> <p>AS/NZS 1680.2.4 Interior lighting - Industrial tasks and processes</p> <p>AS/NZS 1680.2.5 Interior lighting - Hospital and medical tasks</p>
Specific minimum maintained average illuminance levels:	
Office areas	320 lux at working plane.
Secure carparks	40 lux.
Toilets	100 lux at 1 metre above floor level.
Access Toilets	200 lux at 1 metre above floor level.

Item	Design Criteria
Corridors	80 lux at working plane.
Exit and emergency lighting	AS 2293.1 Emergency escape lighting and exit signs for buildings - System design, installation and operation AS/NZS 2293.2 Emergency evacuation lighting for buildings - Inspection and maintenance AS 2293.3 Emergency escape lighting and exit signs for buildings - Emergency escape luminaires and exit signs
Voice/data cabling	AS/NZS 3080 Telecommunications installations - Generic cabling for commercial premises (ISO/IEC 11801:2002, MOD)

1.2 RESPONSIBILITIES

General

Requirement: Provide the electrical services, as documented. Items not included in the specification but shown on the drawings or vice versa shall be included:-

Power Reticulation

- Survey existing u/g services prior to trenching
- Liaise, make application, coordinate and pay all fees for SA Power Networks to supply and installation of a new power supply.
- Liaise with SA Power Networks and energy retailer for supply and installation of a kilowatt hour meter in the main switchboard.
- Supply and install a custom-made Main Switchboard (MSB) and Distribution Boards (DSB) including all associated switchgear, control gear and earthing system.
- Supply and install consumer mains and submains including underground conduits and cable pits.
- Supply and install power and lighting sub-circuits protected by MCB's and RCB's

Accessories

- Provide light switches and pushbutton dimmer switches where nominated on drawings, and install no closer than 500mm from internal wall corner in accordance with DA requirements.
- Supply and install switched socket outlets and isolators
- Supply and install power supplies to all Hydraulic and Mechanical equipment. Isolators mounted externally to be weatherproof.
- Provide RCD protection for all switch socket outlets and lighting circuits.
- Supply and install fire rated wall boxes for all accessories where mounted on fire rated walls.
- Supply and install hand dryers with isolating switch mounted above to all toilets. Mount hand dryers at 1200mm AFL for Male and Female toilets and 1000mm AFL for Disability access toilets.

Luminaires

- Supply and install artificial lighting in accordance with Section J of the NCC including all associated trimmers, fixings, brackets and supports as required.
- Supply and install PIR occupancy and daylight harvesting sensors installed in series with light switch and luminaires.
- Supply and install car park lighting including, PE cell control circuits and cabling.

- Supply and install photo electric cells and time clocks to control all external lighting.

Emergency Evacuation Lighting

- Supply and install exit and emergency lighting in accordance with AS/NZS2293 including automatic test facility to each distribution board.
- Upon failure of the electrical supply to the normal lighting in an area, irrespective of whether or not it is illuminated, each relevant emergency escape luminaire and exit sign shall be energized from its emergency supply in accordance with AS/NZS 2293, Clause 2.3.2.

Telecommunications System

- Supply and install NBN compliant lead-in conduit and cable pit from street to each tenancy in accordance with NBN/Telstra requirements (Final NBN connection by Tenants).

Fire Detection and Alarm system

- Supply and install a AS1670 fully monitored and addressable, fire indicator panel including all associated cabling conduits/trenching and cable tray (Contractor to liaise with SAMFS).
- Supply and install new occupant warning speakers, smoke and thermal detectors.
- Allow for an extra 20 detectors for beams, concealed spaces and other voids to ensure compliance with AS1670.
- Provide a monitored fire line service in accordance with SAMFS and Telstra requirements. Allow to liaise with SAMFS and Telstra. Pay all fees and charges.
- Provide a block plan for the fire indicator panel, mimic panel, repeater panel and fire brigade panel.
- Commissioning and testing of the complete system including SAMFS final site inspection.
- Allow to program the FIP, as required.

General

- Supply and install cable tray and catenary wiring systems.
- Programming, testing and commissioning of the above systems.
- Demolition of redundant equipment, accessories and wiring systems.
- Wall, ceiling and floor penetrations and access for installation of electrical cables and equipment.
- Earthing system to all accessories, power outlets, luminaires, isolators, building structure and switchboard.
- Colours of all electrical equipment, i.e. switchboards, isolators, switches, power outlets, conduits, access hatches, luminaire trims, etc, to Architects selection. Submit samples for approval prior to ordering.
- Submit shop drawings for review and approval.
- Seal all penetrations (fire proof at fire barriers).
- Provision of all hoisting and scaffolding to install the above systems.
- Coordination with other trades.
- Confirm all trenching routes and allow to coordinate with other new and existing underground services. Allow reinstatement of trenches and make good to match surrounding existing surfaces and conditions.
- Maintenance, service, defects liability and warranty for 12 months from date of practical completion.
- Operating and maintenance manuals (bound), refer to later specification section for requirements.

Performance

Requirement: 400 V, 3-phase, 4-wire, 50 Hz multiple earth neutral (MEN) system.

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:

- *0942 Switchboards – custom-built.*

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 *0943 Switchboard components* worksection.

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 *0921 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 *0961 Telecommunications cabling* worksection.

Communications and sound systems: Provide separate cable 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:

- *0951 Lighting.*
- *0971 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.

Fire safety systems

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

- 0972 *Fire detection and alarms.*

Communications systems

Responsibilities: Provide communication systems as documented and to the requirements of the 0961 *Telecommunications cabling* worksection.

1.3 DESIGN**Design for durability and maintainability**

Design for durability: Develop the design so the systems achieve the documented performance, reliability, service life, energy efficiency and safety requirements, and are easily maintainable.

Access for maintenance: Develop the design so the systems conform to **ACCESS FOR MAINTENANCE** in the 0171 *General requirements* worksection.

1.4 PRECEDENCE**General**

Order of precedence:

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

1.5 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0911 *Cable support and duct systems.*
- 0921 *Low voltage power systems.*
- 0942 *Switchboards – custom-built.*
- 0961 *Telecommunications cabling.*
- 0951 *Lighting.*
- 0971 *Emergency evacuation lighting.*
- 0972 *Fire detection and alarms.*

1.6 STANDARDS**Electrical services**

Requirement: To AS/NZS 3000, unless otherwise documented.

Electrical installations

Electrical design: To AS/NZS 3000 and SAA HB 301.

Selection of cables: To AS/NZS 3008.1.1.

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

Rotating and reciprocating machinery noise and vibration: Vibration severity in Zone A to ISO 20816-1 and ISO 10816-3.

Communications systems: To AS/CA S008, AS/CA S009, AS/NZS 3008 and AS/NZS ISO/IEC 14763.2.

1.7 CONTRACT DOCUMENTS

Permits Notices and Inspections

Make applications, obtain all permits, and arrange testing, all as necessary for the installation and placing into operation of the works where required by any Authority including:

- Department of Premier and Cabinet – Safe Work SA
- Environment Protection Authority South Australia
- Australian Communications Authority.
- Site Telecommunications Carrier.
- SA Power Networks (formerly ETSA Utilities).
- SA Fire Services.
- Energy retailer.

Provide all associated documentation required for the applications.

Pay all associated fees.

1.8 SUBMISSIONS

Certification

Requirement: 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.

Products and materials

Data: Submit technical data for all items of plant and equipment, including the following:

- 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.
- Single line diagram(s), including fault levels at switchboards, cable size and type.
- Switchboard layouts.
- Refer also to "Completion Documents" section of the Contract Documents.

1.9 INSPECTION

General

Give 7 days notice so that inspection may be made at the following stages:-

- 1st Fix – At completion of first fix cabling and conduits works but prior to being covered up.
- PC – At completion of PC works prior to handover.

2 PRODUCTS

2.1 ELECTRICAL ACCESSORIES

General

Responsibilities: Provide accessories as documented and to the requirements of **LOW VOLTAGE POWER SYSTEMS**.

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.

3 EXECUTION

3.1 ALTERNATIVES

Electrical equipment

Unless otherwise specified, alternatives will not generally be accepted where equipment has been nominated.

Where alternatives are proposed, the Contractor is to provide adequate information including technical data, fully revised shop and/or installation drawings, manufacturer & supply chain profile, warranty, local after-sales support and calculations which demonstrate that the alternatives are “equal” to the products and/or equipment that have been specified,

Where proposed alternatives relate to luminaires, a fully coordinated luminaire drawing shall accompany the proposal, along with lux/lumen plots, clearly showing compliance to the original project design criteria and the AS/NZS-1680 suite of Standards. Any deviations from Standards should also be documented.

Unapproved alternatives found to be installed shall be removed at the Contractor's cost and the nominated product(s)/equipment shall be installed. Making good of adjacent surfaces shall also be at the Contractor's cost.

3.2 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.

IP rating

Default rating (all internal switchboards): IP52 minimum.

Weatherproof (all external and within Plant Rooms): IP56 minimum.

Cable entries, shall not compromise the IP rating of the Switchboard.

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.

3.3 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.

Support of equipment mounted into suspended ceilings

General: all equipment must be adequately supported, considering its own weight the capacity of what it is installed into and also the environment it is in.

Installation of surface-mount equipment using only "wall mate" or toggle bolts into plasterboard, without additional bracing, would be not acceptable.

Ceiling tiles: Any ceiling-mounted equipment such as down-light fittings, emergency lights, security sensors, speakers, recessed luminaires, smoke detectors and wireless access points, must meet the requirements of the ceiling tile manufacturer. Generally, light-weight ceiling tiles are not warranted to support anything other themselves and so no accessories are to be mounted into them without additional support.

As a minimum,

- 1) Items up to 1000grams are to be fixed to a sheet of 13mm plasterboard or 6mm ply-wood above the ceiling tile, spanning the full width of the tile to the primary ceiling rails, acting as additional bracing.
- 2) For heavier items will need to be suspended from a concrete slab above or fixed directly into the ceiling structural supports. The Contractor is to seek advice from a qualified Structural Engineer to determine the appropriate mounting methods.

No loose items such as junction boxes, transformers, remote switchgear or battery packs, are to solely rest on top of removable ceiling tiles, but are to be securely fixed to ceiling structural supports.

Finally, provision for earthquakes must be considered, such as safety lanyards for T-bar ceiling "troffer" luminaires as required by AS1170.4.

3.4 CONCRETE PLINTHS

Construction

General: Provide plinths conforming to the

- For all floor mounted equipment. Hot dipped or galvanised..
- Concrete: Grade N25
- Finish: Steel float flush with the surround.
- Reinforcement: Single layer of F72 mesh.

- Surround: Provide galvanized steel surround at least 75 mm high and 1.6 mm thick. Fix to the floor with masonry anchors. Fill with concrete.
- Minimum height: 100mm for main switchboard.

3.5 PLANT AND EQUIPMENT ACCESS

General

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

- They comply with the relevant requirements of the appropriate Occupational Health and Safety regulations.
- Failure of plant and equipment (including leaks) does not create a hazard for the building occupants.
- Failure of plant and equipment (including leaks) cause a minimum or no damage to the building, its finishes and contents.
- Inspection and maintenance operations can be arranged to minimise inconvenience and disruption to building occupants or damage to the building structure or finishes.
- Services and equipment are readily accessible for inspection and maintenance and arranged so that inspection and maintenance can be carried out in a safe and efficient manner. Include the following:
 - Conform to the relevant requirements of AS 1470, AS 1657, AS/NZS 1892.1 and AS/NZS 2865.
 - If parts of the plant require regular inspection and maintenance either locate plant so it is safely accessible from floor level or provide permanent access platforms and ladders.
 - In false ceilings locate items of equipment that require inspection and maintenance above tiled parts where possible. If this is not possible (for example if above set plaster or other inaccessible ceilings) provide access panels. Arrange services and plant locations to reduce the number of access panels. Coordinate with other trades to use common access panels where feasible.
 - Modify manufacturer's standard equipment when necessary to provide the plant access in the contract documents, to manufacturer's instructions.

3.6 SEISMIC RESTRAINT

Provisions

General: The installation must comply with AS 1170.4. Section 8 – Design of Parts and Components. Do not rely on gravity and/or friction to resist seismic forces.

Anti-vibration mounts: Use horizontally restrained type.

Components: Do not use components that will be damaged by earthquake conditions. Protect systems against the adverse effects of components such as mercury switches that, although not damaged by earthquake, may malfunction.

3.7 PAINTING AND FINISHES

General

General: If exposed to view (including in plant rooms) paint new services and equipment.

Surfaces painted or finished off-site: Conform to *Metals and prefinishes*.

Exceptions: Do not paint chromium or nickel plating, anodised aluminium, GRP, stainless steel, non-metallic flexible materials and normally lubricated machined surfaces. Surfaces with finishes applied off-site need not be re-painted on-site provided the corrosion resistance of the finish is not less than that of the respective finish in this clause.

Standard

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

Low VOC emitting paints

Provide the following low odour/low environmental impact paint types with the following VOC limits:

- Primers and undercoats: < 5 g/litre.

- Low gloss white or light coloured latex paints for broadwall areas: < 5 g/litre.
- Coloured low gloss latex paints: < 85 g/litre.
- Gloss latex paints: < 90 g/litre.

Painting systems

New unpainted interior surfaces: To AS/NZS 2311 Table 5.1.

New unpainted exterior surfaces: To AS/NZS 2311 Table 5.2.

Paint application

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

Combinations: Do not combine paints from different manufacturers in a paint system.

Protection: Remove fixtures before starting to paint and refix in position undamaged on completion.

3.8 MARKING AND LABELLING**General**

General: Mark services and equipment to provide a ready means of identification.

- Locations exposed to weather or direct sunlight (UV): Provide durable materials.
- Pipes, conduits and ducts: Identify and label to AS 1345.
- Cables: Label at each end to indicate the origin and destination of the cable.

Consistency: Label and mark equipment using a consistent scheme across all services elements of the project and to suit any existing site services naming conventions, in consultation with site management as necessary.

Operating and maintenance manuals: Provide marking and labelling text, identical to the text and terminology used in operating and maintenance manuals, and all as-built drawings.

Switchboards

General: IPA Studs, or Equal shall be provided on circuit breaker escutcheon panels to denote the circuit designation identification. Plastic 'stickers' will not be acceptable

Accessories

Label isolating switches and outlets to identify circuit origin and label communications outlets to identify data port.

Fixing: Securely fixed.

Label Types

General: Select from the following materials:

- For indoor applications only, engraved two-colour laminated plastic.
- Stainless steel or brass ≥ 1 mm thick with black filled engraved lettering.
- IPA studs for low voltage accessories and switch boards escutcheon panels
- Not accepted: Proprietary pre-printed self-adhesive flexible plastic labels

Emergency functions: To AS 1319.

Colours: Generally in conformance with AS 1345 as appropriate, otherwise black lettering on white background except as follows.

- Danger, warning labels: White lettering on red background.
- Main switch and caution labels: Red lettering on white background.

Edges: If labels exceed 1.5 mm thickness, radius or bevel the edges.

Fixing: Fix labels securely using screws, rivets, proprietary self-adhesive labels or double-sided adhesive tape.

- If labels are mounted in extruded aluminium sections, use rivets or countersunk screws to fix the extrusions.
- Use aluminium or monel rivets for aluminium labels.

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

Lettering heights:

- Danger, warning and caution notices: ≥ 10 mm for main heading, ≥ 5 mm for remainder.
- Equipment labels within cabinets: ≥ 3.5 mm.
- Identifying labels on outside of cabinets: ≥ 5 mm.
- Other locations: ≥ 3 mm.

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

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

Underground cable routes

Survey: Accurately record the routes of underground cables before backfilling. Include on the record drawings.

Records: Provide digital photographic records of underground cable routes before backfilling. Include in operation and maintenance manual.

Location marking: Accurately mark the location of underground cables with route markers consisting of a metal marker plate complete with securely fixed direction arrows, set flush in a concrete base.

Marker plates and/or their fixings must not be a trip hazard, and must be finished flush with adjacent surfaces.

Markers: Place markers shall be placed at, building entry/exit points, in-ground cable joints, route junction, change of direction, termination and building entry point and in straight runs at intervals of not more than 100 m.

Marker bases: 200 mm diameter x 200 mm deep, minimum concrete.

Direction marking: Show the direction of the cable run by means of direction arrows on the marker plate. Indicate distance to the next marker.

Plates: Brass, aluminium or mild steel hot-dipped galvanized, minimum size 75 x 75 x 2 mm thick.

Plate fixing: Waterproof adhesive and secure stainless steel fixings.

Marker height: Set the marker plate flush with paved surfaces, and 25 mm above other surfaces.

Marker tape: Underground wiring: provide a 150 mm wide marker tape bearing the words 'WARNING – electric cable buried below', laid in the trench 150 mm below ground level.

Marker tape to be Orange for Electrical, and/or White for Data/Comms/Security and the like.

Draw wire: provide 5mm poly rope for all spare conduits.

Spare conduits must be capped off at all cable pits (and the like) and building entry points with propriety (typically PVC) caps. Expanding foam filler will not be acceptable.

Fire Rating and vermin sealing of building cable entries: Propriety (and removable) fire-rated filler must be provided to all conduit and like entries entering and exiting buildings. Filler material to be (typically) 50mm to 150mm (Maximum) in thickness/depth, Contractors need to provide a sectional detail clearly showing how and with what product they intend to seal such cable entries. Final approval shall be from Superintendents representative approval.

Failure to seek approval, and use of non-approved sealing products, will necessitate complete removal of sealant installed, and the detail/approval/re-sealing of said cable entries will need to be undertaken.

3.9 OPERATION AND MAINTENANCE MANUALS

Manuals

General: Conform to the **OPERATION AND MAINTENANCE MANUALS** clause in the 0901 electrical maintenance worksection.

Additional information

General: Provide maintenance manuals including the following in addition to that specified in the *General requirements* worksection:

- Installation description: General description of the installation.
- Systems descriptions: Technical description of the systems installed, written to ensure that the principal's staff fully understand the scope and facilities provided. Identify function, normal operating characteristics, and limiting conditions.
- Systems performance: Technical description of the mode of operation of the systems installed.
- Equipment descriptions:
 - . Manufacturers' technical literature for equipment installed, assembled specifically for the project, excluding irrelevant matter. Mark each product data sheet to clearly identify specific products and component parts used in the installation, and data applicable to the installation.
 - . Supplements to product data to illustrate relations of component parts. Include typed text as necessary.
- Operation procedures:
 - . Safe starting up, running in, operating and shutting down procedures for systems installed. Include logical step-by-step sequence of instructions for each procedure.
 - . Control sequences and flow diagrams for systems installed.
 - . Legend for colour-coded services.
 - . Schedules of fixed and variable equipment settings established during commissioning and maintenance.
- Maintenance procedures:
 - . Schedule of normal consumable items, local sources of supply, and expected replacement intervals up to a running time of 40 000 hours. Include lubricant and lubrication schedules for equipment.
 - . Instructions for use of tools and testing equipment.
 - . Emergency procedures, including telephone numbers for emergency services, and procedures for fault finding.
 - . Material safety data sheets (MSDS).
- Certificates:
 - . Copies of test certificates for the installation and equipment used in the installation.
 - . Test reports.
 - . Electrical Certificate of Compliance.
 - . Australian Communications Media Authority TCA1 form
 - . Warranty certificates for all systems.
 - . Fire Detection Installation

- . Structural engineering certificates for plinths, column footings, penetrations through concrete slabs etc
- Drawings:
 - . Single line diagrams.
 - . Service route layouts.
 - . Switchgear and control gear assembly circuit schedules including electrical service characteristics, controls and communications.
- Hard copy – A1-A3 AutoCAD drawings and software on CDROM
- Performance Test:
 - Include commissioning data and performance test results.
 - Electronic security and fire detection equipment list
- Training:
 - Mandrel test results for spare conduits
 - Photographic records for underground trenches
 - Certificate of training completion.
 - . Contact details for further training.

3.10 RECORD DRAWINGS

General

General: Show dimensions, types and location of the services in relation to permanent site features and other underground services. Show the spatial relationship to building structure and other services. Include all changes made during commissioning and the maintenance period.

Drawings: Include all documented shop drawings.

Extensions and/or changes to existing: If a drawing shows extensions and/or alterations to existing installations, include sufficient of the existing installation to make the drawing comprehensible without reference to drawings of the original installation.

3.11 TOOLS AND SPARE PARTS

Tools and spare parts schedule

General: In the O&M Manuals, submit a full schedule of tools, portable instruments and spare parts necessary for maintenance of the installation. For each item state the recommended quantity and the manufacturer's current price. Include the following in the prices:

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

Spares

General: Provide spare parts listed in the appropriate worksections.

Replacement: Replace spare parts consumed during the maintenance period.

3.12 COMMISSIONING

Circuit protection

General: Confirm that circuit protective devices are sized and adjusted to protect installed circuits.

Controls

General: Calibrate, set and adjust control instruments, control systems and safety controls.

Notice

General: Give sufficient notice for inspection to be made of the commissioning of the installation.

Reports

General: Submit reports indicating observations and results of tests and compliance or non-compliance with requirements.

3.13 CLEANING**General**

Practical completion: At practical completion, clean the following:

- Insides of switchgear and control gear assemblies.
- Luminaires.
- Switchgear and contactors, and other electrical contacts. Adjust as necessary.
- Switchboards, communications cabinets.

3.14 COMPLETION TESTS**General**

General: Test the works under the contract to demonstrate compliance with the documented performance requirements.

Functional checks

General: Carry out functional and operational checks on energised equipment and circuits and make final adjustments for the correct operation of safety devices and control functions.

Proprietary equipment

General: Submit type test reports confirming compliance of proprietary equipment.

Sound pressure level measurements

Correction for background noise: To AS/NZS 2107 Table B1.

External: To AS 1055.1.

Internal: To AS/NZS 2107.

Measurement positions: If a test position is designated only by reference to a room or space, do not take measurements less than 1 m from the floor, ground or walls.

Sound pressure level analysis: Measure the sound pressure level and the background sound pressure level over the full range of octave band centre frequencies from 31.5 Hz to 8 kHz at the designated positions.

Sound pressure levels: Measure the A-weighted sound pressure levels and the A-weighted background sound pressure levels at the designated positions.

Test instruments

General: Use instruments calibrated by a registered testing authority. Ensure equipment test parameters meet all current standards.

3.15 TRAINING**General**

Duration: Instruction to be available for the whole of the commissioning and running-in periods.

Format: Conduct training at agreed times, at system or equipment location. Also provide seminar instruction to cover all major components.

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

Certification: Provide written certification of attendance and participation in training for each attendee. Provide register of certificates issued.

Demonstrators

General: Use only qualified manufacturer's representatives who are knowledgeable about the installations.

Maintenance

General: Explain and demonstrate to the principal's staff the purpose, function and maintenance of the installations.

Operation

General: Explain and demonstrate to the principal's staff the purpose, function and operation of the installations.

3.16 MAINTENANCE**General**

General: During the maintenance and defects liability periods, carry out periodic inspections and maintenance work as approved. Refer to the 0991 *Electrical Maintenance* worksection for further requirements.

Emergencies: Attend emergency calls promptly (within 24 hours).

Servicing Access

Arrange all plant and equipment to provide minimum access and maintenance requirements in accordance with the equipment manufacturers' recommendations and the requirements of the Occupational Health, Safety and Welfare Act and Regulations.

Maintenance program

General: Submit details of maintenance procedures and program, relating to installed plant and equipment, 6 weeks before the date for practical completion. Indicate dates of service visits. State contact telephone numbers of service operators and describe arrangements for emergency calls.

The program shall meet all of the requirements from:

- 1) the equipment manufacturers
- 2) applicable Australian Standards
- 3) applicable WHS & supply authority regulations

Maintenance records

General: Submit, in binders which match the manuals, loose leaf log book pages designed for recording completion activities including operational and maintenance procedures, materials used, test results, comments for future maintenance actions and notes covering the condition of the installation. Include completed log book pages recording the operational and maintenance activities performed up to the time of Final Completion.

Certificates: Include test and approval certificates.

Certification: On satisfactory Final Completion of the installation, submit certificates stating that each installation is operating correctly.

Number of pages: The greater of 100 pages or enough pages for the maintenance period and a further 12 months.

Referenced documents: If referenced documents or technical worksection s require that log books or records be submitted, include this material in the maintenance records.

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.

Site control

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

0911 CABLE SUPPORT AND DUCT SYSTEMS
--

1 GENERAL**1.1 RESPONSIBILITIES****General**

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

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0901 Electrical systems.

1.3 INTERPRETATION**Definitions**

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

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

Operation and maintenance manuals

Requirement: Submit all operational and maintenance documentation necessary to operate and maintain the equipment and systems installed.

Shop drawings (shall be included in final Operations and Maintenance Manuals): Cable support and duct systems: 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.
- Detailed layout of underground conduits, pits and drainage trenches.
- Invert levels for underground conduits.
- Depth of burial for cables and conduits.
- Provision for expansion and ground movement.

Products and materials

Cable support and duct systems: Submit technical data for the following:

- Ducted wiring enclosure systems.
- Cable support systems.
- Proprietary pits.

2 PRODUCTS**2.1 GENERAL****Marking**

Identification: Marked to show the following:

- Manufacturer's identification.
- Product brand name.
- Product type.
- Quantity.
- Product reference code and batch number.

- Date of manufacture.

2.2 CONDUITS

General

Standards: To AS/NZS 2053.3, AS/NZS 61386.1, AS/NZS 61386.21, AS/NZS 61386.22 and AS/NZS 61386.23.

Communications cabling: To AS/NZS ISO/IEC 14763.2.

Type

General: Rigid.

Sizes

Requirement: Conform to the following:

- Underground: ≥ 32 mm.
- Telecommunications: ≥ 25 mm.
- Other locations: ≥ 20 mm.

Fasteners

Surface mounted: Double sided fixed/saddled.

In concrete slabs: Tie to structural steel or provide separate fixing system, to Superintendent's approval.

Colour

Electrical : Light orange (in plant rooms) or grey (other areas).

Telecommunications systems conduits: White.

Galvanized water pipe

Medium or heavy: To AS 1074.

2.3 METALLIC CONDUITS AND FITTINGS

General

Standards: To AS/NZS 61386.21 and AS/NZS 61386.23.

Type

General: Screwed steel conduit with medium protection outside and inside to AS/NZS 61386.21.

Exposed to dampness or moisture: Steel conduit with high protection outside and inside to AS/NZS 61386.21.

Laid underground: Steel water pipe with protection outside and inside to AS/NZS 61386.21.

Joining

Steel conduit: Screwed joints and ends.

Fasteners

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.

2.4 NON-METALLIC CONDUITS AND FITTINGS

General

Standards: To AS/NZS 2053.3, AS/NZS 61386.21, AS/NZS 61386.22 or AS/NZS 61386.23.

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

Flexible conduit

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

Associated fittings

Type and material: Same as the conduit.

Wall boxes on PVC-U conduits: For special size wall boxes not available in PVC-U, provide prefabricated earthed metal boxes. Allow for fire-rated or acoustically rated boxes as applicable.

Inspection-type fittings

Requirement: Use only in accessible locations and where exposed to view.

Joints

Type: Cemented or snap-on joints.

UV protection

General: All plastic conduit (and accessories) exposed to direct Sunlight shall be Black HFT conduit. All other exterior conduit (and accessories) not exposed to direct sunlight, may also be UV rated medium Duty Grey conduit. Unpainted PVC conduits exposed to view will not be accepted.

Fixings and Supports

Type: In any accessible locations, particularly in vandalism prone locations, fixings are to be securely fixed to/with double-side metal saddles. Zinc plated for internal use and hot dipped galvanised for external use or where exposed.

2.5 CABLE TRAY/LADDER SYSTEMS

General

Standard: To NEMA VE-1.

Type tests: To NEMA VE-1.

Mild steel

Finish exterior or wet exposure: Hot-dipped galvanized after fabrication.

Finish interior dry exposure: Zinc or electro-zinc-coated steel.

Cable tray type: Slotted similar to "Admiralty" pattern with folded or rolled edges.

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: Minimum 50%.

Tray/ladder 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.

Support material finish: Metallic-coated to AS 1397, Grade G2, Coating Class Z275. All cut ends to be de-burred and painted with cold galvanising paint.

Covers: Ventilated flat covers to cable support systems installed in open to view and/or accessible locations. All cable trays exposed to direct sunlight shall be covered.

2.6 CATENARY SYSTEMS

General

Catenary systems: May be used within suspended ceiling spaces instead of cable tray and ladder systems. Catenary system must be tied/strung off the building structure, and not from lightweight ceiling and/or wall, or their framing.

Wire: Stainless steel or coated galvanized cable and couplings.

2.7 CABLE PITS

General

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

Requirement: Installation in accordance with Australian Standard AS3996 Access covers and grates, as a combined installation, and the manufacturers written installation instructions.

Pits must be installed higher than the wider surrounding ground to prevent the entry of surface water, ramping down over to the surrounding area not to become a trip hazard.

Provide drainage/soakage drains to the bottom of the pit. Pits must not be installed so that they become inevitable low lying sumps. Pit/Lid combinations found to be installed too low compared to their surrounding environs, shall be rectified at the contractors cost.

Class "B" load rated Pit / lid combinations to non-vehicle accessed areas, typically garden beds, where there is no risk of the pit being exposed to any vehicle.

Class "D" load rated Pit / lid combination to all vehicle accessible areas ie: paved (vehicle and pedestrian), grassed and open areas.

In general, all lid and their frame assemblies, shall be of ductile iron manufacture.

All pits shall be installed to the manufacturers written installation instructions with drainage and necessary strengthening treatments, such as concrete base, sides and collar, in order to obtain the appropriate load and sealing ratings.

Proprietary cable pits

Pits $\leq 1200 \times 1200$ mm: Proprietary concrete or polymer moulded pits encased in concrete.

Pit covers

General: Provide pit covers to suit external loads. Fit flush with the top of the pit.

Standard: To AS 3996.

Lids must be greased around their frame, to allow easy access when required.

Provide one set of cable pit lid lifters per project, to be handed over to the client at the end of the project.

Weight: < 40 kg for any section of the cover.

Lifting handles: Provide one set of lifting handles for each size and type of cover/lid section.

Evidence will be required that this has been done.

Drainage

General: Provide drainage from the bottom of cable pits, with minimum 50mm PVC pipe to absorption trenches filled with rubble, formed of 16mm aggregate and geotextile barrier. Do not connect to the stormwater drainage system. Provide photographic evidence that this has been completed on request.

Absorption trenches: Minimum size 300 x 300 x 2000 mm.

3 EXECUTION

3.1 GENERAL

Installation of cables

General: To be supported where possible.

Internal: Unsupported cables resting on ceiling are not acceptable.

Provide propriety cable tray system for all consumer mains and sub-mains cabling over 70mm².

External: To be concealed. Minimum thickness shall be 3mm, galvanised and/or powder coated to approval. Exposed cables are not permitted. Cables in PVC conduit on roof tops is not acceptable.

Inaccessible concealed spaces: Cable in UPVC conduit, or tied to catenary systems is permitted.

Face, plastered or rendered masonry surfaces: Cable in UPVC conduit for their full length for this type of cable installation..

All light and power cabling can be run within the stud wall in compliance to AS/NZS3000 and AS/NZS3008. All cabling shall be protected with PVC conduit at locations where cabling is in contact with unbushed metal studwork. Under no circumstances will any unprotected cabling be accepted, where it is run in the gap located/formed where metal studwork meets metal noggins, metal floor/bottom-track, metal head/top-track and the like.

Fire isolation

Requirement: Provide fire-stop sealing where electrical services pass through fire-resisting walls, floors or ceilings. Additionally, the cable support system must not penetrate the fire rated wall, but rather stop 50-100mm from the wall, and then continue again on the other side. Only the cables themselves are to pass through the fire wall, and be appropriately fire sealed to control/minimise the spread of fire.

Fire Sealant:

Provide propriety fire-rated sealant and/or propriety fire stop pillows, correctly oriented and firmly fixed in place with propriety fire-rated sealant.

Expanding foam type fire sealing, shall only be used as a temporary measure for sealing of plasterboard walls only, and following formal approval from Engineer.

Wall boxes in fire-resisting walls: Provide wall boxes containing intumescent fire control medium, and/or fire-resisting barriers behind wall boxes in fire-resisting walls if the integrity of the fire-resistance level has been altered. Consideration shall be given to acoustics between rooms, where electrical accessories and/or equipment has been mounted on walls/ceilings.

3.2 UNSHEATHED CABLES – INSTALLATION

General

Not permitted underground.

Requirement: Provide permanently fixed enclosure systems/conduits, assembled before installing wiring. All conduits shall be glued

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

Set out

Bends

General: Install conduits with the equivalent of ≤ 2 right angled bends per cable draw-in run.

Approval: Superintendent approval required for > 2 bends.

Conduits $> 80\text{mm}$ to have bellmouth cable guides at both ends to minimise damage to cable insulation.

Underground conduit bends must use Large Sweep Bends, Clipsal 247L or 247P series, or approved equivalents

Conduits in roof spaces

General: Locate below roof insulation and sarking. In accessible roof spaces, provide mechanical protection for light-duty conduits. Solar Photovoltaic DC cabling to be meet requirements of AS/NZS5033.

Roof Penetrations

All roof penetrations to be certified and warranted by the roofing contractor for new installations.

Penetration through a high-point of the roofing material profile. Penetrations through low point or pan of the roofing material not accepted. Any penetrations found penetrating the low points or the pan of the roofing deck, will necessitate repair/replacement of the roofing material, and thus be re-wired.

$< 50\text{mm}$ – use a proprietary penetration flashing, eg “Dektite” or similar. Only one cable or conduit per Dektite, to maintain seal.

$> 50\text{mm}$ – through an upstand and overflashing.

Inspection fittings

Location: Locate in accessible positions.

Draw cords

General: Provide 5 mm^2 polypropylene draw cords in conduits not in use.

Spare conduits

Provide spare conduits in underground conduit runs, as documented. These are to be left unused, with draw-cords. Perform mandrel testing to prove suitability and then seal all ends with propriety PVC type caps. Submit test results to Superintendent for review and included in the O&M manuals.

Draw-in boxes

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

- In straight runs at > 30 m: Spacing \leq 28 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: Install in 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. Unpainted PVC conduits exposed to view, will not be accepted.

Conduits in roof spaces

Location: Locate below roof insulation and sarking. In accessible roof spaces, provide mechanical protection for light-duty conduits.

Conduits in concrete slabs

Where in-ground conduits are protruding up through concrete slabs during the construction period, they shall be effectively sealed with propriety PVC conduit/pipe caps. Leaving them open, or taped over is not acceptable.

Route: Do not run conduits in concrete toppings. Do not run within close proximity of pre/post-tensioning cable zones. Cross pre/post-tensioning cable zones at right angles. Route to avoid crossovers and minimise the number of conduits in any location.

Parallel conduit spacing: \geq 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, or be subject to core hole drilling, or the drilling of large anchor bolt points or where

exact plant locations are unknown at time slab is poured. For this reason, surface mounted conduits, cable trays and the like are the preference.

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.

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: At spacing which is less than length of cable support section.
 - . Visible cable support: Loaded deflection \leq span/200.
- Vertical runs: 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 10 mm (hot-dipped galvanised within 1km of the sea, or zinc plated for other areas) attached to hot-dip galvanised U-brackets, or by means of proprietary brackets.

Cut ends: De-burred and painted with cold galvanised paint.

Seismic restraint to AS1170.4.

Fixings must be independent of any other building services (eg mechanical ducts or pipes) or suspended ceiling.

Cable fixing

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

Plastic cable ties shall be premium type long life and UV stabilised black cable ties. Where other colours are required (typically for securing white flexible cabling down a pendant or similar), these shall be by approval.

Fire Rated services:

Fire-Rated cable system installations are to be engineered and installed as a complete "System", comprising of:

- (1) The Fire-Rated Cable.
- (2) The Fire-Rated Cable support system (cable tray, brackets, suspensions, fixing bolts, metal cable ties and anchors etc.)
- (3) The completion of Fire-Rating of penetrations, where Fire-Rated cabling passes through and/or via Fire-Rated penetrations, building envelopes, fire and/or smoke baffles and the like.

Certificates of Conformity for the Fire Rated Cable Systems shall be provided on request, and in Operation & Maintenance Manuals at project completion, and/or as staged completion occurs.

Inside bend radius

Requirement: 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. . All cut ends to be de-burred and painted with cold galvanising paint.

Clearances

Access requirement: 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 hot water unit: > 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 or any other building services (eg mechanical ducts or pipes).

Design loads: Design catenary systems 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 fasteners that allow cables to be added or removed without destroying the integrity of the system.

No more than 5 sub-circuit cables per catenary is permitted.

No more than 25 data/communications cables per catenary is permitted.

3.6 CABLES IN TRENCHES – INSTALLATION**Sand bed and surround**

General: Conform to *0223 Service trenching*.

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 removable waterproof and vermin-proof seals as follows:

- Spare ducts and conduits: Immediately after installation.
- Other ducts and conduits: After cable installation.
- Application of sealant to a maximum of 50mm from the duct/conduit end such that the sealant is easily removable as required. This can be facilitated by putting solid foam or a rolled up cloth in the duct/conduit end to a depth of <50mm first before applying the sealant.

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

Requirement: Provide low voltage power systems, as documented.

1.2 DESIGN**Electrical system design**

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

Fire-resisting protection: Provide for switchboards and associated electrical conductors to BCA C2.13.

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

1.3 PERFORMANCE**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.

Supply system: 400 V, 3-phase, 4-wire, 50 Hz, multiple earth neutral (MEN) system.

Distribution system

General: Provide power distribution system elements, as documented.

Surge protection devices (SPD)

General: Provide surge protection devices, as documented.

1.4 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0901 *Electrical systems.*
- 0911 *Cable support and duct systems.*

1.5 STANDARDS**General**

Requirement: To AS/NZS 3000 Part 2, unless documented otherwise.

Electrical design: To AS/NZS 3000 and 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.

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

Electromagnetic compatibility (EMC): To AS/NZS 61000.

Communications systems: To AS/CA S008, AS/CA S009, AS/NZS 3080 and AS/NZS ISO/IEC 14763.2.

Testing

Standard: To AS/NZS 3017.

1.6 INTERPRETATION

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:

- Extra-low voltage: Not exceeding 50 V a.c. or 120 V ripple-free d.c.
- High voltage: Exceeding low-voltage.
- Extra-low voltage: Not exceeding 50 V a.c. or 120 V ripple-free d.c.

1.7 SUBMISSIONS

Design documentation

Low voltage power systems: On request, 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.
- Stringing calculations for aerial cables.

Final subcircuits: May be treated as typical for common route lengths, loads and cable sizes. Final sub-circuit minimum loading shall be calculated from:

- Connected load, or
- 50% of the circuit breaker rated current,
- and being whichever load profile is the greater one of the above two dot points.

Certification

- Certification of conformance to AS/NZS 3000, for electrical services.

Operation and maintenance manuals

Requirement: Provide all operational and maintenance documentation necessary to operate and maintain the systems installed.

Samples

Low voltage power systems: 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.

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**General**

Responsibilities: Provide site electricity supplies, as documented. Connect project electrical facilities to the network distributors external site electricity supply.

LV supplies from dedicated substations

LV transformer output supply: To AS/NZS 3000 and the SA Power Networks Service and Installation Rules.

Requirement: 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 electricity distributor's standards and the Service and Installation Rules.

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

Metering

Retail: Provide metering to the requirements of the electricity retailer, the electricity distributor and as documented.

Private: Provide additional private metering, as documented.

Photovoltaic metering: As per SA Power Networks requirements and as documented.

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: To *0911 Cable support and duct systems*.

2.3 POWER CABLES

Standards

Polymeric insulated cables: To AS/NZS 5000.1.

Cable

Requirement: Select multi-stranded copper cables.

Default insulation: V-75.

Default sheathing: 4V-75.

Minimum size: Conform to the following:

- Lighting sub-circuits: 2.5 mm².
- Power sub-circuits: 4 mm².
- Submains: 6 mm² with (minimum) 6mm² earthing conductors.

Voltage drop: Select final subcircuit cables within the voltage drop parameters dictated 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.

Distribution cables: To AS/NZS 4961.

Colours

Conductor colours: For fixed wiring cables, provide coloured conductor insulation or at least 150 mm of close fitting coloured sleeving at the termination points of each conductor.

Active conductors in single phase circuits: Red.

Active conductors in polyphase circuits:

- A phase: Red.
- B phase: White.
- C phase: Blue.

Sheath: White.

Aluminium mains and submains

Requirement: Not permitted

2.4 ELECTRICAL ACCESSORIES

General

Style: Provide accessories of the same style and from the same manufacturer, across all trades and disciplines. Electrical contractor is to lead the coordination process with other trades via the lead construction contractor(s).

Accessory selection and locations require approval to ensure that each item is compatible with the final interior design of the space. Refer to the table below for Site Specific requirements.

Quality Assurance

Implement a quality system for the works in accordance with Australian/New Zealand ISO 9000.1 - Quality management and quality assurance Standards - Guidelines for selection and use and Australian/New Zealand ISO 9001 - Quality systems - Model for quality assurance in design, development, production, installation and servicing.

Socket outlets - generally

Standards:

- General: To AS/NZS 3112.

Socket outlet properties: Provide sockets conforming to the following or as documented:

- Type: Integral switched socket outlet.
- Material: High impact plastic.
- Size: refer to table below.
- Current rating: 10 A.
- Pin arrangement: Mount outlets with the earth pins at the 6 o'clock position.

Plastic switched socket outlets

Colour: refer to table below.

Mounting configuration: Horizontal.

Weatherproof socket outlets

Colour: Grey.

Permanently connected equipment

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

Isolating switch: Locate adjacent to equipment, either

- a) on secure and separate metallic Hot dipped Galvanised upstand/bracket, adjacent to the piece of equipment it is serving (and not on the air-conditioning unit), or
- b) wall mounted (if within/adjacent a wall/structure),.

Where the Air Conditioning unit is installed within a cage, the Isolator shall be located within the cage.

Under no circumstance, will an Isolation Switch be accepted if mounted directly on the item of plant.

Coordination: Coordinate with equipment supplier.

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

Isolating switches

Standard: To AS/NZS 3133.

Selection: Clipsal WHT series, Clipsal 56 series, NHP ISO series, IPD W66 series, Wilco A series or Superintendent approved equal

Must switch all live conductors, i.e. 2-pole for single phase, 4-pole for three phase.

Minimum 20 amp rating

Cable entries to be bottom-entry only and sealed to maintain IP rating.

Light Switches

- Provide 15 A minimum rated rocker switch mechanisms suitable for all lighting loads equal to "Clipsal 30USM" or "HPM 770/15" and flush wall mount generally. Mechanisms must be screw-fixed within the retaining plate
- Install at 1000mm AFFL to centre of the plate, to AS1428.1

Appliances & other hard-wired equipment**General:**

- Provide all appliances internally wired and complete with control switches, controllers and connecting links.
- Unless stated otherwise provide an isolating switch adjacent to all direct connected appliances and equipment. The Isolation device, shall not be immediately behind the equipment or on the equipment itself, but be readily accessible adjacent to it.
- Connect each three phase appliance with a separate full size neutral and earth.
- Install the final connection to any equipment installed away from, but within 600mm of, a wall or column in flexible PVC conduit. PVC clad flexible steel conduit shall be used for machinery and in workshop type environments.
- Where any equipment is located at greater than 600mm from the wall, where possible, conceal the cabling. Where it is not practical to conceal the cabling, surface-mounted proprietary aluminium skirting ducting, in-floor ducting cast into the slab/flooring or by securely fixed metallic service pole (minimum 3mm thickness) is acceptable.
- Due consideration will be required for the environment of the installation to include but not be limited to:
 - . Chemical/corrosive resistance may be important in commercial kitchen and laundry environments
 - . Plastic-coated flexible metal conduits, e.g. "Anaconda" or similar, where mechanical damage is likely.
 - . Type of environment/product selected to provide a longevity of in-service installation.

Connection: Shorten lead to minimum length for plug connections.

Test and tagging: provide the initial Test and Tag to all new plug in equipment, to AS/NZS 3760.

Isolating switches: To AS/NZS 3000.

Notes to Site Specific requirements table (below)

- Standard Plate: fixed accessory plate with no removable fascia, e.g. Clipsal 15 or 25 series, HPM Legrand "Standard Range" or approved equivalent
- Safety shuttered: with in-built shutter to added protection of live parts within, e.g. Clipsal 25S, HPM 777S or approved equivalent.
- Weather Proof: with IP rating of 53 minimum

3 EXECUTION**3.1 SITE ELECTRICITY SUPPLY****General**

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

3.2 EARTHING**Earthing systems**

Protective earthing system with a multiple earth neutral (MEN) connection: To AS/NZS 3000 Section 5 and as documented.

Earth electrodes

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

Length: 2 metres minimum

Type: Copper clad metal (Minimum requirement).

Electrode pit

Material: Non-ferrous

Earth electrode pit to be provided. Pit to be non-conductive, and be encased in 100mm concrete surround (200mm depth) to provide secure installation. Internally the earth connection, shall be well wrapped in Petrolatum type tape (as 'Denso Tape') or Self-amalgamating tape.

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**

Classifications: To AS/NZS 3013.

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

Stress: Do not use installation methods that exceed the cable's pulling tension. Use cable rollers, sheaves and slippers for installing cable 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.

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

Circuit loading

Lighting: 1800VA at 240Vac, 1725VA at 230Vac, on a 10amp circuit breaker.

General Power: 6 off double power socket outlets (i.e. 12 single outlets maximum), on a 16amp circuit breaker, or 10 off double power socket outlets (i.e. 20 single outlets maximum) on a 20 amp circuit for circuits in a permanently air-conditioned environment. For this latter option, strict adherence to AS3008.1 will be required. Provide calculations of compliance on request.

Aluminium Cables

General: Not permitted on SA Government projects.

Tagging

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

Marking

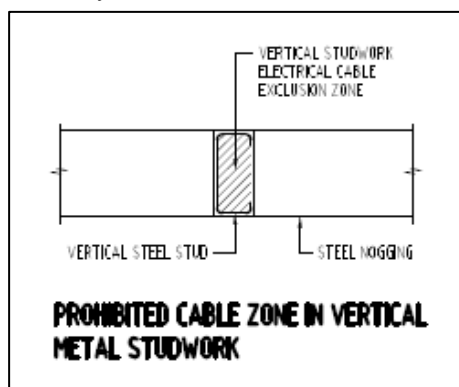
General: Identify the origin/destination of all wiring by legible indelible marking, at termination of both ends.

Submains and final sub-circuits

Installation: Provide the following:

- Cables with conductor size of less than or equal to 35mm²: Run in conduit, cable ducts or support on cable trays, catenary wire or ladders. Cables larger than 35mm² must be supported by cable tray or ladders. Conduits, ducts, trays & ladders must be sized to allow 30% spare capacity for future additions.
- Cables with diameter less than 13 mm: Run in conduit, cable ducts or support on cable trays or ladders.
- Single core cables of 3 phase circuits : Install unenclosed single core cables of diameter greater than 13 mm laid on cable tray in trefoil (RWB) or quadrofoil (RWBN) groups.
- Cables for lighting systems: Run in conduit, cable ducts, suspend on catenary systems or support on cable trays or ladders. Maximum 5 cables per bunch.
- Accessible concealed spaces: Install thermoplastic insulated and sheathed cables.
- Inaccessible concealed spaces: Install cable in PVC-U conduit to allow for future re-wiring.
- Roof spaces: Install cable below thermal 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.
- Accessible ceiling voids: Support or enclose cables on ceiling surfaces or on catenary systems if run adjacent to ceiling suspension systems. Cables within ceiling voids installed on catenary systems, shall be PVC cable tied at (maximum) 600mm intervals.
- Plastered or rendered masonry: Install cable fully within PVC-U conduit. Refer to Plastering worksection for embedment depth and plastering rectification and cover requirements
- Double sided face brick partition: Install cable in PVC-U conduit installed within the brick wall by slotting bricks or using any pathways provided in the brick.
- Stud framed walls with bulk insulation: Install cables in PVC-U conduit, or if walls are timber stud, clip to the stud. Final sub-circuits may be run loose in stud walls where compliance (by calculation) to AS3008.1 has been achieved.
- Timber framed Stud walls: Use propriety cable clips to clip the cable to the stud. Final sub-circuits may be run loose in stud walls where compliance (by calculation) to AS3008.1 has been achieved. Contractor to demonstrate calculation and compliance on request.

Metal framed stud walls: Typically, Install TPS (Data, Communications, Security, and Mechanical or Hydraulic control) cabling allowing for rewirability within all walls, with vertical drops as the preference (thus minimising horizontal cabling) . Additionally, cabling is not permitted to be run vertically within the Vertical Studwork Electrical Cable Exclusion Zone. Typical detail as follows:



- Effectively bush all cable penetrations in steel framing to prevent cable damage. Cables run in through propriety rolled bell-mouth service holes require no further bushing.
- Horizontal cable trays, ladders, switchboard entries: Fix cables using premium quality and durable proprietary nylon cable ties or straps, cable saddles or clips at AS/NZS3000 compliant intervals. Nylon Cable Glands are required for all Cable Entries. Stainless Steel cable ties are required for fire-rated cable systems. Horizontal cable trays or ladders: Fix cables using premium quality and durable proprietary nylon cable ties or straps, cable saddles or clips at 2000 mm intervals. Metal cable ties required for fire-rated cable systems.

- Vertical cable risers: Fix cables using proprietary nylon cable ties or straps, cable saddles or clips at 1000 mm intervals. Metal cable ties required for fire-rated cable systems.
- Plant rooms, Store rooms, and other rooms and the like without ceilings: Install cable in heavy duty PVC-U conduit or on tray or in duct.
- All cabling below 2100,, to be in steel conduit (earthed), or on cable tray with metallic protection covers. If internal cable tray(s) is accessible to any other than pedestrian traffic, metallic protection covers shall be equal to 3mm. Otherwise 1mm (nominal) or as otherwise approved.

3.4 FIRE-RESISTANT CABLES

Protection

General: If exposed to mechanical damage, provide protection to AS/NZS 3013.

Fire-Rated cable system installations are to be engineered and installed as a complete "System", comprising of:

- (1) The Fire-Rated Cable.
- (2) The Fire-Rated Cable support system (cable tray, brackets, suspensions, fixing bolts, metal cable ties and anchors etc.)
- (3) The completion of Fire-Rating of penetrations, where Fire-Rated cabling passes through and/or via Fire-Rated penetrations, building envelopes, fire and/or smoke baffles and the like.

Certificates of Conformity for the Fire Rated Cable System, including supporting manufacturer's technical data, shall be provided on request, and also be included in O&M Manuals at project completion.

3.5 COPPER CONDUCTOR TERMINATIONS

General

Requirement: 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 manufacturers specified crimping method/tool.

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 metal cable duct with a proprietary 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.

3.6 ALUMINIUM CONDUCTOR TERMINATIONS

(FOR EXISTING ALUMINIUM INSTALLATIONS ONLY, NEW ALUMINIUM CABLE INSTALLATIONS SHALL NOT BE ACCEPTED)

General

Conductor surface preparation: Remove oxide as follows:

- Wire brush surfaces to be connected.
- Immediately apply oxidation inhibiting abrasive grease containing zinc or similar particles. Thoroughly cover the surfaces and work the grease between the strands of stranded conductors.

Fittings: Unless joint contact surfaces are factory tinned or factory pre-filled with oxidation inhibiting abrasive grease, prepare as for conductors.

Aluminium-to-aluminium jointing

Compression method: Conform to the following:

- Provide aluminium or aluminium alloy crimp lugs or ferrules to suit the size and shape of the conductors.
- Use compression dies selected to suit lugs or ferrules, with hexagonal dies for stranded conductors and indent dies for solid conductors.
- Fill lugs or ferrules with oxidation inhibiting abrasive grease.
- Insert conductors into lugs or ferrules, driving out excess grease.
- Apply dies to provide at least 2 indentations at each joint or termination.

Termination of electro-tinned aluminium lug: Bolt the palm of the lug to terminals using a stainless steel bolt and nut with a large diameter stainless steel flat washer and two Belleville spring cup washers.

Bolted joints: Tighten to the Belleville spring cup manufacturer's recommended tension requirements. Do not over tension or destroy the ability of the cup washers to maintain the correct tension of the joint. Allow for thermal expansion of the joint.

Fusion weld method: Make joints by fusion welding with aluminium lugs. Protect cable insulation from heat by fixing substantial heat sinks to the cable near the joint. After completion of the weld, wire brush the joint and file sharp projections smooth.

Aluminium-to-copper jointing

Method: Use compression method, as for **Aluminium-to-aluminium jointing**.

Connector types: Select from the following:

- Bi-metal: Lug or pin type with cast copper palm or pin, friction welded to an aluminium barrel section, subsequently factory filled with oxidation inhibiting abrasive grease.
- Termination of electro-tinned aluminium lug: Bolt the palm of the lug to the copper busbar or terminal by means of a stainless steel bolt and nut with a large diameter stainless steel flat washer and two Belleville spring cup washers.

Bolted joints: Tighten to the Belleville spring cup manufacturer's recommended tension requirements. Do not over tension or destroy the ability of the cup washers to maintain the correct tension of the joint. Allow for thermal expansion of the joint.

3.7 ACCESSORIES

Installation

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

- Site specific requirements as per table in section 2.5 above
- Rendered masonry partition: Flush wall box, with PVC rigid conduit chased into wall. Depth: maintain a clearance depth to the top edge of the conduit to the finished wall surface. Typically, expanded mesh to finish a (minimum) of 50mm to each side of the primary chase/conduit is required. Refer to the specification on solid plastering for further details as applicable,
- Double sided face brick partition: Vertically mounted flush wall box, with conduit concealed in cut bricks. If retrofitting an existing installation, surface mounted duct/conduit to Superintendent's approval.
- Face brick external cavity wall: Flush wall box, with thermoplastic insulated (typically known as building wire) cables in conduit run in cavity and tied against inner brick surface, or thermoplastic sheathed (TPS) cables run in cavity.

- Data and/or Communications cabling shall be run in PVC conduit in the walls to enable future rewiring. Minimum size conduit = 25mm.
- Stud partition: Provide fixed propriety wall plate (typically as *Clipsal™ 155P or similar*) or fixed wall box (typically as *Clipsal™ 157 or similar*). Maintain rewirability at the wall plate/box as required. Earth and shroud all metal frame partitions at each accessory location/circuit. Additional equipotential (minimum) 4mm conductor to be provided to all separate (non-electrically/mechanically continuous) freestanding metal wall systems.
- Fire walls: Provide flush proprietary wall box with intumescent material, and conduit built into wall. Principle Contractor to allow to provide additional fire protection around wall boxes, where necessary to maintain fire-resistance rating.

Location: Confirm final location of all outlets and equipment with the Design team and Client Agency representative, before installation.

Spacing from adjacent horizontal surface: ≥ 150 mm to the centre of accessory socket.

Default mounting heights to centre of accessory plate:

- Outlets: 300 mm or 150mm above bench height when at a workstation. No outlets are permitted to rest solely on the surface of benches. SSO installed in a manner where their respective outlets are facing directly upwards are not permitted.
- Switches and controls: 1000 mm to the centre of the faceplate/primary switch mechanism. No control or switch mechanism may be installed outside the AS1428.1 requirement of between 900mm AFFL and 1100mm AFFL, without prior Client Agency approval.

Accessories: Shall be Flush mounted, except in plant rooms and other rooms not provided with ceilings and the like, where surface mounted accessories is acceptable.

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

Restricted location: Do not install any electrical accessories across junctions of wall finishes. Coordinate electrical accessories where proposed/documented to be installed on Pin Board type wall finishes, with architectural documents, to avoid installing accessories on such substrates. Where this is not possible contractors are to provide shop drawings (clearly showing elevations) where accessories clash with pin boards and the like, to the Superintendent for approval.

Surface mounting: Proprietary mounting blocks (minimum 4 secure fixings) may be used.

Installation of ceiling mounted accessories

Connections for appliances: Flush mounted outlets on the ceiling next to support brackets. The installation must be fully electrically insulated above the ceiling, in accordance with AS/NZS3000.

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

Lightweight ceilings, acoustic flush plasterboard ceilings, metallic and acoustic ceiling tiles: Ceiling mounted Electrical accessories and/or luminaire fixtures installed on such ceilings, shall be provided with additional backing boards to fully transfer the weight of the accessory to the primary ceiling rail system.

Connections for fixed equipment: Provide concealed permanent connections.

Fixing: For equipment and appliances heavier than 5 kg, 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.

See also work section 0901 3.5 Support of Plant and Equipment.

3.8 TESTING**Site tests**

Inspection: Visually inspect the installation to AS/NZS 3000 before testing. Record on a checklist and submit to Superintendent on request.

Verification: Test and verify the installation to AS/NZS 3000 Section 8 using the methods outlined in AS/NZS 3017. Record the results of all tests.

Electricity networks: Test and verify the connections to electricity networks to AS 4741 and SA Power Networks Service & Installation Rules. Record the results of all tests, and include in O&M Manuals.

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 and appropriate resistive & inductive components to approximately simulate the expected power factor of the actual installation.

0942 SWITCHBOARDS – CUSTOM-BUILT**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide custom-built switchboards and distribution pillars, as documented.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0901 *Electrical systems.*
- 0921 *Low voltage power systems.*
- 0943 *Switchboard components.*

1.3 STANDARDS**General**

Standards: To AS/NZS 3000, AS/NZS 3439.1 or AS/NZS 61439.1.

1.4 INTERPRETATION**Abbreviations**

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

- TTA: Type-tested assemblies.
- NTTA: Non type-tested assemblies.
- PTTA: Partially type-tested assemblies.

Definitions

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

- Custom-built assemblies: Low voltage switchgear and controlgear assemblies manufactured to order and incorporating either purpose built or proprietary components or either purpose built or proprietary bus-bar assemblies.
- Fault current limiters: Circuit opening devices designed or selected to limit the instantaneous fault current.
- Incoming busbars: Busbars connecting incoming terminals to line side terminals of main switches.
- Main circuit supply busbars: Busbars connecting incoming functional unit terminals, or incoming busbars where no main switches are included, to outgoing functional unit terminals or outgoing functional unit tee-offs.
- Proprietary assemblies: Low voltage switchgear and controlgear assemblies available as a catalogue item, consisting of the manufacturer's standard layout and equipment. Minor modifications are permissible to accommodate equipment and accessories, whilst retaining standard format.
- Rated currents: 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.
- Tee-off busbars: Busbars connecting main busbars to incoming terminals of outgoing functional units.

1.5 SUBMISSIONS**Design documentation**

Calculations: Submit the following:

- Detailed certified calculations verifying design characteristics.
- Design calculations of non-type-tested and non-proprietary busbar assemblies.

Standard: To AS 60890.

Operation and maintenance manuals

Requirement: Submit operational and maintenance documentation necessary to operate and maintain the equipment and systems installed.

Products and materials

Type tests: Submit certificates for components, functional units and assemblies. Verify that type tests and internal arcing-fault tests, if any, were carried out at not less than the designated fault currents at rated operational voltage.

Alterations to TTAs: Submit records of alterations made to assemblies since the tests.

Switchboard product data: 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.

Shop drawings

General: Submit shop drawings showing:

- Types, model numbers and ratings of assemblies.
- Design calculations of non-type tested and non-proprietary busbar assemblies.
- Overall dimensions.
- Rated current of components.
- Number of poles and spare capacity.
- Mounting details.
- Paint colours and finishes.
- Access details.
- Schedule of labels.
- Component details, functional units and transient protection.
- Detailed dimensions.
- Shipping sections, general arrangement, plan view, front elevations and cross-section of each compartment.
- Projections from the assembly that may affect clearances or inadvertent operation, such as handles, knobs, arcing-fault venting flaps and withdrawable components.
- Fault level and rated short circuit capacity characteristics.
- IP rating.
- Fixing details for floor or wall mounting.
- Front and back equipment connections and top and bottom cable entries.
- Door swings.
- External and internal paint colours and paint systems.
- Quantity, brand name, type and rating of control and protection equipment.
- Construction and plinth details, ventilation openings, internal arcing-fault venting and gland plate details.
- Terminal block layouts and control circuit identification.
- Single line power and circuit diagrams for all new and modified switchboards.
- Details of mains and submain routes within assemblies.
- Busbar arrangements, links and supports, spacing between busbar phases and spacing between assemblies, the enclosure and other equipment and clearances to earthed metals.

- Dimensions of busbars and interconnecting cables in sufficient detail for calculations to be performed.
- Form of separation and details of shrouding of terminals.
- Labels and engraving schedules.

Tests

Standard: AS/NZS 3439.1 or AS/NZS 61439.1.

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: NTTAs: 2.5 kV r.m.s. for 15 s.

2 PRODUCTS

2.1 CUSTOM-BUILT SWITCHBOARD CONSTRUCTION**General**

Requirement: Provide custom-built switchboards as documented.

Minimum width of all switchboards shall be >700mm per section.

Switchboard manufacturer

General: Use only switchboard manufacturers employing experienced switchboard personnel with more than 5 years' experience in the design of switchboards.

Switchboard connection

Type: Front connected.

Enclosure

Default material: Metallic-coated sheet steel.

Separation

Default: Form 1.

Metering

Requirement: To *0921 Low voltage power systems*.

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: Minimum 30% spare poles for all boards.

Surge protection

General: Provide surge protection as documented.

Earthing

General: Make provision for connection of communication systems CET at switchboard earth bar to AS/CA S009.

IP rating

Default rating: IP52 minimum.

Weatherproof: IP56 minimum.

Equipment layout

General: Position equipment to provide safe and easy access for operation and maintenance. Group devices by function. Ensure appropriate clearances are allowed, as per AS/NZS 3000.

Connection: Front connected.

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.

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

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

Segregation

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

Supporting structure

Assemblies:

- Wall mounted: Maximum 2 m².
- Floor mounted: Greater than 2 m².

Ventilation

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

Enclosure materials

General: Fabricate from sheet metal of rigid folded and welded construction. Obtain approval for non-welded forms of construction.

Material: Metallic-coated sheet steel to AS 1397.

Material thickness:

- Diagonal dimension:
 - . < 900 mm: Minimum 1.6 mm.
 - . ≥ 900 mm: Minimum 2.0 mm.

Coating class:

- Indoor assemblies: Z200.
- Outdoor assemblies: Z450.
- Stainless steel construction: Refer to 'Materials and Components' section of General Requirements for stainless steel selection criteria.

Insect proofing

General: Cover ventilation openings with non-combustible and corrosion resistant 1 mm mesh.

Equipment mounting panels

General: To support the weight of mounted equipment.

Metallic panels: Construct from metal greater than or equal to 3 mm thick with heavy metal angle supports or plates bolted or welded to enclosure sides.

Non-metallic panels: Provide non-metallic to support the weight of the mounted equipment and design the mounting structure for stability and stiffness.

Non-metallic boards: To IEC 60893-1.

Equipment fixing

Spacing: Provide 50 mm minimum clearance between busbars for the following:

- Lifts, fire services and building emergency services.
- General installation services busbars.
- Equipment.

Mounting: Bolts, set screws fitted into tapped holes in metal mounting panels, studs or proprietary attachment clips. Provide accessible equipment fixings which allow equipment changes after assembly commissioning.

Installation: For lightweight equipment, provide combination rails and proprietary clips.

Earth continuity

General: Strip painted surfaces and coat with corrosion resistant material immediately before bolting to the earth bar. Provide serrated washers under bolt heads and nuts at painted, structural metal-to-metal joints.

Construction

Lifting provisions: For assemblies with shipping dimensions exceeding 1800 mm high x 600 mm wide, provide fixings in the supporting structure and removable attachments for lifting.

Supporting structure: Provide concealed fixings or brackets to allow mounting and fixing of assemblies in position without removing equipment.

Floor-mounting: Provide mild steel channel plinth, galvanized to class Z600, with toe-out profile, nominal 75 mm high x 40 mm wide x 6 mm thick, for mounting complete assemblies on site. Drill M12 clearance holes in assembly and channel and bolt assemblies to channel. Prime drilled holes with zinc rich organic primer to AS/NZS 3750.9.

2.2 CABLE ENTRIES

General

Requirement: Provide cable entry facilities within assembly cable zones for incoming and outgoing power and control cabling. Provide sufficient clear space within each enclosure next to cable entries to allow incoming and outgoing cables and wiring to be neatly run and terminated, without unnecessary bunching or sharp bends.

Cover and gland plates

Cover plates: Provide 150 mm maximum width cover plates butted together and covering the continuous cable entry slot.

Gland plates: Provide removable gland plates fitted with gaskets to maintain the degree of protection.

Materials: Conform to the following:

- Generally: 3mm Aluminium Gland Plates shall be provided to all switchboard cable entries.

Steel (ferrous metal) gland plates are not acceptable.

- All cable entries shall strictly comply with AS/NZS3000, Fire rated measures clause (currently Clause 2.9.7).
- Provide the minimum number of entry plates to leave spare capacity for 30% future cable entries.
- Do not run cables into the top of weatherproof assemblies. These shall be bottom entry only.
- Single core cables: Pass separately through propriety Plastic Glands and via the 3mm Aluminium cable gland plates. Provide Metal glands for Fire Rated cables. Do not provide ferrous metal saddles.
- For MIMS cables and cable glands: 6 mm thick brass.

2.3 BUS TRUNKING SYSTEM ENTRY

General

Requirement: Provide entry plates with close tolerance cut-out to accommodate busbars, fitted with a flange bolted and sealed to assembly enclosure to maintain assembly IP rating. Earth the busway enclosure to the assembly protective earth conductor. Fit busway flanges at assembly manufacturer's premises and retain for transportation.

2.4 DOORS AND COVERS

General

Requirement: Provide lockable doors with a circuit card holder unless enclosed in cupboards.

Door layout

Maximum width: 900 mm, and 600mm clearance, as per AS/NZS3000.

Minimum swing: At least 90°.

Door stays: Provide stays to outdoor assembly doors.

Adjacent doors: Space adjacent doors to allow both to open to 90° at the same time.

Door construction

Protection: Provide single right angle return on all sides and fit suitable resilient sealing rubber to provide the documented IP rating and prevent damage to paintwork.

Hinges: Provide the following:

- Generally: Corrosion-resistant pintle hinges or integrally constructed hinges to support doors.
- For removable doors: Staggered pin lengths to achieve progressive engagement as doors are fitted.
- For doors higher than 1000 mm: 3 hinges.
- For non lift-off doors: Restraining devices and opposed hinges.

Door hardware: Provide the following:

- Corrosion resistant lever-type handles, operating a latching system with latching bar and guides strong enough to withstand explosive force resulting from fault conditions within the assembly.
- Dual, edge mounted, corrosion resistant T handles with provision for key locking cylinder.
- Captive, corrosion resistant knurled thumb screws as an alternative to handles.

Locking: Incorporate cylinder locks in the latching system. 604 Key, 2 keys per assembly.

Door mounted equipment: Protect or shroud door mounted equipment and terminals to prevent inadvertent contact with live terminals, wiring, or both.

Earthing: Maintain earth continuity to door mounted indicating or control equipment with multi-stranded, flexible earth wire, or braid of equal cross-sectional area, bonded to the door.

Covers

Maximum dimensions: 900 mm wide and 1.2 m² surface area.

Fixing: Fix to frames with at least 4 fixings, using corrosion-resistant acorn nuts with serrated washers.

Rest cover edges on the cubicle body or on mullions. Do not provide interlocked covers.

Handles: Provide corrosion-resistant D type handles.

Escutcheons

General: For doors enclosing circuit breakers, provide escutcheon plates as barriers between operating mechanisms and live parts, hinged and removable.

Escutcheon plates and panels

General: Provide hinged plates or hinged removable covers with neat circuit breaker toggle cut-outs allowing interchangeability of 1, 2 and 3 pole circuit breakers. Provide corrosion-resistant lifting handles or knobs. Provide unused circuit breaker toggle cut-outs with blanking in-fill pole covers.

Maximum dimensions: 900 mm wide and 1.2 m² surface area.

Escutcheon panels without hinges will not be acceptable.

General: IPA Studs, shall be provided on circuit breaker escutcheon panels to denote the circuit designation identification. Plastic 'stickers' will not be acceptable.

Pole Fillers: rigid continuous type, covering the spare poles in one continuous section. Single pole 'domestic' type multi-pole fillers will not be accepted.

Anti-Condensation Heaters

External: Provide anti-condensation heaters to all externally mounted/installed electrical distribution boards and the like. Provide a minimum of 1 per switchboard cubical. Sizing to be calculated to a minimum of 20 W/m² of the total Height multiplied by Width of the enclosure.

Provide thermostatic control to anti-condensation heaters, initially set at 25° Celsius.

2.5 FACTORY FINISHES**General**

Standard: To AS 2700.

Extent: Apply protective coatings to internal and external metal surfaces of assembly cabinets including covers, except to stainless steel, galvanized, electroplated, or anodised surfaces and to ventilation mesh covers.

Finish coats: Thermoset powder coating to AS 4506 or two-pack liquid coating of AS/NZS 3750.13 primer and proprietary or epoxy acrylic full gloss spray finish.

Factory finish colours

Mounting structure (brackets): To match enclosure.

Enclosure - indoor: To Architects colour schedule, otherwise

Indoor assemblies: to match wall surface

- Otherwise: Indoor assemblies: Orange X15.

- Assembly interior: Gloss white.

Enclosure - outdoor:

To Architects colour schedule, otherwise

- Outdoor assemblies: Avocado green G34.
- Assembly interior: White Gloss.

Escutcheons - removable equipment panels:

- Internal assemblies: Gloss White.
- External assemblies: Off white Y35.

Doors: To match enclosure.

Plinths: Hot-dipped galvanised.

2.6 BUSBARS

General

Requirement: Provide main circuit supply busbars within assemblies, extending from incoming supply terminals to the line side of protective equipment for outgoing functional units and for future functional units.

Standards: To AS 60890.

Custom-built busbar construction

Material: Hard-drawn high-conductivity electrolytic tough pitched copper alloy bars, designation 110.

Temperature rise limits - active and neutral conductors:

- Maximum rated current temperature rise limits: $65 \pm 1.5^{\circ}\text{C}$ above ambient temperature by type test or calculation to AS 60890.
- Maximum short-circuit withstand current temperature rise limits: 160°C .

Cross section: Rectangular. Remove sharp edges of rectangular busbar by filing the edge or use radiused edges.

Supports: Sufficient to withstand thermal and magnetic stresses due to maximum prospective fault currents.

Support material: Non-hygroscopic insulation capable of holding busbars at 105°C .

Proprietary busbars

Type: Multi-pole proprietary insulated busbar assemblies or busbar systems, verified for short circuit capacity and temperature rise-limits by type tests.

Phase sequence

General: For main busbars and connections to switching devices, set-out phase sequence for phases A, B and C, from left-to-right, top-to-bottom and front-to-back when viewed from the front of the assembly.

Colour coding

General: Provide 25 mm minimum width colour bands permanently applied to busbars at 500 mm maximum intervals with at least one colour band for each busbar section within each compartment.

Active busbars: Red, white and blue respectively for the A, B and C phases.

Neutral busbar: Black.

MEN link: Green-yellow and black.

Protective earth busbar: Green-yellow.

Restrictions: Do not provide adhesive type colour bands.

Current carrying capacity

Active conductors: Take into account thermal stresses due to short circuit current, assuming magnetic material enclosures located indoors in well-ventilated rooms and 90°C final temperature.

Neutral conductors: Size to match incoming neutral conductor current carrying capacity.

Protective earth conductors: Size for at least 50% of the rated short circuit withstand current for 100% of the time duration.

Tee-off busbars current rating

For individual outgoing functional units: Equal to maximum frame size rating of the functional unit.

For multiple functional units: Equal to the diversity factors of AS/NZS 3439.1 or AS/NZS 61439.1, based on frame size rating.

MEN links

MEN links > 10 mm² in cross-section: Bolted removable busbar links stamped MEN LINK, located in the incoming compartment, between neutral and earth busbars.

Fault current limiters

General: Rate busbars connected to fault current limiters to 100% of the indicated fault current limiter circuit breaker frame size or fuse base rating.

Busbar links

General: For current transformers, provide removable busbar links less than or equal to 450 mm long.

Cable connection flags

General: Provide and support busbar flags for equipment with main terminals too small for cable lugs. Provide flags sized to suit cable lug termination, with current rating of at least the maximum equipment frame size.

Phase isolation: Provide phase isolation or barriers between flags where the minimum clearance distances phase-to-phase and phase-to-earth are below the component terminal spacing.

Future extensions

General: Pre-drill the main circuit supply busbar for future extensions and extend busbar droppers into future functional unit locations.

Jointing

General: Use multiple bolted joints on all overlapping busbars with a minimum of two bolts per joint.

Type: High tensile steel bolts, washers and nuts, with lock nuts or spring washers. Do not use tapped holes and studs or the like for jointing current carrying sections.

Custom-built busbar insulation

Active and neutral busbars and joints: Select from the following:

- Polyethylene: At least 0.4 µm thick with dielectric strength of 2.5 kV r.m.s for 1 minute, applied by a fluidised bed process in which the material is phase coloured and directly cured onto the bars.
- Close fitting busbar insulation mouldings at least 1 mm thick.
- Heat shrink material: Only on rounded edge busbars.

Taped joints: Apply non-adhesive stop-off type tape, coloured to match adjacent insulation and half lapped to achieve a thickness at least that of the solid insulation to the manufacturer's instructions.

Damaged insulation: Replace/repair damaged insulation before energising.

2.7 NEUTRAL LINKS AND EARTH BARS

Terminals

General: Provide terminals for future circuits. 2 screw cable tunnel per circuit.

Earth bar: Provide dedicated earth bar for all RCD units

Links

Assembly capacity > 36 poles: Provide neutral links and earth bars at the top and bottom of the circuit breaker section.

Assembly capacity ≤ 36 poles: Provide links and bars at the point of entry of incoming supply cables.

Mounting: Mount neutral links on an insulated base.

Control circuits: Provide separate neutral links and earth bars.

Labels: Provide labels for neutral and earth terminals.

Cables > 10 mm²: Provide bolts or studs.

Communications earth: Make provision for connection of communications systems earth at switchboard earth bar to AS/CA S009.

2.8 INTERNAL WIRING

Wiring

Cable type: 0.6/1 kV copper cables. Provide V-90HT insulation where directly connected to active and neutral busbars.

Cable interconnections

General: For the main circuit supply, provide cable interconnections as follows:

- ≥ 1.5 mm² internal cables, with minimum V75 insulation rating with stranded copper conductors rated to AS/NZS 3008.1.1. Provide cables with current ratings suitable for the internal assembly ambient air temperature and for temperature rise limits of equipment within the assembly.
- Run cables clear of busbars and metal edges.
- Provide cables capable of withstanding maximum thermal and magnetic stresses associated with relevant fault level and duration.
- Run cables neatly. Provide slotted trunking sized for future cables or tie at 150 mm maximum intervals with ties strong enough to withstand magnetic stresses created at the specified fault current. Do not provide adhesive supports.
- Provide for installation of wiring for future equipment without removal of existing equipment.
- Identify power and control cables at both ends with neat fitting ring type ferrules agreeing with record circuit diagrams.
- Terminate control cables and motor control circuits in tunnel terminals or, if necessary, provide suitable palm type lugs and correct crimp tool.
- For equipment mounted on hinged doors run cables on the hinge side to avoid restricting the door opening. Bundle cables with spiral wrap PVC or split conduit and secure to door.
- If recommended by device manufacturers, provide shielded wiring.

Link of adjacent circuit breakers: Not permitted.

Cables > 6 mm²

Terminations:

- Tunnel terminals: Single cables.

- Other connection points or terminals: ≤ 2 cables.

Doors: Do not run cables to hinged doors or removable panels.

Supports:

- Spacing at enclosure: ≤ 200 mm from a termination.
- Spacing generally: ≤ 400 mm.
- Strength: Capable of withstanding forces exerted during fault conditions.

Single core cables rated ≥ 300 A: Do not provide ferrous type metal cable saddles.

Terminals marking: Terminate marked cables for connection to external controls in correspondingly marked terminals within the assembly.

Control and indication circuits

General: Provide conductors sized to suit the current carrying capacity of the particular circuit.

Minimum size: 1 mm^2 with 32/0.2 stranding.

Cable colours

General: Colour code wiring as follows:

- A phase: Red.
- B phase: White.
- C phase: Blue.
- Neutral: Black.
- Earthing: Green-yellow.

2.9 TERMINATIONS

Submains, light and power circuits

General: Connect direct to the control equipment terminals.

Shipping breaks: Provide terminal blocks for interconnecting wiring on each side of shipping breaks.

3 EXECUTION

3.1 ASSEMBLY INSTALLATION

Location

All external Switchboard's shall be provided with full weather protection to enable 24/7 maintenance access at all times. Switchboards shall have covering to a minimum of 1000mm past the open door of the front of the switchboard and typically 500mm to each other side of the switchboard.

Emergency Lighting

Install an AS2293 compliant emergency lighting luminaire in of the front of the board to provide adequate lighting in emergency conditions

Fixing

General: Before making inter-panel connections, fix assemblies and metering equipment enclosures into position, level and plumb. Ensure adequate seismic bracing to AS1170.4.

3.2 ASSEMBLY ENTRIES

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 A: Pass separately through non-ferrous gland plates. Do not use ferrous metal saddles.

Cable enclosures

General: 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

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

Bus trunking system entry

General: Provide entry plates with close tolerance cut-out to accommodate busbars, fitted with a flange bolted and sealed to assembly enclosure to maintain assembly IP rating. Earth the busway enclosure to the assembly protective earth conductor. Fit busway flanges at assembly manufacturer's premises and retain for transportation.

3.3 MARKING AND LABELLING**General**

Switchboard assembly: Label in conformance with AS/NZS 3439.1 or AS/NZS 61439.1 including the following:

- Size and type of all incoming and outgoing mains and submains, including protection settings.
- Emergency operating procedures.
- Sub-circuits: with IPA studs, colour to match phase, number to match circuit. Plastic 'stickers' will not be acceptable.
- Refer also to Legend Card requirements in 0943 work section

3.4 MAINTENANCE**General**

Standard: To AS 2467.

Requirement: Carry out the following:

- 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.

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:

- 0901 *Electrical systems*.
- 0942 *Switchboards – custom-built*.

1.4 INTERPRETATION**Abbreviations**

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

- MSB: Main switchboard
- SPD: Surge protection device.

1.5 SUBMISSIONS**Operation and maintenance manuals**

Requirement: Submit all operational and maintenance documentation necessary to operate and maintain the equipment and systems installed.

Products and materials

Requirement: Submit manufacturer's technical data for all components.

2 PRODUCTS**2.1 REQUIREMENTS****General**

Selection: To AS/NZS 3000 clause 1.7 and Section 2.

Rated duty: Uninterrupted.

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

Utilization category: To AS/NZS IEC 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/NZS IEC 60947.1 and AS/NZS IEC 60947.3.

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 IEC 60947.3 Table 3.

Rated short-time withstand current: As defined in AS/NZS IEC 60947.1 clause 4.3.6.1 and the manufacturer's recommendation for the prospective fault current conditions.

Rated short-circuit making capacity: As defined in AS/NZS IEC 60947.1 clause 4.3.6.2, to conform to the manufacturer's recommendation for the prospective fault current conditions.

Rated short-circuit breaking capacity: To AS/NZS IEC 60947.1 clause 4.3.6.3 and the manufacturer's recommendation for the prospective fault current conditions.

Load make/load break switch-isolators

Rated making and breaking capacity: As defined in AS/NZS IEC 60947.1 clause 4.3.5 to conform to AS/NZS IEC 60947.3 Table 3 and the manufacturer's recommendations for the prospective fault current conditions.

Rated short-time withstand current: As defined in AS/NZS IEC 60947.1 clause 4.3.5, to conform to the manufacturer's recommendation for the current conditions.

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 MOULDED CASE AND MINIATURE CIRCUIT BREAKERS

General

Moulded case breakers: To AS/NZS IEC 60947.1 and AS/NZS IEC 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.

Current limiting: Moulded case breakers 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.

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.

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.

General

Low voltage service protective devices: To AS/NZS 3000, the electricity distributor's requirements and the Service and Installation Rules.

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.

2.5 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/NZS IEC 60947.2.

- RCD protection for patient treatment areas to be installed in the field, not in the switchboard. Sub-circuits to be mechanically protected using galvanised metal conduit.
- General power & lighting circuits, including three-phase socket outlet circuits: Type II.
 - . Default tripping current: 30 mA.

2.6 FUSES WITH ENCLOSED FUSE LINKS

General

Standards: To IEC 60269-1 and IEC 60269-2.

Fuses with fuse links for the protection of semiconductor devices: To IEC 60269-4.

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.

Protection of final subcircuits

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

Maximum discharge current (I_{\max}): 20 kA (8/20 μ s) phase to neutral and 10 kA neutral to earth.

Voltage protection level (U_p): < 600 V at 3 kA and < 700 V at 500 A.

Visual indicator: Provide visual indication of SPD status.

Maximum continuous operating voltage (U_c): 340 V a.c.

Enclosure and installation: House SPD in electrical switchboard or panel.

Enclosure mounting: DIN rail mounted.

2.7 CURRENT TRANSFORMERS (PROTECTION)

General

Standard: To AS 60044.1 class 10P.

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 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.

2.8 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}) per phase to neutral: ≥ 150 kA.

Surge rating (I_{\max}) neutral to earth if remote from the MEN earthing system: ≥ 100 kA.

Residual voltage: < 800 V at 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 protect with a suitable rated circuit breaker or 63A HRC fuse.

Type II SPD

Surge rating (I_{\max}) per phase to neutral: ≥ 100 kA.

Surge rating (I_{\max}) neutral to earth if remote from the MEN earthing system: ≥ 100 kA.

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

Residual voltage: < 800 V at 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 protect 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.

NOTE: All Data and communications cabinets shall be provided with Secondary Surge Protection.

Type III SPD

Surge rating (I_{\max}) per phase to neutral: ≥ 50 kA.

Surge rating (I_{\max}) neutral to earth: ≥ 20 kA.

Residual voltage: < 800 V at 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 protect with a suitable rated circuit breaker or 32A HRC fuse. Connecting lead lengths should not exceed 300 mm.

Combined primary and secondary surge reduction filter protection

General: Provide series connected surge reduction 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}) per phase to neutral primary protection: ≥ 100 kA.

Surge rating (I_{\max}) neutral to earth if remote from the MEN earthing system: ≥ 100 kA.

Residual voltage: < 600 V at 20 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.

Protection of final subcircuits

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

Operating voltage (U_n): 220 – 240V at 50 Hz.

Maximum discharge current (I_{\max}): 20 kA (8/20 μ s) phase to neutral and 10 kA neutral to earth.

Voltage protection level (U_p): < 600 V at 3 kA and < 700 V at 500 A.

Visual indicator: Provide visual indication of SPD status.

Maximum continuous operating voltage (U_c): 340 V a.c.

Enclosure and installation: House SPD in electrical switchboard or panel and protect with a suitable rated circuit breaker equal to or less than the load current rating of the SPD.

Enclosure mounting: DIN rail mounted.

2.9 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 0.4 Ω (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.

2.10 CONTACTORS**General**

Standard: To AS/NZS IEC 60947.4.1.

Type: Enclosed, block type, air break, electromagnetic.

Poles: 3.

Rated operational current: The greater of:

- Full load current of the load controlled.
- ≥ 16 A.

Mechanical durability: 10 million cycles to AS/NZS IEC 60947.4.1.

Electric durability: ≥ 1 million operations at AC-22 to AS/NZS IEC 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.

NOTE: Contactors shall be failsafe to on (may need to be Normally Closed, where used for General Lighting and Power provisions), so that in the event of failure of the contactor or its coil, the facility remains functional.

2.11 CONTROL DEVICES AND SWITCHING ELEMENTS

Time switches

Type: 7 day fully programmable with holiday override function. The override switch must be accessible without the use of a tool or a key and have "Off – Auto – On" facility.

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/NZS IEC 60947.5.1.

Requirement: Provide heavy duty fixed mounted type 3 relays.

Operation: Suitable for continuous operation.

Construction: Plug-in types. Receptacle bases with captive clips which can be operated without using tools.

Type: Modular block.

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	1.25IL	Yes	2
2	10	Plug-in	5 A at 240 V	Yes	2
3	10	Fixed mounting	5 A at 240 V	Yes	4

Time delay relays

Adjustable range: Adjustable over the full timing range with timing repeatability within $\pm 12.5\%$ of nominal setting.

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

Synchronous relays

General: Provide synchronous motor drive type relay fitted with anti-stalling device which protects gearing during normal operation.

Phase failure relays

General: Provide separate solid-state phase failure relays conforming to the following:

- Detect less than 85% of normal voltage.
- Detect single phase failure.
- Detect reverse phase sequence after an appropriate time delay.
- Automatic reset on detection of normal power supply.

Sensing circuit: To reject induced voltage spikes and disturbances with frequencies other than 50 Hz.

Back-up protection: Provide high rupturing capacity fuses to each phase.

2.12 ANTI-CONDENSATION HEATERS**General**

Anti-condensation heaters shall be provided to all external switchboards, except in Domestic installations.

Rating: Provide heaters rated at not less than 20 W/m² of total external area including top of weatherproof enclosure.

Type: Black heat type with surface temperature less than or equal to 50°C, mechanically protected and thermostatically controlled.

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

Requirement: 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.

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 A4 size, with printed 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 holders firmly fixed to the inside of the assembly or cupboard door, next to the distribution circuit switches, stick on type, not acceptable. One schedule card per holder. Protect with hard plastic transparent covers.

Single-line diagrams

Main switchboards and distribution switchboard assemblies: Provide single-line diagrams wall mounted adjacent to all Main Switchboards and Main Distribution Switchboards.

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

Mounting: Enclose in a non-reflective 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.

3.2 MAINTENANCE**General**

Standard: To AS 2467.

0951 LIGHTING

1 GENERAL**1.1 RESPONSIBILITIES****General**

Requirement: Provide lighting and control systems, as documented.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0901 *Electrical systems.*
- 0911 *Cable support and duct systems.*
- 0921 *Low voltage power systems.*
- 0943 *Switchboard components.*

1.3 STANDARDS**General**

AS/NZS 1680.0: Interior lighting - Safe movement

AS/NZS 1680.1: Interior and workplace lighting - General principles and recommendations

AS/NZS 1680.2.1: Interior and workplace lighting - Specific applications - Circulation spaces and other general areas

AS/NZS 1680.2.2: Interior and workplace lighting - Specific applications - Office and screen-based tasks

AS 1680.3 Interior lighting - Measurement, calculation and presentation of photometric data

AS/NZS 1680.4: Interior lighting - Maintenance of electric lighting systems

EMC compliance: To AS/NZS CISPR 15.

Fixed general purpose luminaires: To AS/NZS 60598.2.1.

Luminaires, general requirements and tests: To AS/NZS 60598.1.

Luminaires: To AS/NZS 60598.1.

Recessed luminaires: To AS/NZS 60598.2.2.

Radio interference limits: To AS/NZS CISPR 15.

Minimum energy performance standards (MEPS)

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

1.4 INTERPRETATION**Abbreviations**

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

- CCT: Correlated colour temperature.
- CRI: Colour rendering index.
- EEI: Energy efficiency index.

- EMC: Electromagnetic compatibility.
- LED: Light-emitting diode.
- PIR: Passive infra-red.
- RCD: Residual current device.

Definitions

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

- Control system (lighting): A lighting control system comprising a combination of some or all of the following:
 - . Automatic sensing and control components.
 - . Timers.
 - . Manual overrides.
- Proprietary luminaires: Luminaires available as a catalogue item.

1.5 SUBMISSIONS**Operation and maintenance manuals**

Requirement: Submit operational and maintenance documentation necessary to operate and maintain the equipment and systems installed.

Products and materials

Lighting: Submit technical data on the following:

- Luminaires.
- Drivers.
- Lighting control systems.
- All accessories.

Type test: Submit photometric test results from a registered testing authority as evidence of luminous efficacy for the applicable CCT for the following:

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

Samples

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

2 PRODUCTS**2.1 PROPRIETARY LUMINAIRES****General**

Requirement: All Luminaires shall be LED type, except where documented otherwise. The installation shall be designed by a qualified Lighting Engineer, with luminaires locally sourced from a reputable supplier whom typically carries local stock of selected luminaires. 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.

Colour Temperature: Typically to be 4000 K.

Colour rendering: for all internal areas (unless industrial storage type areas) shall not be less than CRI 80

Terminal blocks

- All luminaires: Large terminal blocks, suitable for 3 X 2.5mm² conductors shall be provided in all luminaires

2.2 LIGHT-EMITTING DIODES (LEDS) LUMINAIRES

General

Requirement: 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 > 80 lumens per watt.

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

Colour: CRI > 80.

CCT: Typically 4000K.

2.3 CONTROL GEAR ENCLOSURE

General

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

Gear tray cover: (For luminaire types with changeable lamp, only) Provide a propriety screw fixed gear tray cover to cover all internal control gear and associated wiring, to allow safe servicing of lamps/tubes for maintenance purposes by non-licensed workers (as, lamp replacement service organisations and the like).

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.

2.4 WIRING

External flexible cords

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

- Length: ≥ 1.5 m.
- Cross sectional area: 0.75 mm².
- 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: ≥ 1 mm².

2.5 LIGHTING CONTROL

General

Requirement: Provide the following as documented:

- Lighting switches.
- Dimmers.

Dimming

- Dimming of LED luminaires shall be strictly in accordance to the luminaire and control gear manufacturers requirements (eg,) comply with Master/Slave interconnecting syncing of control gear assemblies, where multiple luminaires are connected for 1-10V or potentiometer control/dimming, or Touch/Push dimming (also typically called 2-wire or Push dimming), interconnecting cabling methodology (along with propriety cabling/connectors etc.) shall be as Master/Slave syncing interconnection.
- Where basic dimmer mechanisms are provided, they shall be set to offer flicker free dimming, with dimming range from no less than 10% to 100%. Mechanisms shall have a definite "OFF" position, or be provided with a separate switch mechanism.

2.6 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. Electrical contractor shall lead this coordination, and the primary Construction Contractor shall facilitate all other trades to follow this direction/requirement.

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.

Type: Unbreakable polycarbonate rocker.

Colour: White.

Minimum: 15 A, 230 V a.c.

Provide mechanism retaining screws (typically as Clipsal 30J or equivalent) for all light switch and associated mechanisms.

Lighting circuit switches: 15 A, 230V a.c. to suit circuit load.

External switches: Industrial type, rated IP56.

Dimmer switches

General: Provide integral dimmer/switch units as documented.

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.

Where typical security and amenity external lighting is provided to a facility, the lighting shall be configured that it will automatically shut down in daylight hours.

An appropriately labelled override/test switch shall be fitted externally to the originating switchboard, and be accessible without opening the switchboard or its escutcheon panel.

All external lighting circuits also incorporate a 7 day analogue time clock connected in series with the Daylight sensor control system, set in the full bypass mode at Practical Completion, to allow the Client Agency to simply program "to off" exterior lighting, should the need arise.

Motion detector switches

General: Provide motion detection sensors which cover designated areas as documented. Detection devices are to be located and adjusted, so that they are not subject to unnecessarily false tripping from a person walking past in a corridor, without entering the room.

Timer: Incorporate ON timers adjustable between 1 and 120 minutes, typically set at 20 minutes.

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 infrared (PIR) or microwave (MW), as documented.

3 EXECUTION

3.1 SUPPORTS

General

Requirement: Install luminaires on proprietary supports by means of battens, trims, noggings, roses and packing material. See also Support of Plant and Equipment section in work section 0901 Electrical Systems.

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 100 mm wide: A single fixing at each end in conjunction with 1.6 mm backing plates may be used. In vandalism-prone locations, provide minimum 4 fixings in any case.
- Provide battens and support for the fitting.
- Do not direct fix into plasterboard or ceiling tile. See Support of Plant and Equipment section in work section 0901 Electrical Systems.

Recessed luminaires

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

T-bar ceilings luminaires. Inside T-bar type luminaires shall be used. In general, the top of T-bar type luminaires are not accepted, as lumen depreciation is compromised.

Any ceiling-mounted equipment such as down-light fittings, emergency lights, security sensors, speakers, recessed luminaires, smoke detectors and wireless access points, must meet the

installation requirements of the ceiling tile manufacturer. Generally, light-weight fibrous ceiling tiles are not warranted to support any accessories mounted into them without additional support.

As a minimum:

- Items up to 1000grams, shall be fixed through the ceiling tile to a sheet of 13mm plasterboard or 6mm ply-wood, glue laminated to the ceiling tile, spanning the full width of the tile, back to the primary ceiling rails.
- For heavier items the above shall apply, and shall be supported from the soffit or structural members above.
- Items heavier than 5000 grams, the Contractor is to seek advice from a qualified Structural Engineer to determine the appropriate mounting methods.

Seismic

Provide seismic restraint safety wires attached to comply with AS1170.4 part 8 to all luminaires.

Standard: To AS1170

3.2 WIRING CONNECTION

Recessed luminaires

General: Connect recessed luminaires to a plug socket outlet.

Remote Control Gear: must not sit solely on top of a T-Bar ceiling tile, instead shall be firmly attached to the luminaire or the nearby ceiling support system.

3.3 ACCESSORIES

Installation

General: Install accessories and conceal cabling to *0921 Low voltage power systems*.

3.4 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.
- Clean luminaires

4 SELECTIONS

4.1 ALTERNATIVES

Alternative selections: All tenders submitted must be based on the selections below or as shown on drawings, with alternatives for other selections to be priced separately. All submissions for alternatives must be supported by a full redesign at the Contractor's own cost, and submitted for review to the Superintendent's approval, prior to purchase and installation. Details to be submitted include, but not necessary limited to:

- Features and benefits of the alternative product over the specified product.
- Full & detailed costing of material/labour costs for the alternative & assumptions made.
- Revised lighting layout drawings.
- Engineering calculations, demonstrating compliance to all relevant Australian Standards, BCA regulations and any other applicable requirements.
- Electronic copies of the revised lighting calculations in the native format of the lighting software, programs for lighting design include AGI32, Dialux and Relux.
- Details of who performed the redesign.

- Details of supplier, including worldwide/local presence, warranties & support, past projects.

Unapproved alternatives found to be installed shall be removed at the Contractors cost and the nominated product(s)/equipment shall be installed. Making good of adjacent surfaces shall be at the offending contractor's expense.

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

Requirement: Provide single point monitored emergency lighting (non-maintained) and exit signs (maintained), as documented.

Use only LED and Li Ion batteries, unless documented to match existing fittings.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0901 *Electrical systems*.
- 0921 *Low voltage power systems*.

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**Operation and maintenance manual**

Standard: To AS 2293.1, Section 8.

Requirement: Provide all operational and maintenance documentation necessary to operate and maintain the systems installed.

Products and materials

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.

Samples

Emergency evacuation lighting: 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.

Tests

General: Submit type test data.

2 PRODUCTS

2.1 SINGLE-POINT SYSTEM LUMINAIRES

General

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

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: Li Ion batteries 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.

Warranty: 5 years

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 labelled 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.

Sensing of Supply Failure

Type: final sub-circuit sensing shall be provided. Individual phase sensing alone is not acceptable. Maintain compliance to AS 2293.1 where Discharge type lighting is installed, and in particular to the Clause(s) relating to "*Normal lighting requiring cool-down*".

3.2 INSTALLATION

As per requirements AS 2293.1, National Construction Code and of Support of Plant and Equipment section of 0901 Electrical Systems work section.

Remote Control Gear or battery packs: must not sit solely on top of a ceiling tile, instead be firmly attached to the ceiling grid supports.

3.3 MARKING AND LABELLING

Labelling

General: Label each luminaire with a unique identifying number. Provide a label which is permanently fixed, indelible and readable from a standing position at Ground level. Handwritten text is not acceptable..

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

If applicable, update existing maintenance manual, drawings and the Site Emergency Lighting Log Book / register on all existing sites, when and where Emergency lighting systems are being altered, repaired, and/or installed.

3.4 TESTS

General

Requirement: 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, 120 minutes for new fittings, as per AS 2293.1, and control test switch functions, including discharge and restoration.
- Demonstrate system functions under mains fail and local sub-circuit trip condition.
- Demonstrate system functions and re-sets under RCD tripping condition
- Demonstrate compliance to AS 2293.1 where Discharge type lighting is installed, with reference to the Clause(s) relating to "*Normal lighting requiring cool-down*".
- 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.

Maintenance during Defects Liability Period

Carry out all procedures within 1 week prior to the date of Practical Completion and again before the end of the Defects Liability Period stated in the *General requirements* worksection.

Record test results in logbook and locate in maintenance manual.

0972 FIRE DETECTION AND ALARMS**1 GENERAL****1.1 RESPONSIBILITIES****General**

Requirement: Provide fire detection and alarm systems, as documented.

1.2 SYSTEM**General**

System type: Addressable.

Interface: Emergency warning and intercommunications system.

1.3 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0901 *Electrical systems.*
- 0911 *Cable support and duct systems.*
- 0921 *Low voltage power systems.*

1.4 STANDARDS**General**

Standard: To AS 1670.1, AS 1670.5, AS 4428.1, AS 4428.16, AS 7240.2 and AS 7240.13.

1.5 INTERPRETATIONS**Abbreviations**

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

- DSEP: Designated site entry point.
- FDCIE: Fire detection control and indicating equipment.
- VWD: Visual warning device.

1.6 SUBMISSIONS**Operation and maintenance manuals**

Standard: To AS 4428.4 Section 3 and AS 1670.1.

Requirement: Submit all documentation necessary to operate and maintain the systems installed.
Include the baseline data to AS 1670.1 clause 1.7.2.

Products and materials

Requirement: Submit product data for the following:

- Fire indicating panel.
- Detectors.
- Audio visual alarm.
- Occupant warning speakers

Samples

Requirement: Submit samples of the following:

- Detectors.
- Manual call points.

- Audio visual alarm.
- Occupant warning speakers

Shop drawings

General: Submit shop drawings to a scale that best describes the detail, showing the following:

- Fire detector layout.
- Dimensions and details of control and indicating equipment.
- Location of system components.
- Circuit identification.
- Labelling details.

2 PRODUCTS

2.1 AUTHORISED PRODUCTS**General**

Equipment: Provide equipment listed in the ActivFire Register of Fire Protection Equipment.

2.2 CONTROL AND INDICATING EQUIPMENT**Standards**

General: To AS 7240.2.

Alarm investigation facility (AIF): To AS 4428.10.

Alarm signalling equipment: To AS 4428.6.

Power supply units: To AS 4428.5.

Fire brigade panel: To AS 4428.3.

Routing equipment: To AS 7240.21.

Fire brigade panel

General: Provide metal cubicle-type enclosures at the DSEP, to AS 1670.1.

Fire detection control and indicating equipment (FDCIE)

General: Provide metal cubicle-type enclosures.

Isolation

Isolating facilities: Provide on FDCIE to allow testing without the transmission of alarm signals to the fire brigade.

Capacity

Spare zones: 50% minimum.

2.3 DETECTORS**Type**

Areas generally: Optical beam smoke detectors. Ionisation type detectors not accepted.

Power supply: From the fire indicator panel battery power supply.

Standards

Smoke alarms: To BCA Spec E2.2a.

Heat detectors: To AS 7240.5.

Point type smoke detectors: To AS 7240.7 and AS 1603.2.

Optical beam smoke detectors: To AS 1603.7.

Visual warning devices: To AS 1603.11.

Self-indicating detectors

General: Provide a light emitting diode mounted in a clearly visible position, which illuminates whenever detector operation causes an alarm condition to register on the FDCIE. Provide self-indicating devices which, if faulty, will not render the detector inoperative under fire conditions.

Mounting positions of light emitting diodes: Conform to the following:

- Visible detectors: On the outside of the detector or its base.
- Detectors concealed above ceilings: On the underside of the ceiling immediately below the detector.
- Detectors in other concealed spaces: On a visible panel close to the entry to the concealed space housing the detector.
- Remote indicators: To AS 1603.15.

2.4 EXTERNAL ALARM INDICATION

General

Requirement: Provide red flashing VWD strobe to AS 1670.1 clause 3.8.

Standards

Bell circuits: To AS 4428.1.

Strobe lights: To AS 1603.11.

Power supply

To the strobe light and not more than 2 others: From the fire detection control and indicating equipment battery power supply.

To additional strobe lights: From the mains supply. Provide appropriate interface relays, operated by the fire detection control and indicating equipment.

2.5 WARNING SYSTEM

General

Occupant warning system: To AS 1670.1 Section 3.22.

2.6 POWER SUPPLY

General

Surge protection: Make sure that normal operation is maintained and that voltage surges in the power source do not damage the control and indicating equipment.

Sealed batteries: Cycle the batteries before practical completion so that greater than or equal to 100% of nominal capacity is available at practical completion.

2.7 SURGE PROTECTION DEVICES (SPD)

General

Requirement: Provide all mode metal oxide varistor based series connected SPD to protect equipment in racks and cabinets, as documented.

Standard: To AS 4262.1 and AS 4262.2.

Surge rating (I_{max}): ≥ 20 kA (8/20 μ s) phase to neutral and 10 kA neutral to earth.

Voltage protection level (U_p):

- < 600 V at 3 kA.
- 700 V at 500 A.

Visual indicator: Provide visual indication of SPD status.

Enclosure and installation: House SPD in an electrical switchboard or panel and protect with a suitable rated circuit breaker equal to or less than the load current rating of the SPD.

3 EXECUTION

3.1 FIRE ALARM MONITORING

General

Standard: To AS 7240.21.

Connection: Connect the installation to a monitoring service provider. Connect using telecommunications fixed wire carrier lines.

Cable rating: Minimum rating WS51W to AS/NZS 3013 for wiring between the alarm signal equipment and the telecommunication carriage service provider's point of connection.

3.2 DETECTORS

Installation

General: Install detectors so they can be easily inspected and tested in situ, and readily withdrawn from service.

Ceiling mounting: As per requirements of Support of Plant and Equipment section of 0901 Electrical Systems work section.

3.3 INSTALLATION WIRING

General

Standard: To AS 1670.1 Section 3.24.

3.4 TESTING

General

Tests: Test the automatic fire detection system, including out-of-hours tests, to demonstrate performance to AS 1670.1 Appendix J and conformance to the relevant parts of the AS 1603 series. Include the following:

- Test components for correct function and operation.
- Demonstrate detection and alarm performance on site, to at least the level stated in the manufacturer's performance specification for that device.
- Test alarm zone identification.
- Demonstrate air sampling system operation for 14 days with data logger to verify stability of detectors and devices.
- Demonstrate addressable device operation for 14 days with data logger to verify stability of detectors and devices.
- Test interface to interconnected systems.
- Demonstrate correct shutdown sequences during fire mode.
- In situ testers: To AS 1603.16.

3.5 MAINTENANCE

Routine service process and procedures

Requirements: To AS 1851 Section 6.

Baseline data

Requirement: Provide baseline data to AS 1851 clause 1.8.

0991 ELECTRICAL MAINTENANCE

1 GENERAL

1.1 RESPONSIBILITIES**General**

Requirement: Maintain the electrical systems for the documented maintenance period so that the performance, reliability, service life, energy efficiency and safety of the system is equal to or better than that at the beginning of the maintenance period, in parallel with and including:

- Periodic and statutory maintenance, cleaning and replacement of consumables.
- Emergency repairs.
- Condition reporting.

Maintenance period: As documented.

1.2 CROSS REFERENCES**General**

Requirement: Conform to the following:

- 0901 *Electrical systems.*
- 0911 *Cable support and duct systems.*
- 0921 *Low voltage power systems.*
- 0942 *Switchboards – custom-built.*
- 0951 *Lighting.*
- 0971 *Emergency evacuation lighting.*
- 0972 *Fire detection and alarms.*

1.3 STANDARD**General**

Electrical services: To AS/NZS 3000.

Maintenance required

The maintenance program shall meet all of the requirements from:

- 1) the equipment manufacturers
- 2) applicable Australian Standards
- 3) applicable WHS & supply authority regulations

1.4 INTERPRETATION**Definitions**

General: For the purpose of this worksection the following definition applies:

- Consumable: Materials or components intended to be replaced within the service life of the associated plant or equipment.
- Periodic maintenance: Planned routine maintenance of plant and equipment (proactive), including fire safety measures and statutory requirements.
- Repairs: Unplanned/corrective maintenance (reactive).
- Replace/replacement: Replacement of components on a regular cycle on a like for like basis, e.g. repainting, replacement of air conditioning plant.

1.5 SUBMISSIONS

Certification

Annual certification: Inspect and submit certification for all items required to be inspected annually under statutory requirements including, but not limited to, fire detection and emergency evacuation lighting.

Records

Periodic maintenance and performance report: At the frequency documented, submit reports 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 periodic maintenance. Exclude travelling time.
- Dates, number of site labour hours and nature of work for emergency repairs. 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.

1.6 INSPECTION

Notice

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

2 PRODUCTS ---

2.1 GENERAL

Product selection

Proprietary items: Select products, as consumables or 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.

3 EXECUTION ---

3.1 EMERGENCY REPAIRS

General

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

Remedial work: Carry out any remedial work, including temporary work, necessary to restore each system to safe and satisfactory operation. Verify each system is operating correctly before leaving the site. Do not leave the plant in an unsafe condition.

Temporary work: Promptly replace temporary work with permanent rectification.

Contact details

General: Provide contact details including mobile phone numbers for normal working hours and emergency call outs.

Response time

Emergency repair: Attend site for emergency service within the documented response time.

Response period: Starts at the time of notification to the contractor's nominated contact point.

3.2 PERIODIC MAINTENANCE**General**

Routine visits: Make routine service visits at the frequency documented. Service items of equipment in conformance with the maintenance schedules in the operation and maintenance manuals.

Notification of defects: When defects in the installation are identified, give notice.

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

- Attend to reported defects and complaints.
- Check for and repair corrosion.
- 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.

Cleaning

Requirement: At the end of the maintenance period:

- Remove waste and clean all parts of the installation.
- Remove temporary protective coatings, packaging and labels.
- Clean interior of switchboards, switchgear, contactors and other electrical contacts to remove dust and foreign matter.

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

Electrical systems

Requirement: Perform the following:

- 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 conformance 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

Requirement: 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 Section 6.

Baseline data: Provide baseline data to AS 1851.

3.3 END OF MAINTENANCE PERIOD SERVICE**General**

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

3.4 COMPLETION**Maintenance records**

Service records: Record maintenance undertaken in the schedules in the operation and maintenance manuals.

Maintenance reports: Prepare maintenance reports as documented.

General: Submit, in binders which match the manuals, loose leaf log book pages designed for recording completion activities including operational and maintenance procedures, materials used, test results, comments for future maintenance actions and notes covering the condition of the installation. Include completed log book pages recording the operational and maintenance activities performed up to the time of Final Completion.

Existing binders: Update all binders with the relevant information

Certificates: Include test and approval certificates.

Certification: On satisfactory Final Completion of the installation, submit certificates stating that each installation is operating correctly.

Number of pages: The greater of 100 pages or enough pages for the maintenance period and a further 12 months.

Referenced documents: If referenced documents or technical worksection s require that log books or records be submitted, include this material in the maintenance records.

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.

Restitution after maintenance tasks

Requirement: Restore removed, damaged, contaminated or soiled services and building elements when the maintenance task is complete.

Standard: Equal to the condition of the original installation.

4 OPERATING AND MAINTENANCE MANUALS

4.1 SUBMISSION

General

Prior to Practical Completion submit for approval one (1) copy of the Operating and Maintenance Instructions. Following submission and approval of draft copies, prepare three (3) copies of the approved manual.

Folder format

The manuals shall be written in clear concise English, printed or typed on durable printing A4 size paper with each page consecutively numbered.

Folders shall be 3 ring, hardback binders complete with plastic covered label tags between sections.

Folder colour: White.

Title page layout

<p>The front cover to include the following wording:-</p> <ul style="list-style-type: none"> - PROPOSED COMMERCIAL DEVELOPMENT - 97 KING WILLIAM STREET, KENT TOWN - Electrical Services - Secon Consulting Engineers - "Company name of electrical contractor" 	<p>The spine to include the following wording:-</p> <ul style="list-style-type: none"> - PROPOSED COMMERCIAL DEVELOPMENT - 97 KING WILLIAM STREET, KENT TOWN - Electrical Services
--	---

Folder content

The content of the manuals shall include the following sections:-

Title Page

- Title page to include the following wording:
 - . "Project name"
 - . Operating and maintenance manual
 - . Electrical Services
 - . "Company name of electrical contractor"

Index/ table of contents

- Index / table of contents to display each section as listed below in numeric order.
 - . Section 1 – Introduction
 - . Section 2 – Maintenance

- . Section 3 – Accessories
- . Section 4 – Cabling, Conduits and Cable Supports
- . Section 5 – Lighting System
- . Section 6 – Switchboards
- . Section 7 – Telecommunications System (NBN)
- . Section 8 – Fire Detection and Alarm System
- . Section 9 – Certificates, Commissioning Reports and Test Results
- . Section 10 – As-Installed Drawings

Section 1 - Introduction

- General Description of the electrical services installed including:
 - . Scope of works
 - . Main Switchboard location and ampere rating
 - . Distribution board locations and ampere ratings
 - . Submain and earth conductor sizes and installation details
 - . Earthing system including equipotential bonding and communications earthing.
 - . Sub-circuit cable type, size and installation details
 - . Cable support system details.
- Contact details for the Builder, Electrical Consultant and Electrical Contractor including:
 - . Company name
 - . Company address
 - . Contact number (working hours)
 - . Contact number (after hours)
 - . 24hrs emergency contact number
 - . Company website address
 - . Electrical contractor warranty statement including date of practical completion.

Section 2 - Maintenance

- Recommended maintenance program (general, monthly, quarterly, annually and end of warranty).
- Schedule of inspection and preventative maintenance and repair instructions for each item of equipment.
- Schedule of lamps and accessory replacements including:
 - . Item designation symbol
 - . Make and model
 - . Description of item
- Safety in maintenance issues

Section 3 - Accessories

- Index/ table of contents.
- Schedule of technical data including:
 - . Manufacturer
 - . Product code
 - . Description of item
- Technical data sheets and all other relevant manufacturers' literature.

Section 4 – Cabling, Conduits and Cable Supports

- Index/ table of contents.
- Schedule of technical data including:
 - . Manufacturer
 - . Product code
 - . Description of item
- Technical data sheets and all other relevant manufacturers' literature.

Section 5 – Lighting System

- Index/ table of contents.
- Schedule of technical data including:
 - . Item designation symbol
 - . Manufacturer
 - . Product code
 - . Description of item
- Technical data sheets marked with the corresponding item designation symbol and displayed in alphabetical order.
- All other relevant manufacturers' literature.
- Lighting column shop drawings and certification documentation.

Section 6 – Switchboards

- Index/ table of contents.
- As-installed shop drawings.
- Typed sub-circuit legend for each switchboard installed.

Section 7 – Telecommunications System (NBN)

- Index/ table of contents.
- Schedule of technical data including:
 - . Manufacturer
 - . Product code
 - . Description of item
- Technical data sheets and all other relevant manufacturers' literature.
- As-installed drawings with NBN conduit routes.

Section 8 – Fire Detection and Alarm System

- Index/ table of contents.
- Schedule of technical data including:
 - . Manufacturer
 - . Product code
 - . Description of item
- Technical data sheets and all other relevant manufacturers' literature.
- Fire block plan.

- Include maintenance of fire protection equipment documentation – AS 1851.8 Part 8 Automatic fire detection and alarm systems.
- Appendix E – Commissioning test report.
- Appendix F – Standard form of installer's statement for fire alarm system.
- Manufacturer certification and warranty documentation.

Section 9 – Certificates, Commissioning Reports and Test Results

- Index/ table of contents.
- Provide the following Certificates:
 - . Certificate of compliance (CoC).
 - . Form 2.
 - . Switchboards: Manufacturer's Inspection and test report.
 - . Telstra/NBN lead-in conduit – Mandrel test findings form.
 - . Certificate of training completion for all systems installed.
- Provide the following Commissioning Report and Test Results:
 - . LV system as per AS3000, clause 8.3.
 - . Exit and emergency lighting: Initially 120min duration testing.
 - . Fire Detection and Alarm System: Fire detection: AS1670 Appendix E – Commissioning test report & Fire detection: AS1670 Appendix F – Standard form of installer's statement for fire alarm system.

Section 10 – As-Installed Drawings

- Index/ table of contents.
- Hard and soft copy A1-A3 AutoCAD drawings.
- Record during the progress of the project all changes to cable runs, fixture positions, etc. Prepare using AutoCAD 2016 (or later) drafting format. Where errors, discrepancies or omissions are identified, they will be returned to the Contractor for correction.
- The review of Contractor's installed drawings is not intended to be a checking process, and the Contractor remains responsible at all times for the content, accuracy and scope of submitted documents.
- Provide hard copy and soft copy of all As-Installed drawings. Include the following minimum information:-
 - . Actual locations of installed equipment
 - . Interface points with other trades
 - . Circuit numbers and phase for all final sub-circuits
 - . Actual cable tray and communication cable routes
 - . Location depths of all underground conduits and pits dimensioned from permanent landmarks

Electronic Copy

- Provide an electronic copy of the manual on USB stick and securely store within the folder.
- Provide and attach a key tag to USB stick and label with project name.

APPENDIX A

SCHEDULE OF TECHNICAL DATA

Provide the following proposed technical data at the time of tender.

Item	Proposed	
	MSB	DSB's
DISTRIBUTION BOARDS <ul style="list-style-type: none"> - Manufacturer - Limiting overall dimensions (width, height, depth) - Busbar rated current (minimum) - Rated short-circuit current (minimum) - Form of separation (minimum Form 1) - Degree of protection - Door smoke seal - Future circuits required (min 30% spare pole) - Installation Type - Energy consumption meter (manufacturer/model no.) - Main isolator (manufacturer/model no./min. current rating) 		

<ul style="list-style-type: none"> - MCB and MCB/RCD (manufacturer/model no.) 		
<p>ACCESSORIES</p> <ul style="list-style-type: none"> - SSOs (manufacturer/model no.) - Isolators (manufacturer/model no.) - Light switches (manufacturer/model no.) - PE Cell (manufacturer/model no.) - Occupancy sensor (manufacturer/model no.) - Daylight sensor (manufacturer/model no.) 		
<p>CABLE TRAYS AND DUCTS</p> <ul style="list-style-type: none"> - Cable tray (manufacturer/type) - Cable ladder (manufacturer/type) - Ducting (manufacturer/type) 		
<p>LUMINAIRES</p> <ul style="list-style-type: none"> - Type DL1 (manufacturer/model no.) - Type RL1 (manufacturer/model no.) 		

<ul style="list-style-type: none"> - Type RL2 (manufacturer/model no.) - Type SL1 (manufacturer/model no.) - Type SL2 (manufacturer/model no.) - Type SL3 (manufacturer/model no.) - Type SL4 (manufacturer/model no.) - Type WL1 (manufacturer/model no.) 	
<p>EMERGENCY LIGHTING</p> <ul style="list-style-type: none"> - Type EM1 (manufacturer/model no.) - Type EX1 (manufacturer/model no.) - Test facility (manufacturer/model no.) - Warranty details (yrs) 	
<p>FIRE DETECTION SYSTEM</p> <ul style="list-style-type: none"> - FIP (manufacturer/model no./dimensions) - Smoke detectors (manufacturer/model no.) - Thermal detectors (manufacturer/model no.) - Fire speaker (manufacturer/model no.) 	

<ul style="list-style-type: none">- Fire strobe (manufacturer/model no.)- Fire Bell (manufacturer/model no.)- Cable details (manufacturer/model no.)- Warranty details (yrs)	
---	--

EQUIPMENT CONFORMITY

Itemise below all items where the tendered items differ from the specification.

.....

.....

.....

.....

.....

TENDER SUBMISSION

Include with Tender submission the name of the electrical contractor and all other subcontractors that will be undertaking any of the electrical works including communications and security systems:

ELECTRICAL:

FIRE DETECTION AND ALARM SYSTEM:

SECTION COST BREAKDOWN

Tenders shall provide itemised cost breakdowns with their submitted tender, for various components of the works listed below.

The listed components of the works are to be included in the total tender sum. The cost is to include supply, delivery, installation, test, warranty maintenance, overhead and profits.

AMOUNT TENDERED

Consumer mains and submain Cabling	\$
Cable Trays & Support Systems	\$
Earthing System	\$
MSB and DSB's	\$
Power Accessories & Outlets (Including Sub-Circuits)	\$
Lighting Accessories (Including Sub-Circuits)	\$
Luminaires & Occupancy Sensors	\$
Exit & Emergency Luminaires	\$
Labeling	\$
Testing & Commissioning	\$
Maintenance & Servicing	\$

Operating and Maintenance Manuals \$

Other (specify) \$

SUBTOTAL \$

GST \$.

TOTAL \$.

ITEMISED COST BREAKDOWN

Tenders shall provide itemised cost breakdowns with their submitted tender, for various components of the works listed below.

The listed components of the works are to be included in the total tender sum. The cost is to include supply, delivery, installation, test, warranty maintenance, overhead and profits.

Item	Fixed Price
<u>POWER</u>	
- 10 Amp, double, SSO looped to adjacent outlet with 5m of cable.	\$.....Inc GST
- 10 Amp, double, SSO supplied by a dedicated sub-circuit with 40m of cable and RCBO.	\$.....Inc GST
- 1ph, 20 Amp, isolator supplied by a dedicated sub-circuit with 40m of cable and MCB.	\$.....Inc GST
<u>FIRE DETECTION AND ALARMS</u>	
- Smoke detector.	\$.....Inc GST
- Thermal detector.	\$.....Inc GST
- Fire audio visual alarm.	\$.....Inc GST
- Fire speaker.	\$.....Inc GST
<u>LUMINAIRES</u>	
- Type 'DL1' luminaire.	\$.....Inc GST
- Type 'EM1' luminaire.	\$.....Inc GST
- Type 'EX1' luminaire.	\$.....Inc GST
- Type 'RL1' luminaire.	\$.....Inc GST

- Type 'RL2' luminaire. \$.....Inc GST
- Type 'SL1' luminaire. \$.....Inc GST
- Type 'SL2' luminaire. \$.....Inc GST
- Type 'SL3' luminaire. \$.....Inc GST
- Type 'SL4' luminaire. \$.....Inc GST
- Type 'WL1' luminaire. \$.....Inc GST
- PIR occupancy sensor. \$.....Inc GST