Caddens Hill Sports Precinct

Lighting & Electrical Services Specification

Project L150I

Revision	Date	Approved by
T1	17 November 2017	RM

Lighting, Art + Science

Lighting, Art + Science Pty Ltd
Level 1
41 Hume St
Crows Nest NSW 2065
Ph: 02 9436 0998
mail@laands.com.au
ABN 86 152 715 921

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ELECTRICAL SYSTEMS

1 GENERAL

1.1 RESPONSIBILITIES

■ **General**

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

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

The following list identifies the work to be undertaken by the Contractor. The listed items are not intended to limit or exclude any items required by the contract documents.

The Electrical Services work shall comprise the provision of the following major items:

- Service and consumers mains
- Metering
- Main switchboard
- Earthing
- Lighting sub circuit wiring
- Submains
- Luminaires & poles
- Lighting controls including Cloudmaster controller & liaison with the Council for Cloudmaster system commissioning
- Pit & conduit system
- Spare conduits
- Spares
- Miscellaneous works and equipment
- Operating and maintenance manuals and as installed drawings
- Commissioning and demonstration of the operational works
- Preventative maintenance

1.2 WORK ASSOCIATED WITH OTHER TRADES OR PARTIES

Some works and/or provisions associated with the Electrical Services shall be performed by other trades or parties. Liaise with other trades to ensure that all requirements are provided as required for the completeness and proper operation of the equipment or system.

The following works and/or provisions, unless specifically stated as by the Electrical Services Contractor, are not included in the Electrical Services:

■ **Electricity Retailer**

- Metering equipment.

1.3 ELECTRICAL PERFORMANCE

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

Performance criteria: Meet the performance criteria, as documented.

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

■ **Site electricity supply**

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

Network distributor's protection devices: Determine the protection equipment type and protection curves for overload, short circuit and earth fault currents.

Prospective fault current: Determine the high voltage prospective fault current.

■ **Switchboards**

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

- *Switchboards.*

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

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

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

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

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

■ **Electrical cable systems**

Responsibilities: Provide the following cabling systems:

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

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

■ **Lighting**

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

- *Lighting*.

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

1.4 PRECEDENCE

■ **General**

Worksections and referenced documents:

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

1.5 CROSS REFERENCES

■ **General**

Requirement: Conform to the following:

- *Cable support and duct systems.*
- *Low voltage power systems.*
- *Switchboards.*
- *Lighting.*

1.6 REFERENCED DOCUMENTS

■ **General**

Requirement: Conform to the *Referenced Documents* worksection.

1.7 STANDARDS

■ **General**

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

■ **Electrical installations**

Designing to the win: To SAA HB 301.

Selection of cables: To AS/NZS 3008.1.1.

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

EMC: To AS/NZS 61000.

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

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

1.8 CONTRACT DOCUMENTS

Drawings:

- EL-001 Legend & Drawing List
- EL-100 Lighting & Electrical Layout
- EL-200 Lighting Details – Sheet 1
- EL-201 Lighting Details – Sheet 2
- EL-300 Single Line Diagram

1.9 HOLD POINTS

■ Requirement

The following items are hold points for the project:

- Luminaire tech data sheets
- Pole shop drawings
- Pole footing design and certification
- Switchboard shop drawings
- Switchboard factory inspection prior to shipping to site
- Operational lighting & electrical system demonstration
- As-built documentation including test results

■ Notice

Refer to inspection and submissions clauses below for notification timeframes.

1.10 INSPECTION

■ **Notice**

Concealment: If notice of inspection is required in respect of parts of the works that are to be concealed, advise when the inspection can be made before concealment.

Tests: Give notice of the time and place of documented tests.

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

- Service penetrations completed and ready for fire-stopping.
- Finished fire-stopping, before being concealed.

- Authority inspections
- Minimum notice for inspections to be made and for witnessing of tests: one week.

■ **Attendance**

General: Provide attendance for documented inspections and tests.

1.11 SUBMISSIONS

■ General

Submit to: Superintendent.

Default timing: Make submissions at least 5 working days before ordering products for, or starting installation of, the respective portion of the works.

Program: Allow in the construction program for at least the following times for response to submissions:

Proposed products schedules: If major products are not specified as proprietary items, submit a schedule of those proposed for use within 3 weeks of site possession.

■ Identification

General: Identify the project, contractor, subcontractor or supplier, manufacturer, applicable product, model number and options, as appropriate and include pertinent contract document references. Include service connection requirements and product certification.

Non-compliance: Identify proposals for non-compliance with project requirements, and characteristics which may be detrimental to successful performance of the completed work.

■ Errors

General: If a submission contains errors, make a new or amended submission as appropriate, indicating changes made since the previous submission.

■ Submissions - electronic copies

File format: PDF.

File format: CAD files in AutoCAD dwg format using an agreed layering and drawing convention.

Transmission medium: Email.

■ Submissions - hard copy

Quantity:

- Loose documents larger than A3: Laser printed documents the same size as the standard contract drawings.
- Loose documents up to and including A3: One copy.

Standard contract drawing size: As per design drawings.

■ Authorities

Authorities' approvals: Submit documents showing approval by the authorities whose requirements apply to the work.

Correspondence: Submit copies of correspondence and notes of meetings with authorities whose requirements apply to the work.

■ Building penetrations

General: If it is proposed to penetrate or fix to the following, submit details of the methods proposed to maintain the required structural, fire and other properties:

Structural building elements including external walls, fire walls, fire doors and access panels, other tested and rated assemblies or elements, floor slabs and beams.

Membrane elements including damp-proof courses, waterproofing membranes and roof coverings. If penetrating membranes, provide a waterproof seal between the membrane and the penetrating component.

■ Certification

General: Submit certification that the plant and equipment submitted meets all requirements of the contract documents.

■ Execution details

General: Before starting the installation of building services, submit the following:

- Embedded services: Proposed method for embedding services in concrete walls or floors or chasing into concrete or masonry walls.

- Fixing of services: Typical details of locations, types and methods of fixing services to the building structure.
- Inaccessible services: If services will be enclosed and not accessible after completion, submit proposals for location of service runs and fittings.

■ **Inspection and testing**

General: Submit an inspection and testing plan which is consistent with the construction program. Include particulars of test stages and procedures.

Test reports: Submit written reports on nominated tests.

■ **Materials and components**

Product certification: If products must conform to product certification schemes, submit evidence of conformance.

Product data: For proprietary equipment, submit the manufacturer's product data as follows:

- Technical specifications and drawings.
- Type-test reports.
- Performance and rating tables.
- Recommendations for installation and maintenance.

■ **Substitutions**

Identified proprietary items: Identification of a proprietary item does not necessarily imply exclusive preference for the item so identified, but indicates the necessary properties of the item.

Alternatives: If alternatives to the documented products, methods or systems are proposed, submit sufficient information to permit evaluation of the proposed alternatives, including the following:

- Evidence that the performance is equal to or greater than that specified.
- Evidence of conformity to a cited standard.
- Samples.
- Essential technical information, in English.
- Reasons for the proposed substitutions.
- Statement of the extent of revisions to the contract documents.
- Statement of the extent of revisions to the construction program.
- Statement of cost implications including costs outside the contract.
- Statement of consequent alterations to other parts of the works.

Availability: If the documented products or systems are unavailable within the time constraints of the construction program, submit evidence.

Criteria: If the substitution is for any reason other than unavailability, submit evidence that the substitution:

- Is of net enhanced value to the principal.
- Is consistent with the contract documents and is as effective as the identified item, detail or method.

Costs: Pay the cost of submissions and of evaluations and tests of proposed alternatives, whether subsequently adopted or not. The costs will be calculated at the current charge-out rates of the relevant consultant(s).

■ **Samples**

Submission: Submit nominated samples.

Incorporation of samples: If it is intended to incorporate samples into the works, submit proposals. Incorporate samples in the works which have been endorsed for inclusion. Do not incorporate other samples.

Retention of samples: Keep endorsed samples in good condition on site, until the date of practical completion.

■ **Shop drawings**

General: Include dimensioned drawings showing details of the fabrication and installation of structural elements, building components, services and equipment, including relationship to building structure and other services, cable type and size, and marking details.

Diagrammatic layouts: Coordinate work shown diagrammatically in the contract documents, and submit dimensioned set-out drawings.

Services coordination: Coordinate with other building and service elements. Show adjusted positions on the shop and record drawings.

Space requirements: Check space requirements of equipment and services indicated diagrammatically in the contract documents.

Checking: Ensure that the drawings have been checked before submission.

Building work drawings for building services: Submit detailed dimensioned drawings showing all:

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

Proposed products schedules: If major products are not specified as proprietary items, submit a schedule of those proposed for use within 3 weeks of site possession.

■ Technical data

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

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

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

1.12 RECORD DRAWINGS

■ General

General: Submit record drawings. Show the 'as installed' locations of building elements, plant and equipment. Show off-the-grid dimensions where applicable.

Shop drawings: Submit all documented shop drawings, including 'as installed' amendments.

Services: 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.

Services below ground or concealed: If services and fittings are below ground or concealed, show the depth and dimensioned references that will allow the future location of the service for maintenance or expansion.

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.

Diagrams: Provide diagrammatic drawings of each system including the following:

- Controls
- Principal items of equipment
- Single line wiring diagrams
- Access provisions
- Fixings
- Fixtures
- Switchgear and control gear assembly circuit schedules including electrical service characteristics, controls and communications.

■ **Accuracy**

Progress recording: Keep one set of shop drawings on site at all times expressly for the purpose of marking changes made during the progress of the works.

Documents: Incorporate all modifications made during the progress of the work and testing period. Show any provisions for the future.

Endorsement: Sign and date all record drawings.

■ **Drawing layout**

General: Use the same borders and title block as the contract drawings.

■ **Quantity and format**

General: Conform to **SUBMISSIONS.**

■ **Date for submission**

General: Not later than 2 weeks after the date of practical completion.

1.13 OPERATION AND MAINTENANCE MANUALS

■ **General**

General: Submit operation and maintenance manuals for the whole of the work.

Authors and compilers: Personnel experienced in the maintenance and operation of equipment and systems installed, and with editorial ability.

Referenced documents: If referenced documents or technical worksections require that manuals be submitted, include corresponding material in the operation and maintenance manuals.

Subdivision: By installation or system, depending on project size.

■ **Format – electronic copies**

Printing: Except for drawings required in the **RECORD DRAWINGS** clause provide material that can be legibly printed on A4 size paper.

Scope: Provide the same material as documented for hardcopy in electronic format.

Quantity and format: Conform to **Submissions – electronic copies**.

■ **Format – hard copy**

General: A4 size loose leaf, in commercial quality, 4 ring binders with hard covers, each indexed, divided and titled. Include the following features:

- Cover: Identify each binder with typed or printed title *OPERATION AND MAINTENANCE MANUAL*, to spine. Identify title of project, volume number, volume subject matter, and date of issue.
- Dividers: Durable divider for each separate element, with typed description of system and major equipment components. Clearly print short titles under laminated plastic tabs.
- Drawings: Fold drawings to A4 size with title visible, insert in plastic sleeves (one per drawing) and accommodate them in the binders.
- Pagination: Number pages.

- Ring size: 50 mm maximum, with compressor bars.
- Text: Manufacturers' printed data, including associated diagrams, or typewritten, single-sided on bond paper, in clear concise English.
- Number of copies: 3.

2 PRODUCTS

2.1 GENERAL

■ Manufacturers' or suppliers' recommendations

General: Provide and select, if no selection is given, transport, deliver, store, handle, protect, finish, adjust and prepare for use the manufactured items in conformance with the current written recommendations and instructions of the manufacturer or supplier.

Proprietary items/systems/assemblies: Assemble, install or fix to substrate in conformance with the current written recommendations and instructions of the manufacturer or supplier.

Project modifications: Advise of activities that supplement, or are contrary to, manufacturers' or suppliers' written recommendations and instructions.

■ Sealed containers

General: If materials or products are supplied by the manufacturer in closed or sealed containers or packages, bring the materials or products to point of use in the original containers or packages.

■ Prohibited materials

Do not provide the following:

- Materials listed in the Safe Work Australia Hazardous Substances Information System (HSIS).
- Materials that use chlorofluorocarbon (CFC) or hydro chlorofluorocarbon (HCFC) in the manufacturing process.

2.2 TESTS

■ Attendance

General: Provide attendance on tests.

■ Testing authorities

General: Except for site tests, have tests carried out by a Registered testing authority and submit test reports.

- Reports: Submit copies of test reports, including certificates for type tests, showing the observations and results of tests and conformance or non-conformance with requirements.
- Site tests: Use instruments calibrated by authorities accredited by a Registered testing authority.

2.3 MATERIALS AND COMPONENTS

■ Consistency

General: For each material or product use the same manufacturer or source and provide consistent type, size, quality and appearance.

■ Corrosion resistance

General: Conform to the following atmospheric corrosivity category as defined in AS/NZS 2312.

Atmospheric corrosivity category: (delete non applicable categories)

- C, (medium, marine)

■ Situation

The following classification of situation applies to the Corrosion resistance and durability tables.

- Internal: Building fabric protected from salt and moisture by vapour barriers, sarking, sheathing and building wraps.

- External: Includes external leaf and air spaces behind external leaf brickwork or blockwork walls.

■ **Galvanizing**

Severe conditions: Galvanise mild steel components (including fasteners) to AS 1214 or AS/NZS 4680 as appropriate, if:

- Exposed to weather.
- Embedded in masonry.
- Exposed to or in air spaces behind the external leaf of masonry walls.
- In contact with chemically treated timber, other than copper chrome arsenate (CCA).

■ **PVC products**

Verification: Provide third party verification to demonstrate that PVC products proposed for the project satisfy the criteria required by the GBCA for their Credit in the Materials category of Green star assessment.

■ **Bushfire resistance**

Bushfire Attack Level (BAL) to AS 3959: [complete/delete]

Bushfire resistant design and construction: To [complete/delete]

2.4 ELECTRICAL ACCESSORIES

■ **General**

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

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

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

Default finish: Select from the manufacturers standard range.

3 EXECUTION

3.1 OFF SITE DISPOSAL

■ **Removal of material**

General: Dispose of building waste material off site to the requirements of the relevant authorities.

3.2 SERVICES CONNECTIONS

■ **Connections**

General: Connect to network distributor services or service points. Excavate to locate and expose connection points. Reinstate the surfaces and facilities that have been disturbed.

■ **Network distributors' requirements**

General: If the network distributor elects to perform or supply part of the works, make the necessary arrangements. Install equipment supplied, but not installed, by the authorities.

3.3 SERVICES INSTALLATION

■ **General**

Installation: Install equipment and services plumb, fix securely and organise reticulated services neatly. Allow for movement in both structure and services.

Concealment: Unless otherwise documented, conceal all cables, ducts, trays and pipes except where installed in plant spaces, ceiling spaces and riser cupboards. If possible, do not locate on external walls.

Lifting: Provide heavy items of equipment with permanent fixtures for lifting as recommended by the manufacturer.

Suspended ground floors: Keep all parts of services under suspended ground floors at least 150 mm clear of the ground surface. Make sure services do not impede access.

Arrangement: Arrange services so that services running together are parallel with each other and with adjacent building elements.

- **Dissimilar metals**

General: Join dissimilar metals with fittings of electrolytically compatible material.

- **Temporary capping**

Pipe ends: During construction, protect open ends of pipe with metal or plastic covers or caps.

- **Piping**

General: Install piping in straight lines at uniform grades without sags. Arrange to prevent air locks. Provide sufficient unions, flanges and isolating valves to allow removal of piping and fittings for maintenance or replacement of plant.

Spacing: Provide at least 25 mm clear between pipes and between pipes and building elements, additional to insulation.

Changes of direction: Provide long radius elbows or bends and sets where practicable, and swept branch connections. Provide elbows or short radius bends where pipes are led up or along walls and then through to fixtures. Do not provide mitred fittings.

Vibration: Arrange and support piping so that it remains free from vibration whilst permitting necessary movements. Minimise the number of joints.

Embedded pipes: Do not embed pipes that operate under pressure in concrete or surfacing material.

If embedding pipes under pressure is to be permitted typical text replacing this paragraph would be as follows. The precautions in AS 2896 are used here for situations where embedding cannot be avoided:

General: If pipes that operate under pressure are to be embedded in concrete or surfacing material conform to AS 2896 clause 4.3.3.3. Pressure test and rectify leaks before the concrete is poured.

Valve groupings: If possible, locate valves in groups.

Pressure testing precautions: Isolate items not rated for the test pressure. Restrain pipes and equipment to prevent movement during pressure testing.

- **Differential movement**

- General: If the geotechnical site investigation report predicts differential movements between buildings and the ground in which pipes or conduits are buried, provide control joints in the pipes or conduits, as follows:
- Arrangement: Arrange pipes and conduits to minimise the number of control joints.
- Magnitude: Accommodate the predicted movements.

3.4 CONCRETE PLINTHS

- **Construction**

General: Provide plinths for the freestanding switchboards.

3.5 SUPPORT AND STRUCTURE

- **General**

Requirement: Provide incidental supports and structures to suit the services.

3.6 WORK ON EXISTING SYSTEMS

- **Existing electrical systems**

Condition of existing systems:

- If the existing condition does not conform to the requirements in the contract documents, submit proposals to rectify the deficiencies with related costing, time and other impacts.

- Subject to the rectification works on existing systems, achieve the performance in the contract documents.

3.7 SWITCHBOARDS

■ General

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

3.8 SUPPORT OF PLANT AND EQUIPMENT

■ Support of ground level plant and equipment

Ground level:

- If the ground slope is ≥ 15°, 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.

CABLE SUPPORT AND DUCT SYSTEMS

1 GENERAL

1.1 RESPONSIBILITIES

■ **General**

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

1.2 INTERPRETATIONS

■ **Definitions**

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

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

1.3 SUBMISSIONS

■ **Certification**

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

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

■ **Shop drawings**

General: Submit shop drawings showing the following:

- Layout of cable supports and enclosures on the current landscape background coordinated with the structure and other services.
- Layout of underground conduits, pits and drainage trenches.
- Invert levels for underground conduits.
- Depth of burial for cables and conduits.
- In situ pits.
- Provision for expansion and ground movement.
- Fabricated columns.
- Footing for columns.

■ **Technical data**

General: Submit technical data for the following:

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

2 PRODUCTS

2.1 CONDUITS

■ **General**

Standards: AS/NZS 2053.1, AS/NZS 2053.2, AS/NZS 2053.3, AS/NZS 2053.4, AS/NZS 2053.5, AS/NZS 2053.6, AS/NZS 2053.7 and AS/NZS 2053.8.

■ **Type**

General: Rigid.

■ **Sizes**

Conduits: ≥ 20 mm.

Underground: ≥ 25 mm.

Conduits for telecommunications: ≥ 25 mm.

- **Fixings**

Surface mounted: Double sided fixed.

In concrete slabs: Tie to structural steel.

- **Colour**

Conduits generally: Light orange.

Telecommunications systems conduits: White.

- **Galvanised water pipe**

Medium or heavy: To AS 1074.

2.2 METALLIC CONDUITS AND FITTINGS

- **General**

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

- **Type**

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

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

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

- **Joining**

Steel conduit: Screwed joints and ends.

- **Fixings**

Saddles: Conform to the following:

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

- **Corrosion protection**

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

2.3 NON-METALLIC CONDUITS AND FITTINGS

- **General**

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

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

- **Flexible conduit**

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

- **Associated fittings**

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

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

- **Inspection fittings**

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

- **Joints**

Type: Cemented or snap-on joints.

2.4 CABLE PITS

General

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

■ **Proprietary cable pits**

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

■ **Pit covers**

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

Standard: To AS 3996.

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

Lifting handles: Provide a lifting handle for each size of cover section.

■ **Drainage**

General: Provide drainage from the bottom of cable pits, either to absorption trenches filled with rubble or to the stormwater drainage system.

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

2.5 COLUMNS

■ **General**

Columns: Conform to the following for fabricated columns more than 2400 mm high which are designed to support accessories outdoors.

■ **Standards**

Public lighting poles: AS 1798.

Steel structures: To AS 4100.

Structural design of columns: To AS/NZS 4676.

Hot-dipped galvanised (zinc) coatings on ferrous articles: To AS/NZS 4680.

■ **Design**

General: Provide tapped hot-dipped galvanised steel, aluminium or concrete columns, designed, manufactured and tested by a specialist manufacturer.

Mounting: Conform to the following

- Steel columns: Provide base plate mounting, suitable for mounting on rag bolt assemblies.

Footings: Provide footings and rag bolt assemblies detail designed by a professional engineer and independently certified.

Site specifics: Take into consideration the design wind category and the soil conditions.

Dimensions: To AS 1798.

Rag bolt assemblies: Provide galvanised threaded steel rag bolt assemblies of cross-sectional area designed to support each column taking into account the wind loads expected to act on the column and the luminaires mounted on the column. Set the rag bolt assemblies in the concrete footings. Cut holding bolts within 3 threads above top of base plate top lock nuts.

Base sealing: Seal space under pole base plate with grout.

Maintenance access: Provide pole stirrups secured to either side of the column for access to accessories. Locate the first stirrup ≥ 3 m above ground level.

Electrical connections: For hollow metal or concrete poles provide a recess fitted with a flush mounted lockable or screw fixed cover at the base of the column for access to cable connections and equipment.

Cable support: For connections higher than 3 m, provide a catenary wire cable support system unless cable and anchor methods at the ends of the cable suspension are designed for unsupported cable suspension.

Drainage: Provide adequate drainage at the column base.

2.6 CUSTOM DESIGNED POLES/COLUMNS

■ **General**

General: Provide columns designed, manufactured and tested by a specialist manufacturer.

Standards: To the local network distributor's standards and to the local Service and Installation Rules.

■ **Construction**

General: Hot-dip galvanise steel columns and fittings after fabrication.

Drainage: Provide adequate drainage at the column base.

■ **Bases and footings for custom designed columns**

Requirement: Provide bases to custom designed columns as documented.

Bases: Provide mounting bases for rag bolt assembly fixing to reinforced concrete footings.

Footings: Provide footings as required.

Site specifics: Design for the site wind category and the soil conditions.

Dimensions: To AS 1798.

Rag bolt assembly: Cut holding bolts within 3 threads above top of base plate top lock nuts.

Base fixing: Galvanised holding down nut with galvanised lock nut above.

Design of footing and rag bolt assemblies: Undertake design by a professional engineer and provide independent certification.

Base sealing: Seal space under pole base plate with grout.

Finish: Paint, colour as documented.

3 EXECUTION

3.1 CONDUIT SYSTEMS – INSTALLATION

■ **Inspection fittings**

Location: Locate in accessible positions.

■ **Draw cords**

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

■ **Draw-in boxes**

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

- At changes of level or direction.

■ **Expansion**

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

■ **Rigid conduits**

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

■ **Routes**

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

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

3.2 CABLES IN TRENCHES – INSTALLATION

Sand bed and surround

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

■ **Sealing ducts and conduits**

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

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

3.3 COLUMNS – INSTALLATION

■ **General**

General: Install columns as documented including the provision of in situ reinforced concrete footings to **WIRING ENCLOSURES AND CABLE SUPPORT SYSTEMS**.

Columns set in the ground: If the soil is unsuitable, consider alternative pole types and mount in concrete or on rag bolt assemblies set in concrete footings.

LOW VOLTAGE POWER SYSTEMS

1 GENERAL

1.1 RESPONSIBILITIES

■ **General**

General: Provide low voltage power systems as documented.

1.2 SYSTEM DESCRIPTION

■ **Distribution system**

General: Provide power distribution system elements as documented.

■ **Metering**

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

Private: Provide private metering as documented.

■ **Design**

Design parameters: As documented.

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

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

■ **Surge protection devices (SPD)**

General: Provide surge protection as documented.

1.3 CROSS REFERENCES

■ **General**

Requirement: Conform to the following:

- *Cable support and duct systems.*

1.4 STANDARDS

■ **General**

General: To SAA HB 301.

Electrical equipment: To AS/NZS 3100.

Selection of cables: To AS/NZS 3008.1.1.

Distribution cables: To AS/NZS 4961.

■ **Testing**

Standard: To AS/NZS 3017.

1.5 INTERPRETATIONS

■ **Definitions**

Embedded generator: Electricity generator connected to the local electrical distribution network.

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

Low-voltage: Exceeding extra-low voltage, but not exceeding 1000 V a.c. or 1500 V d.c.

High voltage: Exceeding low-voltage.

1.6 SUBMISSIONS

■ **Samples**

General: Submit samples of all visible accessories and equipment.

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

■ **Technical data**

General: Submit the following information for each main, submain and final subcircuit for which calculation is the responsibility of the contractor.

- Single line diagram.
- Fault Levels at switchboards.
- Maximum demand calculations.
- Cable and conductor cross sectional area and insulation type.
- Cable operating temperature at design load conditions.
- Voltage drop calculations at design load conditions.
- Protective device characteristics.
- Discrimination and grading of protective devices.
- Prospective short circuit current automatic disconnection times.
- Earth fault loop impedance calculations for testing and verification.
- Certify compliance with AS/NZS 3000, for electrical services.
- Stringing calculations for aerial cables.

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

■ Shop drawings

General: Submit shop drawings of the following:

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

2 PRODUCTS

2.1 WIRING SYSTEMS

■ General

Selection: Provide wiring systems appropriate to the installation conditions and the function of the load.

2.2 POWER CABLES

■ Standard

Polymeric insulated cables: To AS/NZS 5000.1.

Aerial cables: To AS 1746.

■ Cable

General: Select multi-stranded copper cable generally.

Default insulation: V-75.

Default sheathing: 4V-75.

Minimum size: Conform to the following:

- Lighting sub-circuits: 2.5 mm^2.
- Power sub-circuits: 2.5 mm^2.
- Sub-mains: 10 mm^2.

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

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

Underground residential distribution systems: Select cables according to AS/NZS 4026.

Distribution cables: To AS/NZS 4961.

■ Colours

Cables: For fixed wiring, provide coloured conductor insulation. If this is not practicable, slide at least 150 mm of close fitting coloured sleeving on to each conductor at the termination points.

Active conductors in single phase circuits: Red.

Active conductors in polyphase circuits:

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

Sheath: White.

2.3 ACCESSORIES

■ **Socket outlets**

Standard:

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

Socket outlet switches: Required.

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

■ **Plugs – 230/400 volt**

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

■ **Isolating switches**

Standard: To AS/NZS 3133.

3 EXECUTION

3.1 EARTHING

■ **Earthing systems**

Standard: Provide an earthing system as documented.

■ **Electrodes**

General: Provide electrodes to suit soil resistivity.

■ **Bonding**

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

All metallic lighting poles shall have a equipotential bonds in accordance with AS1768.

Provide a 1.5m diameter grading ring of 16mm^2 uninsulated copper cabling 300mm below ground around all metallic light poles.

All equipotential bonding shall be connected to the earth bar within each lighting pole.

From this earth bar connect to the reinforcement bars within the light pole footing and to the grading ring to give a combined maximum of 10 ohms or less.

■ **Earth and bonding clamps**

General: Provide proprietary earthing and bonding clamps.

Standard: To AS 1882.

3.2 POWER CABLES

■ **General**

Standard: Classifications to AS/NZS 3013.

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

Stress: Ensure that installation methods do not exceed the cable's pulling tension. Use cable rollers for cable installed on tray/ladders or in underground enclosures.

Straight-through joints: Unless unavoidable due to length or difficult installation conditions, run cables without intermediate straight-through joints.

Cable joints: Locate in accessible positions in junction boxes and/or in pits.

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

■ **Tagging**

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

- **Marking**

General: Identify the origin of all wiring by means of legible indelible marking.

3.3 FIRE-RATED CABLES

- **Protection**

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

3.4 COPPER CONDUCTOR TERMINATIONS

- **General**

General: Other than for small accessory and luminaire terminals, terminate copper conductors to equipment, with compression-type lugs of the correct size for the conductor. Compress using the correct tool or solder.

- **Within assemblies and equipment**

General: Loom and tie together conductors from within the same cable or conduit from the terminal block to the point of cable sheath or conduit termination. Neatly bend each conductor to enter directly into the terminal tunnel or terminal stud section, allowing sufficient slack for easy disconnection and reconnection.

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

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

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

3.5 COMPLETION TESTS

- **Site tests**

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

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

SWITCHBOARDS

1 GENERAL

1.1 RESPONSIBILITIES

■ **General**

General: Provide switchboards as follows and as documented.

1.2 CROSS REFERENCES

■ **General**

Requirement: Conform to the following:

- *Low voltage power systems.*
- *Switchboard components.*

1.3 STANDARD

■ **General**

Standards: To AS/NZS 3439.1.

1.4 INTERPRETATIONS

■ **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 control gear assemblies manufactured to order and incorporating proprietary components and proprietary bus-bar assemblies.
- Rated currents: Rated currents are continuous uninterrupted current ratings within the assembly environment under in-service operating conditions.
- Rated short-circuit currents: Maximum prospective symmetrical root mean square (r.m.s.) current values at rated operational voltage, at each assembly incoming supply terminal, excluding effects of current limiting devices.

1.5 TESTS

■ **Routine tests**

Standard: To AS/NZS 3439.1.

Assemblies: Electrical and mechanical routine function tests at the factory using externally connected simulated circuits and equipment.

Dielectric testing: NTTAs and PTTAs: 2.5 kV r.m.s. for 15 s.

1.6 INSPECTION

■ **Notice**

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

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

1.7 SUBMISSIONS

■ **Calculations**

General: Submit detailed certified calculations verifying design characteristics.

Standard: To AS 3865 and AS 60890.

■ **Type test data**

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

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

■ **Routine tests**

General: Submit reports.

■ **Technical data**

Calculations: Submit design calculations of non-type tested and non-proprietary busbar assemblies.

■ **Shop drawings**

General: Submit shop drawings showing:

- Types, model numbers and ratings of assemblies.
- 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.

2 PRODUCTS

2.1 SWITCHBOARD CONSTRUCTION

■ **General**

General: Provide custom-built switchboards as documented.

■ **Separation**

Default: Form 4aih.

■ **Metering**

General: Comply with the *Low voltage power systems* worksection.

■ **Spare capacity**

Default spare poles: ≥ 20%.

■ **Surge diversion**

General: Provide surge diversion as documented.

■ **Earthing**

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

■ **IP rating**

Default rating: IP42 minimum.

Weatherproof: IP56 minimum.

■ **Supporting structure**

Assemblies:

- Wall mounted: ≤ 2 m^2.
- Floor mounted: > 2 m^2.

■ **Ventilation**

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

■ **Layout**

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

Connection: Front connected.

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

Form 1 enclosures: Separate into compartments by means of partitions at 1.8 m maximum centres.

Equipment on doors: Set out in a logical manner in functional unit groups, so it is accessible without the use of tools or keys.

■ **Segregation**

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

■ **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: ≥ 1.6 mm.
  - . ≥ 900 mm: ≥ 2.0 mm.

Coating class:

- Indoor assemblies: Z200.
- Outdoor assemblies: Z450.

■ **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 ≥ 3 mm thick metal with heavy metal angle supports or plates bolted or welded to enclosure sides.

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

Non-metallic boards: To IEC 60893-1.

- **Equipment fixing**

Spacing: Provide 50 mm minimum clearance between the following:

- Busbars for lifts, fire services and building emergency services.
- General installation services, busbars and equipment.

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

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

- **Earth continuity**

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

- **Construction**

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

Supporting structure: Provide concealed fixings or brackets to allow assemblies to be mounted and fixed in position without removing equipment.

Floor-mounting: Provide mild steel channel plinth, galvanised 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.

Ventilation: Provide ventilation to maintain design operating temperatures at full load.

2.2 CABLE ENTRIES

- **General**

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

- **Cover and gland plates**

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

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

Materials: 1.5 mm thick steel, 5 mm thick composite material or laminated phenolic. 6 mm thick brass for MIMS cables and cable glands.

2.3 DOORS AND COVERS

- **General**

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

- **Door layout**

Maximum width: 900 mm.

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 corrosion-resistant pintle hinges or integrally constructed hinges to support doors. For removable doors, provide staggered pin lengths to achieve progressive engagement as doors are fitted. Provide 3 hinges for doors higher than 1000 mm. Provide restraining devices and opposed hinges for non lift-off doors.

Door hardware: Provide the following:

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

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

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

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

■ **Covers**

Maximum dimensions: 900 mm wide and 1.2 m^2 surface area.

Fixing: Fix to frames with at least 4 fixings. Provide corrosion-resistant acorn nuts if the cover exceeds 600 mm in width. Rest cover edges on the cubicle body or on mullions. Do not provide interlocked covers.

Handles: Provide corrosion-resistant D type handles.

■ **Escutcheons**

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

■ **Escutcheon plates**

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

Maximum dimensions: 900 mm wide and 1.2 m^2 surface area.

2.4 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, galvanised, 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 to **Factory finishes schedule.**

■ **Factory finishes schedule**

Mounting structure (brackets)	To match enclosure
Enclosure	Indoor assemblies: Orange X15 Outdoor assemblies: 316 stainless steel N4 finish Assembly interior: White
Escutcheons	Removable equipment panels: Off white Y35
Doors	To match enclosure

Mounting structure (brackets)	To match enclosure
Plinths	Black

2.5 BUSBARS

■ General

General: 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 3768, AS 3865 and AS 60890.

■ Definitions

Incoming busbars: Busbars connecting incoming terminals to line side terminals of main switches.

Main circuit supply busbars: Busbars connecting incoming functional unit terminals, or incoming busbars where no main switches are included, to outgoing functional unit terminals or outgoing functional unit tee-offs.

Tee-off busbars: Busbars connecting main busbars to incoming terminals of outgoing functional units.

■ 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.

■ 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, based on frame size rating.

■ MEN links

MEN links > 10 mm^2 in cross-section: Bolted removable busbar links stamped MEN LINK, located in the incoming compartment, between neutral and earth busbars.

Amend to suit the supply authority or project specific requirements.

■ 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 ≤ 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 between flags where the minimum clearance distances phase-to-phase and phase-to-earth are below the component terminal spacing.

■ **Future extensions**

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

■ **Jointing**

Type: High tensile steel bolts, washers and nuts, with lock nuts or 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 mm thick with dielectric strength of 2.5 kV r.m.s for 1 minute, applied by a fluidised bed process in which the material is phase coloured and directly cured onto the bars.
- Close fitting busbar insulation mouldings at least 1 mm thick.
- Heat shrink material: Only on rounded edge busbars.

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

Damaged insulation: Repair damaged insulation before energising.

2.6 NEUTRAL LINKS AND EARTH BARS

■ **Terminals**

General: Provide terminals for future circuits.

■ **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 mm^2: Provide bolts or studs.

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

2.7 INTERNAL WIRING

■ **Wiring**

General: 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 mm^2 internal cables, with minimum V75 insulation rating with stranded copper conductors rated to AS/NZS 3008.1.1. Provide cables with current ratings suitable for the

internal assembly ambient air temperature and for temperature rise limits of equipment within the assembly.

- Run cables clear of busbars and metal edges.
- Provide cables capable of withstanding maximum thermal and magnetic stresses associated with relevant fault level and duration.
- Run cables neatly. Provide slotted trunking sized for future cables or tie at 150 mm maximum intervals with ties strong enough to withstand magnetic stresses created at the specified fault current. Do not provide adhesive supports.
- Ensure wiring for future equipment can be installed without removal of existing equipment.
- Identify power and control cables at both ends with neat fitting ring type ferrules agreeing with record circuit diagrams. Mark to AS/NZS 4383.
- Terminate control cables and motor control circuits in tunnel terminals or, if necessary, provide suitable palm type lugs and correct crimp tool.
- For equipment mounted on hinged doors run cables on the hinge side to avoid restricting the door opening. Bundle cables with spiral wrap PVC and secure to door.
- If recommended by device manufacturers, provide shielded wiring.

Adjacent circuit breakers: If suitable proprietary multi-pole busbar assemblies are available to link adjacent circuit breakers, do not provide cable interconnections.

■ **Cables > 6 mm²**

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 marked: 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.

2.8 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

■ **Fixing**

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

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 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.

3.3 MARKING AND LABELLING

■ **General**

General: Label the switchboard assembly in conformance with AS/NZS 3439.1 including the following:

- Size and type of all incoming and outgoing mains and submains.
- Emergency operating procedures.

3.4 COMPLETION

■ **Maintenance**

Standard: To AS 2467.

General: 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.

SWITCHBOARD COMPONENTS

1 GENERAL

1.1 RESPONSIBILITIES

■ **General**

General: Provide switchboard components as follows and as documented.

1.2 CROSS REFERENCES

■ **General**

Requirement: Conform to the following:

- *Switchboards*

1.3 DESIGN

■ **Statutory authority's equipment**

General: Liaise with the supply authority with regard to the installation and coordinate with their protective and control equipment.

1.4 SUBMISSIONS

■ **Technical data**

General: Submit technical data for all components.

2 PRODUCTS

2.1 GENERAL

■ **General**

Selection: To comply with the requirements of AS/NZS 3000 clause 1.7 and Section 2.

Rated duty: Uninterrupted.

Rated making capacity (peak): ≥ 2.1 x fault level (RMS) at assembly incoming terminals.

Utilisation category: To AS 60947.1 clause 4.4.

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

Coordination: Select and adjust protective devices to discriminate under over-current, and earth faults.

Enclosure: IP4X minimum.

2.2 SWITCH-ISOLATOR

■ **General**

Standard: To AS 60947.1 and AS/NZS 3947.3 .

Poles: 3.

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

Shrouding: Effective over range of switch positions.

Rated breaking capacity: ≥ rated full load current.

■ **Fuse-switch units**

Operation: Provide an extendable operating handle.

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

2.3 MINIATURE CIRCUIT BREAKERS

■ **General**

Miniature circuit breakers: To AS/NZS 60898.1 or AS/NZS 3111.

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

Trip type: Conform to the following:

- Miniature circuit breakers: Fixed thermal, fixed magnetic.

Isolation facility: Required.

Mounting: Mount circuit breakers so that the ON/OFF and current rating indications are clearly visible with covers or escutcheons in position. Align operating toggles of each circuit breaker in the same plane.

Utilisation category: Moulded case breakers:

- Final sub-circuits category: Category A.
- Mains and submains: Category B.

Trip unit type: Electronic type for ≥ 100A rated circuit breakers, thermal magnetic C curve for miniature circuit breakers. Utilise D curve for motor power supplies to other trades as required.

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.

2.4 RESIDUAL CURRENT OPERATED CIRCUIT BREAKERS (RCBO)

■ General

Standard: To AS/NZS 3190.

Integral non-overload protection type: To AS/NZS 61008.1.

Integral overload protection type: To AS/NZS 61009.1.

Modular type: To AS 60947.2.

Default tripping current: 30 mA.

■ Special features

Miniature circuit breakers:

- Single pole RCBOs: IEC DIN available in current ratings of 6-63A, with sensitivities from 10 to 300 mA, instantaneous and delayed.

Single pole RCBOs: IEC DIN type A characteristic (applicable to both Australia and New Zealand) to AS/NZS 3000:2000, clause 2.5.2.2.

2.5 FUSES WITH ENCLOSED FUSE LINKS

■ General

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

Fuse links: Enclosed, high rupturing capacity type mounted in a fuse carrier.

Breaking range and utilisation category:

- Distribution/general purpose: gG.
- Motors: gM.

Fuse-holders: Mount fuse-holders so that fuse carriers may be withdrawn directly towards the operator and away from live parts. Provide fixed insulation which shrouds live metal when the fuse carrier is withdrawn.

Barriers: Provide barriers on both sides of each fuse link, preventing inadvertent electrical contact between phases by the insertion of screwdriver.

Spare fuse links: Provide 3 spare fuse links for each rating of fuse link on each assembly. Mount spares on clips within the spares cabinet.

Spare fuse holder carriers: Provide 3 spare fuse holder carriers for each size of fuse holder carrier on each assembly. Mount spares on clips within the spares cabinet.

Busbar mounted fuse holders: Provide fuse carriers with retaining clips, minimum fuse holder 32 A.

2.6 SURGE PROTECTION DEVICES (SPD)

- **Primary protection**

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

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

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

Residual Voltage: $U_p < 800$ V.

Visual indicator: Provide visual indication of SPD status and life visible from the switchboard front panel.

Alarm contacts: Provide one set of normally closed dry contacts indicating status.

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

2.7 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.

2.8 INSTRUMENTS AND METERS

- **Standard**

General purpose electronic induction watthour meters: To AS 62053.21.

General purpose induction watthour meters: To AS 1284.1.

Socket mounting system: To AS 1284.4.

- **Accuracy**

Indicating Instruments and accessories: ≤ Class 1.5.

Thermal maximum demand indicators: Class 3.

Electricity meters: Class 0.5.

Power factor meters, phase angle meters and synchroscopes: 2 electrical degrees maximum error.

Transducers: Class 0.5.

- **Mounting**

General: Flush mount on hinged panels.

- **Labels**

General: If associated exclusively with one phase, label meters RED, WHITE, or BLUE as applicable.

- **Protection devices**

Meter potential protection devices: Group together behind associated meter cover or hinged door, preferably next to current transformer test links.

- **Accessories**

General: Mount next to associated instruments, inside cabinets.

- **Multi Function Digital Power Analysers**

General: Provide digital power analysers as per the single line diagram.

Instantaneous data available from meter display:

- Phase to neutral voltages
- Phase to phase voltages
- Neutral to earth voltage
- Phase currents
- Neutral current
- Voltage THD% for each phase
- Current THD% for each phase
- kW
- KVA
- kVAR
- power factor

Historical value data available from meter display (maximum values unless noted otherwise):

- Power factor (minimum)
- Phase current (15 minute period)
- Phase to neutral voltages
- Neutral to earth voltage
- kW (15 minute period)
- KVA (15 minute period)
- kVAR (15 minute period)

Provide auxiliary power supply terminals for Digital Power Anaysers and RS485 bus wiring terminals.

2.9 CONTACTORS

- **General**

Standard: To AS 60947.4.1.

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

Poles: 3.

Rated operational current: The greater of:

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

Mechanical durability: 10 million cycles to AS 60947.4.1.

Electric durability: ≥ 1 million operations at AC-22 to AS 60947.4.1.

Mounting: Mount with sufficient clearance to allow full access for maintenance, removal and replacement of coils and contacts, without the need to disconnect wiring or remove other equipment.

Auxiliary contacts: Provide auxiliary contacts with at least one normally-open and one normally-closed separate contacts with rating of 6 A at 230 V a.c., utilisation category: AC-1.

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

2.10 CONTROL DEVICES AND SWITCHING ELEMENTS

■ Standards

General: To AS 60947.1 and AS 60947.5.1.

Switching elements:

- Electrical emergency stop device with mechanical latching function: To AS 60947.5.4.
- Electromechanical control circuit devices: To AS 60947.5.1.
- Proximity switches: To AS 60947.5.2.

■ Rotary switches

General: Cam operated type with switch positions arranged with displacement of 60°.

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

Rated operational current: At least 6 A at 230 V a.c.

Escutcheon plates: Provide rectangular plates securely fixed to the assembly panel. Identify switch position and function.

■ Control relays

Standards: To AS 60947.5.1.

Operation: Suitable for continuous operation. Provide relays selected in conformance with the **Control relay selection table**.

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

Contact elements: Electrically separate, double break with silver alloy, non-welding contacts.

Configuration: For standard relays, provide assemblies with ≥ 2 sets of contacts and expandable to 8 sets of contacts in the same assembly. Provide at least one normally-open and one normally-closed contact.

On site conversion: Provide contact blocks readily convertible to either normally-open or normally-closed contacts.

■ Control relay selection table

Relay type	Minimum mechanical life (million operations)	Base	Minimum contact rating	Inter-changeable	Minimum number of contact elements
1	5	Plug-in	$1.25I_L$	Yes	2
2	10	Plug-in	5 A at 240 V	Yes	2
3	10	Fixed mounting	5 A at 240 V	Yes	4

■ Push-buttons

Type: Oil-tight, minimum 22 mm diameter, or 22 x 22 mm.

Rated operational current: At least 4 A at 240 V a.c.

Emergency stop devices with mechanical latching: To AS/NZS 3947.5.5.

Marking: Identify functions of each push-button. For latched STOP or EMERGENCY STOP push-buttons, provide label with instructions for releasing latches.

2.11 CONTROLLERS DEVICE INTERFACES

■ **General**

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

- Cloudmaster controller.

Standard: To AS/NZS 62026.1, AS/NZS 62026.2, AS/NZS 62026.3 and AS/NZS 62026.5.

2.12 ANTI-CONDENSATION HEATERS

■ **General**

Rating: Provide heaters rated at not less than 20 W/m^2 of total external area including top of weatherproof enclosure.

Type: Black heat type with surface temperature ≤ 50°C, mechanically protected and thermostatically controlled.

3 EXECUTION

3.1 MARKING AND LABELLING

■ **General**

General: Provide labels including control and circuit equipment ratings, functional units, notices for operational and maintenance personnel, incoming and outgoing circuit rating, sizes and origin of supply and kW ratings of motor starters.

■ **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 consumers mains and submains.
- 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.

Anti-condensation heaters: To prevent accidental switching off, provide caution notices for anti-condensation heaters.

Insulation and shrouding: For insulation or shrouding requiring removal during normal assembly maintenance, provide danger notices with appropriate wording for replacement of insulation shrouding before re-energising assemblies.

Positioning: Locate notices so that they can be readily seen, next to or, if impracticable, on busbar chamber covers of functional units and behind the front cover of functional units. Provide circuit identification labels in the cabling chamber of each functional unit, located next to external terminations.

- **Schedule cards**

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

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

- **Single-line diagrams**

Main and submain assemblies: Provide single-line diagrams.

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

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

- **Marking cables**

General: Identify the origin of all wiring by means of 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.

LIGHTING

1 GENERAL

1.1 RESPONSIBILITIES

■ **General**

General: Provide lighting and control systems, as documented to AS1158.3.1, AS2560.2.3 & AS4282.

■ **Proprietary equipment**

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

■ **Minimum energy performance standards (MEPS)**

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

Self-ballasted lamps: To AS/NZS 4847.2.

1.2 CROSS REFERENCES

■ **General**

Requirement: Conform to the following:

- *Cable support and duct systems.*
- *Low voltage power systems.*
- *Switchboard components.*

1.3 STANDARDS

■ **Standards**

Air-handling luminaires: To AS/NZS 60598.2.19.

EMC compliance: To AS/NZS CISPR 15.

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

Fixed general purpose luminaires: To AS/NZS 60598.2.1.

Floodlights: To AS/NZS 60598.2.5.

Harmonic limits: AS/NZS 61000.3.2.

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

Luminaires: To AS/NZS 60598.1.

Luminaires for swimming pools: To AS/NZS 60598.2.18.

Luminaires for use in clinical areas of hospitals and health care buildings: To AS/NZS 60598.2.25.

Luminaires with built-in transformers for filament lamps: To AS/NZS 60598.2.6.

Portable general purpose luminaires: To AS/NZS 60598.2.4.

Recessed luminaires: To AS/NZS 60598.2.2.

Road lighting luminaires: To AS/NZS 1158.6.

Radio interference limits: To AS/NZS CISPR 15.

1.4 INTERPRETATIONS

■ **Abbreviations**

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

- CCT: Correlated colour temperature.
- CFL: Compact fluorescent lamps.
- CRI: Colour rendering index.

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

■ **Definitions**

General: For the purposes of this worksection the definitions given below apply.

- Control system: A lighting control system comprising a combination of some or all of the following:
  . Timers.
  . Manual overrides.
  . Remote control operation via Cloudmaster controller.
- Proprietary luminaires: Luminaires available as a catalogue item.
- Incandescent lamp: Lamps as covered in AS 4934.2 including both tungsten filament and tungsten halogen types.

1.5 SUBMISSIONS

■ **Technical data**

General: Submit technical data of the following:

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

■ **Shop drawings**

General: Submit shop drawings for the following:

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

■ **Samples**

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

■ **Tests**

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

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

2 PRODUCTS

2.1 GENERAL

■ **Proprietary luminaires**

General: 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.

2.2 LIGHT-EMITTING DIODES (LEDS)

■ **General**

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

■ **Light-emitting diode luminaires**

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

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

Life of the LED in the complete luminaire: L_{70} to IES LM-80-2008, unless documented.

The efficacy shall be confirmed by a photometric test from a NATA approved laboratory. The test shall be carried out for the correct Correlated Colour Temperature.

Colour: CRI > 80.

CCT: 4100 K.

2.3 CONTROL GEAR ENCLOSURE

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

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

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

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

Fixing: Screw fixed.

2.4 WIRING

■ **Flexible cords**

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

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

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

- Cross sectional area: ≥ 1 mm^2.

2.5 WIRING CONNECTION

■ **Recessed luminaires**

General: Connect recessed luminaires to a plug socket outlet.

■ **Lighting tracks**

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

■ **Ingress Protected (IP) Rated Luminaires**

General: Wire to IP rated luminaires in circular cabling with IP68 cable glands into the luminaire manufacturers junction box to the luminaire manufacturer's installation details. Do not use flat cabling through round cable glands unless the luminaire manufacturer's installation instructions nominate flat cables as acceptable into junction device that excludes air gaps.

Pre-Sealed Luminaires: Do not open luminaires that are sealed at the factory where nominated in the luminaire installation instructions.

2.6 CUSTOM DESIGNED POLES/COLUMNS

■ General

Provide columns designed, manufactured and tested by a specialist manufacturer.

Submit shop drawings of all poles for approval prior to fabrication.

Unless specified otherwise all poles shall be flange mounted onto ragbolt assemblies in reinforced concrete.

Provide an earth bar bolted to a strap welded to the pole. The bar shall have separate studs to terminate the incoming earth and the grading ring surrounding the pole.

No mounting screws shall penetrate the outside surface of the pole. Any screws or bolts that are installed in the pole after galvanizing shall be painted with zinc rich epoxy paint.

The pole shall be designed to suit the load and environment.

The footings of carpark light poles shall be installed so that the top of the flange is 150mm below finished ground level. The surface of the pole that is to be below ground level shall be painted inside and out in bituminous epoxy paint.

Following the installation the pole shall be adjusted for verticality using non perishable, non hydroscopic packers. The ragbolts and nuts will then be painted with bituminous epoxy paint prior to backfilling around the pole.

The pole shall have a lockable door it the base. The door shall be flush and shall have a minimum height of 250mm.

■ Standards

Steel structures: To AS 4100.

Structural design of columns: To AS/NZS 4676.

Hot-dipped galvanised (zinc) coatings on ferrous articles: To AS/NZS 4680.

To the local network distributor's standards and to the local Service and Installation Rules.

■ Design

Sports Lighting Columns: Provide tapped hot-dipped galvanised steel columns, designed, manufactured and tested by a specialist manufacturer.

Carpark and Pathway Lighting Poles: Provide straight round hot-dipped galvanised steel columns, designed, manufactured, tested and painted by a specialist manufacturer.

Mounting: Conform to the following

- Steel columns: Provide base plate mounting, suitable for mounting on rag bolt assemblies.

Footings: Provide footings and rag bolt assemblies detail designed by a professional engineer and independently certified.

Site specifics: Take into consideration the design wind category and the soil conditions.

Dimensions: To AS 1798.

Rag bolt assemblies: Provide galvanised threaded steel rag bolt assemblies of cross-sectional area designed to support each column taking into account the wind loads expected to act on the column and the luminaires mounted on the column. Set the rag bolt assemblies in the concrete footings.

Base sealing: Seal space under pole base plate with grout.

Electrical connections: For hollow metal or concrete poles provide a recess fitted with a flush mounted lockable or screw fixed cover at the base of the column for access to cable connections and equipment.

Fuse mounting: Provide fuse(s) within fixed holders mounted on a DIN rail mounting inside the pole/column accessible from the pole/column door. The pole shall be manufactured with a plate to mount the DIN rail prior to galvanising.

Drainage: Provide adequate drainage at the column base.

- **Construction**

General: Hot-dip galvanise steel columns and fittings after fabrication. Paint columns and fittings after fabrication.

Drainage: Provide adequate drainage at the column base.

- **Bases and footings for custom designed columns**

Requirement: Provide bases to custom designed columns as documented.

Bases: Provide mounting bases for rag bolt assembly fixing to reinforced concrete footings.

Footings: Provide footings as required.

Site specifics: Design for the site wind category and the soil conditions.

Dimensions: To AS 1798.

Rag bolt assembly: Cut holding bolts within 3 threads above top of base plate top lock nuts.

Base fixing: Galvanised holding down nut with galvanised lock nut above.

Design of footing and rag bolt assemblies: Undertake design by a professional engineer and provide independent certification.

Base sealing: Seal space under pole base plate with grout.

Finish: Paint, colour as documented.

Carpark light pole bonding: Provide a 1m diameter grading ring of bare 16mm^2 cable to a depth of 300mm below ground level around the light pole/column and equipotential bond to the pole earth bar in accordance with AS1768.

Sports light pole bonding: Provide a 1500mm diameter grading ring of bare 16mm^2 cable to a depth of 300mm below ground level around the light pole/column and equipotential bond to the pole earth bar in accordance with AS1768.

2.7 POST MOUNTED LIGHTS

Supply and install post mounted lights as specified in the Schedule of Luminaires and indicated on the drawings.

The fittings shall be mounted on pole manufactured as indicated on the drawing.

Provide in the base of the pole, fixed, insulated terminals capable of accepting 2 x 16mm^2 cables each.

Terminals shall be provided for circuits looped through the poles as well as the specific pole lighting circuit.

Provide a 5A HRC cartridge fuse carrier and base to protect the cable to the luminaire.

2.8 POLE SURFACE TREATMENT

Sports lighting poles shall be hot-dip galvanised.

Carpark light poles shall be hot-dip galvanised after fabrication and painted with DULUX Ferreko No 3(MIO) coating system as per DULUX specification:

First coat - DULUX Durebild STE - PC237; DFT 150 microns

Second coat - DULUX Ferreko No 3 - PC560; DFT 100 microns

Third coat - DULUX Ferreko No 3 - PC560; DFT 100 microns; Colour - Natural Grey (charcoal black)

Parts of pole below ground level and up to 150mm above ground level - bituminous epoxy paint inside and out, this is to be applied in the factory prior to painting where poles are painted.

2.9 POLE LABELLING

Note: All poles, cubicles etc are to be labelled with the location of supply in accordance with the Service and Installation Rules of NSW. The label shall be engraved Aluminium or Stainless steel and shall be permanently fixed to the pole immediately above the door.

The label shall comply with the Principal's standard asset label drawing. The Superintendent will provide the drawing together with the asset number of each light.

The pole label shall typically state:

"Property of #####

Pole Number ### - ##

Contact Phone Number - #### ####

Supply point – ########"

Letter type shall be 10mm Arial font.

- **Fixing: Fix labels securely.**

The asset number will be provided by the Superintendent.

Fixing methods: Use screws and double-sided adhesive. Fixed in extruded aluminium sections attached to panels with rivets or countersunk screws.

Aluminium labels: Aluminium or monel rivets.

Restrictions: Do not use self-tapping or thread-cutting screws.

Permanent fixing: Fix labels permanently in place.

2.10 LIGHTING CONTROL

- **Manual controls**

General: Provide manual control of luminaires as documented.

- **Digital control system**

General: Provide a proprietary, microprocessor-based system to control lighting under automatic and user interface control, as documented.

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

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

- **Completion Tests**

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

Commissioning: Test and verify the operation of the lighting control installation including the remote booking facility from Council's head end. Verify 100 lux switching.

Demonstration: Demonstrate the operation of the lighting control installation including the remote booking facility from Council's head end to the Council's nominated staff. Provide one week notice of the proposed demonstration evening.

3 EXECUTION

3.1 SUPPORTS

- **General**

General: Install luminaires on lighting column headframes.

3.2 COMPLETION

- **General**

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

- Verify the operation of all luminaires.
- Adjust aiming and controls for all luminaires under night time conditions.

- Replace lamps which have been in service for a period greater than 50% of the lamp life as published by the lamp manufacturer.

SERVICE TRENCHING

1 GENERAL

1.1 RESPONSIBILITIES

■ **General**

General: Provide trenching for underground services in conduits.

1.2 STANDARDS

■ **General**

Earthworks: To AS 3798.

1.3 INSPECTION

■ **Notice**

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

- Services laid in trenches and ready for backfilling

1.4 SUBMISSIONS

■ **General**

Extent: Submit a plan of trench works noting the location and type of service.

Notice: Advise proposed duration of open excavation.

Construction: Submit details of proposed equipment and method of excavation.

Stability: If shuttering and/or bracing of the sides of a trench is required for safety and stability, provide proposals.

Hazards: Identify OH&S hazards that may be encountered with deep trenches including toxic gases and liquids.

Boring: Submit proposals for the following:

- Limits on length.
- Existence of other services and method of protection.
- Pressure grouting to voids.
- The effect of pressure grouting on other services, ground heave and proposals for minimising such effects.
- Access to properties outside the site.
- Council permits.
- Service interruptions including a plan for minimising unintended interruptions.

■ **Off-site disposal**

Disposal location: Submit the locations and evidence of compliance with the relevant authorities for the disposal of material required to be removed from the site.

2 EXECUTION

2.1 EXISTING SERVICES

■ **Location**

Requirement: Before commencing service trenching, locate and mark existing underground services in the areas which will be affected by the service trenching operations.

Utility services: Contact DIAL BEFORE YOU DIG to identify location of underground utility services pipes and cables.

■ **Excavation**

General: Do not excavate by machine within 1 m of existing underground services.

2.2 EXISTING SURFACES

- **Concrete and asphalt pavements**

Method: Sawcut trench set out lines for the full depths of the bound pavement layers except where the set out line is located along expansion joints.

Removal of concrete and asphalt: Break out concrete or asphalt pavement material between the trench set out lines, remove and dispose of off-site.

- **Segmental paving units**

Removal: Take up segmental paving units both full and cut by hand, between the trench set out lines, and neatly stack on wooden pallets.

Concrete edging: Break out, remove and dispose of off-site.

Concrete subbase: If present, sawcut along the trench set out lines.

- **Grass**

Method: Neatly cut grass turf between trench set out lines into 300 mm squares. If the grass is suitable for re-use, take up and store the turf and water during the storage period, otherwise remove and dispose of it off-site.

- **Small plants, shrubs and trees**

Storage: If required for re-planting, take up small plants and store. Wrap the root ball in a hessian or plastic bag with drain holes and water during the storage period.

Unsuitable vegetation: Remove and dispose of off-site.

2.3 EXCAVATING

- **Excavation**

General: Excavate for underground services in conformance with the following:

- To required lines and levels, with uniform grades.
- Straight between access chambers, inspection points and junctions.
- With stable sides.
- To a width tolerance of ± 50 mm unless constrained by adjacent structures.

- **Trench widths**

General: Keep trench widths to the minimum consistent with the laying and bedding of the relevant service and construction of access chambers and pits.

- **Trench depths**

General: As required by the relevant service and its bedding method, refer AS3000 & AS/ACIF S009.

Adjacent to footings: If excavation is necessary below the zone of influence of the underside of adjacent footings, give notice, and provide support for the footings as instructed.

- **Obstructions**

General: Clear trenches of sharp projections. Cut back roots encountered in trenches to at least 600 mm clear of services. Remove other obstructions including stumps and boulders which may interfere with services or bedding.

Tree protection: To AS 4970. Avoid tree roots within the root protection zone.

- **Dewatering**

General: Keep trenches free of water. Place bedding material, services and backfilling on firm ground free of surface water.

Pumping: Provide pump-out from adjacent sumps or install well points.

Adjacent subsidence: Provide recharge points to isolate the dewatering zone.

- **Excess excavation**

General: If trench excavation exceeds the correct depth, reinstate to the correct depth and bearing value using compacted bedding material or sand stabilised with 1 part of cement to 20 parts of sand by volume.

- **Stockpiles**

Excavated material for backfill: If required, segregate the earth and rock material and stockpile, for re-use in backfilling operations.

Locations: Do not stockpile excavated material against tree trunks, buildings, fences or obstruct the free flow of water along gutters where stockpiling is permitted along the line of the trench excavation.

Disposal: If stockpiling is not permitted, dispose of excavated material off-site.

- **Unsuitable material**

Disposal: Remove unsuitable material from the bottom of the trench or at foundation level and dispose of off-site. Replace with backfill material to **Backfill material.**

- **Boring**

Subcontractor: If under road boring is required in lieu of trenches, engage a suitably qualified subcontractor to do the work.

2.4 TRENCH BACKFILL

- **General**

Timing: Backfill service trenches as soon as possible after laying and bedding the service, if possible on the same working day.

Marking services: Underground marking tape to AS/NZS 2648.1.

- **Bedding, haunch, side and overlay zones**

Installation and material: To the particular utility authority or utility service requirements. Secure pipes against floatation.

Overlay zone thickness: Maximum of 300 mm immediately over the utility service.

Topsoil areas: Complete the backfilling with at least 100 mm of topsoil.

Material in reactive clay areas: In sites classified M, M-D, H1, H1-D, H2, H2-D, E or E-D to AS 2870, re-use excavated site material at a moisture content within ± 1% of that of the adjoining in situ clay.

- **Selected material zone**

Extent: The section of trench within the zone, if applicable.

Backfill material: Selected material free from stones larger than 100 mm maximum dimension and the fraction passing a 19 mm Australian Standard sieve to have a 4 day soaked CBR value, in conformance with AS 1289.6.1.2, and not less than that of the adjacent selected material zone.

- **Trees**

General: Backfill at trees, for a minimum 300 mm thickness, around tree roots with a topsoil mixture, placed and compacted in layers of 150 mm minimum depth to a dry density equal to that of the surrounding soil.

Backfill level: Do not place backfill material above the original ground surface around tree trunks or over the root zone.

Watering: Thoroughly water immediately after backfilling the tree root zone.

- **Compaction**

Layers: Compact all material in layers not exceeding 150 mm compacted thickness. Compact each layer before the next layer is commenced.

Precautions: If compacting adjacent to utility services, use compaction methods which do not cause damage or misalignment.

2.5 SURFACE RESTORATION

- **Subbase and base**

Material: Provide crushed rock, DGS20 or DGB20 material and configure in layers and depths to match existing and adjacent work.

Compaction: Uniformly compact each layer of the subbase and base courses over the full area and depth within the trench to a relative compaction of 100 per cent when tested in conformance with AS 1289.5.4.1.

Tests: Test for compaction at a minimum frequency of 1/ every second layer/50 m² of restoration surface area.

■ **Pathways and paved areas generally**

Materials: Provide material consistent with the surface existing before commencement of the works.

Subbase: 150 mm crushed stone DGB20 compacted to 100 percent relative compaction in conformance with AS 1289.5.4.1.

Lippage at patches: Match the surface level at any point along the patch's edge with the adjoining footpath surface within ± 5 mm.

■ **Concrete surfaces**

Construction: Conform to the following:

- Prime coat the cut edges of the existing surfaces with cement slurry. Lay and compact concrete so that the edges are flush and the centre is cambered 10 mm above the adjoining existing surfaces.
- Material: 25 MPa concrete
- Surface finish and pattern: Match existing adjoining work.
- Minimum thickness: 75 mm or the adjacent pavement thickness, whichever is thicker.
- Reinforcement and dowels: If required, provide steel reinforcement with dowels into the adjacent concrete.
- Expansion joints: 15 mm thick preformed jointing material of bituminous fibreboard placed where new concrete abuts existing concrete and in line with joints in existing concrete.
- Control joints:
  . Form control joints strictly in line with the control joints in existing concrete.
  . Around electricity supply poles: Terminate the concrete paving 200 mm from the pole and fill the resulting space with cold mix asphalt.

Curing: Cure by keeping continuously wet for 7 days.

■ **Asphalt footpaths**

Thickness: Match the adjoining footpath.

Finish: Compact to a smooth even surface.

■ **Segmental paving units**

Materials and installation: To *Segmental pavers – sand bed* or *Segmental pavers – mortar bed* as appropriate and as follows:

- Laying: Re-lay to match the pattern and surface levels of the existing paving.
- Damaged paving units: Replace paving units which are unsuitable for relaying with new units of the same material, type, size and colour as the existing.

■ **Landscaped areas**

In topsoil areas: Complete the backfilling with topsoil for at least the top 100 mm.

Lawn: Re-lay stockpiled turf. If existing turf is no longer viable, re-sow the lawn over the trench and other disturbed areas.

Planted areas: Overfill to allow for settlement.

TENDER FORMS FOR LIGHTING & ELECTRICAL SERVICES

Tender Sum

I/We hereby tender for the work exactly in accordance with Lighting, Art + Science specification L150I_ESP and accompanying drawings.

Fixed Lump Sum Tender Price (excluding GST)	**$**
(in words)	
GST	$
(in words)	

Tenderer:

Address:

Signed: Date:

This tender form comprises pages 1 – 2 inclusive and is to be completed in full and returned as part of the tender submission.

Tender Apportionment

The following amounts may be used for the purpose of assessing progress claims:

Main switchboard & incoming power supply		$ .....
Distribution switchboards		$ .....
Metering		$ .....
Earthing		$ .....
Submains		$ .....
Lighting system		
Luminaire installation		$ .....
Luminaire supply		$ .....
Lighting control including Cloudmaster		$ .....
Pit and conduit system		$ .....
Other (specify)		$ .....
Operating and maintenance manual		$ .....
Preventative maintenance		$ .....
GST		$ .....
	Total	$ .....