Lumsden Point Street Lighting

Electrical Technical Specification

Pilbara Ports Authority

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→ **The Power of Commitment**

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TABLE OF CONTENTS

Table of contents **1**
0901 Electrical systems **2**
0911 Cable support and duct systems **5**
0921 Low voltage power systems **9**
0942 Switchboards - custom-built **13**
0943 Switchboard components **22**
0951 Lighting **29**

0901 ELECTRICAL SYSTEMS

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide the electrical services, as documented.

Summary: The electrical services are summarised as follows:

- Supply and installation of street lighting and associated electrical infrastructure.
- Supply and installation of 2-off electrical distribution boards

Performance

Requirement: 415 V, 3-phase, 4-wire, 50 Hz multiple earth neutral (MEN) system.

Performance criteria: Meet the performance criteria, as documented.

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

Site electricity supply

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

Low voltage supplies

Low voltage substation terminals point of supply: To AS/NZS 3000 (2018) and the electricity distributor's standards.

Low voltage protection: Provide low voltage short-circuit and overload protection at the main switchboard that receives the substation terminals supply, using fault current limiting circuit breakers with adjustable overload and short-circuit current setting features.

Low voltage circuit breakers: Include full discrimination and cascade protection while also grading with the incoming substation supply protection system and the downstream reticulation protection devices.

Switchboards

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

- *0942 Switchboards - custom-built.*

Electrical protection equipment: Include all necessary electrical protection equipment, electrical components and the electricity distributor's tariff metering equipment to the requirements of *0943 Switchboard components*.

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 (2018).

Electricity distributor's low voltage service protective device: To AS/NZS 3000 (2018), the electricity distributor's requirements and the Service and Installation Rules.

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

Electrical cable systems

Responsibilities: Provide the following cabling systems:

- Power cables: Provide cable systems as documented and to the requirements of *0921 Low voltage power systems*.

Lighting

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

- *0951 Lighting*.

1.2 CROSS REFERENCES

General

Should there be inconsistencies, the more stringent specification is to be used.

Requirement: Conform to the following:

- *0921 Low voltage power systems*.
- *0942 Switchboards - custom-built*.
- *0951 Lighting*.
- *A1235740 PILBARA PORTS ELECTRICAL SPECIFICATIONS.*

1.3 STANDARDS

Electrical services

Requirement: To AS/NZS 3000 (2018).

Electrical installations

Electrical design: To AS/NZS 3000 (2018).

Selection of cables: To AS/NZS 3008.1.1 (2017).

Verification: To AS/NZS 3019 (2022).

Residual current devices (RCDs): To AS/NZS 3190 (2016).

Degrees of protection (IP code): To AS 60529 (2004).

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

Machinery noise and vibration: Vibration severity in Zone A to ISO 20816-1 (2016) and ISO 20816-3 (2022).

Best environmental practice (BEP) PVC: Conform to AS/NZS 5395 (2024), including all marking requirements.

1.4 SUBMISSIONS

Certification

Plant and equipment - proposed: Submit certification that the plant and equipment proposed meet the requirements and capacities documented.

Plant and equipment - installed: On satisfactory completion of the installation and before the date for practical completion, submit certification that each plant and equipment installation is operating correctly.

Operation and maintenance manuals

Products and materials

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

- Assumptions.
- Calculations.
- Model name, designation and number.
- Capacity of all system elements.
- Country of origin and manufacture.
- Materials used in the construction.
- Size, including required clearances for installation.
- Certification of conformance to the applicable code or standard.
- Technical data schedules corresponding to the equipment schedules in the contract documents. If there is a discrepancy between the two, substantiate the change.
- Manufacturers' technical literature.
- Type test reports.
- Single line diagram(s), including fault levels at switchboards, cable size and type.
- Switchboard layouts.

High voltage supplies: Before ordering the equipment, submit a fault and protection report to **RESPONSIBILITIES**, **High voltage supplies**.

Shop drawings
Requirement: Submit detail drawings at minimum 1:100 scale, showing the following as applicable:
- Switchboard layout, equipment details and labelling.
- Mechanical motor control board layout, equipment details and labelling.
- Layouts of control panels including control functions logic diagram, wiring diagram, proposed terminology and labelling.
- Control system schematics with wire/ terminal identification.
- Control sensor and control device layouts.
- Control cable routes, cable sizes and types of cable, cable identification labelling.
- Wiring diagrams.
- Cable ladder and tray routes.
- Concealed conduit locations with interconnections.
- Cable riser layouts, take-offs and sections.
- Plant room layouts detailing electrical equipment.
- Connections to other services.
- Penetrations and associated building work. If penetrations are through external walls, detail flashing and weatherproofing at 1:10 scale.
- Reflected ceiling plan layouts showing lighting, emergency lighting, emergency warning system equipment, fire detection equipment and HVAC outlets.
- Power and communication system layout.
- Fire detection system layout.
- Security system layout.
- External services layouts including underground cable routes and pit locations, underground communications cable routes and pit locations.
- Lightning protection system layout.
- Submission drawings required by authorities.

2 PRODUCTS

2.1 ELECTRICAL ACCESSORIES

General
Requirement: Provide accessories, as documented.

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.

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 INSTALLATION

Switchboards
Floor mounted island switchboards: Fix to floor plinths, using suitable fasteners able to withstand seismic events nominated in the project documentation.

3.2 COMMISSIONING

General
Requirement: Provide commissioning as documented. Conform to SA TS 5342 (2021).

0911 CABLE SUPPORT AND DUCT SYSTEMS

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide underground wiring enclosures and lighting poles, as documented.

1.2 CROSS REFERENCES

General
Should there be inconsistencies, the more stringent specification is to be used.

Requirement: Conform to the following:

- *0901 Electrical systems*.
- *A1235740 PILBARA PORTS ELECTRICAL SPECIFICATIONS.*

1.3 INTERPRETATION

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

- Poles: Has the same meaning as columns and is a structure that is uniform in diameter or tapered, used to attach overhead power cables or mount luminaires.
- Underground wiring enclosures: Conduit network with draw-in pits.

1.4 SUBMISSIONS

Certification
General: Submit professional engineer's certification for the following:

- Fabricated poles.

Operation and maintenance manuals
Requirement: Submit manual to **COMPLETION**, **Operation and maintenance manuals**.

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

- Proprietary poles.

Type tests: Submit test results for the following:

- Cable support systems: To **CABLE TRAY/LADDER/MESH SYSTEMS**, **General**.

Shop drawings
Cable support and duct systems: Submit shop drawings showing the following:

- Layout of underground wiring enclosures comprising conduits, pits and pit drainage systems.
- Depth of burial for cables and conduits.
- In situ pits.
- Fabricated poles.
- Footing for poles.

2 PRODUCTS

2.1 GENERAL

Storage and handling
Requirement: To Superintendents requirements

Product identification
General: Marked to show the following:

- Manufacturer's identification.
- Product brand name.
- Product type.

- Quantity.
- Product reference code and batch number.
- Date of manufacture.

2.2 CONDUITS - GENERALLY

General

Standard: To AS 61386.1 (2015).

Conduits will be pre-installed by the principal (PPA), and the streetlight installation contractor will need to tie into the existing conduits on site. Contractor to check existing conduits. Any discrepancies from conduits on the drawings must be brought to the Superintendent's attention for resolution and direction.

Type

General: Rigid.

Sizes

Requirement: Conform to the following:

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

Fasteners

Surface mounted: Double-sided fixed.

Colour

Conduits generally:

- Underground: Light orange.
- Above ground: Grey.

2.3 NON-METALLIC CONDUITS AND FITTINGS

General

Standards: To AS/NZS 61386.21 (2015), AS/NZS 61386.22 (2022) and AS/NZS 61386.23 (2015).

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

Conduits and pits will be pre-installed by the principal (PPA), and the streetlight installation contractor will need to tie into the existing conduits on site.

Fibre cement conduit

Requirement: Use heavy duty conduit if increased compressive and tensile strength is required.

Flexible conduit

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

Associated fittings

Type and material: Same as the conduit.

Wall boxes on PVC-U conduits: For special size wall boxes not available in PVC-U, provide prefabricated earthed metal boxes.

Inspection-type fittings

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

Joints

Type: Cemented or snap-on joints.

2.4 CABLE PITS

General

Pits will be pre-installed by the principal (PPA), and the streetlight installation contractor will need to tie into the existing conduits and pits on site. Contractor to check existing pits. Any discrepancies from pits on the drawings must be brought to the Superintendent's attention for resolution and direction.

2.5 LIGHTING POLES

General

Requirement: Provide tapered hot-dip galvanized steel, conforming to the following:

- Propriety pole designed, manufactured and tested by a specialist manufacturer.

- Fabricated pole designed by a professional engineer.

Flush access panel: Fit to base of hollow pole structures for installation of electrical protection equipment and cable connections.

Standards

Public lighting poles: To AS 1798 (2014).

Concrete structures: To AS 3600 (2018).

Steel structures: To AS 4100 (2020).

Hot-dip galvanized (zinc) coatings on ferrous articles: To AS/NZS 4680 (2006).

Bases and footings

Mounting: Conform to the following:

- Steel and aluminium poles: Direct buried footing.
- Concrete poles: Embedded in the ground.

Footings: Provide footings details designed by a professional engineer and independently certified.

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

Dimensions: To AS 1798 (2014).

Drainage: Provide adequate drainage at the pole base.

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

3 EXECUTION

3.1 UNSHEATHED CABLES

General

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

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

3.2 CONDUIT SYSTEMS

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

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

Thermal expansion

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

Rigid conduits

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

Routes

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

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

3.3 CABLES IN TRENCHES

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.

3.4 LIGHTING POLES

General

Requirement: Provide poles including footings, as documented.

Poles embedded in the ground: Set poles in the ground to AS 1798 (2014) and to the manufacturer's requirements.

Soil unsuitable for embedded poles: Mount poles encased in concrete concrete footings to a professional engineer's requirements and the manufacturer's requirements.

3.5 COMPLETION

Operation and maintenance manuals

Requirement: Prepare a manual that includes details necessary to operate and maintain the equipment and systems installed.

0921 LOW VOLTAGE POWER SYSTEMS

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide low voltage power systems, as documented.

1.2 PERFORMANCE

Network supply

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

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

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

Supply system: 415 V, 3-phase, 4-wire, 50 Hz, multiple earth neutral (MEN) system.

Distribution system

General: Provide power distribution system elements, as documented.

Surge protection devices (SPD)

General: Provide surge protection devices, as documented.

1.3 CROSS REFERENCES

General

Should their be inconsistencies the more stringent specification is to be used.

Requirement: Conform to the following:

- *0901 Electrical systems*.
- *0911 Cable support and duct systems*.
- *A1235740 PILBARA PORTS ELECTRICAL SPECIFICATIONS .*

1.4 STANDARDS

General

Requirement: To AS/NZS 3000 (2018) Part 2.

Electrical equipment: To AS/NZS 3100 (2022).

Fire and mechanical performance classification: To AS/NZS 3013 (2005).

Selection of cables: To AS/NZS 3008.1.1 (2017).

Distribution cables: To AS/NZS 4961 (2003).

Degrees of protection (IP code): To AS 60529 (2004).

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

Testing

Standard: To AS/NZS 3017 (2022).

1.5 INTERPRETATION

Abbreviations

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

- RCD: Residual current device.
- SPD: Surge protection device.

1.6 SUBMISSIONS

Certification

Requirement: Submit certification of conformity to AS/NZS 3000 (2018), for electrical services.

Design documentation

Low voltage power systems: 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, including grading charts.
- Prospective short-circuit current automatic disconnection times.
- Earth fault loop impedance calculations for testing and verification.
- Stringing calculations for private aerial cables.

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

Operation and maintenance manuals

Requirement: Submit manual to **COMPLETION**, **Operation and maintenance manuals**.

Tests

Requirement: Submit results of the following:

- Verification testing of the installation to **TESTING**, **Site tests**.
- Connections to electricity networks to **TESTING**, **Site tests**.

2 PRODUCTS

2.1 SITE ELECTRICITY SUPPLY

General

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

LV supplies from dedicated substations

LV transformer output supply: To AS/NZS 3000 (2018) and the Service and Installation Rules.

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

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

Consumers mains

Requirement: Provide consumers mains, associated services and all necessary fault and overload current protection equipment to AS/NZS 3000 (2018) Section 3, the electricity distributor’s standards and the Service and Installation Rules.

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

Metering

Retail: To the requirements of the electricity retailer and the electricity distributor.

2.2 WIRING SYSTEMS

General

Wiring and site cable reticulation systems: Appropriate to the installation conditions and the function of the load. Include the following:

- Underground services.

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

Cable support system: To *0911 Cable support and duct systems*.

2.3 POWER CABLES

Standards

Polymeric insulated cables: To AS/NZS 5000.1 (2005).

Cable

Requirement: Select multi-stranded copper cables, insulated and sheathed. Include protective earthing system earth conductor.

Default insulation: X-90.

Default sheathing: PVC-90.

Minimum size: Conform to the following:

- Lighting subcircuits: 1.5 mm^2.
- Power subcircuits: 2.5 mm^2.
- Submains: 6 mm^2.

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

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

Underground residential distribution (URD) systems: Cables to AS/NZS 4026 (2008).

Distribution cables: To AS/NZS 4961 (2003).

Colours

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

Active conductors in single phase circuits: Red.

Active conductors in polyphase circuits:

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

Neutral conductors: Black.

Earthing conductors: Green-yellow.

Sheath: White.

2.4 ELECTRICAL PROTECTION SYSTEMS

General

Requirement: Provide the following protection systems, as documented:

- Fault protection to AS/NZS 3000 (2018) clause 2.4.
- Overcurrent to AS/NZS 3000 (2018) clause 2.5.
- Residual current to AS/NZS 3000 (2018) clause 2.6.
- Overvoltage to AS/NZS 3000 (2018) clause 2.7.
- Undervoltage to AS/NZS 3000 (2018) clause 2.8.
- Arc fault detection to AS/NZS 3000 (2018) clause 2.9.

3 EXECUTION

3.1 SITE ELECTRICITY SUPPLY

General

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

3.2 EARTHING

Earthing systems

Protective earthing system with a multiple earth neutral (MEN) connection: To AS/NZS 3000 (2018) Section 5 and as documented.

Earth electrodes

General: Provide electrodes to AS/NZS 3000 (2018) clause 5.3.6.

3.3 POWER CABLES

Cable installation

Classifications: To AS/NZS 3013 (2005).

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

Stress: Do not use installation methods that exceed the cable's pulling tension. Use cable rollers 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.

Tagging

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

Marking

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

Submains and final subcircuits

Installation: Provide the following:

- Cables with diameter less than 13 mm: Run in conduit, cable ducts or support on cable trays or ladders.
- Single core cables of 3-phase circuits: Install unenclosed single core cables of diameter greater than 13 mm laid on cable tray in trefoil (RWB) or quadrofoil (RWBN) groups.
- Cables for lighting systems: Run in conduit

3.4 COPPER CONDUCTOR TERMINATIONS

General

Requirement: Other than for small accessory and luminaire terminals, terminate copper conductors to equipment, with compression-type lugs of the correct size for the conductor. Compress using the 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 PVC-U 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 bind the spare cores to the terminated cores.

3.5 TESTING

Site tests

Inspection: Before testing, visually inspect the installation to AS/NZS 3000 (2018). Record on a checklist.

Verification: Test and verify the installation to AS/NZS 3000 (2018) Section 8 using the methods outlined in AS/NZS 3017 (2022). Record the results of all tests in the same sequence as undertaken.

Electricity networks: Test and verify the connections to electricity networks to AS 4741 (2010). Record the results of all tests.

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

3.6 COMPLETION

Operation and maintenance manuals

Requirement: Prepare a manual that includes details necessary to operate and maintain the equipment and systems installed.

0942 SWITCHBOARDS - CUSTOM-BUILT

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide custom-built switchboards, as documented.

1.2 CROSS REFERENCES

General

Should their be inconsistencies the more stringent specification is to be used.

Requirement: Conform to the following:

- *0901 Electrical systems*.
- *0921 Low voltage power systems*.
- *A1235740 PILBARA PORTS ELECTRICAL SPECIFICATIONS .*

1.3 STANDARDS

General

General: To AS/NZS 3000 (2018).

Main switchboards and distribution switchboards: To AS/NZS 61439.1 (2016), AS/NZS 61439.2 (2016) and the recommendations of SA/SNZ TR 61439.0 (2016).

1.4 INTERPRETATION

Definitions

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

- Custom-built assemblies: Low voltage switchgear and controlgear assemblies manufactured to order and incorporating either purpose built or proprietary components or either purpose built or proprietary busbar assemblies.
- Fault current limiters: Circuit opening devices designed or selected to limit the instantaneous fault current.
- Incoming busbars: Busbars connecting incoming terminals to line side terminals of main switches.
- Main circuit supply busbars: Busbars connecting incoming functional unit terminals, or incoming busbars if no main switches are included, to outgoing functional unit terminals or outgoing functional unit tee-offs.
- Proprietary assemblies: Low voltage switchgear and controlgear assemblies available as a catalogue item, consisting of the manufacturer's standard layout and equipment. Minor modifications are permissible to accommodate equipment and accessories, whilst retaining standard format.
- Rated currents: Continuous uninterrupted current ratings within the assembly environment under in-service operating conditions.
- Rated short-circuit currents: Maximum prospective symmetrical root mean square (r.m.s.) current values at rated operational voltage, at each assembly incoming supply terminal.
- Tee-off busbars: Busbars connecting main busbars to incoming terminals of outgoing functional units.

1.5 SUBMISSIONS

Design documentation

Calculations: Submit the following:

- Detailed certified calculations verifying design characteristics.
- Design calculations of the following:
  - . Busbar assemblies that have not been type-tested.
  - . Non-proprietary busbar assemblies.

Standard: To AS 60890 (2009).

Operation and maintenance manuals
Requirement: Submit manual to **COMPLETION**, **Operation and maintenance manuals**.

Products and materials
Type tests: Submit test results of the following:
- Electrical and mechanical routine function: To PRODUCTS, **GENERAL**, **Tests**.
- Dielectric properties: To PRODUCTS, **GENERAL**, **Tests**.

Verification tests to the AS/NZS 61439 series: Submit verification test certificates for components, functional units and assemblies with evidence that the tests, including any internal arcing-fault tests required, were carried out at not less than the designated fault currents at rated operational voltage.

Alterations to assemblies tested to the AS/NZS 61439 series: Submit records of alterations made to assemblies since the tests.

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

Tests
Standard: To AS/NZS 61439.1 (2016).

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

Dielectric properties: To AS/NZS 61439.1 (2016) clause 10.9.

Dielectric test voltage: To AS/NZS 61439.1 (2016) clause 10.9.2.1.

2.2 CUSTOM-BUILT SWITCHBOARD CONSTRUCTION

Switchboard manufacturer

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

Switchboard connection

Type: Front connected.

Enclosure

Default material: Min 2 mm thick powder-coated zinc annealed steel or zinc-alum sheet as per AS/NZS 61439

Separation

Default: Form 3b to AS/NZS 61439.2 (2016).

Metering

Requirement: To *0921 Low voltage power systems*.

Main switchboard main switches

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

Busbars

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

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

Spare capacity

Default spare poles: Provide at least 20%.

Main switchboard incoming busbars and main circuit supply busbars: Provide at least 25%.

Surge protection

General: Provide surge protection, as documented.

IP rating

Weatherproof: IP66 minimum.

Equipment layout

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

Connection: Front connected.

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

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

Supporting structure

Assemblies:

- Floor mounted: Greater than 2 m^2.

Ventilation

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

Arc fault containment: Provide ventilation ducts and covers to allow the escape of hot gases generated under fault conditions.

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 (2021).

Material thickness:

- Diagonal dimension:
  . Less than 900 mm: Minimum 1.6 mm.
  . Equal to or greater than 900 mm: Minimum 2.0 mm.

Coating class:

- Outdoor assemblies: ZF100 .

Insect-proofing

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

Equipment mounting panels

General: To support the weight of mounted equipment.

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

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

Non-metallic boards: To IEC 60893-1 (2004).

Equipment fixing

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

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

Earth continuity

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

Construction

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

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

Floor-mounting: Provide mild steel channel plinth, galvanized to class Z600, with toe-out profile, nominal 75 mm high x 40 mm wide x 6 mm thick, for mounting complete assemblies on site. Drill M12 clearance holes in assembly and channel and bolt assemblies to channel. Prime drilled holes with zinc rich organic primer to AS/NZS 3750.9 (2009).

2.3 CABLE ENTRIES

General

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

Cover and gland plates

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

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

Materials: Conform to the following:

- Generally: 1.5 mm thick steel, 5 mm thick composite material or laminated phenolic.

2.4 BUS TRUNKING SYSTEM ENTRY

General

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

2.5 DOORS AND COVERS

General

Requirement: Provide lockable doors with a circuit card holder unless enclosed in a cupboard or a dedicated room.

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 the following:

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

Door hardware: Provide the following:

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

Locking: Incorporate cylinder locks in the latching system. 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, using corrosion-resistant acorn nuts with serrated washers. Rest cover edges on the cubicle body or on mullions. Do not provide interlocked covers.

Handles: Provide corrosion-resistant D type handles.

Escutcheons

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

Escutcheon plates

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

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

2.6 FACTORY FINISHES

General

Standard: To AS 2700 (2011).

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

Finish coats: Thermoset powder coating to AS 4506 (2024) or two-pack liquid coating of AS/NZS 3750.13 (1997) primer and proprietary or epoxy acrylic full gloss spray finish.

Factory finish colours

Mounting structure (brackets): To match enclosure.

Enclosure - outdoor:

- Outdoor assemblies: Orbital sanded finish
- Assembly interior: Orbital sanded finish.

Escutcheons - removable equipment panels:

- Internal assemblies: Orbital sanded finish.
- External assemblies: Orbital sanded finish.

Doors: To match enclosure.

Plinths: Black.

2.7 BUSBARS

General

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

Standards: To AS 60890 (2009).

Custom-built busbar construction

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

Temperature rise limits - active and neutral conductors:

- Maximum rated current temperature rise limits: 65 ±1.5°C by type test or calculation to AS 60890 (2009).
- Maximum short-circuit withstand current temperature rise limits: 160°C.

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

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

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

Proprietary busbars

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

Phase sequence

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

Colour coding

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

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

Neutral busbar: Black.

MEN link: Green-yellow and black.

Protective earth busbar: Green-yellow.

Restrictions: Do not provide adhesive type colour bands.

Current carrying capacity

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

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

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

Tee-off busbars current rating

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

Multiple functional units: Equal to the diversity factors of AS/NZS 61439.1 (2016), based on frame size rating.

MEN links

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

Fault current limiters

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

Busbar links

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

Cable connection flags

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

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

Future extensions

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

Jointing

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

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

Custom-built busbar insulation

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

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

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

Damaged insulation: Repair damaged insulation before energising.

2.8 NEUTRAL LINKS AND EARTH BARS

Terminals

General: Provide terminals for future circuits.

Links

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

Assembly capacity no more than 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 more than 10 mm^2: Provide bolts or studs.

Communications earth: Make provision for connection of communications systems earth at switchboard earth bar to AS/CA S009 (2020).

2.9 INTERNAL WIRING

Wiring

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

Cable interconnections

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

- Minimum 1.5 mm^2 internal cables, with minimum V75 insulation rating with stranded copper conductors rated to AS/NZS 3008.1.1 (2017). Provide cables with current ratings suitable for the

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

- Run cables clear of busbars and metal edges.
- Provide cables capable of withstanding maximum thermal and magnetic stresses associated with relevant fault level and duration.
- Run cables neatly. Provide slotted trunking sized for future cables or tie at 150 mm maximum intervals with ties strong enough to withstand magnetic stresses created at the specified fault current. Do not provide adhesive supports.
- Provide for installation of wiring for future equipment without removal of existing equipment.
- Identify power and control cables at both ends with neat fitting ring type ferrules agreeing with record circuit diagrams.
- Terminate control cables and motor control circuits in tunnel terminals or, if necessary, provide suitable palm type lugs and correct crimp tool.
- For equipment mounted on hinged doors run cables on the hinge side to avoid restricting the door opening. Bundle cables with spiral wrap PVC 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 more than 6 mm²

Terminations:

- Tunnel terminals: Single cables.
- Other connection points or terminals: No more than 2 cables.

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

Supports:

- Spacing at enclosure: No more than 200 mm from a termination.
- Spacing generally: No more than 400 mm.
- Strength: Capable of withstanding forces exerted during fault conditions.

Single core cables rated equal to or greater than 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.

2.10 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 more than 300 A: Pass separately through integral non-ferrous gland plates. Do not use ferrous metal saddles. Minimise eddy currents.

Cable enclosures

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

Cable supports

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

Bus trunking system entry

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

3.3 MARKING AND LABELLING

General

Switchboard assembly: Label in conformance with AS/NZS 61439.1 (2016) including the following:

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

3.4 COMPLETION

Operation and maintenance manuals

Requirement: Prepare a manual that includes details necessary to operate and maintain the equipment and systems installed.

0943 SWITCHBOARD COMPONENTS

1 GENERAL

1.1 RESPONSIBILITIES

General
Requirement: Provide switchboard components, as documented.

1.2 DESIGN

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

1.3 CROSS REFERENCES

General
Should their be inconsistencies the more stringent specification is to be used.

Requirement: Conform to the following:

- *0901 Electrical systems*.
- *A1235740 PILBARA PORTS ELECTRICAL SPECIFICATIONS .*

1.4 INTERPRETATION

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

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

1.5 SUBMISSIONS

Operation and maintenance manuals
Requirement: Submit manual to **COMPLETION**, **Operation and maintenance manuals**.

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

2 PRODUCTS

2.1 REQUIREMENTS

General
Selection: To AS/NZS 3000 (2018) clause 1.7 and Section 2.

Rated duty: Uninterrupted.

Rated making capacity (peak): Minimum of 2.1 x fault level (r.m.s.) at assembly incoming terminals.

Utilization category: To AS/NZS 60947.1 (2021) clause 5.4 and the recommendations of Annex A.

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

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

Enclosure: IP4X minimum.

2.2 SWITCH-ISOLATOR

General
Standard: To AS/NZS 60947.1 (2021) and AS 60947.3 (2023).

Poles: 3.

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

Shrouding: Effective over range of switch positions.

Fault make/fault break switch-isolators

Rated breaking capacity: To AS 60947.3 (2023) Table 4.

Rated short-time withstand current: As defined in AS/NZS 60947.1 (2021) clause 5.3.6.1 and the manufacturer's recommendation for the prospective fault current conditions.

Rated short-circuit making capacity: As defined in AS/NZS 60947.1 (2021) clause 5.3.6.2, to conform to the manufacturer’s recommendation for the prospective peak fault current conditions.

Rated short-circuit breaking capacity: To AS/NZS 60947.1 (2021) clause 5.3.6.3 and the manufacturer’s recommendation for the prospective fault current conditions.

Load make/load break switch-isolators

Rated making and breaking capacity: As defined in AS/NZS 60947.1 (2021) clause 5.3.5 to conform to AS 60947.3 (2023) Table 4 and the manufacturer's recommendations for the prospective fault current conditions.

2.3 OVERLOAD AND FAULT PROTECTION GENERALLY

General

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

2.4 ARC FAULT DETECTION

General

Requirement: Provide arc fault detection devices on all final subcircuits, as documented, in conformance with AS/NZS 3000 (2018) clause 2.9.

Standard: To AS/NZS 62606 (2022).

2.5 FUSE SWITCH UNITS

General

Standard: To AS/NZS 60947.1 (2021) and AS 60947.3 (2023).

Operation: Provide an extendable operating handle.

Fuse links

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

2.6 MOULDED CASE AND MINIATURE CIRCUIT BREAKERS

General

Moulded case breakers: To AS/NZS 60947.1 (2021) and AS/NZS IEC 60947.2 (2015).

Miniature circuit breakers: Interrupting capacity classification to AS/NZS 60898.1 (2024) and AS/NZS 3111 (2009), as follows:

- General building services: Type C.
- Lighting: Type B

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

Trip type: Conform to the following:

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

Isolation facility: Required.

Current limiting: Moulded case breakers required.

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

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

Utilization category: Moulded case breakers:

- Final subcircuits category: Category A.

- Mains and submains: Category B.

Trip settings: Set as documented, seal and label.

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

2.7 ELECTRICITY DISTRIBUTOR'S SERVICE PROTECTIVE DEVICES

General

Low voltage service protective devices: To AS/NZS 3000 (2018), the electricity distributor's requirements and the Service and Installation Rules.

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

2.8 RESIDUAL CURRENT OPERATED CIRCUIT BREAKERS (RCBO)

General

Standard: To AS/NZS 3190 (2016).

Integral non-overload protection type (RCCB): To AS/NZS 61008.1 (2015).

Integral overload protection type (RCBO): To AS/NZS 61009.1 (2015).

Modular type: To AS/NZS IEC 60947.2 (2015).

- Type II.
  - . Default tripping current: 30 mA.

2.9 SURGE PROTECTION DEVICES (SPD)

Standards

General: To AS 1768 (2021).

Ratings: To AS 1768 (2021) Section 4.

Installation: To AS 1768 (2021) Appendix F and AS/NZS 3000 (2018) Appendix F.

Primary protection

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

Type I SPD

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

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

Residual voltage: < 800 V at 3 kA.

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

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

Enclosure and installation: House SPD in a metal enclosure and protect with a suitably rated circuit breaker, HRC fuse or dedicated surge circuit breaker.

Type II SPD

Surge rating (I_{max}) per phase to neutral: ≥ 40 kA.

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

Nominal discharge current: 20 kA (8/20 µs).

Residual voltage: < 800 V at 3 kA.

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

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

Enclosure and installation: House SPD in a metal enclosure and protect with a suitably rated circuit breaker, HRC fuse or dedicated surge circuit breaker.

Secondary protection

Type III SPD

Surge rating (I_{max}) per phase to neutral: ≥ 10 kA.

Surge rating (I_{max}) neutral to earth: ≥ 5 kA.

Residual voltage: < 800 V at 3 kA.

Visual indicator: Provide visual indication of SPD status and life.

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

Enclosure and installation: House SPD in a metal enclosure and protect with a suitably rated circuit breaker, HRC fuse or dedicated surge circuit breaker. Make sure connecting lead lengths do not exceed 300 mm.

Combined primary and secondary surge reduction filter protection

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

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

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

Residual voltage: < 600 V at 3 kA.

Visual indicator: Provide visual indication of SPD status and life.

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

Enclosure and installation: House SPD in a metal enclosure and protected with a suitably rated circuit breaker or HRC fuse equal to or less than the load current rating of the SPD.

Protection of final subcircuits

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

Operating voltage (U_o): 230 V at 50 Hz.

Maximum discharge current (I_{max}): 40 kA (8/20 µs) phase to neutral and 100 kA neutral to earth.

Voltage protection level (U_p): < 600 V at 3 kA.

Visual indicator: Provide visual indication of SPD status.

Maximum continuous operating voltage (U_c): 275 V a.c.

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

Enclosure mounting: DIN rail mounted.

2.10 INSTRUMENTS AND METERS

Electricity meters (watthour meters)

Standards:

- Socket mounting system: To AS 1284.4 (2006).
- Electronic: To AS 62053.21 (2023).

Electricity meters: Class 0.5.

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

1 or 2-phase metering: Single phase meters.

Current rating: To suit load and overload conditions. Provide direct connect meters suitable for current range of 15 to 100 A and meters with current transformers suitable to 5 A secondary.

Register: Provide a direct reading register of the large figure type. Mark on the scale the metering transformer ratios and the multiplying factor applied to the meter constant.

Covers: Seal main covers.

2.11 CONTACTORS

General

Standard: To AS/NZS IEC 60947.4.1 (2015).

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

Poles: 3.

Rated operational current: The greater of:

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

Mechanical durability: 10 million cycles to AS/NZS IEC 60947.4.1 (2015).

Electric durability: Minimum 1 million operations at AC-22 to AS/NZS IEC 60947.4.1 (2015).

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., utilization category AC-1.

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

2.12 CONTROL DEVICES AND SWITCHING ELEMENTS

Standards

General: To AS/NZS 60947.1 (2021) and AS/NZS IEC 60947.5.1 (2015).

Switching elements:

- Electrical emergency stop device with mechanical latching function: To AS/NZS IEC 60947.5.4 (2015).
- Electromechanical control circuit devices: To AS/NZS IEC 60947.5.1 (2015).
- Proximity switches: To AS/NZS IEC 60947.5.2 (2015).

Rotary switches

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

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

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

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

Time switches

Type: 7 day fully programmable with holiday override function.

Daylight saving switch: Required.

Mains failure operation: 100 hour minimum operating capacity.

Contact rating: Equal to or greater than 16 A at 230 V a.c. resistive load.

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

Dial: Digital with hour and minute display.

Override switch (manual): Required.

Push-buttons

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

Rated operational current: At least 4 A at 230 V a.c.

Emergency stop devices with mechanical latching: To AS/NZS IEC 60947.5.5 (2015).

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

2.13 SEMICONDUCTOR CONTROLLERS AND CONTACTORS

General

Requirement: Provide semiconductor controllers and contactors rated for the characteristics of the controlled load.

Standard: To AS/NZS IEC 60947.4.3 (2015).

2.14 CONTROL AND PROTECTIVE SWITCHING DEVICES OR EQUIPMENT

General

Standard: To AS/NZS IEC 60947.6.2 (2015).

Utilization category: To AS/NZS IEC 60947.6.2 (2015) Table 1.

2.15 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 less than or equal to 50°C, mechanically protected and thermostatically controlled.

3 EXECUTION

3.1 MARKING AND LABELLING

General

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

Labels on assembly exteriors

Manufacturer's name: Required.

Assemblies: Label with essential markings.

Designation labels: For other than main assemblies, provide designation label stating source of electrical supply. Identify separate sections of enclosures.

Assembly controls: Label controls and fault current limiters, including the following:

- Circuit designation for main switches, main controls and submains controls.
- Details of consumers mains and submains.
- Use different colours on labels to distinguish operational requirements such as normal operation, operation under fire or emergency conditions.
- Incoming busbar or cable rating to first tee-off.
- Fuse link size.

Labels on assembly interiors

General: Provide labels for equipment within assemblies. Locate so that it is clear which equipment is referred to, and so that lettering is not obscured by equipment or wiring.

Moulded case circuit breakers: If circuit breaker manufacturer's markings are obscured by operating handle mechanisms or motor operators, provide additional markings open to view on, or next to, the circuit breaker.

Arrestors: Label each group of primary arrestors, stating their purpose and the necessary characteristics.

Danger, warning and caution notices

Busbars: If polymer membrane coating is used without further insulation, provide warning notices on the front cover near the main switch or local main switch and on rear covers, indicating that busbars are not insulated.

Fault current limiters: In assembly sections containing fault current limiter fuses provide caution notices fixed next to the fault current limiters, stating that replacement fuse links are to match the installed fuse link ratings, make and characteristics. Provide separate label stating make and fault current limiting fuse ratings.

Externally controlled equipment: To prevent accidental contact with live parts, provide warning notices for equipment on assemblies not isolated by main switch or local main switch.

Standby power: Provide warning notices stating that assemblies may be energised from the standby supply at any time.

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

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

Positioning: Locate notices so that they can be readily seen, next to or, if impracticable, on busbar chamber covers of functional units and behind the front cover of functional units. Provide circuit

identification labels in the cabling chamber of each functional unit, located next to external terminations.

Schedule cards

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

- 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 switchboards and distribution switchboard assemblies: Provide single line diagrams.

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

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

Marking cables

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

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

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

3.2 COMPLETION

Operation and maintenance manuals

Requirement: Prepare a manual that includes details necessary to operate and maintain the equipment and systems installed.

0951 LIGHTING

1 GENERAL

1.1 RESPONSIBILITIES

General

Requirement: Provide lighting and control systems, as documented.

1.2 CROSS REFERENCES

General

Should their be inconsistencies the more stringent specification is to be used.

Requirement: Conform to the following:

- *0901 Electrical systems*.
- *0921 Low voltage power systems*.
- *A1235740 PILBARA PORTS ELECTRICAL SPECIFICATIONS .*

1.3 STANDARDS

General

Electronic switches: To AS 60669.2.1 (2020).

EMC compliance: To AS CISPR 15 (2017).

Harmonic limits: To AS/NZS IEC 61000.3.2 (2023).

Luminaires, general requirements and tests: To AS/NZS 60598.1 (2017).

Road lighting luminaires: To SA/SNZ TS 1158.6 (2015).

Minimum energy performance standards (MEPS)

General: To AS 4782.2 (2019), AS/NZS 4783.2 (2002) and AS 4934.2 (2021).

1.4 INTERPRETATION

Abbreviations

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

- CCT: Correlated colour temperature.
- CRI: Colour rendering index.
- EEI: Energy efficiency index.
- EMC: Electromagnetic compatibility.
- LED: Light-emitting diode.
- RCD: Residual current device.

Definitions

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

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

1.5 SUBMISSIONS

Operation and maintenance manuals

Requirement: Submit manual to **COMPLETION**, **Operation and maintenance manuals**.

Shop drawings

Lighting: Submit shop drawings for the following:

- Lighting columns.

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

2 PRODUCTS

2.1 GENERAL

Samples
Requirement: Provide samples of luminaires and accessories complete with lamp, and controlgear.

2.2 PROPRIETARY LUMINAIRES

General
Requirement: Provide proprietary luminaires complete with lamps, luminaire control equipment, lighting control equipment, and accessories as documented.

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

2.3 LED LUMINAIRES

General
Requirement: Provide LED luminaires, as documented.

LED luminaires
General: LED luminaires including integral LEDs, reflectors, lenses, heatsinks and drivers.

Standard: LED modules type testing to AS/NZS 62722.2.1 (2024).

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

Life of the LED in the complete luminaire: L70 to IES LM-80 (2021), unless documented.

Colour: CRI > 80.

CCT: 3000 K.

2.4 CONTROLGEAR ENCLOSURE

General
Requirement: Provide controlgear support enclosure within the body of the luminaire, except if 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.

3 EXECUTION

3.1 COMPLETION

Operation and maintenance manuals
Requirement: Prepare a manual that includes details necessary to operate and maintain the equipment and systems installed.

3.2 COMMISSIONING

General
Requirement: Before the date for practical completion carry out the following:

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

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

Digital control system: Commission to the manufacturer's recommendations and to the documented control requirements.