

**SPECIFICATION**

19-0771

**ISSUE**

B

**DATE**

17/8/2020

# Specification

## Electrical Services

**For Morven Livestock Transport Interchange**  
**At Lot 102 Warrego Hwy, Morven**



<b>Ashburner Francis Consulting Engineers</b>		
	Ashburner Francis Consulting Engineers Pty Ltd	
	977 Stanley Street East East Brisbane QLD 4169	
	Phone:	07 3510 8888
	Fax:	07 3510 8899
	Email:	brisbane@ashburnerfrancis.com.au
	Web:	www.ashburnerfrancis.com.au
<b>Offices</b>	Australia	
	Brisbane, Townsville, Toowoomba, Darwin,	
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<b>QA System</b>	Project Engineer:	<b>John Kereczko</b>
	Verification:	<b>Gene Kok</b>

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## **INSTRUCTIONS TO TENDERERS**

Complete and submit the attached Tender Forms, including all schedules before the date and time nominated.

Submit a conforming offer as the base tender price.

Alternatives to specified items may be offered provided:

- the alternative is offered as a separate tender price from the base tender price
- the alternative is technically equal to, or better than the specified item, and data sheets are submitted with the tender to support this.

The lowest or any Tender will not necessarily be accepted.

Tenders shall remain current for sixty days after closing date.

Tenderers are advised to read the Building Designers specification and drawings and to inspect the site before tendering, to fully inform themselves of all existing conditions affecting the contract and to include all works necessary for the proper completion of the works.

Advise the Consulting Engineer of any discrepancy or obvious omission in the drawings or specification prior to submission of the tender.

## **1. PRELIMINARIES**

### **1.1 Conditions of Contract**

Award rates shall be paid and award conditions observed. Site allowances, penalty rates and all applicable award monetary allowances shall be included in the tender amount.

In case of delays to the completion of the contract, the Contractor is responsible for the liquidated damages shown in the Contractors Contract Clauses. This Subcontractor shall be responsible for the whole amount or part of the damages depending on the extent to which he is responsible for the delay.

Irrespective of any trade usage, whenever the term "approved" is used in this specification, it shall be taken to mean approved or as selected by the Superintendent. This approval shall not exempt the Subcontractor from the carrying out of all works in compliance with the requirements of this specification and all relevant properly constituted Authorities.

The Subcontractor shall allow for twelve months service and maintenance of the complete installation. During this period, the Subcontractor shall, without any additional charge to the Proprietor, renew any part of the installation that does not comply with the specified performance.

Ten percent retention will be deducted from progress payments until a limit of five percent of the value of the Contract is reached.

At Practical Completion the retention will be reduced to 2.5% of the Contract Amount.

The retention fund of 2.5% will be retained and will be released after the expiry of the Defects Liability Period, provided all notified defects have been made good.

Failure to rectify defects within the time limits specified nullifies the Contractor's claim to the monies necessary to cover such defects.

The Superintendent shall have the power without further notice to engage other tradesmen to do the work and to pay them from the retention fund.

Should the cost of rectifying the defects exceed the retention sum, the amount in excess shall be recoverable as a debt owing by the Contractor.

### **1.2 Tender Forms**

The Tender Forms attached to this specification, including the forms nominated in Section 1.3, shall be completed and submitted as part of the Tender.

### **1.3 Schedules of Prices and Technical Details**

The Schedule of Prices and Schedule of Technical Details attached to this specification shall be completed and submitted as part of the Tender.

#### **1.4 Contingency, Provisional and Prime Cost Sums**

The amounts stated in the Tender Form shall be included in the Contract Sum. Disbursement of the amounts shall be at the sole discretion of the Superintendent. Any part of the amounts not expended shall be deducted from the Contract Sum.

A Provisional Sum is for foreseeable work which is not detailed in the contract documents.

A Prime Cost Sum is for supply and/or installation of a foreseeable "off the shelf" item which is not detailed in the contract documents.

#### **1.5 Site Visit**

Visit the site to fully evaluate the extent of work and the conditions prevailing. No claim for additional charges will be accepted for failure to comply with this requirement.

## **2. SCOPE**

### **2.1 General**

The work carried out shall comprise the manufacture, supply, delivery, installation, testing, commissioning and maintenance for the specified period of the Electrical System, as described in detail in the following Clauses and shown on the Drawings.

All work shall be carried out in accordance with the Specification, Drawings and such details and instructions as are issued by the Superintendent and/or Consulting Engineers during the progress of the work and to the entire satisfaction of the Superintendent.

All work shall be carried out strictly in accordance with manufacturer's recommendations and industry best practice. The equipment installed shall be handed over to the client in a fully operational state as intended for the equipment function and use.

This Specification shall be read in conjunction with the Drawings, all of which are intended to be mutually explanatory. All work called for by the one even if not by the other, shall be fully executed. The Drawings and Specification are intended to include everything necessary for the proper completion and setting into effective operation of the installation shown. Minor items as used in normally accepted trade practice with installations of this type and which are not specifically mentioned, shall be included in the Tender and installation.

This Specification relates to workmanship and materials used in the work and shall be applied to equipment supplied or installed by any trade, company, or assisting firm engaged to supply or install any materials and/or equipment.

### **2.2 Extent of Work**

The work includes but is not limited to the following main elements:

- Demolition, disconnection and removal.
- Liaison with the Distribution Network Service Provider (DNSP) and Energy Retailer for the installation of new pole mount transformer, LV service line and metering.
- Install new property pole for new Point of Supply.
- Electricity Metering facilities.
- Main Switchboard (MSB) including concrete foundation for MSB.
- Distribution Switchboards.
- Mains and Submains.
- Termination of submains at switchboards provided by other trades.
- Earthing.
- Cabling and cable support systems.
- Trenching, conduits and pits for underground cabling systems.
- Accessories and appliances.
- General and specific power systems.
- Installation of pump power supply as detailed in drawings.

- Equipment supports and bracing.
- Installation of site lighting including installing light poles and foundations.
- Luminaires.
- Lighting Control Systems.
- Lightning protection.
- Mobile elevated work platforms.
- Liaison with other trades.
- As-Installed Drawings.
- Training.
- Maintenance.

## **2.3 Drawings**

The following drawings form part of this specification:

Drawing Number	Title
19-0771 E001	LEGEND & NOTES
19-0771 E010	SCHEMATICS SHEET 1 OF 2
19-0771 E011	SCHEMATICS SHEET 2 OF 2
19-0771 E050	SITE POWER & LIGHTING LAYOUT



### **3. GENERAL REQUIREMENTS**

#### **3.1 General**

This section outlines general requirements which are applicable to all sections of this specification and the works.

#### **3.2 Standards and Regulations**

Conform to the latest editions of all standards and regulations. The following standards and regulations are always applicable:

NCC 2019 Volume One	Building Code of Australia BCA Class 2 to Class 9 Buildings
AS/NZS3000	Wiring Rules
AS3008.1	For Electrical Cables
AS3012	For Construction and Demolition Sites
AS60529	For Degrees of Protection of Enclosures
AS/NZS3017	For Testing for Safety of Low Voltage Electrical Systems

State Workplace/Occupational Health and Safety Legislation  
Electrical Safety Act and Regulations.

All other relevant Acts and Regulations, Local Authority Requirements, Australian Standards and Codes having jurisdiction.

#### **3.3 Quality of Materials and Workmanship**

All materials shall be new, of the best quality and of the class most suitable for the purpose specified.

All equipment shall have a verified history of successful use in the commercial environment. No prototype equipment will be accepted.

All work on the site shall be supervised by a competent tradesman supervisor who shall be present on site when requested by the Superintendent, for all phases of the project. A representative shall be nominated, who shall be present and responsible for the day to day running of the project.

The entire electrical installation shall be executed by licensed, experienced tradesmen, and shall be completed in a neat and first-class tradesman-like manner to the satisfaction of the Architect.

#### **3.4 Uniformity**

All fittings, accessories and equipment of the same type shall be of the same manufacture and catalogue number.

### **3.5 Manufacturer's Warranty**

Provide manufacturer's warranty agreements where applicable.

Complete all necessary documentation on the Owner's behalf.

Include copies of warranties in the maintenance manuals.

### **3.6 Submissions**

#### **3.6.1 General**

Submit drawings, samples, technical data or other details as applicable for systems as specified, prior to ordering or installation.

Allow sufficient time for checking and return of submissions.

Co-ordinate submissions of related items.

#### **3.6.2 Drawings**

Provide hard copies as follows:

- A1 size or larger – 3 sets
- A3 size – 1set
- Electronic - PDF

Drawings shall be submitted in original contract size, AutoCAD or REVIT format as applicable.

#### **3.6.3 Samples**

Provide samples labelled to indicate type, part or catalogue number.

#### **3.6.4 Technical Data**

Provide manufacturers technical specifications, type test report, performance data, installation details etc. as required.

#### **3.6.5 Co-ordination**

Co-ordinate shop drawing design with other building and services elements.

### **3.7 Certification**

Certify that the works have been installed to the requirements of all applicable rules and regulations.

Provide an electrical certificate of test at the completion of the project to certify that all electrical works undertaken as part of the project have been installed and tested in accordance with the respective state government acts, regulations and AS3000. Include a copy of the certificate of test in the O&M manual.

Provide a Form 16 at completion of the works. The Form 16 shall, at a minimum, reference all aspects certified in the designer's Form 15. Where particular aspects of the work to be certified are carried out by other subcontractors, each subcontractor shall provide a Form 16 as relevant to their scope of work.

### **3.8 Hazard Assessment and Risk Management**

Comply with the requirements of the applicable State Occupational / Workplace Health and Safety Act and Regulations with respect to hazard identification and risk management.

Submit a hazard assessment and risk management plan for the construction phase of the works.

### **3.9 Electromagnetic Compatibility**

Ensure that the entire installation covered by this specification meets the Electromagnetic Compatibility requirements of the Australian Communications and Media Authority.

### **3.10 Site Conditions and Precautions**

The site will be occupied and operational for the duration of the contract.

Ensure that systems remain fully connected and operational at all times, except where shutdowns are required.

Where shutdowns of systems are required:

- Provide the Superintendent and Owner with written notification at least 5 days in advance of the intended shutdown time.
- Keep each shutdown time to a minimum.
- For each shutdown, complete the works and ensure that the systems are fully operational prior to leaving the site for the day.

Carry out the work in such a manner as to interfere as little as possible with other trades and persons having access rights.

Ensure that normal access ways within the buildings are unobstructed.

Check existing site services, both underground and overhead, prior to commencing work. Plan work practices based on these existing conditions to minimise risk and maximise workplace safety.

Wherever possible locate all existing services prior to excavation or working on existing structures.

### **3.11 Access to Site**

Generally access to the site, working hours and storage facilities shall be agreed with the Superintendent at construction commencement. However, certain restrictions may be applicable to the project and the Contractor shall include within his tender for any restrictions on access.

### **3.12 Packing Storage and Protection**

Plant equipment, apparatus, materials and parts shall be delivered to the site in as-new condition and properly packed and protected against damage due to handling or adverse weather or other circumstances.

Arrange suitable storage areas for materials, plant and equipment. Storage shall be on purpose made racks, mounts, etc., to ensure no damage or deformation of items.

Any items suffering damage in transit or whilst on site shall be rejected and replaced without cost to the Contract.

### **3.13 Setting Out**

The positioning of equipment as shown on the Drawings is approximate and diagrammatic only, and these Drawings shall not be used for exact setting out. Locations of all equipment shall be confirmed on site by means of a formal and documented process such as drawing mark up, dimensioning or on-site mark up with as a minimum the Superintendent and Contractor in attendance. This co-ordination process shall be the responsibility of the Contractor to organise and it shall be carried out prior to rough-in.

### **3.14 Dedicated Electrical Circuits**

Liaise with main contractor and all other suppliers and subcontractors to confirm electrical requirements of all equipment and appliances prior to ordering or installing any cables.

Cable size, circuit breaker rating and type, and number of phases specified on electrical documents are based on equipment nominated by other disciplines. Suppliers and other subcontractors may select different equipment with different power supplies to those nominated in the design documents.

Adjust cable size, circuit breaker rating and type, and number of phases to suit the equipment being supplied. It is assumed that allowance for these adjustments is included in the main contract tender price.

### **3.15 Demolition**

Decommission, disconnect and remove from site all existing redundant electrical services.

Salvage equipment and deliver to the Owner where specified.

Re-use equipment only where specified.

### **3.16 Work on Existing Electrical Services**

Comply with the requirements of Clause 1.9.3 of AS/NZS 3000:2007 for interfacing to existing electrical services.

Amend existing electrical services as required during the construction to ensure continued operation and integrity of existing electrical services.

Comply with the AS 3012, the Workplace Health and Safety Act and Queensland Electricity Safety Regulation 2002 with respect to working on existing electrical systems.

### **3.17 Installation**

Install equipment and services square and in line with the building elements, plumb and at consistent mounting heights.

Where possible fix directly to the building structure.

Provide noggings, brackets, fixings and supports to manufacturer's recommendations and as required.

Where timber is used for supports or noggings, provide cypress pine or similar termite resistant species.

Organise reticulated services neatly and with applicable segregation.

Provide separate cable support systems for each reticulated service and support all cables over their entire route length.

Provide all access equipment and temporary lighting necessary for the installation of electrical services.

Allow for supports suitable for seismic (earthquake) restraint to AS 1170.4 where applicable.

### **3.18 Co-ordination**

Liaise and co-ordinate with all equipment suppliers to ensure that all equipment is installed and connected in accordance with the installation and functional requirements of the manufacturer. Provide ancillary equipment as required for correct system operation.

### **3.19 Environmental Conditions**

Ensure that all equipment is suitable for the environmental conditions to be encountered under normal circumstances for the site.

### **3.20 Building Penetrations**

Maintain integrity of building systems such as waterproofing and termite management at building penetrations.

### **3.21 Maintenance Access**

Locate all relevant equipment to ensure adequate maintenance access in accordance with Workplace Health and Safety regulations.

### **3.22 Corrosion Protection**

All metallic materials and components shall be suitably protected against corrosion.

Bolts, screws, rivets, etc for external use shall be non-ferrous or stainless steel, or where approved galvanised steel.

Brackets, plinths, rods, etc shall be hot dip galvanised after fabrication.

All steel sheets shall be corrosion protected by means of degreasing, priming and painting as a minimum.

Where the application is in a highly corrosive environment such as in close proximity to the sea, provide suitable grade stainless steel or non-ferrous metallic components.

### **3.23 Finishes**

All equipment shall be painted unless the equipment material is chromium, anodised aluminium, plastics, stainless steel or other non-ferrous metals.

Paint and paint application shall comply with AS/NZS 2311 and AS/NZS 2312.  
Carry out all powder coating to AS3715.

### **3.24 Adhesives**

Provide adhesives and sealants capable of transmitting imposed loads, sufficient to ensure the rigidity of the assembly or the integrity of the joint and which will not cause discolouration or lack of adhesion of finished surfaces.

### **3.25 Fasteners**

Provide masonry anchors, bolts, nuts, washers, screws, nails and plugs as required for installation of electrical services.

Fastener materials, finishes and physical sizes shall be as appropriate for the loads, the types of materials in contact with the fastener and the environment.

Fasteners shall be selected to ensure full compliance with the requirements of Clause 3.20 Seismic Restraint.

### **3.26 Metals**

Provide metal sections and sheet as required for the electrical services.

Finish invisible joints by welding, brazing, soldering, grinding and buffing prior to application of finishes such as galvanising or painting.

Repair galvanised or electroplated metals using two pack organic primer to AS/NZS 3750.9.

### **3.27 Labelling**

Provide labels to equipment as required for identification, operation and warnings.

Labels shall be non-ferrous metal, multi-coloured laminated plastic or pre-printed flexible plastic.

Labels shall be of proven longevity without significant deterioration.

Externally mounted labels shall be weather and corrosion resistant.

Fix labels using nuts and bolts, rivets or self-adhesive material for flexible plastic labels.

Externally mounted fixings shall be corrosion resistant.

Warning labels shall be white lettering on red background with minimum 10 mm high lettering.

Minimum letter heights shall be 3mm.

### **3.28 Fire Integrity**

Where cables or cable support systems pass through a fire rated building element, seal around the penetration using fire sealant materials in accordance with AS 4072.1 and AS 1530.4 to ensure that the required Fire Resistance Level of the building element is maintained.

Comply with the Building Code of Australia statutory requirements.

Label all penetrations through fire rated building elements and provide a penetration schedule in accordance with AS 1851 Section 17.

### **3.29 Smoke Barriers**

Where cables or cable support systems penetrate smoke barriers, install and support this equipment to fully comply with all statutory requirements for smoke barrier building elements.

Label all smoke barrier penetrations and provide a penetration schedule in accordance with AS1851 Section 17.

### **3.30 Acoustic Integrity**

Install electrical services to comply with acoustic isolation requirements of the Building Code of Australia, AS/NZS 3000 and statutory requirements.

Note in particular the requirements for residential units and buildings and provide acoustic rated wall boxes and light fitting covers as required to maintain the acoustic rating.

### **3.31 Operation and Maintenance Manuals**

#### **3.31.1 Manuals**

Provide Operation and Maintenance Manuals for all systems and components covered by this specification. Include As-Installed documentation for the entire installation in these manuals.

Once approved, provide one hard copy of manuals and drawings neatly bound into A4 size hard cover ring binders which are permanently labelled with the Project Name, Contract Description and Contractor's Name. Provide electronic copies on two USB storage devices.

Include the following in each set of manuals:

- Contents page with page numbers for each section
- Copies of all test results, certificates and approvals.

- Manufacturer's operating instructions and details of model numbers, serial numbers, operating instructions, and manufacturer's guarantee certificate for equipment and appliances.
- Service and user manuals for proprietary products and systems.
- Emergency Lighting Log Book to AS 2293 requirements, as published by General Lighting Services Pty Ltd or equal approved.
- Brief description of the Electrical installation and distribution network etc.
- A recommended maintenance programme for all equipment installed.
- A recommended list of spare parts.
- As-Built Drawings (refer to As Built Drawing section)

Provide a draft set of the Operation and Maintenance Manuals to the Superintendent not less than 2 weeks before the date of practical completion, for the purpose of review and comment. The draft manual for approval shall be an electronic version submitted via electronic means (email or file transfer).

Submit final sets of the Operation and Maintenance Manuals to the Superintendent not more than 2 weeks after the receipt of comments on the draft from the Superintendent.

Final contract payment will not be approved until satisfactory Operation and Maintenance Manuals have been received.

### **3.31.2 As Built Drawings**

Produce a full set of as-built drawings in both DWG and PDF format, which conform to the following general requirements:

- Legend, site plan, schematic, and layout drawings in the same size and form as the original contract drawings, but modified to reflect all changes which occurred during construction.
- Remove or re-word notes that no longer apply to the "as built" state. For example, a note reading "Contractor to install garden lighting power supply in accessible ceiling space" should be re-worded to "garden lighting power supply installed in ceiling space" with an arrow showing the exact location.
- Indicate locations of any equipment that may require inspection or maintenance, that has been installed in locations that are concealed from view (such as remote LED drivers and power supplies, lighting control modules, large marshalling/junction boxes etc)
- Device numbering labels for all security and fire systems components, which match the field labels
- Circuiting labels for all power circuits, lighting circuits and dedicated circuits
- System schematic diagrams and schedules.
- The title block of each drawing amended to include the Contractor's name and contact details, Contractor's drawing number and date and name of issue.
- 'AS BUILT' stamp applied to all drawings

### **3.32 Clean Up**

At completion clean all electrical equipment to as-new condition.

Remove all waste and debris on a continuous basis.



### **3.33 Completion**

All equipment and systems shall be fully operational and complete, all in accordance with manufacturers recommendations, prior to final testing and commissioning.

### **3.34 Testing and Commissioning**

Fully test and commission the complete electrical installation prior to practical completion.

Provide project specific Inspection, Testing and Commissioning Plans for all electrical systems. Only suitably qualified personnel shall carry out testing and commissioning. Provide evidence of qualifications when requested.

Record all test results and submit for inspection prior to practical completion.

### **3.35 Construction Phase Procedures**

#### **3.35.1 General**

Comply in all respects with procedures established by the Superintendent for the construction phase of the project.

#### **3.35.2 Line of Communication**

Ensure compliance with formal transmission of emails, RFIs and submissions through the agreed line of communication.

Advice received by other avenues will not be considered as a formal instruction.

#### **3.35.3 Variations**

Variation price submissions shall be accompanied by a detailed description of the work involved. Provide supporting documentation where necessary and as requested.

All costs shall be submitted on a spreadsheet showing itemised break-ups of all materials and labour.

### **3.36 Practical Completion**

Practical Completion will be granted after the following is provided:

- Finalisation of all testing and commissioning
- Certification that the installation complies with the specified requirements and all applicable Statutes and Standards
- Authorities approval obtained as required
- Preliminary instruction on safe plant operation has been provided
- Critical defects have been rectified
- Operation and Maintenance Manuals and As-Installed drawings have been provided

### **3.37 Test Instrument Calibration**

All test instruments shall have current calibration certificates. Certificate copies shall be provided to the Superintendent prior to commencement of tests. Certificate currency shall be 12 months maximum.

### **3.38 Inspection at Practical Completion**

Arrange for a Practical Completion Inspection by the Superintendent. A minimum of 5 working days notice shall be given.

Ensure that the installation is fully operable and practically completed before requesting an inspection.

Should the inspection reveal that the installation is not fully operable or practically completed and require further inspections, these inspections will be charged to the Electrical Subcontractor.

### **3.39 Instructions and Training**

Provide skilled operators to instruct such persons as may be nominated by the Architect in the effective operation of all of the electrical systems in the installation. Instructions shall not be given until completion of all tests and adjustments.

Conduct training at agreed times and locations and for durations commensurate with the complexity of the systems.

### **3.40 Maintenance and Warranty During Defects Liability Period**

Carry out preventative maintenance on a regular schedule for systems as detailed in other sections of this specification.

Promptly rectify all defects during the defects liability period. Attend site within 1 working day of notification of defect. Critical system defects shall be rectified in the time schedule as detailed in other sections of this specification.

## **4. SUPPLY AND METERING**

### **4.1 Definitions & Abbreviations**

DNSP                      Distribution Network Service Provider  
NER                        National Electricity Rules

### **4.2 General**

Supply will be taken at low voltage from the point of supply:

- Overhead point of attachment on property pole

### **4.3 Supply**

Supply will be to Network Standards 3 phase, 230/400V, 50Hz, 4 wire, MEN earth system.

### **4.4 Distribution Network Services Provider (DNSP)**

The DNSP is:

***Ergon***

DNSP Project Reference (i.e. Work Request) Number: **1548646**

Contact: ***Rhett Barton***

Email: ***rhett.barton@ergon.com.au***

### **4.5 Standards**

Comply with all regulations, standards and requirements of the Local Electricity Act & Regulations, NER, DNSP requirements, local council and BCA.

### **4.6 HV/LV Substation**

The DNSP will supply and install a HV Supply and provide a pole mount transformer rated at 200 kVA.

Liaise with the DNSP to ensure provision of supply of electricity as required by the project program.

The DNSP will provide the following:

- Incoming overhead HV and LV service wire to Point of Attachment.
- Pole mount transformer.

### **4.7 Retail Metering**

Supply and install all equipment and enclosures as required for the provision of electricity metering. Carry out all works to DNSP and Energy Retailer requirements.

The general arrangement of metering facilities shall be as shown on the drawings.

Arrange for and coordinate the installation of retail meters with the DNSP, the Energy Retailer, and the Accredited Metering Provider.

The DNSP, Energy Retailer or Accredited Metering Provider will install and energise retail meters.

#### **4.8 Applications**

Coordinate the actions required by all parties including owner, tenants, electricity retailer, metering provider and DNSP to ensure the electricity service and all required metering is installed to meet project timeframes.

This includes

- The completion and lodgement of all application forms
- Lodging and managing the electricity application on the DNSP's online portal

#### **4.9 Consumers Mains**

Supply and install consumers mains from the point of supply to the MSB.

Provide all necessary lugs, glands and terminations for connections at both ends.

#### **4.10 Phase Rotation**

Check phase rotation with the DNSP and provide uniform phase rotation in the project cabling system.

#### **4.11 Supply Shutdowns**

Co-ordinate all shutdowns of supply with the Customer (Owner) and DNSP.

Arrange all shutdowns in advance (a minimum of 5 working days) so that alternative operational arrangements can be made.

Keep supply shutdowns to a minimum.

## **5. CABLES AND CABLE SUPPORTS**

### **5.1 General**

Supply and install all required cables and cable support systems.

### **5.2 Quality**

#### **5.2.1 Standards**

- Installation and selection to AS/NZS 3000, AS/NZS 3008.1, AS/NZS 3003, AS/NZ 3013 and SAA HB301.
- Cables to AS/NZS 5000.1, 2 and AS/NZS 4961.
- Conduits to AS 2053 Series.
- Conduits for telecommunications to AS/ACIF S008 and S009.
- Fire and mechanical performance to AS/NZS 3013.
- Testing to AS/NZS 3017.

### **5.3 Products**

#### **5.3.1 Power Cables**

Cables shall be multi-stranded copper conductor with PVC, XLPE and/or fire-rated insulation and sheath.

Cables shall be 0.6/1kV, V75 rated as a minimum standard.

Cables shall be colour coded as detailed in AS 3000:2007 Clause 3.8.

Minimum cables sizes shall be:

- Lighting sub-circuits: 1.5mm<sup>2</sup> or 2.5 mm<sup>2</sup>
- Power sub-circuits: 2.5mm<sup>2</sup>
- Submains: 6mm<sup>2</sup>

Select cable sizes to comply with volt drop, short circuit and earth fault/touch voltage requirements of AS 3000.

Cable lugs shall be of the correct size and material for the conductor.

Cables for exterior lighting circuits shall be double insulated, external grade, suitable for use in underground conduit systems.

#### **5.3.2 Conduits**

Conduits shall generally be rigid non-metallic (UPVC or PVC), minimum 20mm diameter. Provide metallic conduits where shown or specified.

Conduits shall be to AS/NZS 2053 series.

Conduits for telecommunications systems shall comply with AS/ACIF S008 and S009.

Conduits for underground low voltage cabling shall be heavy duty rigid PVC to AS 2053.

Non-metallic conduits and fittings shall be grey or orange PVC as appropriate.

Metallic conduits and fittings shall be galvanised steel with screwed connections.

Provide flexible conduit only as required for connection of cables to equipment which is subject to movement or vibration.

Conduit fittings shall be of the same material and finish as the conduit.

### **5.3.3 Ducted Wiring Enclosures (Cable Ducts)**

Cable ducts shall be purpose made zinc coated steel or PVC complete with matching purpose made accessories, lids and covers as required for a complete enclosure system.

Lids or covers shall be screw fixed or clip on, removable only by means of tools.

Miniature wiring duct for final sub-circuits shall be rigid, white PVC with snap-on lid.

### **5.3.4 Cable Ladders and Trays**

Cable ladders and trays shall be proprietary fabricated steel complete with all accessories and fittings for a complete tray system. Provide screw fixed lids as required.

Cable trays shall be perforated sheet steel folded and welded as required. Cable trays and accessories shall be zinc coated steel for internal use and hot dip galvanised for exterior use.

Cable ladders and accessories shall be welded steel construction, hot dip galvanised finish.

### **5.3.5 Cable Mesh**

Cable mesh shall be folded zinc coated welded steel wire or expanded mesh complete with matching accessories for a complete cable support system.

### **5.3.6 Cable Pits**

Provide cable pits as shown and as required for installation of cables in the underground cable duct system.

For pit plan dimensions up to 1200mm along any side provide proprietary cast polymer or cast concrete pits.

For pits larger than 1200mm side dimension construct in situ using reinforced concrete and galvanised steel lid support frame.

Pit lids shall be cast concrete, hot dip galvanised steel or trafficable cast iron and concrete filled.

Small pits for communications systems generally shall be polymer type, but refer to the legend and drawings for specific details.

Pits in trafficable areas shall be constructed to suit the expected loads and to Class C to AS 3996 as a minimum. Polymer pits shall not be provided for trafficable areas.

Pits in footpaths shall be fitted with cast iron, concrete filled lids, finished flush with the surrounding path.

### **5.3.7 Underground Services Tracer Wires**

Tracer wires shall be copper clad steel with insulation sheath. Provide tracer wire accessories such as test station termination points and ground anodes.

## **5.4 Installation**

### **5.4.1 Cables and Cable Supports Generally**

Install low voltage cables in accordance with AS/NZS 3000:2007 and in particular all of Section 3 "Selection and Installation of Wiring Systems".

Install telecommunications cabling systems in accordance with AS/ACIF S009.

Maintain minimum installation clearances in accordance with AS/ACIF S009 and AS/NZS 3000.

Install all wiring systems (cables and their supports) concealed within the building fabric throughout unless in mechanical plant spaces, risers or as noted otherwise. Where it is proposed to run exposed wiring systems, obtain approval for the route and method before proceeding.

All wiring shall be fully supported along the entire route length.

Fix cable support systems to structural elements of the building only.

Cables run underground shall be installed in a conduit and pit system.

Cables and wiring for separate systems shall be run separately and on separate cable support systems or in segregated sections of the same support system unless where otherwise noted.

Low voltage cable sizes shown on the drawings are based on installation methods to avoid derating in accordance with AS 3008.1 Tables 22 to 26. Increase cable sizes as required when cables are installed in a manner requiring a derating factor to be applied.

Run circuit earth cables over the same route and in the same wiring enclosure as the circuit active cables.

All cables shall be installed in a manner which enables easy removal and rewiring.

Cables in ceiling spaces shall be supported above the top of recess mounted light fittings.

All wiring shall be installed on the loop-in system with connections made at equipment or accessories.

Wiring in chases shall be run in concealed conduit.

Ensure minimum bending radius requirements for all cable types are maintained at all times.

For cables run in conduit use draw wires to pull in cable groups from point to point. Fill conduit to a maximum of 75% of the capacity noted in AS/NZS 3000.

Run all wiring systems grouped, tied or enclosed, square and parallel to the building structure.

Do not use adhesive fixing for cable support systems.

Run cables in external cavity walls in a manner which does not compromise the weather protective wall construction.

Support vertical cable runs to avoid damage due to cable mass.

Install cables in a manner that does not damage the cable during installation.

#### **5.4.2 Mains and Submains**

Run in conduits or on cable support systems such as cable ladder or tray.

Terminate using cable lugs and crimping tool.

Terminate submains to all switchboards provided by other trades (such as mechanical, hydraulics and lift services), unless noted otherwise.

Use suitable glands when entering equipment or assemblies.

Identify cables at both ends using stamped tags or similar.

Ensure that all cables are protected from accidental application of paint. Where cables have been painted the extent shall be assessed by the superintendent and cables shall be replaced at no cost as directed.

#### **5.4.3 Conduits**

Conduits shall be rigid UPVC, PVC or metallic throughout except for short length final connections to direct connected equipment where smooth or corrugated flexible conduit may be used.

Install in straight, parallel runs, set at changes of direction, with maximum 90° bends, free of burrs and foreign materials. Provide draw-in boxes, expansion joints and saddles to ensure a conduit system free of visible sags and able to have cables pulled in after conduit installation. Draw in boxes shall not be located in inaccessible positions.

Conduit shall not be run against or in insulation.

Conduits run in reinforced concrete shall be run in the centre of the concrete slab or wall. Parallel runs of conduits shall have a minimum of 50 mm separation. Conduits cast into concrete shall be adequately secured to avoid movement of damage during pouring. Conduit ends shall be secured and capped to avoid damage and ingress of foreign material.



PVC conduits and fittings shall be joined using the recommended jointing adhesive.

Provide polypropylene draw cords or stranded and insulated draw cable (2.5 mm<sup>2</sup>) for all unused conduits.

For steel conduits paint ends and threads with zinc rich primer.

Use flexible conduit for connection to equipment subject to vibration.

All associated fittings shall be of the same material and colour as the conduit.

For telecommunications conduits:

- Inspection fittings shall not be used
- All bends shall be large radius type to ensure minimum bending radius conditions of cables are met
- Apply temperature derating to AS/NZS 3080 where conduit is run in roof spaces.

#### **5.4.4 Cable Ducts, Trays, Ladders, Mesh and Skirting Duct Systems**

Install completed systems with all necessary lids, brackets, supports, fixings, rods and hangers.

Light duty cable tray shall only be used in concealed spaces or risers to carry and support final sub-circuits and ELV cabling systems (data, security, fire and MATV etc.).

Cable trays where run exposed shall be medium or heavy duty trays or cable ladders.

Groups of mains or submains cables shall not be run on light duty cable trays.

Cable tray lid shall not be used to support any cables.

For telecommunication systems, install to AS/ACIF S009.

Fixings, brackets and supports shall be fabricated from steel of suitable strength and rigidity to provide support to AS 1170.4.

Separate low voltage power cables by distances sufficient to avoid derating in accordance with AS/NZS 3008.1 Tables 22 to 26.

Comply with manufacturer's recommendations for support spacings based on maximum carrying capacity.

Size systems to ensure minimum cable bending radius requirements can be achieved at all times.

Provide clear space around cable support systems to enable installation of cables.

Provide segregation between cable support systems for different wiring systems. Ensure minimum separation of wiring systems as required by applicable standards and regulations.

Fix cables in suitable groups using cable clamps, ties or straps.

Provide bends with a minimum inside radius of 12 times the outside diameter of the largest cable installed.

Install clear of hot or wet equipment or surfaces in accordance with AS/NZS 3000.

Provide peaked galvanised steel lids over cable support systems where run exposed to sunlight and the elements.

Provide cable protection where cables enter or leave cable support systems.

Provide separate conduit access between skirting wiring duct compartments and ceiling space. Run conduits into proprietary cable access boxes located behind the skirting duct.

Ensure that 25% minimum spare capacity remains in all cable support systems at completion. Size all cable support systems accordingly.

## **5.4.5 Underground Systems**

### **5.4.5.1 General**

Provide excavation, removal from site, rock excavation, conduits, pits, backfilling, reinstatement, cable markers and tracer wires for all underground cabling.

Provide separate underground conduit and pit systems for separate services (low voltage, communications, fire, etc).

Low voltage wiring systems shall be in accordance with AS/NZS 3000, Clause 3.11.

Cables shall not be installed direct buried.

Cables run in underground conduit systems shall be exterior grade. Power and lighting cables shall be insulated and sheathed. Single insulated cable shall not be accepted.

Record the route of underground systems prior to backfilling.

Set out conduit routes and obtain approval for these routes prior to excavation.

Provide polypropylene draw cords or insulated copper draw wires in all spare conduits.

Allow for final landscaped and finished levels when installing conduits and pits. Maintain minimum required cover. Pit lids shall be installed flush with the surrounding finished hardstand areas such as concrete or paving. Pit lids in landscaped areas shall be finished 50mm above the finished soil level to allow for mulching etc.

### **5.4.5.2 Inspection and Hold Points**

Each trench section must be inspected for approval by the Superintendent prior to backfilling.

A photographic record may be acceptable for this purpose but it will be necessary to obtain Superintendent approval for this prior to proceeding past the hold points. Photographs of the trench sections shall show trench depth and calendar date.

Hold points shall be:

- When the trench excavation is completed
- When the services have been laid in the trench
- Arrange for inspection by the Superintendent at each hold point.

#### **5.4.5.3 Excavation**

Ascertain the locations of all other in-ground services prior to excavation.

Saw cut or remove existing surfaces as appropriate.

Excavate trenches to the required depths and remove excess material from site.

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

Remove all sharp objects, rocks and organic material.

Give notice if rock is encountered to enable agreement on quantity.

Provide safety barriers to all open trenches.

Excavate and fill trenches in short sections to minimise safety hazards.

#### **5.4.5.4 Boring**

Engage a suitably qualified specialist contractor for all boring works. Fill all voids by pressure grouting.

#### **5.4.5.5 Conduits**

Provide bedding sand below, around and above conduits with minimum 50mm cover. Bedding sand under roads shall be stabilised with 3% cement mix.

Maintain separation between electrical, communications, Telstra, gas, water and other underground services to statutory requirements.

Provide conduit stubs for future extension where shown. Stubs shall be 1000mm and capped.

Use large radius bends for turned up conduits.

Use large radius bends and/or pits for changes of direction.

Install marker tape to AS/NZS 2648.1 above low voltage electric conduits.

Neatly cut conduits and remove all burrs and conduit filings so that cable stripping is avoided.

Secure all conduit sections using the recommended jointing adhesive.

Clean installed conduits free of debris and water.

Seal all conduits after cable installation using a product specifically manufactured for this application.

#### **5.4.5.6 Pits**

Provide sufficient pits to enable easy installation of cables.

The top of pits shall be finished flush with the surrounding surfaces.

Pit sizes nominated on electrical drawings.

Prior to installation, cut pit walls for conduit entries using separate circular holes for each conduit. Use suitable hole saws for this work. Pits cut in large sections for more than one conduit entry shall be rejected and these pits shall be replaced.

Seal around conduit entries after pit installation to prevent ingress of water and silt.

Drain pits to stormwater drainage system. Alternatively, obtain approval for rubble absorption trenches if draining to stormwater is not possible. Minimum rubble trench size shall be 300 x 300 x 2000 long using coarse gravel.

Install pits into a levelled and compacted excavation.

Found pits onto a wet concrete base at least 50mm thick or onto a compacted rubble base where the pit is drained to rubble.

The top of the pits and pit lids shall finish flush with surrounding surfaces in hardstand areas such as pavers, tiles and concrete. For landscaped areas allow for the pit lids to finish slightly above the finished soil areas to allow for turf, mulch or similar landscaped finish.

Cut conduit entries not more than 50mm past the inside faces of the pit walls.

Provide rigid conduit bracing bars inside the pits to prevent wall collapse.

Provide poured concrete haunches (minimum 150mm thick) around multiple conduit entries.

For pits in trafficable areas (Class C and above) backfill around the pits to the finished surface with concrete (minimum thickness 100mm).

For all other pits backfill around pit using compacted bedding sand and finish at the surface perimeter of the pits with a 200 wide and 200 thick in-situ poured and trowelled concrete collar, reinforced as necessary.

#### **5.4.5.7 Backfilling**

Backfill trenches and compact using a ramming machine in maximum 200mm layers. Complete the backfill with a 100mm minimum layer of topsoil.

Backfill material shall not contain any rocks, organic material, or sharp objects.

Backfill under roads and paved areas shall be fine crushed rock compacted in 150mm layers to 100% STD compaction.

#### **5.4.5.8 Reinstatement**

Existing surfaces shall be reinstated to their original condition.

Lawn areas – Reinstall removed lawn segments or provide new turf to match existing.

Paving – Lay pavers on sub-base to match existing. Provide additional pavers as required.

Concrete – Key new poured concrete into adjacent existing concrete using reinforcing steel grouted into drilled holes.

Roads – Provide rock sub-base, base and bitumen to match existing.

#### **5.4.5.9 Route Markers**

Provide route markers to accurately indicate the location of underground conduit routes.

Install markers on pits, at 50 m intervals on straight runs, at changes of direction and at ends of run.

Markers shall consist of 16mm thick engraved stainless steel arrows, discs or rectangles as appropriate showing direction and type of service. Fix markers to concrete base using stainless steel friction pins with mushroom head.

#### **5.4.5.10 Trench Warning Tape & Trace Wire**

Install 100mm wide detectable trench tape in all electrical and communications trenches above each group of corresponding service conduits. The tape shall be installed at approximately 200-300mm below finished ground level.

Trench tape to contain words to the effect of:  
"WARNING ELECTRIC/COMMUNICATIONS CABLE BELOW"

Trench tape to have 316 stainless steel wire inlaid, in a wave pattern to facilitate stretching and to improve detectability, laminated between two layers of low density, lead free rot-resistant polyethylene tape.

Trace wires shall be joined using approved crimp connectors to ensure continuity.

Trace wires to be terminated at the start and end of each trench route and at each pit using appropriate clamps in accessible locations, fixed to pit walls or building elements. Trace wires should be earthed to manufacturer's recommendations.

Trench tape to be Tapex Wavelay or similar, installed in accordance with manufacturer's instructions.

#### **5.4.5.11 Cables**

Install cables within conduit systems in accordance with manufacturer's instructions.

The cable cross sectional area shall not exceed 40% of the internal cross sectional area of each conduit. Provide additional conduits as required.

Run individual submains circuits in separate conduits.

Cables with insulation or sheathing damaged during installation shall be removed and replaced.

Run insulated and sheathed cables for external light and power circuits.

#### **5.4.5.12 Surveyed As-Built Drawings**

For underground conduit systems provide surveyed as-built drawings showing exact routes and locations, and include in the as-installed drawing set in the maintenance manuals.

### **5.5 Completion**

Carry out all tests as detailed in AS/NZS 3000 Section 8 "Verification".

Use AS/NZS 3017 "Electrical Installations – Testing and Inspection Guidelines" as the basis for test procedures.

Record all test results and include in Maintenance manuals.

## **6. EARTHING**

### **6.1 General**

Supply and install Protective and Functional earth systems to ensure safe operation of the electrical installation.

The protective earth system shall be multiple earthed neutral (MEN), or TN system to IEC60364.

### **6.2 Quality**

#### **6.2.1 Standards**

AS/NZS 3000 Section 5 "Earthing Arrangements and Earthing Conductors" for electrical system earthing.

AS/NZS 3003 for patient areas of hospitals, medical and dental practices.

AS/NZS 2381 series and AS/NZS 61241 series for hazardous locations.

AS/NZS 1768 for lightning protection bonding earths.

AS/ACIF S009 for telecommunications cabling functional earths and equipotential bonding.

### **6.3 Products**

Provide earthing system components manufactured from copper, brass, stainless steel or copper clad steel for earthing electrodes.

Provide equipment as required for the protective earth system, functional earths, telecommunications system connection to earthing system and equipotential bonding.

Provide guards, covers, pits and enclosures as required to ensure mechanical protection of the complete earthing system.

Earth rods shall be copper clad steel suitable for direct complying. Provide driving tips and couplings as required.

Provide labels for earthing components as required.

### **6.4 Installation**

#### **6.4.1 General**

Protect the complete earthing system from mechanical and environmental damage.

Ensure all earthing system components are sized to resist the electrical forces (fault currents). Provide calculations where required. Refer to AS/NZS 3000 Clause 5.3.3.1.2.

Earth all exposed conductive parts of the electrical system.

Earth all conductive building materials and structural metalwork, including reinforced concrete for pools, spas, and floors of bathrooms, safety showers and similar wet areas.

Provide separate earth cables for each circuit.

Install earth electrodes in locations which ensure effective contact with moist soil and are separated from conductive enclosures of other buried services such as water, gas and telecommunications.

Where high soil resistivity is encountered provide drilled cores with bentonite resistivity enhancer and multiple earth electrodes as required.

Bond incoming conductive enclosures of buried services such as water, gas and telecommunications to the protective earthing system. Refer to AS/NZS 3000 Clause 5.6.

Provide equipotential bonding as required for other systems or equipment as noted in AS/NZS 3000 Clause 5.6 and related standards for the particular systems.

Ensure continuity of earthing connections to all earthed systems and structures.

Conduct visual inspections and electrical earth continuity testing of equipotential bonding of steel reinforcing prior to concrete being poured.

Provide telecommunications system earthing to AS/ACIF S009, related ACMA standards and AS 3080.

#### **6.4.2 Main Electrical Earth**

Provide a low resistance main earth bond to the general mass of earth appropriate for the site (near the MSB and / or near each MEN point).

Provide accessible earth rod inspection pits for earth electrodes and label in accordance with AS/NZS 3000. Earth rod inspection pits shall be ERITECH PIT-03 or approved equal.

Determine soil resistivity conditions either by measurement or visual inspection of the site. Resistivity of typical soil types are as follows:

Clay	8 to 70Ωm
Loam	5 to 250Ωm
Sand	200 to 3,000Ωm
Gravel or Rock	3,000 to 30,000Ωm

For sand, gravel / rock or very dry soil conditions provide a project specific main earth solution.

Ensure that the earth grid electrodes are installed into the original natural soil. Installation into any type of fill material shall not be permitted.

Ensure that the earth grid is installed into soil which is naturally moistened as a result of weather activity. (Note that the resistivity of a sample sand / clay mix can vary from 1,500Ωm at 2.5% moisture content to 40Ωm at 30% moisture content).



Provide as a minimum in favourable soil conditions such as loam or clay the following main earth electrode arrangements:

<63A supply	One 1440mm long driven copper clad steel earth rod.
>63A up to 400A supply	Two 1440mm long driven copper clad steel earth rods, either coupled for a total driven depth of 2880 or separately driven with a minimum separation of 2m and bonded with a 95mm <sup>2</sup> copper, insulated earth cable and proprietary earth rod clamps finished with cold gal.
>400A supply	A minimum of two 2880mm long (2 x 1440mm each) driven copper clad steel earth rods spaced a minimum of 3m apart and bonded with a 95mm <sup>2</sup> copper, insulated earth cable and proprietary earth rod clamps finished with cold gal.

For less favourable soil conditions such as sand, gravel / soil loose mixtures and solid rock, provide soil resistivity enhancing material around each earth rod (Erico Gem or equal). Provide earth rods of increased quantity, spacing and depth as required to achieve a minimum measured resistance to earth of 10Ω.

## **6.5 Specific Earthing Arrangements**

Provide large cross-section earth conductors as required for specific installations such as lifts and UPS. Confirm required earth cable size with equipment manufacturer.

## **6.6 Completion**

Inspect and test the earthing system in accordance with AS/NZS 3000 Section 8 "Verification" including all applicable mandatory tests (Clause 8.3.3), continuity of the earthing system (Clause 8.3.5) and earth fault loop impedance (Clause 8.3.9).

## **7. SWITCHBOARDS**

### **7.1 General**

Supply and install all switchboards as shown on the drawings.

Switchboards shall be constructed by a specialist switchboard manufacturing company.

Switchboards shall be fully enclosed, metal cubicle, circuit breaker type unless shown otherwise.

### **7.2 Quality**

#### **7.2.1 Standards**

AS 3439 Series for switchboard design and construction.

AS/NZS 61439 Series for switchboard design and construction (for large project  $\geq 1000$  Amps)

AS/NZS 60898.1 and AS 3111 for miniature circuit breakers.

AS 60947 Series for low voltage switchgear and controlgear.

AS/NZS 3190 for RCD circuit breakers.

AS 61818 series for HRC fuses.

AS 60044.1 for current transformers.

AS 4070 Category 11 for surge diverters (transient protection).

DNSP for metering provisions and general arrangement.

#### **7.2.2 Submissions**

##### **7.2.2.1 Type Test Data**

Submit type test or verification certificates in the name of the switchboard manufacturer for assemblies and components to demonstrate compliance.

##### **7.2.2.2 Shop Drawings**

Submit shop drawings showing:

- Types, model numbers and ratings of assemblies.
- Component details, for all functional units and transient protection.
- Detailed dimensions.
- Type test or verification certificate details for particular assembly components.
- 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.
- Ingress Protection (IP) rating for the Assembly and for the internal barriers.
- Fixing details for floor or wall mounting.
- Pollution degree
- 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.
- 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.

#### **7.2.2.3 Calculations**

Submit design calculations to verify design assumptions, in accordance with AS3439.1 and AS/NZS 61439 Series.

Submit design calculations to verify busbar ratings.

Submit protection device grading calculations for the electrical distribution system to demonstrate full discrimination and AS3000 compliance for all sources of electricity supply (ie Authority grid and/or generator).

#### **7.2.3 Design Criteria**

Construct switchboards to comply with the following:

- Rated busbar current:
  - As shown on drawings for Main Switchboards
  - 160A (minimum) or as shown on drawings for distribution boards
  - Full size neutrals
- Rated prospective short circuit current:
  - Greater than calculated fault level at switchboard location
  - As shown on drawings for Main Switchboards and as calculated by manufacturer
  - 6 kA (minimum), or as shown on drawings for distribution boards
- Degree of Protection:
  - IP42 to AS 60529 for internal switchboards in a dedicated switchboard cupboard or switchboard room
  - IP56 to AS60529 for switchboards located in a path of travel for containment of smoke (NOTE: applies to any switchboard that is not in a dedicated switchboard room or cupboard)

- IP56 to AS 60529 for external switchboards
- IP2X between adjacent compartments in switchboards (after cable installation)
- Arc Fault Containment
- Form of Separation:
  - Form 3bh for Main Switchboards
  - Form 1 for Distribution Boards or as denoted on drawings
- Physical Size:
  - Designed for installation into the spaces allocated on the drawings
- Future Circuit Spare Capacity:
  - 25% or as shown on drawings, whichever is the greater
- Grading of Protection Devices:
  - Designed to ensure full co-ordination with calculated grading from DNSP protection through to sub-circuit protection i.e. full discrimination
  - Design protection grading for both Mains and Generator supplies where applicable.
- Busbar Temperature Rise Limits:
  - Maximum rated current – temperature rise 50°C, ambient temperature 40°C
  - Maximum short-circuit current – temperature rise 160°C
- Limitation of Internal Arcing Fault Currents:
  - Comply with AS/NZS3000 Section 2.5.5.
- Uniformity
  - Provide circuit breakers from one manufacturer to ensure complete protection grading.
- Pollution Degree
  - 3 for Main Switchboards rated at more than 250A
  - 2 for distribution boards

#### **7.2.4 DNSP Requirements**

Incorporate all DNSP equipment and requirements into the switchboard assemblies.

Obtain DNSP approval as required for the design prior to fabrication.

#### **7.2.5 Verification and Testing**

Provide verification details for Assembly construction (PTTA to AS3439.1). Factory test and verify Assembly for Routine test in accordance with AS/NZS61439.2 and 3.

### **7.3 Products**

#### **7.3.1 General**

Switchboards shall be fully enclosed, metal cabinet type, proprietary construction for distribution boards (typically) and custom built for main switchboards.

Front access assemblies with frontal area less than 2m<sup>2</sup> shall be wall mounted. All other assemblies shall be floor mounted.

Design assembly cabinets to enable transportation to site and positioning into the available space during construction.

### **7.3.2 Assembly Cabinets**

Provide rigid, square enclosure cabinets of fabricated sheet metal, folded and welded construction and of sufficient structural rigidity to ensure transport to site and installation without distortion or damage.

Design the assembly cabinet to fit in the space provided, ensuring compliance with AS3000 2.10 for clearances around the assembly.

Indoor assemblies shall be 1.6mm (minimum) metallic coated sheet metal.

Outdoor assemblies shall be stainless steel, brushed finished, minimum 304 grade or 316 in salt laden environments.

Machine fold sheet metal angles. Weld all joints and finish flush with adjacent surfaces. All bare edges shall be lipped with minimum return of 13mm. Provide stiffening members as required for rigid construction.

Support frames and structural members shall be cold rolled or extruded steel sections welded or bolted to the cabinet metalwork. Steel for outdoor assemblies shall be hot dip galvanised.

Provide degree of separation as specified by means of horizontal and vertical steel partitions.

In addition, provide panels in vertical compartment walls for controlled cable and busbar access between adjacent compartments. Busbars and cables shall penetrate the vertical panels at right angles. Provide adequate seals and cable glands to maintain the Degree of Protection and Form of Separation.

Ensure vermin proof construction throughout. Cover ventilation openings with non-ferrous 1mm mesh.

Fix equipment or components to panels or support frames using corrosion resistant bolts, studs, set screws or proprietary clips. Fixings shall be accessible after completion to enable future equipment changes.

Lifting provisions shall be included for assemblies larger than 1800mm high x 600mm wide, or as required for transportation and installation.

Provide mounting structure and fixings which allow assemblies to be fixed in position without removing equipment.

Floor mounted assemblies shall be provided with hot dip galvanised steel plinth, minimum 75mm high, 40mm wide, 6mm thick, drilled and bolted to assembly base and floor or plinth.

### **7.3.3 Doors, Removable Panels and Escutcheons**

Provide lockable doors, removable panels and escutcheons for complete assemblies.

Fabricate from the same material and construct as for the assembly cabinet.

Maximum panel widths shall be 800mm. Minimum door and escutcheon swing shall be 90°. Maximum cover and escutcheon area 1.2m<sup>2</sup>.

Doors and covers shall have right angle returns on all sides fitted with continuous sealing rubber gasket fixed on a metal retaining frame with industrial grade adhesive.

Provide stays to exterior mounted assembly doors.

Ensure door seal contact onto the assembly flat surface and for exterior mounted assemblies the door seal shall be outside a gutter formed around the full perimeter of the assembly opening. "French door" style arrangements are not acceptable.

Provide chrome plated non-ferrous door furniture of sufficient strength to withstand fault condition explosive forces within the assembly.

Provide doors, covers and escutcheons as follows:

- Doors
  - Lift off hinges with unequal pin lengths
  - Min. of 3 hinges for doors higher than 1000mm
  - Flush door handles activating wedge type latching mechanism or latching bar and guides, with padlocking facility.
  - Locking mechanism integral with the latching system, keyed alike, 2 keys per assembly, Lowe and Fletcher 92268 or as directed.
  - D handles for removal and replacement.
- Covers
  - Lift off hinges as for doors
  - Captive knurled thumb screws
  - D handles for removal and replacement
- Escutcheons
  - Hinged
  - Knurled thumb screws with locating pins or quarter turn slotted cam locks, minimum 4 fixings
  - D handles for removal and replacement

Maintain earth continuity to all doors, covers and escutcheons.

#### **7.3.4 Cable Entries**

Provide cable entries for incoming and outgoing cables.

Provide sufficient clear space to allow installation of cables, including cables for all future circuit provision, without undue bunching or sharp bends.

Provide removable non-ferrous gland plates as installed to maintain the degree of protection.

At cable entries run all cables through neat-fitting compression glands. All cable entries shall be sealed against the spread of fire and smoke, and sealed against the ingress of moisture, debris and vermin.

Provide cable support systems within the cables zones for fixing of cables. Size cable supports to allow for future circuits to the capacity of the assembly.

### **7.3.5 Finishes**

Apply protective coatings to internal and external metal surfaces of assembly cabinets except for stainless steel, galvanised or anodised surfaces and ventilation mesh.

Paint finish shall be thermoset powder coating to AS3715 and APAS-0155/1 with finish colours as follows:

- Indoor Assemblies:
  - External surfaces – orange X15
  - Internal surfaces – white
- Outdoor Assemblies:
  - External surfaces – brushed stainless steel
  - Internal surfaces – white
- Distribution Boards:
  - External surfaces – standard finish
  - Internal surfaces – white

### **7.3.6 Busbars**

Provide solid busbars within assemblies from the incoming supply terminals to the line side of protective equipment for outgoing functional units, including future functional units.

Busbars shall be solid electrical grade hard drawn copper, rectangular section, tinned.

Use of flex busbar and cables in lieu of solid busbar is not acceptable unless specifically noted on the drawings.

Neutral busbars shall be of the same current carrying capacity as the active busbars.

Busbar ratings shall be as noted on the drawings or as detailed in the design requirements.

Tee-off busbars shall be rated to the maximum frame size rating of the functional unit or the diversified rating for multiple functional units on the one tee-off.

With the exception of busbars that are within a dedicated busbar zone, all busbars shall be fully insulated by colour coded insulation using non-deteriorating insulation material.

Busbars in main switchboards shall be vertical laid to facilitate cooling. Horizontal lay for busbars will be rejected except for short runs such as tee-offs. For busbars rated at 1000A and above spacing between phases shall be a minimum of 100mm.

Support busbars on non-hygroscopic insulating material designed to withstand temperature rise and fault current parameters.

Busbars passing through slots shall be sleeved with plastic shrink type sleeving.

Provide fully insulated and colour coded busbars for distribution boards.

Provide colour coded bands at least 50mm wide on uninsulated busbars in main switchboards. Locate on each busbar section in every compartment. Do not use adhesive tape.

Colour code busbars as follows:

Active: red, white, blue  
Neutral: black  
Earth and MEN link: green/yellow

Maintain phase sequence throughout the assembly.

Run neutral and earth busbars into each compartment containing functional units. Number all terminations. Provide terminals for all future circuits. For cables greater than 10mm<sup>2</sup> provide bolts or studs. Tunnel type terminations are acceptable for cables up to 10mm<sup>2</sup>.

Where functional units of the switchboard are rated at 1000Amps or greater, the neutral busbars shall follow the active busbar through the functional units via the same gland plates.

Join busbars using high tensile bolts and nuts, locked in position and tightened to the recommended torque using a tension wrench. Busbar joints shall be fully lapped to maintain adequate joint surface area.

Busbars marked by scribing will be rejected. All marking shall be pencil or ink.

Provide pre-drilled main circuit supply busbar for future extension where shown.

Extend busbar tee-offs to all future functional unit locations.

Provide removable busbar sections less than 400mm long for current transformers.

For MEN links greater than 10mm<sup>2</sup> provide bolted removable busbar link. .

Provide busbar flags for equipment with terminals too small for cable lugs. Support busbar flags as required. Provide barriers where minimum clearance distances are not satisfied.

Pre-drill the main busbar for the future extension and extend busbar droppers to spare locations. Drill each dropper to suit connection of future equipment of the same type as that specified.

Distribution board busbar chassis pole quantities are based on 1 pole position for integral MCB/RCD's. Increase pole quantities if integral MCB's/RCD's take up more than 1 pole location.

### **7.3.7 Wiring**

Provide all required internal wiring in switchboard assemblies with insulation grade appropriate to the design temperature at terminations.

Cables shall be sized for current rating based on the internal ambient temperature and also fault current withstand capability.

Run cables neatly and support clear of busbars and functional units.



Identify cables at both ends.

Shroud terminals where exposed, particularly on hinged panels and doors.

Identify all internal instrumentation and control cable ends by clip on markers. Adhesive markers shall not be acceptable. Indicate numbering on "As Installed" circuit diagrams. No numbers shall be duplicated.

### **7.3.8 Facilitation of Safe Inspection & Maintenance**

Switchboards must be designed, manufactured, and installed in a fashion that facilitates safe inspection and maintenance. This includes competent persons conducting inspections, testing, and thermographic scanning.

Irrespective of, and in addition to the specified Form Rating of the switchboard, all live conductors in all compartments that contain functional units or other equipment shall be provided with insulating barriers or housings arranged in such a fashion that a person opening any escutcheon is separated from live parts to IP2x (standard test finger).

This may be achieved by the following means:

- Insulated Busbars & chassis
- Clear acrylic barriers
- Proprietary termination shields and phase barriers for switchgear

Barriers and shield shall be secured in place and shall be able to be easily removed and replaced for testing purposes. Cables ties are not an acceptable means of securing in place. Screws or nuts & bolts are acceptable.

Spliced, wrapped, and cable tied heat shrink is not acceptable and will be rejected.

Switchboard shall be manufactured and supplied with all means for compliance with this requirement, along with any instructions required for the installing electricians to follow.

### **7.3.9 Equipment Layout**

Arrange equipment in logical positions to provide a neat and simple design.

Locate equipment to minimise derating due to temperature rise and to ensure that the design temperature is not exceeded at each functional unit and inside the assembly.

### **7.3.10 Exterior Mounted Switchboards**

Additional requirements for externally mounted switchboards include:

- Weather and sun shading tilting "roof" located 50mm above the assembly top and extending out 100mm on front and sides.
- Bottom cable entry only.
- Anti-condensation heater and thermostat in each compartment
- IP65 LED profile with diffuser full width of switchboard below sun shade, controlled by switch on escutcheon panel.
- Custom made concrete cable pit and concrete slab for mounting switchboard, with trafficable steel access covers to access cable pit below.

### **7.3.11 Circuit Breakers**

Provide circuit breakers of Schneider, NHP Terasaki, Eaton, ABB, Heinemann or Siemens manufacture.

For loads to 63A provide 18mm wide miniature circuit breakers (MCB's) (where fault level & outgoing cable size permits).

For loads 63A to 125A provide 27mm wide miniature circuit breakers (MCB's) (where fault level & outgoing cable size permits).

For loads greater than 125A up to 1600A, or where cable size is too large for miniature circuit breaker terminals, or where fault level exceeds the rating of a miniature circuit breaker, provide moulded case circuit breakers (MCCB's).

For loads greater than 1600A provide air circuit breakers.

#### **7.3.11.1 Miniature Circuit Breakers (MCBs)**

Provide miniature circuit breakers of the specified fault and current rating complying with AS/NZS 60898.1 and AS 3111.

Miniature circuit breakers shall be of the same manufacture throughout.

Mount miniature circuit breakers to manufacturer's requirements and to ensure that 1, 2 or 3 phase MCBs are interchangeable onto the same busbar chassis.

Align operating toggles in the same plane.

#### **7.3.11.2 Residual Current Operated Circuit Breakers (RCD/MDBs)**

Provide combined RCD/MCBs of the same manufacture as miniature circuit breakers, complying with AS/NZS 3190 and with a maximum RCD tripping current of 30mA.

Provide RCD/MCB's which use the same poles and pole spacing as MCBs.

Select the correct type of RCD for the circuit in accordance with AS3000 Clause 2.6.2.2, manufacturer's advice for specific equipment, and the following table provided for general guidance:

<b>RCD Type:</b>	<b>AC</b>	<b>A</b>	<b>B</b>	<b>F</b>
<b>Loads:</b>	<b>AC-only loads</b>	<b>Comb. AC &amp; DC loads</b>	<b>Electronic loads</b>	<b>Electronic loads</b>
<b>Typical Use Examples</b>	Hot water systems	Lighting circuits	Solar inverters	Solar inverters
	Heaters	SSO Circuits	Data centre	Inverter air con
	AC fan motors		EV Chargers	Data rack/UPS
	Cooking appliances		Inverter air con	EV Charger

#### **7.3.11.3 Moulded Case Circuit Breakers (MCCBs)**

Provide MCCBs of the specified fault and current rating complying with AS 60947.1 and AS 60947.2.

Derate MCCBs as required for installation conditions.

Use MCCBs of the same manufacture throughout.

Align operating toggles in the same plane.

Mount MCCBs in accordance with manufacturer's recommendations.

Trip units for MCCBs rated at 160A or greater shall be adjustable electronic type.

#### **7.3.11.4 Air Circuit Breakers**

Provide air circuit breakers to AS 60947.1 and AS 60947.2, open construction, withdrawable with integral solid state protection relay.

#### **7.3.12 Interlocks**

Provide Castell, Rhonis (or approved equal) key interlocking equipment as required to prevent parallel operation of multiple supplies.

#### **7.3.13 Switches/Isolators and Fuse Switches**

Provide units complying with AS 60947.1 and AS/NZS 60947.3 and rated to the enclosure installation conditions and anticipated loads.

Provide locking facilities in the OFF position.

Shall be from the same manufacturer as for all other switchgear.

#### **7.3.14 Contactors**

Provide contactors to AS 60947.4.1 rated for the enclosure conditions and anticipated loads.

Shall be from the same manufacturer as for all other switchgear.

#### **7.3.15 Fuses with Enclosed Fuse Links**

Provide HRC type fuses and fuse carriers to AS 61818 series.

#### **7.3.16 Current Transformers**

Provide current transformers complying with AS 60044.1, cast resin encapsulated window type with busbar clamps.

Provide test links and secondary shorting links in accessible positions.

Accuracy Class shall be:

- Energy measurements: Class 0.5
- Indicating instruments: Class 3

#### **7.3.17 Transient Protection**

##### **7.3.17.1 Surge Diverters – Main Switchboard**

Provide distribution switchboard parallel surge protection on Main Switchboard as follows:

- 240v nominal system voltage

- 275v max continuous operating voltage
- MOV and/or gas discharge type with visual indication, replaceable modules and alarm contacts
- Maximum Discharge Current, I<sub>Max</sub>, 100kA per line 8/20us
- Nominal Discharge Current, I<sub>n</sub>, 40kA per line 8/20us
- Three mode protection; L-E, L-N, and N-PE
- Mechanical flag status indication
- Overcurrent fuses as per manufacturer recommendations

Must be selected from either Critec/Erico, Schneider, Novaris, DEHN, Eaton, or NHP Cirprotec manufacture.

#### **7.3.17.2 Surge Diverters – Distribution Boards**

Provide distribution switchboard parallel surge protection on all distribution boards as follows:

- 240v nominal system voltage
- 275v max continuous operating voltage
- MOV and/or gas discharge type with visual indication, replaceable modules and alarm contacts
- Maximum Discharge Current, I<sub>Max</sub>, 50kA per line 8/20us
- Nominal Discharge Current, I<sub>n</sub>, 20kA per line 8/20us
- Three mode protection; L-L, L-N, and N-PE (depending on whether the board has an MEN or not – confirm correct type with supplier)
- Mechanical flag status indication
- Overcurrent fuses as per manufacturer recommendations

Must be selected from either Critec/Erico, Schneider, Novaris, DEHN, Eaton, or NHP Cirprotec manufacture.

### **7.3.18 Control Devices and Switches**

#### **7.3.18.1 Rotary switches**

Provide cam operated type with switch positions arranged with displacement of 60°. Locate off position at 12 o'clock. Provide rectangular escutcheon plates securely fixed to the assembly panel. Identify switch position and function.

#### **7.3.18.2 Time switches**

Provide simple DIN mount mechanical analogue time switches with:

- Long life battery backup
- Minimum contact rating of AC1 16A
- 15 minute time block adjustments

Time switches shall be NHP Finder MECHD1211B, Schneider ACTI9 ARM, Hager EH111 or approved equal.

Time switches shall be mounted so that they can be adjusted by any person without opening switchboard escutcheon panels.

#### **7.3.18.3 Control relays**

Provide control relays as follows:

- Suitable for continuous operation. Provide relays selected in conformance with the load duty.
- Plug-in type with bases with captive clips which can be operated without using tools.
- Electrically separate, double break with silver alloy, non-welding contacts.
- With contact blocks readily convertible to either normally-open or normally-closed contacts.

#### **7.3.18.4 Time delay relays**

Provide time delay relays as follows:

- Adjustable over the full timing range with timing repeatability within  $\pm 12.5\%$  of nominal setting.
- Incorporate light emitting diodes indicating energisation states of relays.

#### **7.3.18.5 Phase failure relays**

Provide separate solid-state adjustable phase failure relays which release at the following:

- $< 85\%$  of normal voltage (adjustable).
- Single phase failure.
- Reverse phase sequence after an appropriate time delay.

#### **7.3.18.6 Push-buttons**

Provide push buttons as follows:

- Oil-tight, minimum 22mm 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 60947.5.5.

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

### **7.3.19 Marking and Labelling**

#### **7.3.19.1 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.

#### **7.3.19.2 Labels on assembly exteriors**

Provide Manufacturer's name and details.

Compliance engraved label to be provided on fascia of switchboards which includes information regarding current rating, fault rating, type test certificate, form of segregation, pollution degree, month and year of manufacture, dimension of switchboard and rated voltage.

Provide designation label (assembly name).

Indicate source of electrical supply.

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.

#### **7.3.19.3 Labels on assembly interiors**

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

#### **7.3.19.4 Danger, warning and caution notices**

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

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

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

Stand-by power: Provide warning notices stating that assemblies may be energised from the stand-by supply at any time.

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

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

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

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

#### **7.3.19.5 Size**

Engrave as follows:

Assembly designation 10mm black letters on white

Main Switches 7mm white letters on red

Main Equipment 7mm black letter on white

Minor Equipment 4mm black letters on white

Essential Services 7mm white letters on red

Warning Notices 7mm and 4mm red letters on white

#### **7.3.19.6 Schedule cards**

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

- Submain origin & upstream circuit protection device rating
- Location of earth electrode (where applicable)
- Light and power circuit numbers and current ratings, cable sizes and type and areas supplied.

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.

#### **7.3.19.7 Single-line diagrams**

Provide single-line diagrams for custom built assemblies.

Provide non-fading print, at least A3 size. Laminate and enclose in a non-reflective PVC frame and wall mount close to assembly.

#### **7.3.19.8 Marking cables**

Identify the origin of all wiring. Provide durable labels fitted to each core and sheath, permanently marked with numbers, letters or both to suit the connection diagrams.

All final sub circuit cables shall be ferrule labelled to indicate circuit number.

All control cables shall be ferrule labelled at both ends.

All mains and sub main cables shall be labelled at connections to the protection devices.

#### **7.3.20 Final Sub-circuit Distribution Boards**

Provide final sub-circuit distribution boards as indicated on the drawings. Distribution boards shall be fully assembled by a specialist switchboard supplier, tested and subject to the manufacturer's quality assurance program prior to delivery to site.

IP Rating:

- Minimum IP42 for indoor distribution boards in a dedicated, smoke-sealed switchboard cupboard or switchboard room;
- Minimum IP56 for indoor distribution boards located in a general room, open area, or path of travel, for containment of smoke hazards;
- IP66 for outdoor distribution boards, 2.0mm 316 stainless steel with rainhood cover, padlockable handle, door stay, and plinth where floor mounted.

Distribution boards shall be:

- provided with internal finger duct cable management on both sides of chassis for cable management;
- a minimum of 240mm deep (including door but not handle) for indoor distribution boards and a minimum of 300mm deep for outdoor distribution boards;

- Provided with sufficient space and DIN rail mounting provisions for all required ancillary devices, including timers, contactors, time clocks, and separate compartment for BMS equipment (where required);
- Provided with separate escutcheons, dividing mullions and barriers to separate each metered section of the distribution board and the main switch section;
- fitted with hinged escutcheons, with meters and indicating devices fitted flush;
- fitted with non-ferrous gland plates;
- have lift-off hinged doors with 3-point locking;
- fully welded construction;
- provided with NC encapsulated 250A or 400A MCB chassis;
- provided with dummy pole filler modules held in place by screw onto the chassis rail for all spare poles (clip in pole fillers are not acceptable);
- left with minimum of 30% spare pole capacity on completion (i.e. A 60-pole chassis shall be populated to no more than 42 poles on completion);
- left with a minimum of 30% spare capacity on gland plates and cable management for future cable installation, taking care to lay out gland plate cable entries to make future cable installation neat and simple;
- Provided with typed circuit card indicating: outgoing final sub-circuit cable sizes, circuit breaker rating, circuit breaker number, description of the circuit; origin of submains supplying the DB; size of submain cables; and size of upstream protection device;
- Provided with 1 copy of the fully detailed shop drawings printed in A3 colour, and placed in a clear sleeve mounted on the inside of the DB door;
- textured orange paint finish for both indoor and outdoor distribution boards.

Distribution boards shall comply with the rest of the Switchboards section of this specification in all other respects.

## **7.4 Installation**

Install switchboards level and plumb in the spaces provided.

Fix wall mounted assemblies using a minimum of 4 non-ferrous or galvanised metal fixings.

Mount floor mounted assemblies on purposed built suitable foundation or plinth, generally reinforced in-situ poured concrete.

Secure assembly plinth to foundation using a minimum of 4 masonry anchors.

Provide assembly mounting structure over switchboard entry pits, and finish off with galvanised steel checker plate or Gatic type lid sections complete with lifting provisions.

Bolt transportation sections together to form a rigid assembly. Complete all necessary inter-panel connections.

Install DNSP equipment as required.

Ensure isolation of dissimilar metals to prevent galvanic corrosion in external locations.

For concrete plinth mounted switchboards provide a bituminous impregnated cork gasket between the switchboard base and the concrete plinth. Provide reinforced concrete foundation / plinth, trowel finished a minimum of 100mm above surrounding



ground level. Secure switchboard to concrete base using corrosion resistant fixings suitably isolated from the switchboard metalware.

Continue cable support systems to the assembly and complete cable access in a manner which retains the IP rating of the assembly.

Leave spare capacity at cable entries and gland plates for future circuit cable entries.

For all cables provide glands and gland plates.

For final sub circuit cable entries provide suitable vermin proof cable enclosure.

For distribution switchboards exposed to view, provide cable access cover from switchboard to ceiling and/or floor as appropriate to neatly conceal cables and provide a uniform appearance.

Externally mounted assemblies shall have bottom cable entry.

Fully support all cables inside enclosures using cable duct or trays. Secure cables using non-metallic ties. Support and secure cables to within 200mm of terminations.

Ensure earth bonding throughout the assemblies.

Run internal switchboard cabling at right angles through compartment walls and gland off or seal in the same manner as for switchboard cable entries.

## **7.5 Testing And Verification**

Carry out all type tests and routine tests for a PTTA in accordance with Section 8 of AS/NZS 3439.1.

Submit test results for verification.

## **7.6 Completion**

Adjust, set and program all adjustable or programmable equipment.

Carry out all required site tests.

Clean all assemblies and remove all waste.

Energise assemblies in accordance with Workplace Health & Safety and company quality assurance procedures.

Ensure all required insulating barriers and housing have been installed.

### **7.6.1 Thermographic Test Report**

For all switchboards and distribution boards, carry out thermographic scans and submit report 1 month after practical completion, and again one month prior to the end of the defects liability period.

Thermographic scanning shall be conducted under full load conditions. Coordinate with the building operator to ascertain when this is and carry out the scans at this time.

The load currents on each phase for each outgoing functional unit or conductor shall be measured at the time of the scan and logged in the report.

Carry out all corrective actions recommended in the report at no cost.

## **8. LUMINAIRES AND LIGHTING**

### **8.1 General**

Supply and install all luminaires, lamps and lighting controls as scheduled, specified and shown on the drawings.

Luminaire manufacture, model and/or catalogue number shall be as shown on the drawings. Alternatives will not be accepted.

Any unauthorised luminaire substitutions will void the design certification.

### **8.2 Quality**

#### **8.2.1 Standards**

All luminaires shall meet the following standard as applicable to that luminaire type:

- AS/NZS 60598 series for luminaire construction
- ZHAGA Standard for LED interchangeability
- IESNA LM-79 for LED Electrical and Photometric Measurement of LED Luminaires
- IESNA LM-80 for LED Lumen Maintenance of LED light sources
- IESNA TM-21 for projected Lumen Maintenance of LED light source
- IESNA TM-30 and CIE CRI ( $R_a$ ) for colour rendering properties
- EMC Compliance to AS/NZS CISPR 15
- IEC 62717:2014 LED modules for general lighting - Performance requirements

Lighting design & installation shall comply with the following standards as applicable:

- AS1680 series (interior lighting)
- AS1158 series (exterior lighting)
- AS4282 (obtrusive lighting)
- AS2560 series (sports lighting)

#### **8.2.2 Submissions**

Provide samples where requested.

Provide product data sheets and test reports for all luminaires

Provide product data for lighting control systems and dimmers.

Provide luminaire compliance certificates upon request.

### **8.3 Products**

#### **8.3.1 LED Luminaires**

Provide LED luminaires as specified.

Luminaires and/or luminaire components shall have RCM certification and be on the ERAC register.

LED Luminaires shall be purpose-designed for use with LED light sources. Traditional style lamp luminaires fitted with retrofit-style LED lamp units will not be accepted, except where specified (such as feature pendant lights and decorative luminaires).

Illumination of visible diffusers shall be even. LED 'spots' shall not be obviously visible through the diffuser of any opaquely diffused luminaire.

Luminaires shall use optically-designed lenses, reflectors, and/or diffusers to control the output of light and to mitigate glare to below AS1680 UGR levels.

### **8.3.2 Warranty**

All LED luminaires shall be covered by a minimum 5 year manufacturer repair or replacement warranty. Warranty is to include all components of the luminaire including housing, driver and LED light source.

If any LED luminaire fails or falls below the "end of life" performance levels within 5 years of practical completion, the luminaire shall be repaired or replaced.

Luminaires shall be sourced from manufacturers with local, manufacturer-endorsed agencies for warranty and after-sales services purposes. Luminaires sourced via direct import from manufacturers or distributors without a full-time agent in Australia will not be accepted.

Provide warranty statements for all luminaires and include within the O&M manuals.

### **8.3.3 LED Light Engines**

Unless specified otherwise, LED luminaires shall incorporate replaceable LED light engines compatible with the Zhaga modular LED specification or an equivalent standard.

Actual spectrally tested Correlated Colour Temperature (CCT) of LED shall be within +/- 100 Kelvins from the specified temperature (e.g. 4000k), and all LED chips shall have a CCT binning quality tolerance of no greater than 3 MacAdam Steps, and must be maintained within this tolerance throughout its rated life.

LED luminaires shall have a Colour Rendering Index (CRI,  $R_a$ ) or TM-30 Fidelity Rating  $R_f$  of no less than 80, or higher where specified.

### **8.3.4 LED Photometric Performance (IESNA LM79)**

The Complete LED luminaire package (luminaire + driver) shall have published electrical and photometric results from a laboratory or lighting test facility that is a signatory to ILAC (International Laboratory Accreditation Cooperation) such as a NATA laboratory or international equivalent.

All LED luminaires shall have measured photometric performance to support claimed performance in accordance with IESNA LM79.

All photometric files shall be of an "absolute photometry" method.

### **8.3.5 LED Lumen Maintenance (IESNA LM80 & TM21)**

LED luminaires shall have published IESNA TM21 depreciation projections from a NATA or international equivalent certified lighting test facility which are based on actual test results.

Each luminaire type shall have minimum TM21 projected performance equal to or better than the following characteristics:

- L80 B10 @ 50,000 hours @ 25 Degree C for interior luminaires
- L80 B10 @ 50,000 hours @ 40 degrees C for exterior luminaires and luminaires used in industrial environments

where "L" = projected lumen depreciation at end of life, and "B" = the overall percentage of luminaires that are projected to drop below "L" at a given time (e.g. 50,000 hours).

E.g. For L80 B10, at 50,000 hours no greater than 10% of the luminaires will have dropped below 80% of their original lumen output.

Where quoted TM21 projections are those of the LED module manufacturer and not that of a complete tested luminaire, the luminaire manufacturer must be able to prove, through in-situ temperature measurement (ISTM), that the thermal management of the luminaire is within the tolerances specified by the LED module manufacturer in order for the LED module TM21 projections to remain valid for that luminaire in which it is used.

In addition, specified luminaires may also have a spot failure rating, which may or may not be expressed as a third "C" figure. Where a specified luminaire has a manufacturer published spot failure rate, any proposed alternatives shall have equal or lower spot failure rates.

The test conditions and rated characteristics of any specified luminaire overrule these standard minimum requirements. Any proposed alternative must be able to demonstrate equivalent or better performance to the specified luminaire under equivalent or more onerous test conditions.

#### **8.3.6 Luminaire Construction**

Provide proprietary luminaires and associated equipment as specified.

Luminaires shall:

- be thermally designed to ensure optimum operation and component operating temperatures below recommended limits;
- be rigid, true and symmetrical in construction;
- have support and fixing mechanisms to suit the intended application;
- have photometric performance equivalent to the published data;
- be constructed of durable and corrosion resisting materials suitable for the installed conditions and environment;
- be complete with all required lamp holders, terminal blocks, fuses, control gear, temperature rated cabling, diffusers, reflectors, light sources, cable clamps, and fixings as required for complete luminaires;
- have control gear and light sources matched for optimum performance; have purpose built low loss electronic controllers for LED lamps;
- have terminal blocks suitable for up to 2 x 2.5mm<sup>2</sup> cables or flex & plug; and
- have Regulatory Compliance Mark (RCM/C-Tick) certification.

Steel sheet metal construction shall:

- be minimum 0.8mm thick zinc-anneal sheet, free from blemishes with all exposed joints welded, filled and rubbed smooth; and
- Be finished using approved polyester powder-coat surface treatment and paint.

Recess mounted luminaires shall be provided with flex and AU 3 pin plug top.

Diffuser material shall be acrylic, polycarbonate or similar UV stabilised plastic product suitable for use as a diffuser in luminaires.

#### **8.3.7 Luminaire Control Gear & Power Supplies**

For non-dimmable LED's provide constant current or constant voltage electronic drivers suitably rated for the load.

For dimming type LED fittings provide purpose built electronic controllers rated for the load, with DALI, DSI, or phase dimming as specified.

DALI dimmable ballasts shall be DALI certified and shall be auto-addressing.

Provide ballasts suitable for the specified luminaire and control gear arrangements, taking into account requirements such as remote mounting of control gear, dimming and lighting control systems.

#### **8.3.8 Power Quality**

Luminaire power factor shall be 0.95 – 0.99 lagging.

Luminaire voltage Total Harmonic Distortion (VTHD) shall be no more than 5% to IEEE standards.

### **8.4 External Luminaire Poles & Fittings**

Provide hot dip galvanised steel poles complete with rag bolt foundation assembly, component hatch secured with vandal-proof bolts, outreach arm, mounting spigot and corrosion resistant fixings.

Foundations shall be of approved structural design for the installation conditions and environment.

All external luminaire poles shall have fused take-offs mounted at the base of the pole with access from the component hatch. Pre-wire fittings between the luminaire and the take-off fuse. Fuse carriers shall be Legrand Modular for industrial cylindrical cartridge fuses or approved equal.

### **8.5 Installation**

#### **8.5.1 General**

Install luminaires in complete accordance with manufacturer instructions. Where ambiguity or conflict exists between manufacturer's instructions, and any mandatory Australian standard or the design documents, seek clarification before installing.

Install luminaires in line, parallel or square to the building structure, level, at the same mounting height, plumb and flush with surrounding surfaces.

Support luminaires using proprietary supports, battens, trims, noggings, ceiling roses, chains, suspension rods, trunking, ducting, stainless steel braided wire or lighting track as appropriate.

Fix and secure luminaires to ensure permanent mounting under service conditions. Provide a minimum of 2 fixings per luminaire and more as required to avoid movement or distortion.

Install luminaires so that there are no light leaks.

Mount luminaires and control gear clear of insulation and flammable materials in accordance with AS/NZS 3000 Clause 4.5.2.3.

Size conductors supplying ELV lamps to ensure volt drop is minimised.

Install PE cell switches in locations suitable for reliable performance.

Make wiring connections using flex and plug or hard wiring as appropriate.

Adjust lamp locations and aim luminaires.

Install LED type luminaires to ensure heat dissipation in accordance with manufacturer's requirements.

#### **8.5.2 Electronic Components**

Install electronic components including electronic ballasts, LED drivers and LED arrays in locations suitable for limitation of temperature rise to within manufacturer's specified limits.

Follow manufacturer's instructions for the allowable quantity of luminaires on a circuit, ensuring the installation is within the safe limits of the circuit protection for earth leakage and inrush current levels to eliminate nuisance tripping or premature failure of switching relays.

#### **8.5.3 External Lighting**

Secure to structure using corrosion resistant fixings.

Maintain IP rating at cable entry and fixings. Use circular cables for entering all exterior light fittings through compression glands or rubber grommets. Flat TPS cable is not acceptable for exterior light fittings as it will not create an effective seal with the proprietary glands and grommets found in exterior light fittings.

Install blockouts in masonry or in-situ concrete for recessed luminaires.

Provide cable entries to manufacturers recommendations to maintain weather or water proof enclosure.

Install cabling between components to ensure moisture protection integrity is maintained. Run continuous cable lengths between components.

Provide in-situ concrete footings to structural design requirements for all post or pole mounted luminaires, bollards and in-ground uplights. Exposed concrete shall be trowel finished and gaps between concrete foundation and base plates shall be grouted and finished smooth.

Aim all external lighting systems as required after sunset.

**8.5.4 Wiring to External Lighting**

Install double insulated cabling for all external lighting circuits in accordance with Specification Section 5 "Cables and Cable Supports".

**8.6 Completion**

Test and verify operation of all luminaires.

Program all lighting control systems.

Adjust all controls in conjunction with the Superintendent for system operation as required.

Clean all luminaires and diffusers to as-new condition.

Provide all necessary access equipment for luminaire and lighting controls commissioning



## **9. FLOODLIGHTING POLES**

### **9.1 General**

Supply and install high mast lighting poles as shown on the drawings, complete with engineered footings suitable for the prevailing conditions. A soil test must be completed to ensure footings are correctly engineered. Poles shall be supplied and installed by a specialist high mast light pole manufacturer, with in-house local engineering capability to design, manufacture, install and certify poles and footings fit for purpose for the location and function as intended by the electrical lighting design.

### **9.2 Standards**

The pole is to be continuously tapered, hot dip galvanised and multi-sided, conforming with the requirements of all relevant standards, in particular:

- AS/NZS 4677:2000 Steel utility poles
- AS/NZS 4676:2000 Structural design requirements for utility services poles
- AS/NZS 1170.0:2002 Structural design actions Part 0: General principles
- AS/NZS 1170.1:2002 Structural design actions Part 1: Permanent, imposed and other actions
- AS/NZS 1170.2:2011 Structural design actions Part 2: Wind actions
- AS4100 – 1998 Steel structures
- AS/NZS 4600:2005 Cold-formed steel structures
- AS/NZS 1554.1:2014 Structural steel welding – Welding of steel structures
- AS1275-1985 Metric screw threads for fasteners
- AS/NZS 1112.1:2015 ISO metric hexagon nuts - Style 1 - Product grades A and B
- AS/NZS 1112.2:2015 ISO metric hexagon nuts - Style 2 - Product grades A and B
- AS 3600-2009 Concrete structures
- AS/NZS 4680:2006 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles
- AS 1798-2014 Lighting poles and bracket arms – Preferred dimensions
- British Standard BS EN 40-3-3:2013 Lighting columns - Part 3-3: Design and verification - Verification by calculation
- AS 1657-2013 Fixed platforms, walkways, stairways and ladders-Design construction and installation
- AS/NZS 1252:1996 High strength steel bolts with associated nuts and washers for structural engineering

### **9.3 Importance Level**

AS/NZS 1170.0:2002 Structural design actions Part 0: General principles and the Building Code of Australia (the BCA) (refer Tables B1.2a and 1.2b) - Poles shall be designed for Importance Level 1 for poles less than 20m and Importance Level 2 for poles 20m and over. Design working life shall be a minimum of 50 years.

Importance Level 1 has a design wind event with a 1:100 annual probability of exceedance in non-cyclonic areas.

Importance Level 2 has a design wind event with a 1:500 annual probability of exceedance in non-cyclonic areas.

## **9.4 Wind Loading**

Wind loading on the column shall be determined using the relevant annual probability of exceedance obtained from the BCA.

The fraction of critical damping shall be taken as 0.05 (ultimate) and 0.01 (serviceability) for poles with more than two- (2) overlaps and 0.02 (ultimate) and 0.005 (serviceability) for all others. The natural frequency of the pole shall be calculated considering varying diameters and thicknesses over the height of the pole and using a 1.1 safety factor for the mass at the top of the pole. Poles are typically wind sensitive structures with natural frequencies of less than 1. A second order analysis shall be performed.

## **9.5 Deflection**

Pole deflection at serviceability wind speeds shall be less than 6.7% for poles under 30.0m and less than 3.3% for poles 30.0m and over or for poles with integral access, i.e. climbing rungs.

## **9.6 Welding**

Welds shall be by a continuous automatic gas shielded electric arc process complying with the relevant parts of AS1554 Structural steel welding. The longitudinal seam welds on pole sections shall conform to GP standards while baseplate and spigot welds shall conform to SP standards as mentioned in AS1554. Weld sizes shall be verified by a qualified structural engineer and specified in the engineering report and on workshop drawings.

## **9.7 Foundation Bolts**

All poles are to be baseplate mounted and founded on a cast-in-situ concrete footing. A galvanised foundation bolt assembly complete with positioning template and two nuts and washers per bolt is to be provided to suit the pole baseplate. Foundation bolts must be manufactured from deformed reinforcing bars with a nominal yield stress of 500 MPa. Bolts shall be threaded in accordance with AS1275-1985 Metric screw threads for fasteners and fitted with class 5 nuts in accordance with AS/NZS 1112.1:2015 ISO metric hexagon nuts Style 1. Foundation bolts shall be tied to a suitable reinforcing cage. The length of each foundation bolt must allow for the length of the thread above ground, a minimum of 100mm cover and a development length in accordance with AS3600-2009 Concrete structures, Section 13. The underside of the baseplate shall be grouted in accordance with Clause 24.16 in this Section and to the Superintendent's satisfaction. Grout performs a structural function in the design of the pole and stability of the pole may be undermined if it is neglected.

## **9.8 Access Doors & Gear Trays**

Flush fitting access doors shall be provided to house luminaire control equipment. The pole section at the access door shall be reinforced and analysed according to British Standard BS EN 40-3-3:2013 Lighting columns - Part 3-3: Design and Verification - Verification by Calculation, or a recognised finite element analysis package. Poles housing more than eight sets of control gear shall have a vented bottom access door.

Access doors shall be fixed to the pole using a minimum of two standard hex key bolts.

Provide gear trays behind access doors for mounting of lighting control gear, electrical switchgear and associated electrical accessories. Gear trays shall be manufactured as part of the pole prior to hot dip galvanising to ensure that the integrity of the galvanising is maintained. Where possible, threaded studs or pre-drilled bolt holes shall be provided for mounting of equipment to gear trays. All holes drilled in the gear tray for mounting equipment shall be deburred and treated with a rust-resisting paint.

Provide a screw-fixed, all-weather, UV resistant engraved label to each access door with wording similar to:



"WARNING" lettering to be WHITE, minimum 10mm high  
Other lettering to be WHITE, minimum 5mm high  
Background to be RED

## **9.9 Design Calculations**

The section capacity of the pole shall be analysed over a minimum of 100 increments according to AS4100 – 1998 Steel Structures and AS/NZS 4600:2005 Cold-formed steel structures. Pole manufacturers shall submit a fully documented computer printout verifying structural adequacy and conformance to current Australian Standards and this specification. Printouts shall include all input parameters including drag coefficients, cross-sectional properties and design assumptions authorised by a qualified structural engineer and include a statement of compliance with all aspects of this specification. Calculations shall prove pole section capacity, access door reinforcing and foundation bolt suitability.

## **9.10 Luminaire Maintenance Provisions**

### **9.10.1 External Luminaire Maintenance**

Luminaires shall be accessed by external machinery eg- cherry pickers. Luminaire cross-arms shall be designed to ensure easy access of fittings for re-lamping and aiming. Climbing rungs and maintenance platforms are not required.

## **9.11 Accessories**

All cross-arms shall be supplied with structural bolts (certified to AS1252 and tested as per the Australian Steel Institute Tech Note #1-06) for mounting luminaires, and cross-arms shall be suitable for aiming luminaires in the required directions without shadowing or clashing occurring.

## **9.12 Corrosion Protection**

The pole and all steel accessories shall be hot dip galvanized after fabrication in accordance with AS/NZS 4680:2006 Hot-dip galvanized (zinc) coatings on fabricated ferrous articles.

## **9.13 Tolerances**

Manufacturing tolerances shall be in accordance with AS 1798-2014 Lighting poles and bracket arms – Preferred dimensions. In particular the poles shall be checked for compliance with the straightness requirements of this standard: 0.3% of height, as detailed in Clause 5.1.

## **9.14 Assembly and Erection**

Assembly and erection shall be carried out only by qualified rigging personnel. Assembly and erection instructions are to be provided with every pole over 6.0m mounting-height.

## **9.15 Grouting Procedure**

The underside of all pole baseplates shall be grouted with a non-shrink grout with a minimum strength of 32MPa at 28 days within seven days of installing the pole.

Grouting the underside of pole baseplates serves the following functions:

- Grouting plays a significant part in the structural capacity of the pole and foundation bolts in resisting high wind forces.
- Preventing injury to persons through electrocution caused by handling or tampering with exposed cables;
- Preventing damage to electrical cables by vermin;

A Ø16 weep hole shall be installed under the baseplate to the exterior to facilitate condensation from inside the pole to drain to the surrounding ground.

## **9.16 Certification**

For work designed for and carried out in Queensland, all geotechnical, civil and structural engineering work associated with the design of poles and footings shall be carried out in accordance with the Professionals Engineers Act (QLD) and certified by competent Registered Professional Engineer of Queensland (RPEQ). Provide copies of the RPEQ certification.

## **A. TENDER FORM A - TENDER INFORMATION**

This tender will be deemed non-compliant and will not be accepted unless a completed Tender Form, Tender Breakdown, Schedule of Details and Unit Rate Schedule is submitted as a part of the tender submitted.

For Electrical Services

At Morven Livestock Transport Interchange

I/We, the undersigned, hereby tender the following sum to complete the works in accordance with the Specification and Drawings

1. Tender Sum	\$
2. Prime Cost and Provisional Sums	\$
3. Contingency Sum	\$
4. Total Fixed Lump Sum	\$
5. Goods and Services Tax	\$

### **A.1 Schedule Of Rates**

Rate per cubic metre for rock excavation \$

### **A.2 Addenda**

We acknowledge receipt of each Addendum to the Specification as listed below and confirm that the costs associated with each of these have been included in the above Tender Price.

List each addendum number received:

Include a signed copy of each of the above Addenda with this Tender Submission.

<b>Company</b>	
<b>Contact Name</b>	
<b>Signed</b>	
<b>Date</b>	
<b>Witness</b>	

## **B. TENDER FORM B - ITEMISED TENDER FORM**

The total tender price for the Electrical Services installation comprises the following:

<b>Service</b>	<b>Total Price (Excl. GST)</b>
New property pole and supply termination	\$
Mains cabling	\$
Main switchboard	\$
Submains cabling	\$
Distribution switchboards	\$
Cable support systems	\$
Trenching, conduits and pit system for mains and submains	\$
Supply and installation of site lighting poles	\$
Supply and installation of site light fittings and associated fixtures to mount to poles.	\$
Lighting wiring systems and earthing for site lighting. This includes supplying and terminating associated switchgear and terminal blocks at the light poles.	\$
Trenching, conduits and pit system for site lighting and subcircuits.	\$
Power wiring systems, earthing and associated wiring. This includes yard pump power supply, and all additional power outlets/permanent connections as detailed on drawings.	\$
Other items not included above (to be nominated)	\$
	\$
	\$
	\$
<b>TOTAL LUMP SUM FIXED PRICE (excl. GST)</b>	<b>\$</b>

<b>Company</b>	
<b>Contact Name</b>	
<b>Signed</b>	
<b>Date</b>	
<b>Witness</b>	

## **C. TENDER FORM C - SCHEDULE OF TECHNICAL DETAILS**

The schedule of technical details forms part of the specification and shall be completed in full and returned with the tender.

<b>Equipment</b>	<b>Manufacturer</b>	<b>Model No. or Type</b>
Main Switchboard		
Switchboard Assembly		
MCCBs		
MCBs		
Surge Diverter		
Contactors		
Distribution Switchboards		
Switchboard Assemblies		
Isolators		
Circuit Breakers (as shown)		
Surge Diverters		
Contractors		

<b>Company</b>	
<b>Contact Name</b>	
<b>Signed</b>	
<b>Date</b>	
<b>Witness</b>	

Equipment	Manufacturer	Model No. or Type
Luminaires		
W1		
W2		
X1		
W3		
Light Poles		
Yard lighting Poles		
MSB security lighting pole		
Rail loading zone lighting Pole		

<b>Company</b>	
<b>Contact Name</b>	
<b>Signed</b>	
<b>Date</b>	
<b>Witness</b>	



## **D. TENDER FORM D – SCHEDULE OF UNIT RATES**

The following rates shall be used to assess variations and shall include all allowances for overheads, profit, attendance, mark-up, union requirements, superannuation payments and the like.

Variations for work that requires disruption to the normal sequence of work (such as installing additional points in areas after walls and ceilings have been sheeted) shall be treated on a materials + labour break up as per items D.1 and D.2.

Unit rates from item D.3 onwards are intended to be applied to variations which occur without disruption to the normal sequence of work. These rates will be assumed to be applicable equally to additions or deletions, with any supplier restocking fees treated separately.

### **D.1 Labour**

#### **D.1.1 Electrical Contractor**

	<b>Normal Time</b>	<b>Time and a Half</b>	<b>Double Time</b>
Qualified Tradesman	\$ /hr	\$ /hr	\$ /hr
Apprentice Tradesman	\$ /hr	\$ /hr	\$ /hr

#### **D.1.2 Technician**

	<b>Normal Time</b>	<b>Time and a Half</b>	<b>Double Time</b>
Technician	\$ /hr	\$ /hr	\$ /hr

#### **D.1.3 Other**

	<b>Normal Time</b>	<b>Time and a Half</b>	<b>Double Time</b>
	\$ /hr	\$ /hr	\$ /hr

<b>Company</b>	
<b>Contact Name</b>	
<b>Signed</b>	
<b>Date</b>	
<b>Witness</b>	

## **D.2 Mark Up**

Mark-up to be applied to the electrical contractor's purchase cost of materials or specialist subcontractor works for the purposes of out-of-sequence variations. % \_\_\_\_\_

Mark up does not apply to variations items that use unit rates contained herein. Unit rates are assumed to include all overheads and mark-up.

Evidence of costs shall be produced upon request, such as supplier or specialist subcontractor quotes or invoices.

## **D.3 Lighting**

Supply and installation of a one gang light switch incl 15m cable	\$	each
Supply and installation of a one lighting point incl 30m cable	\$	each

Luminaire	Light Fitting Only	Supply & Install Light Fitting (Incl. Lighting Point and 5m Cable)
Type W1	\$	\$
Type W2	\$	\$
Type X1	\$	\$
Type W3	\$	\$

<b>Company</b>	
<b>Contact Name</b>	
<b>Signed</b>	
<b>Date</b>	
<b>Witness</b>	

#### **D.4 Switchboards**

Supply & installation of standard 10A-32A single phase MCB including termination of sub-circuit cable	\$	each
Supply & installation of standard 10A-32A single phase ELCB including termination of sub-circuit cable	\$	each
Supply & installation of standard 10-40A three phase MCB including termination of sub-circuit cable	\$	each
Supply & installation of standard 40-63A three phase MCB including termination of sub-circuit cable	\$	each

#### **D.5 Power**

Supply & installation of standard 10A SSO (single) including 20m of cable, wall mounted	\$	each
Supply & installation of standard 10A SSO (double) including 20m of cable, wall mounted	\$	each
Supply & installation of 20A single phase direct connection including 40m of cable and weatherproof isolator	\$	each
Supply & installation of 20A three phase direct connection including 40m of cable and weatherproof isolator	\$	each

#### **D.6 Trenching**

##### **D.6.1 Excavation to 760mm deep, sanding, backfill and compaction**

	<b>Addition Cost</b>	<b>Deletion Cost</b>
300 wide / linear meter	\$	\$
600 wide / linear meter	\$	\$

##### **D.6.2 Excavation in rock**

	<b>Addition Cost</b>	<b>Deletion Cost</b>
Rate per cubic metre for rock excavation	\$	\$

#### **D.7 Sub Mains**

	<b>Addition Cost</b>	<b>Deletion Cost</b>
4C 10mm Cu + E PVC/PVC	\$	\$
4C 16mm Cu + E PVC/PVC	\$	\$

<b>Company</b>	
<b>Contact Name</b>	
<b>Signed</b>	
<b>Date</b>	
<b>Witness</b>	

4x1C 16mm Cu + E PVC/PVC	\$	\$
4C 25mm Cu + E PVC/PVC	\$	\$
4x1C 25mm Cu + E PVC/PVC	\$	\$
4x1C 35mm Cu + E XLPE/PVC	\$	\$
4x1C 50mm Cu + E XLPE/PVC	\$	\$
4x1C 70mm Cu + E XLPE/PVC	\$	\$
4x1C 95mm Cu + E XLPE/PVC	\$	\$
4x1C 120mm Cu + E XLPE/PVC	\$	\$
4x1C 150mm Cu + E XLPE/PVC	\$	\$
4x1C 185mm Cu + E XLPE/PVC	\$	\$
4x1C 240mm Cu + E XLPE/PVC	\$	\$

## D.8 Cable Tray

Unit price / metre of cable tray including brackets & accessories, installed.

	Addition Cost	Deletion Cost
150mm wide	\$	\$
300mm wide	\$	\$
600mm wide	\$	\$

## D.9 Cable Ladder

Unit price / metre of cable ladder including brackets & accessories, installed.

	Addition Cost	Deletion Cost
300mm wide	\$	\$
450mm wide	\$	\$
600mm wide	\$	\$

<b>Company</b>	
<b>Contact Name</b>	
<b>Signed</b>	
<b>Date</b>	
<b>Witness</b>	

**D.10 Cable Mesh**

Unit price / metre of cable ladder including brackets & accessories, installed.

	Addition Cost	Deletion Cost
150mm wide	\$	\$
300mm wide	\$	\$
600mm wide	\$	\$

<b>Company</b>	
<b>Contact Name</b>	
<b>Signed</b>	
<b>Date</b>	
<b>Witness</b>	