



PROJECT

**129 BARRACK ROAD**

DOCUMENT

**ELECTRICAL SERVICES SPECIFICATION**

SITE ADDRESS

**129 BARRACK ROAD  
CANNON HILL QLD 4170**

PROJECT MANAGER

**ANTHONY JOHN GROUP  
LEVEL 27 RIVERSIDE CENTRE,  
123 EAGLE STREET  
BRISBANE QLD 4000**

DESCRIPTION

**REVISION: A  
DATE: 30 JULY 2009**



1.0 EXTENT OF WORKS

1.1 SCOPE

The electrical services sub-contract includes but is not limited to the following:

- Supply and installation of all components forming part of the electrical services.
- Co-ordination.
- Authorities' approvals.
- Approvals.
- Shop drawings.
- Installation drawings.
- Work-as-executed drawings.
- Inspections.
- Testing and commissioning.
- Maintenance.
- Programming.
- Manuals.
- Cabling, cable support systems and access.
- Samples.
- Spare conduits, wall boxes and draw wires for future use and use by other trades.
- Quality assurance.
- Power distribution.
- Lighting.
- All minor components and incidental works not specifically referred to, however necessary to complete the electrical services installation such that it is handed over complete, operational and fit for the intended use.

With the tender response provide a copy of the Electrical Sub Contractors licence. Include a copy of all of the above licence in the maintenance manual.

Accept full responsibility for liaising, arranging and co-ordination all works that have an effect on or will be affected by the electrical services.

1.2 ASSOCIATED WORKS

Co-ordinate with the relevant bodies for the following works associated with but excluded from the electrical services sub-contract. The electrical sub contractor is responsible for coordinating the interface of the electrical services with the following services:

<b>Service</b>	<b>Responsibility</b>
Communications cabling	Telstra.
Building works.	Building contractor.
Signage.	Specialist signage contractor.
Connection of the power supply from the isolator to the sign.	Specialist signage contractor.
Fixed equipment such as HWS and cooking equipment.	Dependant on the equipment either the contractor, other sub contractor, specialist contractor or proprietor.
Plug in equipment such as fax machines.	Dependant on the equipment either the contractor, other sub contractor, specialist contractor or proprietor.

1.3 CONTRACT DRAWINGS

The electrical service's document schedule C0757a-0001.xls details the electrical drawings, details, schedules and associated documents that form part of the electrical service's sub-contract. The electrical service's documents are diagrammatic only and the Electrical Sub Contractor must familiarise themselves with all other services documents and the architectural documents to establish the scope to be allowed for.

The current architectural drawings form part of the electrical sub-contract and as such information which appears on the architectural drawings which affects the electrical services will not be accepted as the basis of a cost variation. The electrical installation must be installed in accordance with the architectural drawings issued for construction.

#### 1.4 SITE CONDITIONS

As part of the tender, the tenderer is required to familiarise themselves with all site conditions and allow for such conditions within the tender. Changes or additions due to site conditions or requirements which could have been established during a tender period site inspection will not be accepted as the basis of a cost variation.

#### 1.5 DEFINITIONS

Refer to the main contract for the definitions to be read into the electrical services documents

#### 1.6 PRELIMINARIES

Carry out all of the electrical services works in accordance with the Builder's program and the preliminaries defined in main contract.

#### 1.7 CORROSION AND UV PROTECTION

Ensure that all metal surfaces are suitably protected against corrosion, and that all plastic materials are UV stabilised. Repair to new condition or replace any components showing any signs of corrosion during the defects liability period.

Ensure that all metal surfaces are suitably protected against corrosion likely to be experienced during the life of the installation. Cover all electrical terminations including terminal screws and exposed raw metal including exposed conductors with clear synthetic resin based insulating enamel before fixing the terminal covers in place. Provide all fixings exposed to the weather and those in potentially corrosive environments as stainless steel. Do not use materials that will react with or cause galvanic reactions with adjacent materials or surfaces.

Use only plastic materials, paints, insulation materials and coatings that are UV stabilised and will not break down with the normal exposure to ultra violet radiation during the life of the installation. Provide written evidence for approval that all such materials are UV stabilised. Do not install PVC in locations it will be exposed to direct sunlight.

#### 1.8 WORKMANSHIP

Ensure that the work is performed by the holder of a current Electrical Sub Contractor license. Provide a copy of the license before commencing work onsite and include a copy in the operating and maintenance manual.

Ensure the installation and all components, fixtures, fittings, outlets and cables are supplied and installed to a high standard throughout, and installed in a neat and tradesman like manner, to the current industry standards. Ensure all materials and components of a similar type are of the same manufacturer and installed in a uniform manner.

It is the Electrical Sub Contractor's responsibility to ensure that the installation is fit for purpose and is provided as a complete working installation. It is the Electrical Sub Contractors' responsibility to provide all

components, fittings, fixtures, systems, programming etc irrespective of the level detailed in the documents such that the installation is provided as a complete working installation.

Irrespective of the information documented it is the Electrical Sub Contractors' responsibility to ensure all aspects of the installation comply with and meet the requirements of all relevant authorities and the relevant current Australian Standards.

Provide all materials as new, and of the highest class available for their respective types.

It is the electrical sub contractor's responsibility to ensure all conduits are not damaged during concrete pours.

Within the tender allow to conceal all wiring and conduits. Exposed cabling or conduits are generally not acceptable. For extreme circumstances a written request to allow the running of an exposed service in a specific location may be considered. In such circumstances the Electrical Sub Contractor is to agree to a variation credit of \$1,000.00 to the contract for each exposed service.

Provide all circuits and outlets required by any control or communications equipment supplied as part of this contract, irrespective of whether these outlets and circuits are shown on the drawings. Such outlets may include, but are not limited to, the following:

- Amplifiers.
- Control panels.
- Communication and intruder detection equipment.

During the course of the building being painted, remove flush plates, light fittings and other equipment that is likely to be marred by painting and mask/cover other equipment such as switchboards and the like. On completion of the painting replace all equipment, remove masking/covers and the like. Clean off any paint marks and return the finish to as new condition.

Install components and equipment in accordance with the manufactures recommendations and ensure such components and equipment are not operated outside of the limits specified by the manufacturer.

Irrespective of the extent of information or the accuracy of such information it is the Electrical Sub Contractor's responsibility to confirm the location of all existing services on site. The cost of repairing and of disruption to service due to damage to existing services is to be met by the Electrical Sub Contractor.

Ensure all components, equipment and materials supplied are new, unused, designed and selected to ensure satisfactory operation under varying atmosphere, climatic, humid tropical conditions without distortion and deterioration in any part affecting efficiency and reliability of the systems. Design and select all equipment to provide the necessary safety to human life and property during operation and maintenance with particular attention given to electrical safety and segregation precautions.

Check the finished paintwork around the area of each installation and touch up all damaged parts and finishes after the installation of the electrical services.

Within the tender response provide a list of sub contractors that will be engaged by the electrical sub contractor including the postal address, fax number, telephone number and e-mail address. Within two weeks of being awarded the contract provide the names and contact phone numbers of the electrical sub contractors supervisor and site foreman as well as the supervisor and site foreman of each of the sub contractors that are to be engaged by the electrical sub contractor.

## 1.9 PROGRAM

Carry out all of the electrical services works in accordance with the Builder's program. Within ten working days of the contract being awarded to the contractor the contractor is responsible for providing an electrical services program and procurement schedule for the ordering and delivery of all components forming part of the electrical installation. The electrical services program is to include the start and finish dates for each of the following:

- Engage Electrical Sub Contractor.
- Shop drawings for approval.
- Power to be energised.
- Testing.
- Commissioning.
- Practical completion.

Where a component or document is noted as requiring to be submitted for approval, it is the electrical sub contractor's responsibility to obtain in writing the approval of such from the client, the project manager, the engineer and from a senior member of the electrical sub contractors firm. The electrical sub contractor must give each of the approving parties one weeks notice of the pending requirement for the approval and give each approving party a minimum of two working days to respond. Should an approval not be given it is the electrical sub contractor's responsibility to revise the material being submitted for approval and resubmit such material. The re-submission of material for approval does not constitute grounds for an extension of time.

#### 1.10 ACCESS

Allow to provide all necessary access to install and complete the electrical services. This includes though is not limited to the following:

- Conduits.
- Blockouts.
- Ducts.
- Risers.
- Cable trays and ladders.
- Chasing.
- Cutouts.
- Pits and trenching.

#### 1.11 ALTERNATIVES

Alternative components and design will be considered with the cost of the consideration being borne by the Electrical Sub Contractor. Any alternative may be rejected without a reason being provided. Alternatives which are used without written approval must be removed from the installation and replaced with the complying item at the electrical sub contractor's cost.

#### 1.12 DEFECTS

Should more than two defect inspections due to poor workmanship, be required to be performed by the electrical engineer the cost of such inspections will be passed on the electrical sub contractor. The approval of the contract payment will be dependent upon the rectification of such defects and the settlement of the respective inspection costs.

When advice of a defect is received by the electrical sub contractor provide written advice within 24 hours of the date the defect will be rectified.

The expiration of the warranty period does not exclude the contractor or the electrical sub contractor from the responsibility of latent defects discovered after the warranty has expired.

#### 1.13 ANOMALIES

It is a requirement that the tenderer allow for within the tender, the most expensive solution to address anomalies which may exist between any of the drawings, the drawings and the specification or between any of the contract documents and an authority requirement or a relevant Australian Standard. The Electrical Sub Contractor is to identify any anomalies and request in writing a direction on which option to proceed with. Any such direction will not constitute grounds for a variation or an extension of time.

#### 1.14 APPROVALS

Where information has been nominated as requiring to be submitted for approval or the information must be approved, apply the following definition:

Each request for approval must be made in writing, accompanied with all necessary supporting information to allow for the prompt assessment of the request. Each request must be first approved by a senior member of the contracting firm prior to being submitted. For the approval to be valid the following parties must each grant an individual approval:

- A senior member of the contracting firm.
- The engineer.
- The project manager.
- The client.

Each request for approval must include the following information:

- Project name.
- Approval name.
- Approval submitted date.
- Approval required date.
- Description of what approval is required and how the approved information / items will be used.
- Facility for each of the approving parties to date and acknowledge their approval.

A typical request for approval is available from the Electrical Design Group web site [www.edg.net.au](http://www.edg.net.au).

It is the Electrical Sub Contractor's responsibility to seek approvals and do so in a timely manner with the understanding that approvals may not be given and the request for approval may have to be modified and resubmitted. Delays in submitting requests for approval and resubmitting revised requests for approval will not constitute grounds for an extension of time. Unless advised otherwise the Electrical Sub Contractor must allow one working week for the approval to be given by the engineer, the project manager and the client.

#### 1.15 CUSTOMER ACCEPTANCE

At the conclusion of the installation a preliminary walkthrough with the installation contractor and the customer's representative will be performed to check for installation quality, accurate performance of the work, and to verify the accuracy of work-as-executed documents. Complete any modifications to the documentation or the installation that may be required within a 2 week period from the walkthrough. Customer Acceptance will be given following a final walkthrough with the installation contractor and the customer's representative if all previously identified issues have been addressed.

If the Electrical Sub Contractor has advised that the previously identified issues have been addressed and it is found they have not been, the Electrical Sub Contractor is responsible for meeting the costs of subsequent customer acceptance inspections at the rate of \$200.00 per hour plus GST plus disbursements. The walk through will be scheduled within 3 weeks of the completion of the installation in order to turn the project and documentation over to the end user. Please note that "Customer Acceptance" does not release the Contractor from repairing any cabling errors or improperly labelled circuits, caused by the Contractor that may be discovered at a later date.

## 2.0 QUALITY REQUIREMENTS

### 2.1 STANDARDS

Irrespective of information contained in the electrical service's documents or in instructions, it is the electrical sub contractor's responsibility to ensure all electrical services works are be installed in accordance with the requirements of the following. Refer any discrepancies between the requirements of the following and/or the electrical services documents and instructions to the Architect for clarification prior to the placing of orders, fabrication or installation of the items/methods in discrepancy.

- Building Code of Australia.
- Electricity Act.
- Electrical Safety Act.
- Workplace Health and Safety Act.
- Telecommunications Act.

Unless specifically detailed within this specification, undertake all works to the requirements of the relevant standards included in the Standards Schedule C0757a-0003.xls. Refer any discrepancies between the following standards and or the specification to the Architect for clarification prior to the placing of orders, fabrication or installation of the items/methods in discrepancy.

It is the electrical sub contractor's responsibility to obtain from all equipment and component suppliers confirmation that the equipment and components supplied as part of the electrical service's installation comply with all of the following relevant standards and codes. Specific specification of equipment or a component does not alleviate the electrical sub contractor of the aforementioned requirement.

Keep on the site a copy of AS3000 and AS3008.

### 2.2 AUTHORITIES

Ensure all of the electrical services comply with the requirements of all regulatory authorities having jurisdiction over the site including but not limited to the following:

- ACMA.
- Local Council.
- Local Supply Authority.
- State Government Department of Environment and Heritage.
- Qld Government, Division of Workplace, Health and Safety.
- Queensland Fire and Rescue Authority.

If any of the responsible Authorities, pursuant to the statutory powers vested in them, elect to perform, supply, inspect or test wholly or part of the works, make all necessary arrangements and co-ordinate with the Authorities.

Provide "for approval" copies of all Authorities' Approvals.

Pay all relevant authority fees and charges necessary to complete the electrical services installation to leave it in operating condition meeting all of the authority requirements.

## 2.3 CONTRACTOR DOCUMENTS

### 2.3.1 SHOP DRAWINGS

Before commencing fabrication or erection of the nominated item, submit a R14 AutoCAD electronic copy of detailed shop drawings via compact disc or via e-mail to brisbane@edg.net.au for approval. Prepare all drawings as A3 or A1 size to AS1100, AS1102, AS1103 and AS3702 with information detailed at the following minium scales:

- Layout Drawings: 1:100
- Site Plans: 1:500

- Equipment Assembles: 1:50

Ensure the shop drawings include the following information:

- General arrangement of all equipment: Include layout and clearances around equipment.
- Mounting details, structural details and calculations verifying the structural efficiency of load-bearing slabs, etc., footings and the like, supporting electrical equipment mounting structures, poles, lighting masts, etc.
- Supports: Details of equipment and cable support brackets and fixings including mountings.
- Physical cable layouts: Showing arrangement, location and identification of interconnecting wiring and cabling. All cable penetrations, connections and terminations details. Include all forms of conductors such as Bus Bars and Busducts.
- Labelling: Details of labelling and engraving.
- Earthing.
- The type, rating and capacity of all equipment and components.
- Comprehensive schematic diagrams showing the configuration and operation of all components.
- Co-ordination details with all other services.
- Plant Room Layouts.

### 2.3.2 WORK-AS-EXECUTED DRAWINGS

Prior to practical completion, provide for approval the following Work-as-Executed Drawings:

- Reticulation Drawings.
- Layout Drawings.
- Schematic Drawings.

Ensure the Work-as-Executed Drawings include the following information:

- All information required by the shop drawings.
- Comprehensive details on the reticulation for all of the Electrical Services including:
  - Support types and locations.
  - Conduit types and locations.
  - Junction Boxes.
  - All cable locations.
  - Circuiting.
- Comprehensive details on the layout of all outlets, fittings and equipment of all of the Electrical Services including:
  - Outlet types and locations.
  - Equipment types and locations.
  - Mounting Detailing.
- Cross reference to the onsite labelling and numbering of all components and outlets.

Submit a R14 AutoCAD electronic copy of the work-as-executed drawings via compact disc or via e-mail to [brisbane@edg.net.au](mailto:brisbane@edg.net.au) for approval.

### 2.4 INSPECTION AND WITNESSING

Arrange for and give sufficient notice so that inspection for approval may be at the following stages:

- Concealed conduits: Prior to concrete pours, etc.
- Cables laid: After laying underground cables and before and after laying protective covering and marker tape.
- Roughin: Cables have been installed in walls and the ceiling space before the like has been sheeted.
- Connection: Connection of cabling and wiring.
- Factory testing of all control panels and switchboards.
- Factory inspection of all custom made components.
- Earthing: Installation and connection of earthing system.
- Acceptance: Installation ready for acceptance.
- Inspections required by Regulatory Authorities prior to their approval of the installation or its stages.
- All testing and commissioning.

To prevent an abortive factory visits the manufacturer is to provide written evidence, including appropriate certification, that testing has been carried out to the required specification prior to the factory visit. As part of the factory testing and commissioning all operational, functional and safety sequences are to be simulated and checked. Should the factory testing and witnessing have to be repeated due to the manufacturer failing to provide the required written evidence or appropriate certification and or failing to carry out the testing prior to the visit, the Electrical Sub Contractor is to agree to a variation credit of \$2,000.00 to the contract per repeated factory test.

The manufacture is to undertake the following prior to the factory visit:

- Undertake all required tests and ensure that signed test sheets and relevant product documentation and certification are in place.
- Obtain copies of the latest design specification and drawings
- Confirm the 'as built' drawings incorporate the latest modifications to the design drawings.
- Wire external switches on a temporary basis to simulate operational conditions for testing. Note that external switches and pots can be connected for test purposes.

## 2.5 TESTING

Arrange for and give two weeks notice so that, the tests may be witnessed for approval.

Undertake on site the following tests:

- Insulation resistance measurements: on motors and major medium voltage equipment items, at 1000-volt D.C.; On cables and wiring.
- Functional checks: Full functional and operational checks on energised control equipment and circuits, including adjustments for the correct operation of safety devices.
- Motor rotation: Checking and where necessary altering connections for the correct motor rotation.
- Earth resistance.
- Earthing: Confirmation of effective earthing of the exposed metal of electrical equipment.

During testing, replace fuses and equipment damaged as a result of incorrect installation work.

Provide all Test Results for approval within one (1) week of the test being undertaken on A4 paper and as a electronic PDF file copy on CD for approval.

## 2.8 COMMISSIONING

Commission all components of the electrical services to ensure the correct interfacing operation and control of all systems to the satisfaction of the engineer as per the approved commissioning method statement and commissioning plan. Arrange for and give two weeks notice so the commissioning may be witnessed for approval.

Provide all necessary software, equipment and personnel to fully program and configure all systems to the satisfaction of the architect.

Following the completion of the commissioning and prior to Practical Completion thoroughly clean all components of the electrical installation to the satisfaction of the engineer.

Following commissioning, operate each component and system at the convenience of the engineer to the satisfaction to provide evidence to the engineer that each component and system is working correctly.

A record of all settings, set point and offsets should be maintained throughout the commissioning period and included in the operation and maintenance manual. Update the operation and maintenance manual record following the completion of each of the post practical completion commissioning requirements. The defects and liability period will not end until the operation and maintenance manual has been updated.

Provide independent testing and certification of the accuracy of each of the private meters. This testing and certification is to be undertaken once the metering commissioning has been completed.

## 2.9 LAYING OUT

The positions of outlets, switches, and equipment shown on drawings are diagrammatic only. Check on site for positions and verify locations and mounting heights with the architect. When any relocating is required to conform to the above, undertake such relocation without additional costs. Verify locations of all outlets, switches, and equipment to ensure:-

- The work of any other trade does not interfere with the electrical installation.
- They are not shrouded by door swings and tracks, furniture or equipment.
- They conform to any pattern formed by ceilings, panels, tiles, beams, and the like.
- They are not located in restricted zones as defined by AS3000. It is the Electrical Sub Contractor's responsibility to check the volume of all sinks, tubs and basins.

Promptly report any anomalies, for consideration and instructions. Work proceeding without obtaining approval, will not be accepted as basis for a variation.

Locate all adjacent outlets at the same height and ensure power and non power outlets are segregated by 150mm.

## 2.10 OPERATING PARAMETERS

Ensure the electrical service's installation is installed in accordance with the following operating parameters and service conditions:

- Nominal voltages:
  - Line: 400-volt
  - Phase: 230-volt
- Frequency: (Hz): 50Hz
- Number of phases: Three
- Number of wires: Four
- Neutral Connection: Star Point
- Earthing System: MEN
- Ambient air temperature range: (°C): -5°C to 40°C
- Maximum relative humidity: (%): 90%

## 2.11 SAMPLES

Submit samples for approval for permission to use materials, fabrication, or workmanship, or as an example of design. All subsequent work is to be of the same quality as the sample on which the permission to use was given. Permission to use may be withdrawn if the standard of the sample is not maintained.

Keep approved samples in good condition on the site for the duration of the contract.

The Electrical Sub Contractor will be solely responsible for the consequences of delay resulting from failure to allow adequate time for the assessment and approval of samples, or from the rejection of samples which do not comply with the specification, or the like.

With every sample provide a sample information sheet: A separate sample information sheet must be provided for every location the relevant sample is to be installed where any of the installation conditions are different. Should a coordination conflict arise in a location that has not been addressed by a specific sample information sheet, the rectification of such a conflict must be undertaken at the Electrical Sub Contractor's expense and such conflicts will not be accepted as grounds for a variation.

The sample information sheets are provided as evidence that the Electrical Sub Contractor has checked the coordination of all components of the installation.

Ensure the sample information sheets are A4 in size and include the following information:

- Sample identification.
- Project identification.
- Sample submitted for approval date.
- Details of the location/s the sample will be used in.
- Details of how the sample will be mounted in each location.
- Details of how the cabling will be run to and connected to the sample in each location.

Typical sample information sheets are available from the Electrical Design Group web site at [www.edg.net.au](http://www.edg.net.au).

## 2.12 QUALITY ASSURANCE

Establish and maintain records which give evidence that the trade works has passed inspection and/or test with defined acceptance criteria and submit one (1) copy of all such records within seven (7) days of completion of the relevant work.

Allow approved representatives the right to verify at source or upon receipt that the purchased product conforms to the specified requirements. Such verification will not absolve the Electrical Sub Contractor of the responsibility to provide acceptable product nor will it preclude subsequent rejection.

Ensure a quality system is planned, established, implemented and maintained according to the requirements of AS9002 for and during the carrying out of the Services.

Allow approved representatives appointed as a Quality System Auditors the right to undertake a quality assurance audit. Provide access and all necessary assistance to the Auditors in order to demonstrate compliance with the requirements of the quality standard.

Review and analyse the cause of any deficiency revealed in the report of an audit by the Quality System Auditors and develop and implement or procure the development and implementation of corrective action to prevent recurrence.

## 2.13 LABELLING

Permanently label and individually number all components, fixtures, fittings, outlets and cables installed as part of this contract such that they can be quickly and accurately identified. All labels must be permanent with the type and size of label appropriate to the location and conditions. The label type must be appropriate for weathering, UV exposure, vandalism and mechanical damage. Stick on and hand written labels are not acceptable. The numbering and identification is to be consistent and consecutive for all items. Provide matching labelling and numbering where an existing numbering and labelling system exists. Submit all labelling types, identification schemes and numbering schemes for approval. Ensure all labelling is clearly identified and cross-referenced in the manual and on the work-as-executed drawing. Double sided tape is not acceptable as a method of securing labels.

## 2.14 KEYING

Ensure all of the lockable enclosures provided as part of the electrical installation are keyed alike and keyed as part of the sites master key system. Where enclosures are required to be accessed by authorities, key the enclosure to the authorities' requirement.

### 3.0 INSTALLATION REQUIREMENTS

#### 3.1 UNDERGROUND SERVICES

##### 3.1.1 EXCAVATION IN PUBLIC AREAS

Before excavating any public area including roads, footpaths, reserves, and the like, obtain the approval of the relevant authorities and comply with their requirements for alternative traffic arrangements, excavation methods, backfilling and reinstatement.

Restore areas outside the limits of the Works, which have been disturbed by the Works, to their original condition on completion of the excavation. Reinstatement surfaces to their original level without subsidence and without cracking at junctions with existing surfaces. Restore pavements to match existing. Regrass grassed areas.

##### 3.1.2 TRENCHING

Unless noted otherwise provide all trenching, bedding, backfilling and reinstatement required to complete the electrical services.

Excavate trenches in sections of suitable length, lay and bed the relevant service length, and backfill the trench section, with the minimum of delay, and if possible on the same working day, unless otherwise approved.

Provide all saw cuts in existing concrete or bitumen surfaces in a straight line to a minimum depth of 75mm before excavation is commenced. Lift and store paving slabs for later reinstatement.

Ensure all trenches are cleared of sharp projections.

Notify, and obtain approval from, the appropriate owner or authority before any excavation is commenced beyond the site boundary. Carry out the excavation to the owner's or authorities' requirements. Reinstatement the surface to match existing.

##### 3.1.3 BORING

Where specified or required by the relevant authorities, provide under road boring, by an approved specialist in lieu of trenches. Make the bored dimension to ensure a tight fit. If voids are encountered, fill by pressure grouting.

##### 3.1.4 CONDUITS IN TRENCHES

Provide polypropylene draw cords in all conduits not in use.

Provide a minimum surrounding of 50mm clean sand around cables and conduits installed underground.

Under roadways and areas subject to traffic movement, install cables in a duct or conduit extending to not less than 1m on either side of the sealed surface or trafficable area and encase in concrete with a strength of 20MPa having a minimum cover thickness of 100 mm.

Seal the buried entries to ducts and conduits with a pliable non-setting waterproof compound. Seal spare ducts or conduits immediately after installation, and seal the other after the cable installation.

##### 3.1.5 BACKFILLING TRENCHES

Backfill trenches as soon as possible after approval of laid and bedded service to the following:

- Garden areas: Backfill the top 150mm of the trench with topsoil.
- Lawn areas: Re-loam the top 150mm and returf trenches passing through existing lawned areas.

Remove all excess soil and fill from the site unless otherwise directed. Reinstatement existing surfaces and assets disturbed or removed as a result of the excavations of trenching. Reinstatement concrete surfaces to the original level using approved reinforcing steel, keyed to the existing and laid to prevent the reinstalled concrete from subsiding and cracking.

In existing bitumen surfaces camber the reinstated surface so that the edges are flush and the centre is 10mm above the existing pavement. Fill the top 150mm below the bitumen surface with mechanically compacted finely crushed gravel. Prime coat the existing bitumen edges of the trench with bitumen prior to laying 75mm minimum of hot pre-mix bitumen to the finished cambered surface. If it can be shown that hot pre-mix is not available, cold pre-mix will be accepted. Provide a written certification that the backfilling has been completed as specified and compaction completed such that the trench will not subside.

### 3.1.6 CABLE PITS

Provide draw-in pits as required to complete the electrical service's installation and to allow all underground cabling to be removed and reinstalled after the installation is complete. Irrespective of the number of pits shown on the drawings, provide all pits necessary to complete the electrical installation. All sizes shown refer to the inside dimensions and are given as an absolute minimum.

Irrespective of the number of pits shown on the drawings do not run underground conduits between pits spaced further than:

- High voltage conduits: 120 meters.
- Low voltage conduits: 75 meters.
- Communications, intruder detection and audio visual conduits: 50 meters.

Provide pits that contain conduits larger than 63mm diameter as 75mm minimum thick insitu concrete or moulded fibre cement or polycrrete. Incorporate an additive to any insitu concrete to prevent the ingress of water. All pits that have more than ten conduit penetrations must be cast on site. Pits that do not contain conduits larger than 63mm diameter can be provided as PVC pits with a pre cast labelled concrete lid if they are located in non trafficable areas.

Use concrete pits with cast iron covers and frames of ribbed plate design in locations the pit is required to be capable of carrying traffic. Ensure the pit and lid is rated at the traffic loading of the site. Ensure vertical and horizontal seating surfaces on both cover and frame to be machined surfaces to prevent movement by traffic loading and to provide a watertight fit when a thin film of grease is applied.

Where infill lids are nominated provide lids with a minimum of 50mm depth to accommodate the infill material. Ensure the infill section has reinforcing welded to the pit lid to allow permanent bonding of the infill material to the lid. Infill the pit lid to the same finish as the surrounding hardscape.

All pits are to be provided with keyholes to positively locate the keys, and are fitted with plastic plugs to prevent entry of dirt. Ensure all pit lids are capable of being secured and are not accessible without the use of a specialist tool. Seal all pits such that they are vermin proof.

Ensure all pits are provided with a reinforced cast insitu concrete surround collar a minimum of 250mm wide x 200mm deep. The concrete collar is to fall away from the pit lip by 10mm over the 250mm width. The top of the collar is to be flush such that the pit can be mowed over as part of normal lawn mowing without chipping or damage to the pit.

All pits are to be a minimum dimension of 350 x 350 x 700mm deep unless noted otherwise and bedded on a minimum of 300mm of gravel aggregate.

Pits for use other than by Telstra will not have any reference to Telstra on them. Mould the word 'ELECTRICAL' into a lid for use on any pit containing electrical power cables. Mould the word 'COMMUNICATION' into a lid for use on any pit containing COMMUNICATION CABLES. Under no circumstances shall communications cabling and power cabling be run through the same pit.

Provide each pit with a 30mm diameter weep hole in the base of the pit to allow the disbursement of any accumulated water. Provide fixed drainage to the pit system by one of the following methods:

- Drain back to the existing system, if pipe work is an extension of an existing system.
- Drain from the lowest point of a pit to nearest stormwater drain.
- Drain to a soakage pit of adequate size if above is not possible.

Lay all conduits with a drainage fall of at least 1:100 to drain the pit system to the lowest pit or pits.

Irrespective of the orientation shown on the drawings orientate the pits such that they are true and square with the surrounding hardscape and architectural finishes.

Provide all conduits and pipes entering the pits with bell mouths where they enter the pits. Seal the bell mouths to the pit wall. Seal around all conduits and pipes entering the pits such that moisture does not enter the pits around the outside of the conduits or pipes.

Clean out all pits prior to practical completion. Open all of the pits at practical completion for inspection by the project manager. Seal all pit lids once the inspection is complete.

### 3.1.7 ROUTES

Accurately locate underground cables and conduits using route markers placed at intervals of not more than 100 metres for straight distances, and at joints, route junctions, changes of direction, terminations and entry points to buildings. Indicate all such route markers, conduit locations, sizes and quantities on the work-as-executed drawings.

Provide orange plastic warning tape above all runs of underground pipes and direct laid cables with tape 300mm below surface. Use 100mm wide tape with the words "CAUTION - ELECTRICAL CABLE BURIED BELOW" clearly marked continuously along tape.

Mark the direction of cable runs and the location of all underground conduits by marker plate direction indicators. Provide four distinct versions of the marker plate containing, 'single', 'through', 'L' and 'T' arrows, with the latter three containing a centre marking. A group of two or more plates may be required at some route junctions.

Set the marker plate flush in a 200mm minimum diameter concrete base, not less than 200mm deep or locate in pit shoulder. Set the marker flush to the surface in footpaths, roadways, paved areas, etc., and flush with the surrounding surfaces.

Where cable is drawn around corners or turning in cable pits, place rollers to conform to the Manufacturers' bending radius specification for the cable, to prevent serving or armouring being damaged by scraping on the ground. Draw cable into pipe ducts after laying the ducts and backfilling. Arrange installation so that cable may be drawn out of the duct in the event of cable failure. Install cables when both the cable and the ambient temperature are at or above 0°C and have been so for the previous 24 hours.

## 3.2 CABLES

### 3.2.1 INSTALLATION

Unless otherwise specified, install and terminate cables in accordance with manufacturers' recommendations. Unless noted otherwise joints are not acceptable. Install power wiring utilising the loop-in, loop-out system with joints in cables being effected at outlets.

Remove redundant equipment and wiring, including that in accessible ceiling spaces, and make good exposed surfaces before commencing the installation of new wiring.

Handle cables so as to avoid damage to insulation and serving or sheathing. Replace all wiring with insulation damage after determining and removing the cause of damage.

Identify multicore cables and trefoil groups at each end and at crowded intermediate points by means of stamped, non-ferrous tags, clipped around each cable, or trefoil group.

Install and adequately support fixed wiring as specified throughout the installation. In accessible false ceilings, keep cables clear of all ceiling insulating material and/or removable ceiling tiles by securely fixing the cabling to permanent structural members. If the structural members are more than 1,200mm above the suspended ceiling, provide a catenary support system. It is not allowable to fix cables to the ceiling hangers.

Provide flexible connections or an approved form of vibration/movement isolation on the terminations of all cables that will experience vibration or movement under their normal operation.

Cable installation in areas where there are motors and/or generators shall comply with the guidelines set out in AS/NZS 3548 and AS/NZS 2834.

### 3.2.2 GENERAL CABLING REQUIREMENTS

Ensure all of the electrical services cabling comply with the following requirements:

- All cabling is concealed from view.
- Chasing of masonry walls is co-ordinated with other trades. Horizontal wall chases must be approved.
- Coordination of the installation of conduits and cables in the ceiling space does not interfere with the operation or maintenance of any equipment.
- Cables do not come into contact with hot water pipes.
- Above suspended ceilings, all conduits and cables are secured to the ceiling support members or roof structure above. Conduits and cables laid directly on the ceilings (on the ceiling suspension system or framing) are not acceptable.
- All cables in underground conduits are approved by the manufacture for external use, PVC insulated and sheathed.
- Enclose cables from above down to switches, outlets and equipment in conduits where the equipment is installed on single leaf masonry walls or concrete walls. TPS power cables where installed in cavity walls may be unenclosed within the cavities, unless otherwise detailed.
- Cables are secured to prevent any strain on the cable terminations. Support cables at a maximum of 1200mm spacing with minimum sag.
- The use of spring clips will not be permitted without approval.
- Do not install double insulated cables in locations where they can not easily be withdrawn for rewiring purposes. Where double insulated cables are installed in accessible locations such as cavities, stud partitions and the like, do not clip or secure the cables such that they can not be withdrawn.
- Double insulated cables are installed in conduits where they are installed within cement render, masonry walls or concrete slabs.
- External cabling is installed underground where installed between buildings, connecting signs, luminaries and the like.
- Catenaries are provided between cable trays and access conduits.
- Where cables traverse areas above set plasterboard ceiling (or similar) particularly in an office environment and providing access difficulties, use conduit secured to a catenary wire, or suitably saddled to the ceiling.
- Support all horizontal cabling via a dedicated catenary, cable tray, cable ladder, or via a structurally secure cable support system specifically installed to support cabling. All cable support systems must be submitted for approval. It is not acceptable to use double sided tape, stick on hangers to support cables or to support cables from the ceiling support system or any other services support system.
- All cables entering wall cavities are to enter vertically above the outlet position and the access into the cavity allows for simple withdrawal of the cable and the simple installation of a second cable of equal size.
- Do not run cables horizontally through walls. Where such runs are necessary, (half height walls), use corrugated conduit to facilitate the cable run to the outlet or switch. Indicate the extent and location of all cables reticulated horizontally through walls.

- All cables passing through a metal surface, any sharp surface or any surface that could damage the cable insulation over the life of the installation is to be protected by grommetted nylon bushes.

Provide mechanical protection of all cables in the following locations:

- Within 2,400mm of any floor, platform or landing that is accessible under normal operation and routine maintenance.
- All locations it is reasonable to expect that the cabling would be interfered with.
- All locations the cable could be subject to damage during normal operation and maintenance.

### 3.2.3 SETTING OUT OF RETICULATION

The routes shown on the Drawings are approximate only. Determine the final routes to suit the building structure or site conditions. Obtain approval for the final routes prior to installing consumers' mains and sub-mains. Unless otherwise specified, conceal and protect cables and conduits. Arrange cables and conduits parallel with walls, ceilings and floors. Provide the main switchboard with a diagram indicating the route of any underground consumers' mains, printed on a durable card or similar, and indicating run distances for each 'leg' of the consumers' mains route.

### 3.2.4 WIRING IN CONDUIT

Complete and permanently fix the conduit run before installing the wiring. Use draw wires to pull in the conductor groups from outlet to outlet. For vertical conduit runs in excess of 15m make adequate provision for supporting the weight of the wiring to avoid insulation damage. Run circuits originating at different distribution boards in separate conduits.

### 3.2.5 TERMINATIONS

Terminate all cables installed as part of this contract. It is the Electrical Sub Contractor's responsibility to check and ensure the component or equipment the cable is being terminated to is appropriate and suitable for the cable to be terminated to. Advise the architect of any concerns with the component or equipment prior to the cable being terminated.

Where core identification is required, fit to each core durable numbered ferrules permanently engraved with numbers and/or letters to suit the specified connection diagrams. Terminate and identify any spare cores into spare terminals, if available; otherwise neatly insulate and bind the spare cores to the terminated cores.

Insulation displacement terminations or connections are not acceptable for 240 volt cabling. All 240 volt terminations must be screw type.

## 3.3 CONDUITS

Ensure all conduits installed as part of the electrical services are installed in accordance with the following requirements:

- Conduits are sized to permit drawing-in of cables to finished conduit runs without damage to cables.
- Rigid UPVC conduit fittings are fastened to the conduits by fresh solvent cement in accordance with the manufacturer's recommendations.
- Corrugated UPVC conduit fittings may be fastened with solvent cement as above or by use of snap-lock connectors.
- Flexible smooth wall PVC conduit fittings of the black nylon conduit clamp band type are provided.
- Conduits, pipes and conduit fittings are not visible on any wall, floor or ceiling surface with the exception of Switch rooms, Plant rooms and risers.
- Installation of conduits enable wiring to be drawn in and out at any future time without damage to the building and cabling and without disruption of the conduit continuity.
- Only conduit, deep draw-in boxes and couplings are to be cast in concrete. Do not cast conduit tees and elbows in concrete.
- Constant supervision at all times is provided when concrete containing conduits is being poured.

- Conduits passing through expansion joints are provided in concrete slabs with approved flexible expansion couplings.
- Conduits with expansion joints are provided as required to accommodate the expansion of the conduits and the supporting surfaces with a minimum of an expansion joint in straight runs at intervals of no more than 12,000mm.
- Unless noted otherwise provide conduit located internally as PVC light duty (LD), high impact rigid, minimum size being 20mm circular. Corrugated PVC conduit shall not be used unless approved.
- Unless noted otherwise, provide conduit located externally as PVC heavy duty (HD) conduit and stamped "underground" type.
- Conduit adaptors are lock nutted into metal wall boxes or welded into PVC boxes.
- Conduits, fittings and welding solution of the same manufacture are used.
- All change directions of conduits are set. Undertake setting by warming the conduit and bending around an internal spring. Ensure burn marks are not visible as a result of warming. Cold bending is not permitted.
- Conduit ends above ceilings at right angles are set in the direction of the cable run.
- Conduit ends are cut square and free from sharp edges, burrs, and the like.
- Where subject to mechanical damage, exposure to sunlight, weather and/or damp conditions and/or ambient or contact temperatures exceeding 60 degrees Celsius, use heavy duty galvanised screwed steel conduit. Provide mechanical protection to UPVC conduit for a height of not less than 3m above ground or platform level.
- Where PVC conduit is embedded in concrete which is screeded or vibrated after pouring, or where conduits may be subjected to heavy traffic prior to concrete pour, provide constant supervision by a tradesperson to ensure that conduits are not damaged.
- All conduits are installed in concrete slabs above the bottom layer of reinforcement and securely tied in place. Boxes are firmly fixed to the formwork.
- Groups of conduits in slabs are separated by a distance equal to the diameter of the conduit/s. Obtain approval prior to installing conduits greater than 40mm OD in concrete slabs.
- Proprietary sealing caps (or aluminised flashing tape if sealing caps are not manufactured) are fixed to all conduit ends prior to the commencement of pouring of slabs, laying of bitumen, gravel, and the like and are to remain in position until the conduits are finally terminated.
- Prior to the installation of wiring, ensure conduits are clear of debris and liquids.
- All underground electrical conduits and conduits/pipes for special services (including spares) are sealed internally to approval at switchboards and/or at special services enclosures and where entering buildings to prevent the ingress of water.
- Two fixings per conduit saddle are provided. Do not use explosive-powered or similar equipment unless approved.
- Conduits are fixed to wood using matching saddles and round head cadmium-plated steel wood screws.
- Conduits are fixed to masonry using matching saddles and round head cadmium-plated steel screws screwed into expanded lead or other proprietary type plugs, neatly fitting into drilled holes.
- Conduits are fixed to steel using cadmium-plated steel metal-thread screws. Drill and tap the steelwork for each saddle.
- UPVC conduits installed in accessible roof spaces and the like are protected by timber battens.
- Up to the commercially obtainable conduit lengths of run, conduits are installed without joints. Remove all jags, burrs, and sharp edges from each length before completing each conduit joint. Fit molded plastic screwed bushes to the free ends of metallic conduit runs before installing the conductors.
- All inspection fittings and the like, are accessible.
- Draw-in boxes are provided at suitable intervals not exceeding 30m in straight runs, and at intervals not exceeding 25m in other runs including directional changes.
- Conduits are not run in topping slabs unless approved.
- After removal of sharp edges, burrs, etc., ends and joint threads of steel conduits are painted with a rust-inhibiting metallic paint, which maintains conductivity.
- Standard size wall boxes of the same material as the conduit are used. Where special size boxes are specified and where such boxes are not obtainable in UPVC, use pre-fabricated metal boxes.
- Galvanised steel water pipe may be used for cable enclosures buried in the ground or run in concrete trenches or the like. Seal joints against the entry of water or moisture. Associated fittings will be either galvanised steel, cast iron or approved non-ferrous metal.
- Round off sharp edges and provide PVC bushes or the like for cable entries into metallic ducting.

- All conduits and ducts on cool room panels are mounted on 25mm stand offs.
- All PVC conduit located externally to a height of 2,000mm AFFL are protected with 1.6mm thick folded galvanised sheet steel hat section. Where the conduit is in an exposed location, paint the exposed conduit and hat section to match the building colour.
- All conduits are installed such that any moisture in the conduit drains away from the electrical connections. Where required provide the conduits with weep holes and drip loops.
- All conduits are installed and sealed such that insects can not nest or seek refuge in them.
- All conduits are sealed such that the sealant can be removed in the following locations to prevent vermin and moisture entering through the conduits:
  - Conduits passing between different functional parts of the building such as food preparation areas, plant rooms, service areas and public areas.
  - Conduits passing between levels.
  - Conduits entering or leaving the building.

### 3.4 PENETRATIONS

Seal all penetrations in a neat and tidy manner in such a way that the sealing material can be removed to allow future use of the penetration. Ensure all penetrations are sealed to at least the original integrity of the member or structure being penetrated. Provide independent certification of all fire rated and sound rated penetrations. Do not penetrate fire rated finishes, structural members, acoustically rated finishes or damp courses without approval. Run pipes entering a building at ground level under the waterproof membrane and vertically penetrate the membrane and the floor slab. Provide a suitable seal between the pipe and the roofing material.

Fit a UPVC sleeve for each penetration through ground floor slabs, ground floor beams and external walls for cables not enclosed in conduit. In addition, for MIMS cables fit a sleeve for each masonry penetration. Provide a penetration of diameter 10mm greater than the pipe or sleeve diameter for pipes and sleeves penetrating existing external walls, ground slab, or ground floor beams.

Fireproof all penetrations through fireproof walls or floor slabs, irrespective of size, upon completion of installation of cables. Provide fireproofing by fixing a suitable galvanised sheet metal cover (minimum thickness 1.6mm) around the cables on both sides of the wall and underside of slab, pack space with fireproof material. Provide independent certification of the rating of all penetrations through fire rated members. Fix plastic grommet around metal edges bearing against cables. Paint sheet metal covers to match surrounding areas.

Provide all electrical penetrations into refrigerated enclosures as rigid conduit extending a minimum of 50mm beyond each side of the refrigerated panel. Seal inside and outside of the refrigerated panel around the conduit with Sikaflex. After the cabling has been installed, seal around the cable within the conduit with Sikaflex. Ensure all penetrations into outlets, switches and fittings within refrigerated enclosures are waterproof.

In all locations where underground conduits pass under a building or structure, provide flexible conduit with a smooth interior for 300mm each side of the transfer to accommodate movement of the building or structure. All such conduits are to be similar to Vindex Coreflow conduit.

Provide all outlets and switches flush mounted within floors, walls and ceilings that have an acoustic or fire rating with additional protection to achieve the same acoustic and / or fire rating as the base structure. Provide a copy of an independent certification for approval of the additional protection that the required acoustic and /or fire rating is achieved with the installation method and components employed. Provide a copy of the certification in the maintenance manual and indicate the location of all such additional protection installations on the as build documents. Surface mounted wall blocks are not acceptable as methods of achieving the required rating if the outlet / switch has been specified as flush. If additional furring channel and or wall / ceiling sheeting is required that is not part of the base design all such additional materials must be included as part of the tender price.

Provide ceiling roses or flush faceplates with a cable gland to trim all cables penetrating a wall or ceiling that are to be connected to equipment that is bracket mounted that does not inherently accommodate concealed cabling.

### 3.5 ACCESSORIES AND FITTINGS

Provide all accessories and fittings in accordance with the following requirements:

- All switches and outlets provided are of a like appearance, flush set sized at 115 x 70mm.
- Switch flush plates are mounted with the 115 dimension orientated vertically. Outlets are mounted with the 115 dimension orientated horizontally.
- All accessories shall be flush mounted rocker action type. Use red switch toggle marker 'dots' on GPO's but not on light switches. Provide accessories as white in colour unless specifically detailed otherwise.
- Flush plates are installed plumb and fit hard against wall surfaces. Wall boxes are used for masonry and concrete walls and proprietary mounting accessories for "stud" type partition walls.
- Switches and power outlets in exposed locations and in areas such as plant rooms and car parks are provided as IP56 rated light grey in colour with one piece covers where available.
- All wall boxes specified for future use are provided with blank flush plates.
- Instructions for final positions of all outlets and switches are requested at least ten working days in advance.
- Relocation of outlets and switches is allowed for at a maximum of 1.5m without additional cost, providing chasing is not required.
- Outlets, switches and accessories are installed to suit tiling and surrounding fixtures. The mounting heights shown on the electrical services drawings shall be taken as indicative only.
- All accessories are to be flush mounted installed in wall boxes.
- Supply of all outlets mounted within the joiners or nominated as being mounted below bench via surface duct run within the joinery is allowed for. Allow to mount all such outlets on surface mounting blocks. Coordinate the location of the duct and the outlets on site with the joinery. If the installation permits counselled cabling and flush mounted outlets do not install the surface duct or mounting blocks.
- All suspended equipment provided is mounted off a raked ceiling with an adjustable ceiling mounting such that all suspended equipment hangs vertically.
- All fittings and accessories installed in refrigerated rooms and enclosures must be non ferris.
- All mechanisms and blank mechanism fillers are to be screwed fixed in place on the rear of the faceplate.
- The circuit identification is to be provided using indelible ink on all light switches in a concealed location.
- The circuit identification is to be provided by engraving with a contrasting infill colour on the faceplate of all power outlets and isolators in a permanently visible location. Such engraving is not permitted to be located on clip on faceplates or clip on faceplate surrounds. If the entire faceplate is clip on then the label is to be provided as a screw fixed trefolite panel engraved with a contrasting infill colour mounted immediately above the outlet. The power outlets and communication outlet identification method is to be identical in type and style.
- The outlet identification is to be provided by engraving with a contrasting infill colour on the faceplate of all communication outlets in a permanently visible location. Such engraving is not permitted to be located on clip on faceplates or clip on faceplate surrounds. If the entire faceplate is clip on then the label is to be provided as a screw fixed trefolite panel engraved with a contrasting infill colour mounted immediately above the outlet. The power outlets and communication outlet identification method is to be identical in type and style.

### 3.6 EARTHING

Provide a comprehensive earthing system throughout the project addressing all aspects of the structure, all services, all systems and components in addition to those forming part of the power distribution.

Provide earth electrodes as 19mm diameter of either copper or steel rod copper clad and will incorporate integral driving heads and points. Stainless steel rods grade 302 are also acceptable. Install earth electrodes vertically. Electrodes may be driven direct into the ground or installed in holes previously drilled and packed with a suitable conductive graphite slurry. At ground level cover the rods with fibreglass reinforced concrete pits with appropriately embossed or stamped lids flush with the surrounding ground. Bond all exposed metallic parts or components in the project (ie. conduits, frames, water pipes, enclosures, light fittings, sinks, cable

sheaths, cable trays, skirting duct, partitions and the like) by means of adequate clamping/fixing. Where allowed by the supply authority, provide the earthing system as a combined earthing system.

Where electrodes are to be installed in rock, fill the gap between the rock and electrode with a bentonite clay or resin compound or as otherwise approved. Where electrodes are to be installed in corrosive soil, install each electrode in a 200 mm bore hole, backfill with a conductive metallic grouting compound and compact with a vibrator.

Run a PVC-insulated copper conductor from the main switchboard earth bar to the slab reinforcing mesh. Clamp conductor to mesh (one point of contact only required) with a brass earth clamp. Wrap clamp and exposed copper conductor with insulation tape. Provide a label engraved 'Slab Reinforcing Mesh Bond' adjacent to the termination on earth bar.

Copper conductor is to penetrate slab inside building enclosure and be such as to avoid moisture penetration to slab reinforcing mesh.

Bond the electrical earth to all piped services (if metallic pipes) at the closest practical point to where these piped services enter the building. This includes cold water, hot water, soft water, steam, condensate return, waste, medical gases, suction and the like. The bonding earth conductor to be 6 sq. mm minimum.

### 3.7 ACCESS

In non-habitable locations such as plant rooms and store rooms provide cable access to surface mounted electrical equipment such as switchboards, control panels, intruder detection panels and communication equipment by surface mounted PVC or metal duct. Provide the duct with a removable lid of lengths not exceeding 1,200mm and arrange the duct such that it runs square with the building. Silicon seal between the duct the wall, the floor and the ceiling. Cover all conduits entering through the floor with such duct. Where the duct abuts the boards/panels provide neat cutouts free of burrs in the duct and boards/panels to allow cable access. Where the duct does not adjoin the boards/panels provide cable glands in the duct and the boards/panels for all cable access. Ensure all of the cables run within the duct are supported vertically and horizontally to the cable manufactures requirements and as a maximum such supports are not to exceed 1,200mm. Provide or paint the duct to match the wall colour.

#### 4.0 POWER DISTRIBUTION

##### 4.1 SCOPE

The power distribution component of this contract includes the connection of a new supply authority service padmount substation and under ground consumers' mains to a site MSB. The MSB is to incorporate bulk supply authority metering. Power is to be reticulated from the distribution boards to equipment isolators and to outlets via final sub circuits. Submains are to be provided to distribute power to the distribution boards and meter panels. The switchboards are to contain connection points for the building contractor to connect the unit submains to.

The unit submains and works within the accommodation buildings is by the building contractor.

In addition to the unit submain connection points provide community light and power circuit connection points for the building contractor to connect the community lighting and power within the building to.

Provide joint power / communications trenching as required by Telstra to allow Telstra to install the communications conduits. Backfill the trenches as part of the electrical sub contract works.

The power distribution component of this contract includes, but is not limited to the following extent of work:

- Power distribution.
- Earthing.
- Switches, Outlets, Isolators and Accessories.
- Supply Authority Coordination.
- Lead-in services.
- Trenching.
- Pits.
- Conduits.
- Consumers' mains.
- Switchboards.
- Metering.
- Submains.
- Final sub-circuits.
- Connection to equipment.

Any changes required by the authorities will be at the electrical sub contractor's expense should the electrical sub contractor not obtain authority approval of the shop drawings above.

Arrange with the supply authority to have the supply connected to the site and the metering installed. Submit all necessary forms and obtain all necessary signatures from the operator required by the supply authority for connection of supply and installation of the metering.

Provide written advice to all associated contractors and sub contractors of the following information where switchboards and control panels are supplied outside of the electrical services and are provided with power by the electrical services: Provide a copy of such advice for approval and provide a copy of each piece of advice within the operation and maintenance manual.

- Upstream protective device size and configurations.
- The fault level at the final point of termination.
- The cable size, type and configuration.
- Control and interface configuration and requirements.

Provide a sample of each type of switch and outlet. Provide shop drawings of all switchboards, distribution boards, load centres, metering panels and control panels. As part of the tender submission the Electrical Sub Contractor must include for all contractual requirements and costs required by the suppliers to the electrical sub-contract to provide the necessary samples. The Electrical Sub Contractor must bear the cost of supplying samples of the components specifically specified as well as those specified generically or by performance.

All suppliers and sub-contractors to the Electrical Sub Contractor must ensure they are familiar with and comply with the requirements of sections 1.0, 2.0 and 3.0 of this specification

## 4.2 INSTALLATION

### 4.2.1 CABLING

Use stranded copper conductor with a minimum size of 2.5 mm sq and 0.6/1kV V75 PVC insulated or 0.6/1kV V75 PVC insulated and PVC sheathed stranded cables unless otherwise specified. Use grey insulation for all TPS power cabling. Use PVC insulated and PVC sheathed cables for all cables run underground in conduits. For all cables supplying essential equipment use fire rated approved cables.

Provide all final connections from the wall box or isolator in flexible smooth wall PVC conduit to equipment. Enter the isolator with flexible conduit from the underside thus forming a drip loop and neatly install such conduit to minimise retention of grease, etc.

The cable sizes indicated on the drawings are provided as a minimum only. The current capacity, voltage drop and fault capacity of the cables must be established by the Electrical Sub Contractor and the cables sized accordingly by the Electrical Sub Contractor. Size all cables to accommodate the respective loads, starting currents and maintain a spare capacity of 10%. All loads and fault levels must be confirmed on site by the Electrical Sub Contractor with the actual equipment being supplied.

For fixed power wiring, colour the conductor insulation or, if this is not practicable, slide not less than 150 mm of close-fitting coloured sleeving to each conductor at the termination points as follows:

Active conductors in single phase circuits: RED.

Active conductors in polyphase circuits:

- A PHASE - RED
- B PHASE - WHITE
- C PHASE - BLUE

Unless otherwise approved, terminate copper conductors to equipment, other than small accessory and luminary terminals, by means of compression-type lugs of the correct size for the conductor, compressed only by the correct tool.

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

Provide flexible connections on the terminations of all cables that would experience sufficient stress/force under a bolted line fault condition that would cause damage to the cable termination or the equipment.

### 4.2.2 SWITCHBOARDS

Ensure all switchboard enclosures are appropriate for the location they are intended to be installed in and have appropriate space and capacity to contain all equipment and cabling in the final configuration.

The switchgear sizes indicated on the drawings are provided as a minimum only. The current capacity and fault capacity of the switchgear must be established by the Electrical Sub Contractor and the switchgear sized accordingly by the Electrical Sub Contractor. Size all switchgear to accommodate the respective loads, starting currents and maintain a spare capacity of 10%. All loads and fault levels must be confirmed on site by the Electrical Sub Contractor with the actual equipment being supplied.

All switchgear throughout the entire site is to be of the same manufacturer. All miniature circuit breakers are to be compact DIN style DIN rail mounted circuit breakers.

### 4.2.3 OUTLETS AND ACCESSORIES

The outlet and accessories sizes indicated on the drawings are provided as a minimum only. The current capacity and fault capacity of the outlet and accessories must be established by the Electrical Sub Contractor and the outlet and accessories be sized accordingly by the Electrical Sub Contractor. Size all outlets and accessories to accommodate the respective loads, starting currents and maintain a spare capacity of 10%. All loads and fault levels must be confirmed on site by the Electrical Sub Contractor with the actual equipment being supplied.

Ensure all electrical connections to equipment other than light fittings and control panels or switchboards with integral isolators are via a switched outlet or a switchable isolator. Provide all isolators as 20 Amp, lockable, IP56 isolators. Connect all isolators to the respective equipment via smooth flexible conduit unless noted otherwise.

Do not connect any motors larger than 5Kw to an isolator without motor protection relay and a control contactor.

#### 4.2.4 FAULT PROTECTION

Unless specifically shown otherwise, provide overload, short circuit and earth fault protection utilizing automatically operated circuit breakers.

Provide 30mA earth fault protection of all cabling and outlets within residential areas, all general purpose outlets and circuits that the public could have access to during normal operation.

Ensure all circuits are suitably protected against earth faults and the protective device operates within the required time. Include details of how such protection is achieved with the testing and commissioning data for the worst case point on every circuit and submain. Such details must be in the form of one of the following:

- Circuit protected by a 30 mA RCD.
- Perspective fault current at the point, circuit impedance and protective device tripping characteristics

#### 4.2.5 SUBSTATION

Provide as part of the electrical services the following padmount substation equipment to the requirements of Energex and as per the Energex Drawings included as part of the contract documents:

- Flexible LV connections to the transformer.
- Substation foundations.
- Footings.
- Pre cast culvert.
  - 1 x unicultvert (CSR Humes product No. 5029130 or equivalent).
  - 2 x end walls (CSR Humes product No. BC1200.9510 or equivalent).
  - 1 x base slab (CSR Humes product No. 5028308 or equivalent).
- Backfilling.
- Surface finishing.
- HV and LV leadin conduits.
- Substation civil works.
- Paving around the substation.

As part of the electrical services arrange with Energex for the new HV service and substation. Coordinate all of the Energex requirements with the contractor and other relevant sub contractors.

#### 4.3 COMMISSIONING

As part of the commissioning of the power distribution undertake the following tests as relevant on all components of the power distribution installation: Typical test result forms are available from the Electrical Design Group web site [www.edg.net.au](http://www.edg.net.au).

- Has been fully commissioned in accordance with this specification and the requirements of CIBSE Commissioning Codes.
- Phase rotation.

- Power availability.
- Resistance to earth.
- Voltage.
- Overload protection.
- Fault protection.
- Earth leakage residual current protection.
- All mechanical fixings.
- Maximum demand of each switchboard and submain.

Schedule the results for each item and component and include a copy of all test results in the operation and maintenance manual.

Ensure the correct phase sequence at the main switchboard after connection of the supply.

Balance the load as evenly as practicable at Practical Completion. Re-check and, where necessary, re-balance the load at completion of the Defects Liability Period. Submit the balance results for approval and include a copy of the results in the operation and maintenance manual.

As part of the commissioning of the power distribution, undertake any necessary adjustments to components of the power distribution installation which, have integral adjustment capacity as directed. Record all adjustments undertaken and include a copy of all adjustments in the operation and maintenance manual.

Upon the completion of the commissioning of the power distribution provide a written and signed statement that the power distribution installation:

- Has been fully programmed as necessary.
- Has been tested.
- Complies with the intent of the contract.
- Complies with the relevant authority requirements.
- Complies with the relevant standards and codes.
- Is fit for purpose and suitable for the intended use.

Include a copy of the power statement in the operation and maintenance manual. Typical statement of compliance forms are available from the Electrical Design Group web site [www.edg.net.au](http://www.edg.net.au).

Ensure the following components of the power distribution system installation are complete and have been checked and tested prior to the adjusting of the power distribution system installation to commence:

- Labelling.
- Correct operation of the power distribution system.
- All components have been installed and are operating.

Should these items not be complete prior to the adjusting of the power distribution installation the additional expenses in re-attending the installation to undertake the adjusting of the power distribution installation as incurred by the engineer will be charged to the Electrical Sub Contractor.

Provide all equipment such as ladders, scaffolding and tools necessary for adjusting the power distribution installation. Should the Electrical Sub Contractor not have available the necessary equipment to complete the adjusting and aiming of the power distribution installation, the additional expenses in re-attending the installation to undertake the adjusting and aiming of the power distribution installation as incurred by the engineer will be charged to the Electrical Sub Contractor.

The adjusting and aiming of the power distribution installation will include the following:

- Adjusting mountings and brackets.
- Adjusting switch gear settings.
- Testing all operations of the power distribution installation.
- PE Cells.
- Time clocks.

Allow to attend site twice during the defects and liability period and undertake the above adjustments to and reprogram as directed by the operator the power distribution .

#### 4.4 OUTLETS

Provide all power outlets and connections as follows:

- Provide isolators for motors with a suitable motor rating; where motors are supplied by other trades, confirm motor ratings prior to sizing isolators.
- Unless otherwise detailed, all appliances will be supplied and installed by other trades, and connected by the Electrical Sub Contractor either by means of an isolator or by means of a power outlet.
- It will be the responsibility of the Electrical Sub Contractor to check with suppliers that cable and circuit breaker/fuse sizes are suitable for the equipment being installed prior to the installation of cables and circuit breakers and/or fuses.
- Specific details regarding connection to various items of equipment are not given in the specification where it is considered that the installation is of a straightforward nature and full details are available from single line diagrams/circuit schedules.
- Ensure all three phase power outlets throughout the installation have identical phase rotation and polarity.
- Install a neutral conductor to every three phase power outlet.
- The location of sinks and fittings and swing of doors shall be confirmed before the installation of general purpose outlets and light switches.
- Mount outlets of the one type where grouped together under the common flush plate.
- Provide all outlets mounted on stainless steel joinery of the flush stainless steel type with black mechanisms.
- On face plates, secure the mechanism with retaining screws, or construct the faceplate and mechanism so that the mechanism cannot be displaced during normal operation.
- Orientate switch mechanisms to operate in the vertical plane.
- Provide all GPOs as the safety type, 10 amp, 3 flat pin flush, impact resistant, polycarbonate switch plug combinations, all mounted under the one cover plate with the earth pin at the 6 o'clock position.
- Mount all special purpose outlets with the earth pin at the 6 o'clock position, the neutral pin in the centre, and the red, white and blue phases in a clockwise sequence when viewed from the front of the socket.
- Provide a matching plug top with a screw ring for each three phase and screw type outlet.
- All accessories are to be flush mounted installed in wall boxes.

#### 4.5 SWITCHBOARDS

##### 4.5.1 AUTHORITIES

Provide space for the Supply Authority metering equipment. Arrange to obtain the relevant metering equipment from the supply authority such that the metering equipment is installed in the workshop prior to the delivery of the switchboard.

Make all necessary provisions for Supply Authority metering, including appropriate alterations to switchboard designs and allow for all associated metering establishment costs.

Supply and install all of the supply authority metering facilities, including a current transformer metering cubicle complete with CT's and potential fuses as part of the main distribution board. Provide all necessary line-side isolation facilities for each set of supply authority metering CTs. Provide a separate surface mounted external meter box and all interconnecting wiring and accessories.

Ensure all metering is code compliant to allow the supply to the installation to be contested by the appropriate supply authorities.

##### 4.5.2 TESTING

Supply a copy for approval of a 'certificate of verifications and tests', stating the testing authority, manufacturer, and details of parameters and results for each test. Provide documentation to verify that the tests were carried out on a switchboard of essentially identical design to that specified. The manufacturer will hold available certificates of type tests showing evidence of compliance with Australian Standards, together with detailed particulars of the equipment as tested and a record of any alterations that have been made to the equipment subsequent to the type test.

If certificates of type tests are not available for a switchboard of identical design to that specified, provide available certificates and other evidence, to AS 3000 Appendix J guidelines, in support of the design and acceptance of untested assemblies.

Provide routine switchboard tests, carried out at the manufacturers' works and repeated at the site. Use externally connected simulated circuits and equipment at the works to undertake functional electrical tests.

Provide a copy of the type test certificates and the routine test results in the operation and maintenance manual.

#### 4.5.3 OPERATIONAL MAINTENANCE

During the maintenance period, provide the following for each switchboard:

- Carry out periodic inspections and maintain the switchboard installation in a condition to meet the specified performance.
- Promptly rectify all faults.
- Replace faulty materials and equipment without charge.
- Provide a thermoscan report undertaken by Thermoscan Inspection Services PTY LTD [www.thermoscan.com.au](http://www.thermoscan.com.au) at Practical Completion, at 6 months and at end of Defects Liability Period.
- Provide written reports on maintenance activities.
- Provide on line chart recording of the mains supply for a period of one week at Practical Completion, at 6 months and at end of Defects Liability Period.
- Ensure the chart recorder includes the following information:
  - Voltage of each phase to earth and each phase to phase.
  - Current of each phase.
  - Power factor.

Include the chart recorder and thermoscans information within the operation and maintenance manual with simple explanation of the findings of each.

#### 4.5.4 SITE ERECTION

Install floor mounted switchboards level and plumb using neatly cut and fitted packing plates under the channel base. Align shipping sections and bolt together. Fix the base to the floor by means of minimum 12mm stainless steel fixing screws, front and rear, at either end and at intervals of 2 meters along the length of the board.

Complete bus bar connections after alignment and bolting procedures are completed. Neatly pack the space under the base after leveling with sand-cement grout. Complete the inter-panel wiring.

Provide all floor mounted switchboards with a hot rolled steel 75mm channel plinth finished in black bitchumastic paint. Provide concrete plinths where required as 20Mpa strength grade with a 80mm slump with a single layer of mesh.

Fix wall-mounted switchboards to masonry wall only. Load centres may be fixed to non-masonry walls.

#### 4.5.5 TRANSIENT PROTECTION

Provide equipment and accessories, which generally incorporate protection of semiconductor components against damage caused by switching and other external transients.

#### 4.5.6 EXTERNAL DESIGN

Provide enclosures comprising panels, doors and the like, giving the specified enclosure, segregation and degree of protection. Provide separate compartments with metal segregation for all extra low voltage equipment.

Provide all switchboards with lockable doors.

Provide separate doors to all supply authority meter panels and cubicles.

Fabricate supporting frames from rolled, cold formed or extruded metal sections, with joints fully welded and ground smooth. Provide concealed fixing or brackets located to allow the assembly to be mounted and fixed in the specified location without removal of equipment.

Machine fold sheet metal angles, corners and edges with a minimum return of 25 mm around the edges of front and rear panels, and 13 mm minimum return edge around doors. Provide stiffening to panels and doors where necessary to prevent distortion or drumming. All panels are to be continuously welded and ground smooth.

Provide equipment mounting panels, fixed to threaded metal inserts, located inside the enclosure at the rear of the mounting panels.

Provide fixings in the supporting structure, and removable attachments, for lifting switchboard assemblies whose shipping dimensions exceed 1.8 m high x 0.6 m wide.

Provide all visible hardware or hardware immediately behind doors, as chromium plated or stainless steel. Hardware behind escutcheons, Bramite panels and the like which is not normally visible, may be cadmium plated for internal switchboards and chromium plated or stainless steel for external switchboards. Secure Bramite panels using dome headed hexagonal nuts.

For all switchboards with a rating above 400Amps and in cases where the cabling can not be concealed within wall, seal from the top of the switchboard to the ceiling with a framed removable covers of a material and finish to match the switchboard. Provide the removable covers with vermin proof seals that allow the cover panels to be removed and replaced maintaining the seal. Hang the covers on fixed studs with knurled nuts or captive nuts with knurled bolts, in either case fixing is to remain part of the panel or cover when the panel or cover is removed.

All switchboard covers, panels and doors are to be a minimum of 1.6mm thick to achieve BCA compliance.

#### 4.5.7 REMOVABLE PANELS AND COVERS

The maximum width of any removable panel is 750 mm. Hang panels and covers on fixed studs with knurled nuts or captive nuts with knurled bolts, in either case fixing is to remain part of the panel or cover when the panel or cover is removed. Provide chromium plated 'D' type handles to each removable plate. Provide a resilient strip seal, of foam neoprene or the like, around each cover or panel, housed in a suitable channel or housing, fixed with an approved industrial adhesive. In indoor locations, provide certified smoke seals to all panels and covers. For external switchboards provide a continuous positive line of weatherproof contact.

All doors are to be locked using the EMKA three-point locking system and operated by Selectric stainless steel lockable swing handles. Supply four keys on individual stamped aluminium key tags. Ensure all of the switchboards are keyed alike and are keyed on the site master key system. All meter panels located externally and in areas subject to unauthorised access are to be locked to the supply authorities' requirements using the supply authority key.

Provide each door with a substantial internal stiffener fitted with plan pockets and EMKA 1087U1 wind stops.

Provide all fixings on switchboards located externally or in potentially corrosive environments as stainless steel. Provide all fixings on switchboards located internally in non corrosive environments as chrome plated. Plastic or nylon fixings are not acceptable.

#### 4.5.8 ESCUTCHEON PLATES

The maximum width of any escutcheon plates is 750 mm and the maximum height is 1,200mm. Hang escutcheon plates on lift-off pin hinges on one side and secure on the other with fixed studs with knurled nuts or captive nuts with knurled bolts, in either case fixing is to remain part of the escutcheon when the escutcheon is removed. Provide chromium plated 'D' type handles to each side of the escutcheon. Provide removable escutcheon plates with neat cutouts for circuit breaker handles and the like. Provide a continuous 12 mm wide support frame for the fixing of each escutcheon plate, including additional support where necessary to prevent panel distortion. Hang escutcheon plates on hinges, which allow opening through a minimum of 90 and permit the removal of the escutcheon when in the open position.

Provide cutouts in the escutcheons for all spare future circuit breakers. Provide blank fillers in all spare escutcheon cutouts.

Ensure all circuit breaker labels and adjustment dials are visible through the escutcheon when the escutcheon is closed.

#### 4.5.9 FINISHES

Where metal surfaces are to be painted:

- Unprotected steel: Remove rust by abrasive blast to AS 1627.4 Class 3, clean by immersing in trichloroethylene or an alkaline solution, and apply a coat of iron phosphate.
- Galvanised steel: Clean by immersing in a suitable alkaline or acidic solution, apply a chromate or zinc phosphate chemical conversion coating, rinse and degrease.
- Aluminium: Clean by immersing in a suitable alkaline or acidic solution, caustic etch and apply a chromate chemical conversion coating.

Paint the internal and external surfaces of all switchboards, control panels and meter panels located externally in a polyurethane epoxy or epoxy powder coat. Paint the external surfaces, escutcheons and doors of all switchboards, control panels and meter panels located internally with a baked enamel or epoxy powder coat. Paint the internal surface of switchboards, control panels and meter panels located internally as acrylic, baked enamel or epoxy powder coat. Ensure all paint finishes are applied in accordance with the manufacturers' recommendations.

After the switchboards have been installed, repair all chips and scratches in the paintwork to an as new condition.

#### 4.5.10 CONDUCTORS

##### 4.5.10.1 BUS BARS

Provide bus bar systems as high conductivity copper capable of withstanding the thermal, magnetic and physical stresses set up by the fault level detailed for a period of one second. Provide fault level calculations with the shop drawings. Phase colour the bus bars at appropriate intervals for ease of identification over their entire length at any opening, to within 10.0mm of fixings and terminations. Ensure the connections from the bus bars to the equipment are as short as possible and made using bus bars unless the latter is physically impossible. Design bus bar systems for continuous full load operation over a 24 hour period at an ambient temperature of 40°C, with short time peaks of 50°C, resulting in a maximum final bus bar temperature of 105°C. Make allowance for totally enclosed cubicles and for cubicles installed within recesses with or without doors. Provide neutral links and earth bars with sufficient capacity and terminals for connection of all conductors, one conductor per terminal, with spare capacity as detailed and with each terminal being numbered by means of stamping. Clearly mark and number terminal connections. Provide neutral bars with a current carrying capacity equal to that of the incoming phase conductors. Provide bus bar circuits within the

switchboard, extending from the termination of the incoming unit to the line side of protective equipment for outgoing circuits. Provide stud connections for cables of cross section 16 mm<sup>2</sup> or larger.

Divide the bus bar system into separate 'essential' and 'non-essential' circuits, each segregated from the other by fixed and continuous barriers. Clearly label each segregated section of the bus bar system.

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

Radius all bus bar edges and corners to prevent damage to insulation. Provide support sufficient to withstand without damage, the maximum prospective fault currents. Make bus bar joints with high tensile bolts and nuts, locked in position with lock nuts or locking tabs. Tighten bolts to the manufacturer's recommendation with a tension wrench. Do not use tapped holes and studs or the like for jointing current-carrying sections.

Colour the insulation or bus bar as follows:

- Active Bus Bars: Red, white or blue.
- Neutral Bus Bars: Black.
- Earth bus bar: Green and yellow.

#### 4.5.10.2 NEUTRAL AND EARTH LINKS

Locate neutral and earth links within 0.6 m of each cable entry. Provide terminals for incoming and outgoing neutral and earth conductors, including the MEN link. Provide additional terminals for future circuits. Provide a bolted removable copper bar link in the incoming compartment, between the neutral and earth Bus Bars in the main switchboard labelled "MEN LINK".

#### 4.5.10.3 WIRING

Provide all wiring within switchboards as follows:

- Install all internal cabling neatly horizontally and vertically. Cable trough (PVC with slotted sides) may be used, or alternatively cables may be laced/loomed using proprietary cable ties, with adequate insulated supports being provided. Ensure laces/looms are not unnecessarily tight.
- Unless otherwise specified, provide PVC wiring ducts to support and manage all switchboard control wiring and outgoing sub circuits. Ensure the total cross section of the wiring within any one duct, including allowance for outgoing connections, does not exceed 40% of the duct cross sectional area.
- Support cabling to ensure that strain does not occur at terminations.
- Use crimp type lugs at terminations, unless equipment has been specifically designed to preclude terminations being made in this manner. Use lugs with insulated ends.
- Fix cables 25.0mm<sup>2</sup> and over in size to internal cable trays.
- Bush openings in internal barriers for the passage of cables to prevent damage to insulation using Wattmaster or equivalent 'movable' bushing, glue fixed in position.
- Install cables associated with metering equipment and current transformers in conduit.
- Identify wiring at each end of each conductor with a captive type marking ferrule. Horizontally mounted markings are read from left to right and vertically mounted markings are read from top to bottom.
- Provide the cable lugs associated with consumers' mains and/or submains with permanent identification to denote phase colours.
- Provide sufficient space on mounting rails for future outgoing circuits possible in any cabling compartment.
- Provide terminal blocks for interconnecting wiring on each side of shipping breaks.
- Identify, by markers, each control core using an approved numbering system.

Provide cables sized to suit a current carrying capacity of not less than the maximum continuous rating of the equipment mounted within the switchboard, or sized to withstand the 'let-through' energy of the circuit protective device, whichever is the greater. If the conductors are to be bunched or installed within wiring ducts, apply appropriate de-rating factors when determining conductor size. The minimum size power conductor is multistrand 2.5 mm<sup>2</sup>.

Provide control and indication conductors of not less than 1.0 mm<sup>2</sup> with 32/0.2 stranding and otherwise sized to suit the current carrying capacity of the particular circuit.

Colour code the wiring as follows:

- A Phase: Red.
- B Phase: White.
- C Phase: Blue.
- Neutral: Black.
- Earthing: Green/Yellow.

If no provision is made in wiring ducts for external connecting cables, install a galvanised perforated cable tray between terminal blocks and cable entries, of a size, and with available access space, sufficient to permit ready installation of the external wiring.

Segregate electric circuits subject to possible interference, and the like.

For connections up to 15 kW load, provide rail-mounted, spring-loaded, tunnel type terminal blocks. For connections to circuits above 15 kW load, provide stud type terminals of a size to continuously carry the load and not less than 5mm diameter. Fit washers and lock washers to each stud, and barriers between adjacent studs. For tunnel type terminals, connect one conductor only into each end of the tunnel and interconnect terminal groups where necessary, by standard cross connectors. Terminate wiring into terminal blocks using compression type lugs compatible with the terminals and crimped by the use of the correct tool. Lugs for connection to tunnel type blocks will be of pre-insulated lipped blade type. Terminate internal wiring to the one side of the terminal block, leaving the other side for outgoing circuits.

Segregate terminal groups and install together terminals for each outgoing circuit, in the same order throughout, as follows:

- Terminals for power wiring: 3 phases or phase and neutral;
- Control terminals: In numerical or alphabetical order of wire identification, with the lowest number or letter next to the power terminals.

Where more than two 100Amp submains/circuits are reticulated through the switchboard for more than 600mm, provide a metal segregated cable zone to accommodate such cabling.

#### 4.5.11 SWITCHGEAR AND CONTROL GEAR

##### 4.5.11.1 AIR CIRCUIT BREAKERS

Provide air circuit breakers (ACB) to the following requirements:

- Provide circuit breakers, which are all of the same manufacture.
- Ensure the ACB has a rated thermal current applicable to the unit when installed within the nominated enclosure.
- Ensure the ACB has a rated short circuit breaking capacity not less than the switchboards fault level unless otherwise specified.
- Ensure the ACB has a closing operation that provides a trip-free closing mechanism for the required operation, with a positive mechanically operated on-off indication.
- Ensure the ACB has an opening operation in addition to other releases specified, that provides a mechanically operated release for opening.
- Provide auxiliary switches with a minimum rated operational current of 6A.
- Ensure each ACB can be padlocked in its open position.
- Unless the door serves only as a cover, provide a means of preventing a compartment door being open whilst the circuit breaker is in its closed position.

Provide a means to prevent the following incorrect operation in service:

- Slow closing or opening of the contacts.
- Hand closure, if springs fail.
- Release of charged springs whilst the contacts are closed.

Provide a means of slow closing the circuit breaker for inspection, and adjustment when disconnected. Supply a set of tools, necessary for installation and servicing all ACBs.

#### 4.5.11.2 MOULDED CASE AND MINIATURE CIRCUIT BREAKERS

Provide all circuit breakers of the same manufacture.

Mount the circuit breakers so that the 'ON-OFF' and current rating indications are clearly visible with the cover or escutcheon in position, and so that arc discharges from the circuit breakers are directed away from live metal and insulation. Align operating toggles in the same plane.

For miniature overcurrent circuit breakers provide clip tray assemblies, capable of accepting the installation of single, double, or triple circuit breakers, and related Bus Bars. Provide moulded clip-on pole fillers for all unused portions of the chassis.

Maintain sufficient space around the circuit breakers to allow all incoming and outgoing cables, including cables to spare poles, to be installed and terminated without overcrowding. For clip tray chassis mountings, the clearance between the circuit breaker terminals and compartment walls will not be less than 90 mm up to 36 poles and 115 mm above 36 poles.

Provide auxiliary contacts shunt trips, motor operators and other required accessories. All motor operated circuit breakers for load shedding switchboards to be fitted with under volts trips.

#### 4.5.11.3 RESIDUAL CURRENT DEVICES

Unless specifically noted otherwise provide residual current devices (RCD) with a maximum tripping current of 30milli-Amps and a maximum tripping time of 20 milli-seconds. Use RCDs specifically designed to be added to or integral to the circuit breaker and be suitable for mounting in the same manner as specified for moulded case and miniature circuit breakers. Ensure all RCDs have a test facility which can be operated with the escutcheon closed. Use RCD/circuit breaker combinations that do not use more than a single pole per single phase circuit and no more than four poles per three pole circuit.

All RCDs that protect supplies to variable speed drives are to have a minimum tripping current of 300milli-Amps.

Ensure that short circuit, cascading, a discrimination performance of the circuit breaker will not be affected by the earth leakage device.

#### 4.5.11.4 SWITCH-ISOLATOR AND FUSE-SWITCH UNITS

Ensure switch-isolator and fuse-switch units have a rated thermal current applicable to the unit when installed in the nominated enclosure and they have an uninterrupted rated duty. Ensure the rated short-circuit making capacity is not less than the switchboard fault level. For circuits comprising essentially motor or other highly inductive loads, use units with a utilisation capacity not less than AC-23. For other circuits, ensure the utilisation capacity is not less than AC-22.

Ensure that independent manual operation with a positive manually operated on-off indicator facility to lock the unit in the OFF position is provided.

Use totally enclosed units incorporating arc control devices and shrouded stationary contacts.

#### 4.5.11.5 TIME SWITCHES

Provide time switches that operate either by synchronous motor or electronically controlled drive from 240 V 50 Hz supply. Provide day omit and manual override facilities. Photoelectric cell input for operation is to be integral.

To account for mains failure, provide either a 24-hour spring or a battery with 100-hour operating capacity and a guaranteed life of 5 years.

The minimum contact rating is to be 20A at 240 V AC to utilisation category AC-22.

Provide a readily accessible means of adjustment of the switch operation. Ensure the switch operational settings are clearly visible when the switch cover is fitted.

Provide engraved or etched surrounds or labels, identifying the control function of each push button and switch and the operation at each switch position.

#### 4.5.11.6 CONTACTORS

Provide contactors with a minimum rating of 20A at AC-22 of the block type, air break rated for continuous duty. Ensure the contactor is rated above the full load current of the load controlled when mounted in the nominated enclosure. Provide contactors with a utilisation category above AC-3 or DC-3 as applicable. Provide auxiliary contacts for the specified control circuits. Where space is available, fit not less than two sets of spare contacts. Where the number of specified auxiliary contacts exceeds the number which can be accommodated, provide a separate slave relay. Ensure reversing contactors are mechanically and electrically interlocked.

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

Do not connect contactors in series or parallel to achieve the specified ratings.

#### 4.5.11.7 CONTROL RELAYS

Provide control relays with a minimum rating of 5A suitable for continuous operation under the specified conditions with operating characteristics suitable for the application. Use plug-in types latched to the receptacle base by a captive clip, which can be applied and released without the use of tools.

Ensure the control relays employ electrically separate, double break, silver alloy, and non-welding contacts.

For standard control relays, provide assemblies with a minimum of four sets of contacts and capable of being expanded to a total of eight contacts in the same assembly. Where space is available, provide not less than one normally open and one normally closed contact.

Provide contact blocks, which are readily convertible in the field to either normally open or normally closed contacts.

Use time delay relays adjustable over the full timing range and have a timing repeatability within 12.5% of the nominal setting.

Use phase failure relays of the solid-state type, which drop out at 80% of the normal voltage after an appropriate time delay. Ensure the sensing circuit rejects disturbances having frequencies other than 50 Hz, and induced voltage spikes.

#### 4.5.11.8 FUSES WITH ENCLOSED FUSE LINKS

Provide fuse-holders and fuse-links of the same manufacture throughout the installation. Mount the fuse-holders so that the fuse carrier may be withdrawn directly towards the operator and away from live parts, and provide fixed insulation which shrouds all live metal when the fuse carrier is withdrawn.

Provide fused links as enclosed, high rupturing capacity (HRC) type mounted in a fuse carrier. Provide a "fuse blown" indication, which is visible, when the link is fitted to its carrier. Where necessary, for safe removal and insertion of the fuse carrier, provide extraction handles and mount them on clips within the spares cabinet.

Provide fault current limiting fuses as HRC fuses (cartridge and fitting) with a minimum and maximum current rating.

Provide three spare fuse cartridges in each switchboard of each size installed in each switchboard, mounted on a holder fitted internally to the switchboard such that it is not visible when the door is closed. Provide tools fixed in a similar manner required to remove or install all of the fuse sizes used.

#### 4.5.11.9 SURGE PROTECTION

Provide the main switchboard with surge protection in accordance with AS1768 with the following features and requirements:

- The Maximum Discharge Current,  $I_{max}$ , as defined in IEC 61643-1 must be 100kA , 8/20 $\mu$ s per phase.
- The Nominal Discharge Current,  $I_n$ , as defined in IEC 61643-1 must be 70kA , 8/20 $\mu$ s per phase.
- The Impulse Current,  $I_{imp}$ , as defined in IEC 61643-1 must be 20 kA , 10/350 $\mu$ s per phase.
- The Voltage Protection Level Up as defined in IEC 61643-1 must be less than 800V at 3kA 8/20us and 6kV 1.2/50us.
- The Voltage Protection Level Up as defined in IEC 61643-1 must be less than 1000V at 20kA 8/20us and 6kV 1.2/50us.
- The Maximum Continuous Operating Voltage,  $U_c$  must be 415 Volts.
- The products must be UL recognised under UL1449-2 standard.
- (The product must be equivalent to CRITEC TDS MT277 or the CRITEC TDS MPM)
- The surge diverter must have 5 Segment light indication and voltage free contacts. An alarm must be raised when there is approximately 50% depletion of the surge material on any phase.
- Provide a manufactures warranty of a minimum of 5years for the surge diverter.
- Tested in accordance with the requirements of UL1449 Edition 2 and EC 61643-12 Class I and II

#### 4.5.12 INSTRUMENTS

Provide test links for the connection of calibration instruments and meters and for the shorting of current transformer secondaries. Energy meters, maximum demand meters and ammeters, where specified, will each be provided with a set of links comprising screw-clamped slide links and an earth link.

For energy and demand meters provide potential test studs or plug connections adjacent to associated current transformer links.

Provide current transformers with an accuracy classification and class of:

- Energy measurements: 0.5M.
- Indicating and recording instruments: 2M.
- Rated short-time current: Not less than the short-time current equivalent of the potential fault capacity of the circuit in which the current transformer is installed.

Provide the main switchboard with maximum demand indicator and voltage meters reading the incoming supply.

Support moving elements between shock-resistant jewel bearings. Provide indicating and recording instruments with damped movements with facility for external adjustment of the zero. Ensure the glass cover is impact-resistant and non-reflective.

Provide instruments and meters with black lettering on white background with black pointer, capable of indicating the maximum value of the variable being measured and the scale marking indicating a normal maximum loading in red.

Provide instruments and meters with an accuracy class 2.5 or better.

Provide accessories associated with measurement and, where practicable, mount these adjacent to associated instruments, inside the cubicles.

Provide ammeters as moving iron type, overscale demand indicator ammeters, which may be subjected to appreciable, motor starting currents. Provide a single meter per phase.

Provide voltmeters as moving iron type. Provide a voltage selector switch for measurement of phase-to-phase and phase-to-neutral voltages.

Provide polyphase electromechanical kilowatt-hour meters with pulsed outputs suitable for private revenue metering. Ensure current transformers associated with the kWh meters are measurement class with an accuracy classification of 0.5.

Provide indicating lamps as incandescent low voltage lamps fully enclosed behind a coloured lens supplied by an integral step down transformer.

#### 4.5.13 LABELS

Provide a two-colour laminated plastic schematic for each switchboard. Provide additional control schematics as required. Securely fix the schematics to the front of the switchboard or behind the switchboard door if it switchboard is provided with a door.

Include the following information on the schematics:

- All installed cable types and cable sizes.
- All protective device frame sizes and settings.

Provide samples of proposed label material, label sizes, lettering sizes and lettering text for approval.

Screw-fix each label adjacent to its relevant item of equipment, but not on the equipment.

Provide warning notices as white letters on red background and other labels as black lettering on a white background.

Provide the lettering height not less than:

- Switchboard designation: 25mm.
- Main switches: 20mm.
- Feeder control switches: 10mm.
- Identifying labels: (on outside of cubicle rear covers, etc.): 6mm.
- Equipment labels within cubicles: 4mm.
- Warning notices: 4mm.

For light and general power distribution, provide schedule cards of minimum size 200mm x 150mm with text typewritten to show:

- Sub-main designation size, rating and route length.
- Light and power circuit number, type and area supplied.

Provide the main switchboard with a diagram indicating the route of any underground consumers' mains, printed on a durable card or similar, and indicating run distances for each 'leg' of the consumers' mains route.

#### 4.5.14 SWITCHBOARD OPERATING PARAMETERS

##### 4.5.14.1 MAIN SWITCHBOARD

Provide the main switchboard to the following requirements:

- Line: 400 v.
- Phase: 230 v.
- Frequency: 50 HZ.
- Number of phases: three.
- Number of wires: four.
- Neutral connection: star point.
- Earthing system: MEN.
- Ambient air temperature range: -5 to +45deg c.
- Relative humidity: 90%.
- Switchboard designations: main switchboard.
- Mounting: floor mounted.
- Degree of protection: IP56.
- Numerical designation: category 1.
- Incoming supply compartments and essential equipment supply compartments form 3. General light and power supply compartments form 1.
- Equipment connection: front connected.
- Gland plates: 3mm thick brass or aluminium or 6mm thick grey UV stabilised PVC in internal locations. Provide all gland plates with a neoprene gasket.

#### 4.5.14.2 METER PANELS & DISTRIBUTION BOARDS

Provide the meter panels and distribution boards centres to the following requirements:

- Line: 400 v.
- Phase: 230 v.
- Frequency: 50 HZ.
- Number of phases: three.
- Number of wires: four.
- Neutral connection: star point.
- Earthing system: MEN.
- Maximum fault level symmetrical: 6 (ka r.m.s.).
- Ambient air temperature range: -5 to +45deg c.
- Relative humidity: 90%.
- Switchboard designations: DB.
- Mounting: semi recessed wall mounted.
- Degree of protection: IP56.
- Numerical designation: category 1.
- Form 1.
- Equipment connection: front connected.
- Gland plates: 3mm thick brass or aluminium or 6mm thick grey UV stabilised PVC in internal locations. Provide all gland plates with a neoprene gasket.

#### 4.5.15 MATERIALS AND FINISH

Enclosure: Zinccanear, powder coat colour to be confirmed by the architect.

Escutcheons: Zinccanear, powder coat white.

Doors: Zinccanear, powder coat colour to be confirmed by the architect.

Plinths: Mild Steel, Painted Black.

#### 4.6 EARTHING SYSTEM

Provide a comprehensive earthing system throughout the project addressing all aspects of the structure, all services, all systems and components in addition to those forming part of the power distribution.

Provide transient earth clamps between the power earth system and the connection to all other earthing systems.

Provide a dedicated LV earthing system which includes a minimum of two earth electrodes a minimum of 2,000mm apart:

- Type: MEN.
- Material: Copper.
- Maximum earth resistance: .5 OHM.

Provide the earth electrodes as solid copper rod incorporating integral driving heads and points. Solid stainless steel rods grade 302 are also acceptable. Install earth electrodes vertically. Electrodes may be driven direct into the ground or installed in holes previously drilled and packed with a suitable conductive graphite slurry.

Where electrodes are to be installed in rock, fill the gap between the rock and electrode with a bentonite clay or resin compound or as otherwise approved.

Install each electrode in a 200 mm bore hole, backfill with a conductive metallic grouting compound and compact with a vibrator.

Locate each earth stake in a PVC enclosure flush with the surrounding ground level with a lid that is removable with the use of a tool. The lid is to be permanently labeled "Power supply Earth Stake". Stick on and hand stenciled labels are not acceptable. Configure the enclosure such that the top of the earth stake and the bond to the interconnecting cable can be readily inspected when the lid is removed.

Provide additional bonding between the earthing system and the following:

- Slab reinforcing mesh.
- Building services.

Run a PVC-insulated copper conductor from the main switchboard earth bar to the slab reinforcing mesh. Clamp conductor to mesh (one point of contact only required) with a brass earth clamp. Wrap clamp and exposed copper conductor with insulation tape. Provide a label engraved 'Slab Reinforcing Mesh Bond' adjacent termination on earth bar.

Copper conductor to penetrate slab inside building enclosure and be such as to avoid moisture penetration to slab reinforcing mesh.

Bond the electrical earth to all piped services (if metallic pipes) at the closest practical point to where these piped services enter the building. This includes cold water, hot water, soft water, steam, condensate return, waste, medical gases, suction and the like. The bonding earth conductor to be 6mm<sup>2</sup> minimum.

In all public accessible arrears and areas the earth stakes could be subject to interference during normal operations such as being bumped locate each earth stake in a flush propriory in-ground earth stake pit complete with a permanent label "Electrical Earth Stake. Do not disturb". Where the earth stake is not located in a propriory pit provide a permanently fixed label adjacent the earth stake "Electrical Earth Stake. Do not disturb"

## 5.0 LIGHTING

### 5.1 SCOPE

The lighting component of this contract includes the external body corporate lighting that is not fixed to the residential buildings. All of the light fittings and accessories are to be provided as part of this contract.

The community building lighting is to be provided as part of these works.

The lighting component of this contract includes, but is not limited to the following extent of work:

- Lighting.
- Light fittings and accessories.
- Lamps.
- Earthing of the lighting installation.
- Lighting control.
- Trenching.
- Pits.
- Conduits.
- Lighting subcircuits.

All suppliers and sub-contractors to the Electrical Sub Contractor must ensure they are familiar with and comply with the requirements of sections 1.0, 2.0 and 3.0 of this specification.

### 5.2 INSTALLATION

#### 5.2.1 CABLING

Use stranded copper conductor with a minimum size of 2.5mm<sup>2</sup> and 0.6/1kV V75 PVC insulated or 0.6/1kV V75 PVC-insulated and PVC-sheathed stranded cables unless otherwise specified. Use cables with white insulation for all lighting wiring. Use PVC-insulated and PVC-sheathed cables for all cables run underground in conduits. For cabling run through continuous rows of light fittings use V105 insulation. For all cables supplying essential equipment, use fire rated approved cables.

The cable sizes indicated on the drawings are provided as a minimum only. The current capacity, voltage drop and fault capacity of the cables must be established by the Electrical Sub Contractor and the cables sized accordingly by the Electrical Sub Contractor. Size all cables to accommodate the respective loads, starting currents and maintain a spare capacity of 10%. All loads and fault levels must be confirmed on site by the Electrical Sub Contractor.

#### 5.2.2 CONTROLS

The control sizes indicated on the drawings are provided as a minimum only. The current capacity and fault capacity of the controls must be established by the Electrical Sub Contractor and the controls sized accordingly by the Electrical Sub Contractor. Size all controls to accommodate the respective loads, starting currents and maintain a spare capacity of 10%. All loads and fault levels must be confirmed on site by the Electrical Sub Contractor.

### 5.3 COMMISSIONING

#### 5.3.1 GENERAL

Upon the completion of the commissioning of the lighting, provide a written and signed statement that the lighting installation:

- Has been fully programmed as necessary.
- Has been tested.
- Complies with the intent of the contract.
- Complies with the relevant authority requirements.

- Complies with the relevant standards and codes.
- Is fit for purpose and suitable for the intended use.

Include a copy of the lighting statement of compliance in the operation and maintenance manual. A typical lighting installation statement of compliance form is available from the Electrical Design Group web site [www.edg.net.au](http://www.edg.net.au).

As part of the commissioning of the lighting, undertake the following tests as relevant on all components of the lighting installation: Typical test result forms are available from the Electrical Design Group web site [www.edg.net.au](http://www.edg.net.au).

Schedule the results for each item and component and include a copy of all test results in the operation and maintenance manual.

As part of the commissioning of the lighting, undertake any necessary adjustments to components of the lighting installation which have integral adjustment capacity as directed by the project manager. Record all adjustments and include a copy of the adjustment records in the operation and maintenance manual.

Chemically clean all reflectors, lenses, diffusers and lamps prior to the aiming and adjusting of the lighting installation.

Undertake each of the following mechanical checks for each component of the lighting installation as part of the commissioning process:

- All luminaires have been positioned to coordinated with other installers (such as air conditioning contractors, installers of girders and plasterers).
- All luminaries are in the correct position and in the correct orientation.
- All luminaries are clean and undamaged with the correct lamps fitted (i.e. manufacturer, rating, phosphor and electrical type).
- All channel dials and function switches (as appropriate) have been set to the specified settings.
- All sensor levels have been set to the specified levels.
- All components are uniquely and clearly labelled.
- The alignment of all luminaries has been adjusted to avoid glare and unwanted over-spill.
- All cover plates have been fitted and electrical segregation is complete.
- All raise and lower gear has been checked.
- All safety chains, safety cords and filter holders etc. on luminaries have been securely mounted; associated control gear have been fixed securely on lighting trusses, booms, barrels and bars, or placed in a secure position.

Undertake each of the following electrical checks for each component of the lighting installation as part of the commissioning process:

- All luminaries, switched and sensors have been wired according to the wiring diagram provided.
- All lights and track circuits have been wired to the specified control switch or dimmer.
- All mains wiring has been tested and certified as complying with the recommendations of AS3000.
- The voltage and frequency is stable and within the relevant authority limits.
- Control operation.
- The Resistance to earth of each fitting switch panel and exposed metallic component.
- The supply voltage and frequency at each fitting.
- Overload protection has been installed and operates correctly.
- Fault protection has been installed and operates correctly.

At practical completion replace all lamps in emergency luminaries that have operated for more than 96 hours during the construction phase.

### 5.3.2 LIGHTING CONTROLS

Confirm all light sensors are located in an appropriate representative location for the intended task. Calibrate the light sensor to indicate the light levels as advised by the engineer on site. Confirm the calibration of the light sensors with an independent NATA certified portable light sensor.

Confirm all light occupancy sensors are located and orientated appropriately in relation to the occupants. Confirm the occupancy sensor sensitivity is appropriate by adjusting the detector sensitivity to ensure the occupant movement is detected throughout the occupied zone. Configure the sensitivity to ensure seated occupants are detected, whilst movement outside the controlled zone does not activate the lights. Confirm the time delay setting is representative of the occupant work/movement patterns and is assessed when the building is occupied.

Set all start and stop times along with override controls (e.g occupant or security staff override) as advised by the engineer on site.

#### 5.4 LUMINARIES

##### 5.4.1 GENERAL

It is the electrical sub contractor's responsibility to ensure the luminaire is appropriate for the intended location considering the following:

- Mounting requirements.
- Fitting size.
- IP protection.
- Exposure to corrosive environment.
- Hazardous environment.
- UV exposure.
- Safety.
- Heat.
- Vandalism.

Irrespective of the fitting type specified, provide all light fittings in compliance with the restricted zone requirements of AS3000. Provide all light fittings over baths as Class II double insulated.

Provide each fitting with a screw tunnel type fused terminal block capable of housing 4x2.5mm<sup>2</sup> conductors in each terminal.

Provide all discharge fittings with low loss control gear. Replace any ballasts causing audible humming or crackling. Ensure all discharge lamps are compatible with the ballasts and other starting and control gear. Provide written evidence from the manufacturer of such and include it within the manuals.

Provide recessed luminaries with an external 1500 mm length of 1mm<sup>2</sup> 3-core PVC/PVC flexible cord to AS 3191, connected to a 10 A 3-pin plug top to AS 3112 (Flex and Plug).

Provide all discharge light fittings with power factor correction to achieve a power factor of not less than 0.9 lagging after two hours of continuous operation.

Where required by the supply authority, provide blocking inductors to the authority's approval.

Provide luminaries with all internal wiring colour coded to AS3137.

Provide each extra-low voltage luminaire with a dedicated step down copper wound, iron core sealed type c/w internal automatic thermal switch and a flex and plug. Provide the engineer with written confirmation that the proposed step-down transformers are compatible to be dimmed by the dimmers specified. Mount the transformers such that they are hanging in free air in a concealed location such that they can be accessed and removed.

##### 5.4.2 FLUORESCENT LAMP BALLASTS & STARTERS

Unless specifically specified otherwise provide all fluorescent lighting with electronic control gear.

Where fluorescent fittings, including compact fluorescent fittings, are specified with conventional (ferromagnetic) control gear, provide a separate ballast per lamp; having an energy efficiency index (EEI) of B1. Provide fluorescent starters as Osram ST111.

Where fluorescent fittings including compact fluorescent fittings, are specified with non-dimmable electronic control gear, provide a soft-start / warm-start ballast per lamp. Provide ballasts having an EEI of A3 or better.

Where fluorescent fittings, including compact fluorescent fittings, are specified with dimmable electronic control gear, provide one ballast per lamp. Provide ballasts having an EEI of A1.

### 5.4.3 MOUNTING

Co-ordinate with other trades to ensure that mounting locations are clear of other services. Ensure the locations of all luminaries are symmetrical with the adjacent fixtures and that unintentional glare is avoided.

Provide luminaries suitable for mounting in the required position or ceiling type. Ensure that all luminaries and luminary control gear are not covered by insulation and have appropriate ventilation. Mount all light fittings to fixed rigid supports.

For fixing of surface-mounted luminaries to ceilings or walls, provide not less than, four fixings in square and rectangular luminaries and three fixings in circular luminaries, placed symmetrically.

Provide poles which incorporate a tamper resistant access panel within the pole base. All poles are to be provided with baseplates that incorporate a minimum of four hold down bolts. Provide poles and insitu concrete footings designed specifically to suit the local conditions and be able to withstand wind gusts of 250km/h. The design of the pole and the footing is to be undertaken by a resisted structural engineer. Provide a certificate from the structural engineer indicating the poles and footings meet the specified design criteria. Provide detailed drawings of all poles and footings for approval. Provide a fused connection within each pole located behind the pole base access panel. Connect the pole to the electrical earth via a lug fixed to a stud welded to the pole located within the pole located behind the pole base access panel. Trim the hold down bolts such that they do not protrude more than 15mm above the nut. Treat the trimmed hold down bolt against corrosion and ensure it does not contain sharp edges that represent a hazard. Ensure the base plate is between 50 and 100mm above the finished landscape level. Provide a neat smooth finished concrete grout fill under the base plate ensuring any splatter is immediately washed off the base plate and pole. Extend the conduit into the pole 50mm above the base plate.

### 5.5 LAMPS

Supply luminaries complete with lamps. Replace as part of the contract any lamp which fails within 80% use of its rated life. Lamps which fail after 80% use of the rated life will be replaced by the operator.

Ensure all lamps of the one type are of the same manufacture.

Provide a legible label in each luminaries, fixed in a position convenient for reading at the luminaries installed position, which clearly identifies the lamp type to be installed in the luminaries.

Provide tubular fluorescent lamps with low resistance cathodes and standard bi-pin caps.

Provide all filament lamps rated at 250 V.

Unless noted otherwise, provide lamps with the following performance characteristics:

- Tubular fluorescent: 4,100K, CRI Min 85, 16,000Hour Life.
- Compact Fluorescent: 4,100K.
- Mercury vapour lamps: Coated. 4,100K.

- Metal halide lamps: 4,100K.
- Incandescent lamps: Pearl, 2,400Hour Life.
- Dichroic Lamps: 5,000Hour Life, Sealed 60Deg Beam.
- Tungsten Halogen Lamps: 2,000Hour Life.
- BI Pin Lamps: Xenon filling. 16,000Hour Life.

## 5.6 LIGHTING CONTROL

Provide all manual light switches that are not controlling inductive loads (luminaries that do not have transformers or magnetic ballasts) as 20A mechanisms mounted with the rocker operating in the vertical position. Provide all manual light switches that control inductive loads (luminaries that do have transformers or magnetic ballasts) as 15A inductive load mechanisms mounted with the rocker operating in the vertical position. Position manual light switches and switch panels at 1100mm AFFL unless noted otherwise. Where multiple switches are located in the same location, use multigang switchplates. Use standard faceplates for quantities of up to six switches. For quantities of more than six switches and in locations dimmers and fan controllers are required, use flush engraved black marked stainless steel multigang switchplates. Where the function of any switch is not immediately logically obvious, label the switch with an engraved contrasting colour label on the switchpanel.

Provide all switch mechanisms in bathrooms, laundries, toilets, amenities and in locations the switch is within 2,000mmm of a tap as IP56.

Switch the load via an AC3 20 Amp switching contactor for all switched lighting loads above the following ratings :

- Resistive loads above 2,500 watts.
- Inductive loads above 1,500 watts.
- Capacitive loads above 1,000 watts.

In locations that have accessible ceiling space, locate the switching contactors in an IP56 PVC storm grey din rail enclosure mounted in the ceiling space above the switch panel no more than 1000mm horizontally from the switch panel. In service areas that do not have accessible ceiling space, locate the switching contactors in an IP56 PVC storm grey din rail enclosure wall mounted against the ceiling or at 2,400mm AFFL immediately above the switch panel, no more than 1000mm horizontally from the switch panel. In all other locations, locate the switching contactors in the distribution board.

Provide a screw fixed engraved label with the words "This switch panel has two sources of supply" immediately above any switch panel that has supplies from different sources or distribution boards.

Utilise battery backed-up 24 hour 7 day programmable time clocks with a separate contactor to switch the time clock controlled load. Locate the time clock and contactor within an equipment section of the associated switchboard. Provide each time clock with a key-operated bypass switch mounted on the door of the associated switchboard. Obtain from the operator the settings of each time clock. Ensure the operating and programming instructions for each time clock are included in the operation and maintenance manual.

Utilise adjustable photo electric (PE) cells with a separate contactor to switch the PE Cell controlled load. Locate the PE Cell on site such that it is able to obtain an accurate indication of the daylight level under normal operation and such that it will not be obscured by the future growth of vegetation or effected by incident light from any light fittings on this site or adjacent sites. Mount the PE Cell in an inverted position. Provide each PE Cell with a key operated bypass switch mounted on the escutcheon of the associated switchboard. Ensure the PE cell is located on the work-as-executed drawing and the operating and programming instructions for PE cell clock are included in the operation and maintenance manual.

Provide all over-rides of the automatic lighting control with adjustable time over-ride periods. Provide the timers with a time range from one minute to two hours. Locate the adjustable timers in the associated distribution board and label appropriately.

## 5.7 ADJUSTING AND AIMING OF LIGHTING INSTALLATION

Ensure the following components of the lighting Installation are complete and have been checked and tested prior to the adjusting and aiming of the lighting installation to commence:

- Circuiting.
- Labelling.
- Connection of correct lights to correct channels.
- Correct operation of lighting control system.
- All lights have been installed and are operating.

Should these items not be complete prior to the adjusting and aiming of the lighting installation the additional expenses in re-attending the installation to undertake the adjusting and aiming of the lighting installation as incurred by the project manager will be charged to the Electrical Sub Contractor.

Provide all equipment such as ladders, scaffolding and tools necessary for adjusting each luminaries. Should the Electrical Sub Contractor not have available the necessary equipment to complete the adjusting and aiming of the lighting installation, the additional expenses in re-attending the installation to undertake the adjusting and aiming of the lighting installation as incurred by the engineer will be charged to the Electrical Sub Contractor.

The adjusting and aiming of the lighting installation will include the following:

- Setting all PE cells and time clocks.
- Focusing of lights.
- Adjusting mountings and brackets.
- Aiming of fittings.
- Testing all operations of the lighting control system.
- Testing the emergency and exit lighting system.

Allow to attend site twice during the defects and liability period and undertake the above adjustments to and reprogram as directed by the operator the lighting installation.

Document the final results of all adjusting and aiming of the lighting installation and include them in the operational and maintenance manuals.