



PROJECT

CATHEDRAL OF ST MICHAEL & ST JOHN, BATHURST
LANDSCAPE

DOCUMENT

LANDSCAPE ELECTRICAL SERVICES SPECIFICATION

SITE ADDRESS

CORNER WILLIAM STREET & KEPPEL STREET
BATHURST
NSW 2795

LANDSCAPE ARCHITECT

THOMPSON BERRILL LANDSCAPE DESIGN
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MANLY
NSW 2095

DESCRIPTION

REVISION: A
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REVISION SCHEDULE	
REVISION	PARAGRAPH/S CHANGED
Rev A	Original revision

Post the original revision the most recent changes are in italic and bold as per this note.

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.
- Attendance at a handover meeting.
- Co-ordination.
- Authorities' approvals.
- Approvals.
- Shop drawings.
- Work-as-executed drawings.
- Inspections.
- Testing and commissioning.
- Maintenance.
- Programming.
- Cabling, cable support systems and access.
- 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.

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:

Service	Responsibility
Build in sleeves, supports, hangers, fixings, anchorages and the like	Contractor
Make good after the installation of electrical services provided it is in the normal construction sequence	Contractor
Anti-termite treatments	Contractor

1.3 CONTRACT DRAWINGS

The electrical services document schedule C2056a-0001.xls details the electrical drawings, details, schedules and associated documents that form part of the electrical service's sub-contract. The electrical services 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 architectural specification 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 the architectural specification.

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.

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 Contractor's 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 Contractor's 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.

Install components and equipment in accordance with the manufacturer's 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 email address. Within two weeks of being awarded the contract provide the names and contact phone numbers of the electrical sub contractor's 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.

Provide an electronic digital photograph for approval of all works that are carried out that will not be visible after installation, within five working days after the respective work has been completed. Each photograph is to be electronically stamped with the time and date and be either named with descriptive name that allows the location to be simply identified or accompanied with a tabulated description.

1.9 PROGRAM

Carry out all of the electrical services works in accordance with the Builder's program.

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 engineer unless the approval is specifically noted as being required from another entity. The electrical sub contractor must give each of the approving parties one week's 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 irrespective of the electrical services access provisions detailed on the drawings. The electrical services access provisions detailed on the drawings are not intended to be comprehensive or provide all of the access requirements necessary to complete the electrical installation. This includes though is not limited to the following:

- Conduits.
- Blockouts.
- Ducts.
- Risers.
- Hat sections.
- Covers.
- 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.

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 each approving entity.

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. 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 services 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.

- NCC Building Code of Australia.
- Electricity mains connection legislation.
- Electrical Safety legislation.
- Workplace Health and Safety legislation.
- Telecommunications Act.

Unless specifically detailed within this specification, undertake all works to the requirements of the relevant sections of the following standards:

AS/NZS 3111:2009	APPROVAL AND TEST SPECIFICATION - MINIATURE OVERCURRENT CIRCUIT-BREAKERS
AS/NZS 4325.1:1995	COMPRESSION AND MECHANICAL CONNECTORS FOR POWER CABLES WITH COPPER OR ALUMINIUM CONDUCTORS - TEST METHODS AND REQUIREMENTS
AS/NZS 1125:2001	CONDUCTORS IN INSULATED ELECTRIC CABLES AND FLEXIBLE CORDS
AS 60529-2004	DEGREES OF PROTECTION PROVIDED BY ENCLOSURES
AS/NZS 5000.2:2006	ELECTRIC CABLES - POLYMERIC INSULATED - FOR WORKING VOLTAGES UP TO AND INCLUDING 450/750 V
AS/NZS 3560.2:2003	ELECTRIC CABLES-CROSS-LINKED POLYETHYLENE INSULATED-AERIAL BUNDLED-FOR WORKING VOLTAGES UP TO AND INCLUDING 0.6/1 (1.2) KV-COPPER CONDUCTORS
AS/NZS 4961:2003	ELECTRIC CABLES-POLYMERIC INSULATED-FOR DISTRIBUTION AND SERVICE APPLICATIONS
AS/NZS 1429.1 :2006	ELECTRIC CABLES-POLYMERIC INSULATED-FOR WORKING VOLTAGES 1.9/3.3 (3.6) KV UP TO AND INCLUDING 19/33 (36) KV
AS/NZS 5000.1:2005	ELECTRICAL CABLES - POLYMERIC INSULATED - FOR WORKING VOLTAGES UP TO AND INCLUDING 0.6/1KV
AS/NZS 3008.1.1:2017	ELECTRICAL INSTALLATIONS - SELECTION OF CABLES - CABLES FOR ALTERNATING VOLTAGES UP TO AND INCLUDING 0.6/1KV - TYPICAL AUSTRALIAN INSTALLATION CONDITIONS
AS/NZS 3000:2018	ELECTRICAL INSTALLATIONS (KNOWN AS THE AUSTRALIAN/NEW ZEALAND WIRING RULES)
AS 1798-2014	LIGHTING POLES AND BRACKET ARMS - PREFERRED DIMENSIONS
AS 2756:1997	LOW VOLTAGE SWITCHGEAR AND CONTROL GEAR - MOUNTING RAILS FOR MECHANICAL SUPPORT OF ELECTRICAL EQUIPMENT
AS/NZS IEC 60947.2:2015	LOW VOLTAGE SWITCHGEAR AND CONTROL GEAR - CIRCUIT-BREAKERS
IEC 60269.1 ED 4.2	LOW-VOLTAGE FUSES - GENERAL REQUIREMENTS
AS/NZS IEC 60947.2:2015	LOW-VOLTAGE SWITCHGEAR AND CONTROL GEAR - CIRCUIT BREAKERS
IEC 62026.1 ED 2.0	LOW-VOLTAGE SWITCHGEAR AND CONTROL GEAR - CONTROLLER DEVICE INTERFACES - GENERAL RULES
AS/NZS IEC 60947.1:2015	LOW-VOLTAGE SWITCHGEAR AND CONTROL GEAR - GENERAL RULES
AS/NZS 60598.1:2017	LUMINARIES - GENERAL REQUIREMENTS AND TESTS
AS/NZS 60598.2.1:2014	LUMINARIES - PARTICULAR REQUIREMENTS - FIXED GENERAL PURPOSE LUMINARIES

AS 4702:2000	POLYMERIC CABLE PROTECTION COVERS
AS/NZS 4836:2011	SAFE WORKING ON LOW-VOLTAGE ELECTRICAL INSTALLATIONS
AS 60052:2005	VOLTAGE MEASUREMENT BY MEANS OF STANDARD AIR GAPS

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 services 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.

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 authorities, codes, standards and regulations:

- ACMA.
- Local Council.
- Local Supply 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 an AutoCAD 2000 format electronic copy of detailed shop drawings via compact disc or via email 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 minimum 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 Bus ducts.
- 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 an AutoCAD 2000 format electronic copy of the work-as-executed drawings via compact disc or via email to brisbane@edg.net.au for approval.

2.4 MAINTENANCE

Undertake all necessary maintenance of the electrical installation during the Defects Liability Period for a period of 12 months.

Carry out periodic inspections and perform maintenance work at the frequencies and following the procedures recommended by the manufacturers of the supplied equipment with at least one visit each three months. Promptly rectify all faults. Replace faulty materials and equipment, including luminaire lamps, and accessories.

In addition to the above maintenance requirements repeat the complete commissioning process three months, six months, nine months and twelve months from the date of practical completion.

The defects and liability period will not end until such certification has been approved.

2.5 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.

2.6 OPERATING PARAMETERS

Ensure the electrical services 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%

2.7 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 on the work-as-executed drawing. Double sided tape is not acceptable as a method of securing labels.

2.8 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.

2.9 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 any 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 manufacturer 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 ports can be connected for test purposes.

2.10 TESTING

Arrange for and give two week's 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 an electronic PDF file copy for approval.

Check control systems for correct operation under representative operational conditions.

2.11 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 week's 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.

As part of the commissioning process ensure the following actions are completed:

- Check that time schedules enable the intended operation at the correct times.
- Check that the specified routine to ensure unified time clocks throughout the complete control system operates correctly.
- Check for the correct control and operation on start-up and shutdown. Check that the defined restart routine operates correctly when power is reinstated after failure. Check for any specified sequenced start-up to accommodate high loads.

Check the control system to confirm its specified operation following a mains power supply failure. In particular undertake the following checks:

- Check that controllers preserve control strategy configuration data for a specified period when the mains power is lost.
- Check that the condition of any volatile data protection system is regularly and automatically monitored. Check that an alarm is raised on loss of data by any controller or other device and/or failure of the monitoring system.
- Check that the control system will automatically return to normal action without operator intervention restoration of the mains electrical power supply.
- Check that any specified load shedding procedures operate correctly.

The manufacturer is to check all switchboards and control panels at the factory. Specific items or routines to be checked include though is not limited to:

Visual outside

- The finish to ensure there are no sharp edges.
- The metalwork: hinges on doors, flush doors, opening and closing doors, no sagging or drooping of doors when open, interlocking of doors.
- The door seals and gland plate gaskets are in place and securely fixed.
- The common key for all panels.
- For secure operation of door locks.
- That safe access to the control equipment is possible without having to isolate the control panel where specified.
- That the physical arrangement of the panel will allow transport to site and mounting in the final location.
- If the completed panel weighs more than 50kg check that eyebolts are fitted.
- The location and labelling of switches and indicators (including colour).
- That plastic rivets or screws are used to mount labels.
- The scale of analogue devices and the status of digital devices.

Inside

- That all doors on any panel containing exposed dangerous voltages are provided with interlocking isolators so that the door cannot be opened except with the isolator in the 'off' position.
- That equipment that requires on-line adjustment and testing by non-electrically qualified personnel is accessible and usable without interrupting the supply or overriding the safety interlocks. (In general, outstations must not be located within control panels where isolation is necessary to gain access.)
- Access for incoming cables
- Access for outgoing power and control cables
- Provision of suitable gland plates
- All doors/gland plates to be earthed by cable links
- Bus bars and power cabling as specified
- Anti-condensation heaters and thermostats are included and correctly set where specified
- Ventilation grills, filters and fans and thermostats are included and correctly set where specified
- Panel ventilation is adequate for the heat load
- Tightness of all connections, bolted power connections and bus-bar bolts tightened to the correct torque
- Neatness of cable looms with no pinching
- Sufficient spare capacity in all cable trunking to comply with BS 7671(13).
- Colour coding and numbering of all cables where specified and corresponding with numbering of terminals.
- Numbering of all terminals
- Shrouding and labelling of non-isolated equipment
- Shrouding of switches, lamps etc on doors if low voltage
- Segregation of power cabling and switch-gear from control cabling and electronic equipment
- Trunking lids cross referenced

- Connections between panel sections are numbered as specified, accessible and physically simple to connect/disconnect.
- Link type terminals for control system cables if specified
- Drawing holder
- Layout of equipment against drawings
- Ensure spare back panel space is provided as specified
- Ensure no equipment is mounted on the bottom or sides of the panel (similarly terminations) unless back/side plates are fitted
- Labelling of equipment in panel
- Access to all equipment especially devices requiring adjustment
- Power outlet is provided complete with 30 mA RCD protection
- Flexible looms connecting door mounted to interior mounted components will not weaken or break with repeated door opening. Check that the loom is arranged to avoid pinching or looping when the door is closed and is fully supported at each end.
- Screen and earth connections associated with the control system equipment comply with the manufacturer's installation requirements

All wiring is to undergo though not be limited to the following checks and testing:

- Cable type as specified
- Cable identified at both ends
- Cable cores identified at both ends if not self numbered or colour coded
- Security of fixing/protection of cables to walls etc where surface-run
- Cable carrier/container in accordance with the specification (tray, basket, conduit/trunking etc)
- Cable management in accordance with the specification
- Cables not damaged
- Secure termination of wires (using ferrules)
- Screening continuity
- Cable only earthed at one end (field controller) or as specified
- Electrical continuity ('belling out')
- Correct polarity where applicable
- Correct input/output (by briefly disconnecting cable)
- Correct and secure termination
- Separation of mains and signals cables
- No short circuits line-to-line and line-to-earth
- Volt-free contacts are volt-free (prior to the installation of the field controllers).

2.12 TRAINING

Provide the operator with sufficient training such that they are capable of understanding how the system operates as a complete system and how the controls work as part of the system.

Beyond time spent during commissioning stage, at times to be agreed with the operator, instruct the operator's staff in the recommended methods of operation the electrical services. Allow to provide two such operational training sessions on site each for duration of 1 hour.

Provide the basic operator training such that following the training an operator with this level of training will have a basic understanding of the control system architecture and have the ability to view point data. It is not expected that the operator will make any alterations to the system. The basic operator abilities include;

- call up and view point data from schematics and/or points lists
- acknowledge system alarms
- view trend logs

3.0 INSTALLATION REQUIREMENTS

3.1 UNDERGROUND SERVICES

3.1.1 EXTENT OF UNDERGROUND SERVICES

The conduits and pits detailed within the electrical services documentation have been included as there are specific requirements that need to be accommodated do not cover every requirement necessary to complete the installation. Unless the conduits and pits detailed within the electrical services documentation have been noted as being for future use or for use by another trade it is acceptable to install the cabling for the initial installation through the conduits and pits detailed within the electrical services documentation. As the conduits and pits detailed within the electrical services documentation do not cover every requirement necessary to complete the installation the electrical-sub contractor must allow for all additional pits and conduits necessary to complete the electrical installation.

Under no circumstances are buried direct cables permitted.

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.

Provide a reinforced plastic, 150mm wide, underground, yellow or orange coloured marking tape with the words 'WARNING - ELECTRIC CABLES BURIED BELOW' or similar above all underground conduits at a depth of 200mm below ground level for the entire length of all underground conduits.

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

Install all underground conduits 500mm below ground level and provide each conduit with a spare polypropylene draw cord.

Provide a minimum surrounding of 75mm 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.

Install all conduits either straight or with large radius sweeping bends with a radius 40 times the diameter of the conduit. All conduits must be installed in such a manner to allow simple removal and installation of additional cables following the completion of the project. In cases where multiple conduits have been specified, install all initial cabling within the first conduit. Written approval must be obtained from the engineer prior to installing any cabling in the subsequent conduits.

Where underground conduit rise above ground, ensure they rise vertically and they are protected at ground level by a concrete plinth extending 250mm below ground, 100mm above ground. The plinth is to extend in each direction beyond the conduits more than three times the diameter of the largest conduit other than the side of the plinth / conduit that is against a structure. Provide the plinth with a fall such that water does not pool against the conduit or the adjacent structure.

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. Reinstate existing surfaces and assets disturbed or removed as a result of the excavations of trenching. Reinstate 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 services 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.

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.

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 run communications and power cabling or conduits 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 or a pit bush flush with and sealed to the side of the pit. 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.

Ensure all cable entries and exits within a pit are level.

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.

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.

Provide electronic digital photographs for approval of each pit prior to any cabling being installed that allow the conduits to be clearly identified, within five working days after the pit and conduit work has been completed. Provide electronic digital photographs for approval of each pit on completion of all cabling being installed that allow the cables to be clearly identified, prior to practical completion. Each photograph is to electronically stamped with the time and date and be either named with descriptive name that allows the location to be simply identified or accompanied with a tabulated description.

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, and 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 underground orange plastic warning tape 300mm above all underground power conduits. Use 100mm wide tape with an integral cable detection metallic strip and the words "CAUTION - ELECTRICAL CABLE BURIED BELOW" clearly marked continuously along the tape.

Provide underground white plastic warning tape 300mm above all underground communications and security conduits. Use 100mm wide tape with an integral cable detection metallic strip and the words "CAUTION - COMMUNICATIONS CABLE BURIED BELOW" clearly marked continuously along the 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.

3.2 CABLES

3.2.1 INSTALLATION

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

Ensure oil, wax and powder based electrical cable lubricants are not used as cable lubricants. If cable lubricants are required to be used then use polymer-based for copper cables and silicon-based for optical fibre cables.

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

The terms wiring and cabling are used interchangeably throughout this contract to refer to any cabling types and relevant standards.

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

- All cables are installed without joints.
- All cabling is concealed from view.
- All cabling installed externally is installed in conduit.
- All cabling that is installed in locations that are not concealed such on exposed roof trusses, are to be run in conduit.

- Cabling fixed to trusses and beams in concealed ceiling spaces is to be fixed to the side of the truss / beam and not on top of the bottom cord of the truss / beam.
- 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 manufacturer for external underground use.
- 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.
- Replace all wiring that contains kinks or abrasions.
- 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.
- 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.

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.

Provide all power and lighting cabling in accordance with the following:

- All T.P.I and T.P.S power and lighting wiring is to utilise stranded copper conductors with a minimum size of 2.5 mm sq with 0.6/1kV V90 PVC insulation .
- Ensure all power and lighting wiring and cabling utilises stranded copper conductors.
- Ensure all wiring is provided and installed in such a manner that it's installed overload rating exceeds the overload rating of the protective device.
- 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

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. Unless otherwise specified, conceal and protect cables and conduits. Arrange cables and conduits parallel with walls, ceilings and floors.

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 be 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:

- Corrugated conduits are not permitted in any food preparation, food storage or food servery area.
- Conduits are sized to permit drawing-in of cables to finished conduit runs without damage to cables.

- Protect all PVC conduits against UV exposure.
- Steel and galvanized conduit are not installed underground.
- Rigid UPVC conduit fittings are fastened to the conduits by fresh solvent cement in accordance with the manufacturer's recommendations. The cement is to be a contrasting colour to the conduit.
- Corrugated UPVC conduit fittings may be fastened with solvent cement as above or by use of snap-lock connectors in accordance with the manufacturer's recommendations.
- 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 enables 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. Secure conduits within 50mm of each change in direction.
- Secure 40mm or larger conduits every 500mm or less. Secure conduits less than 40mm every 300mm or less.
- 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.
- All conduits cast into a concrete slab, protrude perpendicular 100mm above the surface of the slab and are located as close as practicable to a wall.
- 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.
- Metallic saddles with corrosion protection equal to hot dipped galvanizing with two galvanized fixings per conduit saddle are used to secure all surface mounted conduits. Do not use explosive-powered or similar equipment unless approved. Ensure the metallic saddles and fixings do not create a galvanic reaction with the support structure. In locations it is not practical to use saddles, submit details of the

proposed conduit securing method for approval prior to commencing installation of the conduit. Any alternative conduit securing method must provide corrosion protection equal or better than galvanizing.

- 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 moulded 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.
- Arrange conduits below 2,700 AFFL such that a person cannot hang from or climb from the conduit by using the conduit as a foot hold or hand hold.
- All PVC conduits located externally above ground to a height of 2,000mm AFFL are protected with 1.6mm thick folded galvanised sheet steel hat section. Galvanized conduit may be substituted in the above ground location in lieu of the PVC conduit and 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.
- Do not use conduits smaller than 20mm diameter in any circumstance or conduits smaller than 25mm diameter underground.
- Do not use light duty (MD-UPVC) conduit underground or where it may be exposed to mechanical damage or to sunlight.
- Ensure all associated plastic conduit fittings are of the same material as the conduits.
- Install conduits so the installation can be wired using the 'draw-in loop-in' principle.
- Provide power circuit conduit s so the power circuit wiring is drawn in only at outlets and the initial conduit entry point.
- Install conduits directly from the entry point to the termination point, with the minimum number of sets ensuring the number bends does not exceed the equivalent of 3 x 90 degree bends.
- Do not install elbows, tees, etc. in inaccessible locations.
- Cap all conduits during construction.
- Do not run conduits in roof spaces directly below the thermal insulation or sisalation.
- Do not run conduits in roof spaces or ceiling spaces directly on top of the ceiling.
- Provide deep pattern wall boxes securely fixed such that the front edge of the box is no more than 10mm behind the wall finish.
- Do not install wall boxes across the junction between different wall finishes.
- Provide all plastic wall boxes with threaded brass inserts for securing the flush plates.
- Do not use wall boxes with sliding type lugs for attaching flush plates.
- Earth all metal wall boxes.

- Run conduits within concrete slabs such that they are securely fixed to the reinforcing rods and pass above a single layer of rods or between a double layer of rods, generally midway in the thickness of the slab.
- Space parallel conduits within concrete slabs more than 75mm apart.
- Arrange conduits within concrete slabs such that cross overs are avoided and the number of conduits in one location is kept to a minimum.

Rectify all damage caused by flooding or vermin ingress that has occurred as a result of the conduits not being correctly sealed. Any such damage post practical completion is to be considered a latent defect and must be rectified as such.

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. 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.

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 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 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 replacement of the main switch board and new underground consumers mains.

The new main switchboard is to be located internally with the final position confirmed on site with the operator.

The existing supply authority aerial service is to be modified and reconnected to a new galvanized steel property pole. New underground consumers mains are to drop down within the property pole then run underground to the new main switchboard.

Arrange for a new NMI to be created for the parish hall as well as facilitating the creation of the retail account and all associated paperwork to allow the parish hall to be separately metered from the cathedral in the new main switchboard.

The existing NMI / metering is to be used to supply the cathedral / DB-A.

Provide a new underground submain from the main switchboard to the existing parish hall distribution board. Reconnect the existing DB-A submain to the new main switchboard.

Remove all existing cabling made redundant by the works and the existing main switchboard.

Provide the parish and cathedral operators with two weeks written notice of any power outage which must be contained between 10.00 pm and 6.00 am. All supply authority out of hours costs are to be included within the electrical services tender price.

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.
- Property pole.
- Trenching.
- Pits.
- Conduits.
- Consumers' mains.
- New Main Switchboard.
- Metering.
- Submains.
- Removal of all redundant cabling and the existing main switchboard.

Arrange with the supply authority to have the supply modified and 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.

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 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.

All switchgear is to be match the brand used in DB-A.

4.2.2 CABLING

Unless otherwise specified provide all power cables with copper conductors, a minimum size of 2.5mm² with insulation coloured as follows:

- Actives of single phase circuits: Red
- Actives of multiphase circuits:
 - A phase: Red
 - B phase: White
 - C phase: Blue
- All neutrals: Black

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.

- Has been fully commissioned in accordance with this specification.
- Phase rotation.
- Power availability.
- Resistance to earth.
- Voltage.
- Overload protection.
- Fault protection.
- Earth leakage residual current protection.
- All mechanical fixings.

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.

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.

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 attending site twice during the defects and liability period and undertaking the above adjustments to and reprogram as directed by the operator the power distribution.

4.4 SWITCHBOARDS

4.4.1 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.

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

4.4.2 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.

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.

4.4.3 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 at Practical Completion, at 6 months and at end of Defects Liability Period.
- Provide written reports on maintenance activities.

4.4.4 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 levelling 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 bitumastic paint. Provide concrete plinths where required as 20Mpa strength grade with an 80mm slump with a single layer of mesh.

4.4.5 TRANSIENT PROTECTION

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

4.4.6 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 the main switchboard 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.

Provide all removable doors and panels with locating pins designed to prevent it from falling when the fastening screws are removed.

Provide all switchboard doors with / as:

- Dished type
- Fitted with a combined lock and catch and a separate key
- Concealed door hinges

In locations the door covers a section of board where live terminations could be exposed once the door is opened, provide the door with the following engraved laminate red/white/red label with 10mm text;

'DANGER'
LIVE ELECTRICAL TERMINATIONS

**LICENSED ELECTRICIAN OR
SUPPLY AUTHORITY REPRESENTATIVE
ONLY TO OPEN.**

4.4.7 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.

All doors are to be locked using a three-point locking system and operated by a stainless steel lockable swing handles. Supply four keys on individual stamped aluminium key tags.

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

4.4.8 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 cut-outs.

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

4.4.9 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.

4.4.10 CONDUCTORS

4.4.10.1 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 mm² or larger.

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.

4.4.10.2 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".

4.4.10.3 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 25.0mm² 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 mm².

Provide control and indication conductors of not less than 1.0 mm² 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.

4.4.11 SWITCHGEAR AND CONTROL GEAR

4.4.11.1 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.

4.4.11.2 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 an 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. All contactors mounted in switchboards are to be extended through the escutcheon.

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

4.4.11.3 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.

4.4.12 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, lengths 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.

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

4.4.13 SWITCHBOARD OPERATING PARAMETERS

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: IP44.
- 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.

4.4.15 MATERIALS AND FINISH

Enclosure: Zinc anneal, powder coat Light Grey, (AS 2700 - colour N35).

Escutcheons: Zinc anneal, powder coat white.

Doors: Zinc anneal, powder coat Light Grey, (AS 2700 - colour N35).

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 an earth electrode:

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

Provide the earth electrodes as solid copper rod incorporating integral driving heads and points. Solid stainless-steel rod grade 302 is also acceptable. Install the earth electrode vertically. Electrodes may be driven direct into the ground or installed in holes previously drilled and packed with 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.

Where installed in a hole, install the electrode in a 200 mm bore hole, backfill with a conductive metallic grouting compound and compact with a vibrator.

Locate the 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 labelled "Power supply Earth Stake". Stick on and hand stencilled 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.

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 6mm² minimum.

In all publicly accessible arrears and areas the earth stakes could be subject to interference during normal operations such as being bumped locates each earth stake in a flush proprietary 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 proprietary 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 replacement of the external lighting controlled by a Philips Dynalite lighting control system with the Philips Dynalite equipment located in DB-A. The works includes all new lighting sub circuit wiring. All of the light fittings and accessories are to be provided as part of this contract. All light sources are to be solid state LED with a 5-year manufacturer's warranty.

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

- Lighting.
- Light fittings and accessories.
- Poles and footings.
- Earthing of the lighting installation.
- Lighting control.
- Philips Dynalite lighting control system
- Lighting subcircuits.

All of the Philips Dynalite control equipment is to be located within DB-A.

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 COMMISSIONING

5.2.1 GENERAL

As part of the commissioning of the lighting, undertake the following tests as relevant on all components of the lighting installation:

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.

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 coordinate with other installers (such as air conditioning contractors, installers of girders and plasterers).
- All luminaires are in the correct position and in the correct orientation.
- All luminaires are clean and undamaged with the correct lamps fitted (i.e. manufacturer, rating, phosphor and electrical type).
- All sensor levels have been set to the specified levels.
- All components are uniquely and clearly labelled.
- The alignment of all luminaires 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 luminaires 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 luminaires, 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.

The Philips Dynalite lighting control system is to be programmed at practical completion to the satisfaction of the operator.

5.2.2 LIGHTING CONTROLS

The Philips Dynalite lighting control system is to be programmed and commissioned by a specialist lighting control contractor experienced in programming and commissioning Philips Dynalite lighting control systems.

Undertake the programming and commissioning Philips Dynalite lighting control system at practical completion to the satisfaction of the operator and again at one month post practical completion and at 6 months post practical completion.

Ensure that scenes operate as advised by the operator. Ensure that scenes are labelled adequately to allow an untrained user to select the correct option.

5.3 LUMINARIES

Provide each fitting with a screw tunnel type fused terminal block capable of housing 4x2.5mm² conductors in each terminal.

Provide luminaries with all internal wiring colour coded to AS3137.

Provide each luminaire with a dedicated electronic driver.

5.4 POLES

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 poles which incorporate a tamper resistant access panel within the pole base. All poles are to be provided with base plates 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.

Provide poles less than 20m that comply with AS/NZS 1170.0:2002 Structural design actions Part 0: General principles - Importance level 1 and poles that are more than 20m that comply with importance level 2 both with a design working life of 50 years.

Design the poles to a wind loading as per S1170 AS/NZS 1170.0:2002 Structural design actions Part 0: General principles. The fraction of critical damping is to be taken as 0.05 (ultimate) and 0.01 (serviceability) for poles with more than two- (2) overlaps and 0.02 (ultimate) and 0.005 (serviceability) for all others. The natural frequency of the pole is to be calculated considering varying diameters and thicknesses over the height of the pole and using a 1.1 safety factor for the mass at the top of the pole.

Ensure pole deflection at serviceability wind speeds have a deflection less than 6.7% for poles under 30.0m and less than 3.3% for poles 30.0m and over or for poles with integral access i.e. climbing rungs.

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

Provide all poles with a galvanised foundation bolt assembly complete with positioning template and two- (2) nuts and washers per bolt provided to suit the pole baseplate. Foundation bolts must be manufactured from deformed reinforcing bars with a nominal yield stress of 500 MPa. Provide bolts threaded in accordance with AS1275-1985 Metric screw threads for fasteners and fitted with class 5 nuts in accordance with AS/NZS 1112:1996 ISO metric hexagon nuts. Foundation bolts must be tied to a suitable reinforcing cage. The length of each foundation bolt must allow for the length of the thread above ground, a minimum of 100mm cover and a development length in accordance with AS3600-1994 Concrete structures, Table 13.1.2.2(A). The underside of the baseplate is to be grouted.

Provide flush fitting access doors to house luminaire control equipment. The pole section at the access door is to be reinforced and analysed according to BS EN 40-3-3:2003 Lighting columns, Design and verification-verification by calculation or a recognised finite element analysis package. Poles housing more than eight sets of control gear are to have a vented bottom access door.

The section capacity of the pole is to be analysed over a minimum of 100 increments according to AS4100 - 1998 Steel structures and AS/NZS 4600:2005 Cold-formed steel structures.

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

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

If powder coating is required, poles are to be sanded after galvanizing and preheated to 220°C to drive off any trapped gas under the galvanized surface. A zinc rich prime coat - Interpon Polyzinc 660 or equivalent shall be applied to within 60µm and 80µm within four hours of preheating and green cured to 200°C for 3 minutes. Prime coat shall be lightly sanded before application of top coat. Colour topcoat shall be a ripple, high build finish to within 50µm and 70µm. If painting is required either two coat polyurethane or epoxy painting systems shall be used.

Ensure all manufacturing tolerances are in accordance with AS 1798-1992 Lighting poles and bracket arms - Preferred dimensions. In particular the poles shall be checked for compliance with the straightness requirements of this standard: 0.3% of height.

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

Grout the underside of all pole baseplates within seven- (7) days of installing the pole.

5.5 LIGHTING CONTROL SYSTEM

Provide a programmable lighting control system which incorporates multi-channel control panels, sensors, switch panels, programmable time clock and a programmable PE cell all daisy-chained together via a STP data bus. Provide dedicated data bus for each distribution board with each separate bus interconnected via an optically isolated bridge unit.

As part of the programmable lighting control system, allow to program the operation of the programmable lighting control system on site under the instruction of the engineer to the satisfaction of the engineer.

5.6 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.

Allow for the adjustment and aiming of luminaries over a period of four (4) hours per night for two (2) nights during the hours of darkness to achieve final set-up. This work will be carried out under the direction and to the satisfaction of the project manager.

Provide all equipment such as ladders, scaffolding and tools necessary for adjusting each luminaire. 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.
- Setting all sensors.
- Testing all operations of the lighting control system.
- Testing the emergency and exit lighting system.

Allow attending site twice during the defects and liability period and undertaking the above adjustments to and reprogram as directed by the operator.