ELECTRICAL DESIGN GROUP

ELECTRICAL BUILDING SERVICES CONSULTANTS

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PROJECT

WHITSUNDAY ANGLICAN SCHOOL RSDC

DOCUMENT

ELECTRICAL SERVICES SPECIFICATION

SITE ADDRESS

2/16 CELEBER DR, BEACONSFIELD QLD 4740

PROJECT MANAGER

BSPN ARCHITECTURE
116 BROOKES STREET
FORTITUDE VALLEY QLD, 4006

DESCRIPTION

REVISION: D
DATE: 28 FEBRUARY 2022

ELECTRICAL DESIGN GROUP BRISBANE PTY LTD ACN 092 710 793
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REVISION SCHEDULE	
REVISION	PARAGRAPH/S CHANGED
Rev A	Original revision
Rev B	Tender
Rev C	Clause 1.1 Requirement to advise the school of all network and internet connections added. Clause 5.1 The requirement to provide the school with software and training to adjust the lighting control system has been removed. Clause 6.1 The core A rack requirements have been revised and rack CR-A4 has been added. The fly leads and patch leads have been nominated as being by the school. Clause 7.1 The security system has been revised to include a new Inner Range Integrity security system and the Aperio access control has been called up as being provided as part of the electrical scope. Clause 8.1 The IP to audio system has been nominated as Barix.
Rev D	Clause 2.5.1 Smoke alarms removed and fire detection system added. Section 9.0 Fire detection system added.

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.
- Installation drawings.
- Work-as-executed drawings.
- Inspections.
- Testing and commissioning.
- Maintenance.
- Programming.
- Manuals.
- Cabling, cable support systems and access.
- Spare conduits, wall boxes and draw wires for future use and use by other trades.
- Quality assurance.
- Power distribution.
- Lighting.
- Communication cabling.
- Security.
- School Bell System.
- ***Fire Detection System.***
- 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.
- Within the electrical services include a provisional allowance of $25,000.00 exc GST.

With the tender response provide a copy of the Electrical Sub Contractor's licence. Include a copy of all of the above licences in the Maintenance Manual.

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

Should the Electrical Sub Contractor not provide the information required to be submitted by this specification and the Schedule Of Information To Be Submitted within two weeks of being requested to do so or as agreed to in writing, the Electrical Sub Contractor is to agree to a variation credit of $2,000.00 to the contract in lieu of the provision of such information.

Should the Electrical Sub Contractor not provide the Work-As-Executed drawings within two weeks of practical completion or as agreed to in writing, the Electrical Sub Contractor is to agree to a variation credit of $2,000.00 to the contract in lieu of the provision of the Work-As-Executed drawings.

Should the Electrical Sub Contractor not provide the Operations and Maintenance Manual within two weeks of practical completion or as agreed to in writing, the Electrical Sub Contractor is to agree to a variation credit of $2,000.00 to the contract in lieu of the provision of the Operations and Maintenance Manual.

All electrical connections that are not water proof must be above RL 6.650 AHD.

In addition to undertaking the electrical works in accordance with the contractors program the electrical installation is to be staged as follows:

- 2022 June July school holidays – Upgrade CR20A.

- Once the school has relocated the servers to core A and they are operational – upgrade CR20.
- Once the new building is operational – Remove the temporary power supply in DB-15 supplying DB-14 and the associated cable to allow building 14 to be demolished.
- Once the new building is operational – Remove the temporary fibre connection in CR-15 supplying CR-14 and the associated cable to allow building 14 to be demolished.

Program the sequencing of all works to existing services outside of School's normal "Hours of Operation as nominated in the head contract. Allow all diversion, temporary services works and approvals to maintain functionality across the campus. Stage 2 (Eastern Wing of the Science Building) is required to remain operational throughout the duration Stage 1 works. A number of services will need to be diverted, made temporary or constructed new prior to demolition works occurring in Stage 1. Program the sequencing of these works to maintain functionality across the campus and to Stage 2 at all times during School's normal "Hours of Operation.

Provide the school with a list of all network and internet connections including the necessary ports six months prior to practical completion for the electrical, mechanical, hydraulic and lift 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
Cool rooms and freezers	Refrigeration services sub contractor.
Motorised roller shutters,	Contractor.
Auto Doors	Contractor.
Electric strikes and power transfer hinges.	Contractor.
Cooking and refrigeration services	Contractor or school dependant on the item
Active communications equipment	School.
Illuminated signage	Signage contractor
Connection of the power supply from the isolator to the sign.	Specialist signage contractor.
Mechanical Services	Mechanical services sub contractor.
Sub mains from the MSSB to the mechanical plant.	Mechanical services sub contractor.
Hydraulic Services	Hydraulic services sub contractor.
Fixed equipment such as HWS and cooking equipment.	Dependant on the equipment either the contractor, other sub contractor, specialist contractor or tenant.
Plug in equipment such as fax machines.	Dependant on the equipment either the contractor, other sub contractor, specialist contractor or proprietor.
Communications equipment fly leads.	Specialist communications contractor.
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
Fire rated boots over recessed lights in fire rated ceilings	Contractor
Rebates/cut-outs in fire stair door jambs for electric strikes and reed switches	Contractor
Provision of penetrations through floors and walls. The electrical contractor to provide fire rating to penetrations after cables are installed if required.	Contractor
Anti-termite treatments	Contractor

1.3 CONTRACT DRAWINGS

The electrical services document schedule C2237a-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 section A of 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 section A of 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. Provide a copy of the license before commencing work onsite and include a copy in the Operations and Maintenance Manual.

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

It is the Electrical Sub Contractor's responsibility to ensure that the installation is fit for purpose and is provided as a complete working installation. It is the Electrical Sub 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. In such circumstances the Electrical Sub Contractor is to agree to a variation credit of $1,000.00 to the contract for each exposed service.

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

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

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

Install components and equipment in accordance with the 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. Include a copy of the photos in the in the Operations and Maintenance Manual.

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 weeks' notice of the pending requirement for the approval and give each approving party a minimum of two working days to respond. Should an approval not be given it is the electrical sub contractor's responsibility to revise the material being submitted for approval and resubmit such material. The re-submission of material for approval does not constitute grounds for an extension of time.

1.10 ACCESS

Allow to provide all necessary access to install and complete the electrical services 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 at the rate of $200.00 per hour plus GST plus disbursements. The walk through will be scheduled within 3 weeks of the completion of the installation in order to turn the project and documentation over to the end user. Please note that "Customer Acceptance" does not release the Contractor from repairing any cabling errors or improperly labelled circuits, caused by the Contractor that may be discovered at a later date.

1.16 HANDOVER

Within two weeks of the contract being awarded, the contractor's site foreman and the Electrical Sub Contractor's site foreman are both required to attend an electrical services handover meeting for a duration that will not exceed three hours. The time and location will be confirmed by the Electrical Design Group. The contractor's site foreman and the Electrical Sub Contractor's site foreman are both required to confirm in writing to the Electrical Design Group that they will be attending the handover meeting. The intention of the handover meeting is to review the following information, answer any questions and identify any potential issues:

- How the electrical services design is documented and the purpose of each document.
- The services available on the Electrical Design Groups web site.
- The communication process and channels used by the Electrical Design Group.
- The relationship between the electrical services documents and the other discipline documents.
- The client's expectations of the electrical services.
- An overview of the contractual arrangements.
- A summary of the unusual contractual requirements within the electrical services.
- Identify any areas and items that may be subject to further design development or change.
- Identify any electrical services authority requirements.
- Summarise the major risks and or difficulties within the electrical services.
- Review the design of each system within the electrical services identifying the design critical components and components within the design that are open to the contractors input.
- Review the layout of each system within the electrical services identifying the design critical areas and layouts that are open to the contractors input.
- Summarise the major areas of coordination and the coordination requirements.

Prior to the hand over meeting the contractor's site foreman and the Electrical Sub Contractor's site foreman are both required to have reviewed the electrical services documents. The Electrical Sub Contractor's site foreman is required to bring a full size set of the current electrical services documents to the handover meeting. Others such as the Client, Architect, Contractors supervisor and Electrical Sub Contractor's supervisor are encouraged to attend the handover meeting, though not considered essential. If the Electrical Sub Contractor's site foreman do not attend the full duration of the handover meeting the contractor agrees to a credit variation of $1,000.00 to cover the costs of the aborted handover meeting and the handover meeting is to be rescheduled.

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 Act.
- Electrical Safety Act.
- Workplace Health and Safety Act.
- Telecommunications Act.

Unless specifically detailed within this specification, undertake all works to the requirements of the relevant standards included in the Standards Schedule C2237a-0003.xls. Refer any discrepancies between the following standards and or the specification to the Architect for clarification prior to the placing of orders, fabrication or installation of the items/methods in discrepancy.

It is the electrical sub contractor's responsibility to obtain from all equipment and component suppliers confirmation that the equipment and components supplied as part of the electrical 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, AS3008, AS2293.1 and AS2293.2.

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.
- State Government Department of Environment and Heritage.
- Queensland Department of Justice and Attorney-General, Workplace Health and Safety Queensland
- Queensland Health
- Queensland Department of Justice and Attorney-General, Industrial Relations
- Building Regulations 2006
- Fire and Rescue Services Act 1990
- Building Fire Safety Regulation 2008
- Queensland Electricity Act
- Queensland Electricity Regulation
- Queensland Electrical Safety Act
- Queensland Electrical Safety Regulation
- Queensland Development Code
- Queensland Fire and Rescue Service (QFRS)
- Queensland Electricity Connection and Metering Manual
- SAA Communications Cabling Manual
- AS/NZS 3000 SAA Wiring Rules
- The building certifier.
- Queensland Sustainable Planning Act and Regulation 2009
- Queensland Building Act 1975
- National Construction Code (NCC) Building Code of Australia (BCA).

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 / BUILDING TUNING

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 DOCUMENTATION

2.5.1 OPERATIONS AND MAINTENANCE MANUAL

Within ten working days prior to practical completion, provide an electronic copy of combined Operations and Maintenance technical manuals for approval, written in clear concise English, containing the following data in the following format:

Within ten working days of receiving approval of the combined Operations and Maintenance technical manuals, provide the two copies of each of the approved combined Operations and Maintenance technical manuals.

Within ten working days of practical completion, provide the two copies of a combined Operations and Maintenance technical manuals, written in clear concise English, containing the following data in the following format: A typical combined Operations and Maintenance technical manual is available for download and editing from the Electrical Design Group web site www.edg.net.au.

- Contents.
- Project details.
  - Description of the project and the electrical services sub-contract.
  - Description of the major components of the electrical services sub-contract.
  - Description of the manual and its intended use.
  - Contact details of the electrical sub contractor and each of the major suppliers.
- Licences and certificates.
  - Copies of all licences, certificates and statements of compliance as required by the specification.
- Operating instructions.
  - Provide an overall description of the operation of the electrical installation.
  - Describe the safe working procedures of the electrical installation.
  - Detail the environment that must be maintained for the safe and satisfactory operation of the electrical installation.
  - Detail the specific operating requirements for each component of the electrical installation.
  - Include a reference to the following government website for Electrical Safety at Work information. http://www.justice.qld.gov.au/fair-and-safe-work/electrical-safety/business-and-industry/electrical-safety-at-work#cords

Include a copy of relevant first aid hints.

- Maintenance instructions.
  Include a description of the general maintenance requirements for the electrical installation.
  Include a description of the safe working procedures for the maintenance of the electrical installation.
  Detail the specific maintenance requirements for each component of the electrical installation.
- Lighting.
  Provide a detailed description of the lighting installation.
  Include any information associated with the lighting installation required to be provided by the specification such as programming and aiming details.
  Provide a schematic of the lighting control system detailing the catalogue number of each component. Provide a schedule of the lighting control system reconciling the control channels against the items controlled, the associated circuit and identify all spare capacity.
  Provide a schedule of each light fitting, the fitting manufacturer, catalogue number and lamp type.
  Provide a brochure of each component and details on how the configure / adjust / programme the component / system.
  Provide a copy of the lighting control system training notes / instructions.
- General electrical components.
  Provide a schedule of each general electrical component, the component manufacturer and catalogue number. This schedule does not include light fittings or the power distribution components.
- Power distribution.
  Provide a detailed description of the power installation and the statutory operation and maintenance requirements.
  Include any information associated with the power installation required to be provided by the specification such as programming and aiming details.
  Provide a schedule of each component of the power installation, the component manufacturer and catalogue number. This schedule is to include switchgear.
  Provide a copy of each switchboard schedule.
  Provide a brochure of each component and details on how the configure / adjust / programme the component / system.
  Provide a copy of the power distribution system training notes / instructions.
- Work-as-executed drawings.
  Provide a hard copy and an electronic copy on CD ROM in AutoCAD 2000 format. For all A1 and B1 drawings provide an A3 set as well as the full size set.
- Emergency lighting.
  Describe the emergency light installation and the statutory operation and maintenance requirements.
  Detail the individual manual test features of each emergency light fitting.
  Detail the AS2293 group test feature.
  Provide a copy of an emergency lighting maintenance log book similar to the GLS publication available from Caribou Sales Phone (07) 3891 1112. Complete the entries in the emergency light maintenance log book.
- Test results.
  Include all test results required to be provided by the specification.
- Communications cabling.
  Provide a copy of the schematic layout of the communications cabling detailing the catalogue number of each component and how each component is connected.
- Security.
  Provide a copy of the schematic layout of the security system detailing the catalogue number of each component and how each component is connected.
- School Bell System.
  Provide a copy of the schematic layout of the School Bell System detailing the catalogue number of each component and how each component is connected.
  Provide a detailed description of the school bell system.
  Provide a brochure of each component and details on how the configure / adjust / programme the component / system.

- ***Fire Alarm System.***
  Provide a detailed description of the fire alarm system and the statutory operation and maintenance requirements.
  Provide a copy of the fire alarm layout detailing the catalogue number of each component and how each component is connected.
  Provide a brochure of each component and details on how the configure / adjust / programme the component / system.
  Include a copy of the FIP operation manual.
  Provide a copy of the fire alarm system training notes / instructions.

Provide the manuals as A4 size, machine printed or typed on durable printing paper, with each page consecutively numbered, and neatly bound in a permanently labelled durable white vinyl covered ring binder folder. Securely fix a labelled CD containing all of the information in the manual including Auto CAD files of all drawings.

2.6 LAYING OUT

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

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

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

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

2.7 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%

2.8 QUALITY ASSURANCE

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

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

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

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

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

2.9 LABELLING

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

- Power outlets and light switches with clip-on faceplate / surrounds are to have the circuit identification labelled by using indelible ink in a concealed location under the clip-on faceplate / surround on the screw fixed plate.
- Isolators and power outlets and light switches that do not have clip-on faceplate / surrounds (such as weather proof outlets) are to have the circuit identification labelled by engraving with a contrasting infill colour on the faceplate of all power outlets and isolators in a permanently visible location. Such engraving is not permitted to be located on clip on faceplates / surrounds. If the entire faceplate is clip on then the label is to be provided as a screw fixed trefolite panel engraved with a contrasting infill colour mounted immediately above the outlet.
- Communication outlets are to have the circuit / channel identification labelled by engraving with a contrasting infill colour on the faceplate of all outlets in a permanently visible location. Such engraving is not permitted to be located on clip on faceplates / surrounds. If the entire faceplate is clip on then the label is to be provided as a screw fixed trefolite panel engraved with a contrasting infill colour mounted immediately above the outlet.
- All exposed labels and identification method are to be identical in type and style.

2.10 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.

2.11 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.

2.12 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 on CD for approval.

Check control systems for correct operation under representative operational conditions. During the commissioning period these conditions may not arise because the building is unoccupied, and it is difficult properly to verify the performance of seasonal variations in control strategies. Control systems should therefore be checked when the building is occupied. In addition, illuminances cannot be checked until the space is completely fitted out and furnished. Representative operational conditions will often involve checks at dusk and/or night time.

The extent and frequency of post-occupancy checks should be included in the control system specification as part of the contract between the building owner and the construction supply chain and will depend on the nature and complexity of the control system. Lease documents should support any contractual requirements for post-occupancy evaluation and ensure that the leaseholder is required to provide reasonable access for their performance.

Post-handover checks comprise a continuation of functional checking relating directly to the lighting control system. Where a central control system is implemented, use should be made of its logging functions and the ability to display trend logs once it is confirmed that they are operating accurately.

2.13 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.

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

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 operates correctly under generator standby and UPS power if applicable,
- 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
- Spare fuses and fuse ways if specified
- Drawing holder
- Fuses (type and ratings) against fuse chart
- 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

General Function test

- The lamp test facility, if specified.
- Wiring interlocks by progressively energising or de-energising relay contacts, switches, timers etc in each circuit. Switches must be used to test that the system operates correctly in response to input signals.

- All indicators and signals out of the panel, e.g. those used to switch items of plant or to send status signals to the control system. Safety interlocks, e.g. coil freeze protection and fire overrides, must be checked in ‘manual’, ‘off’ and ‘auto’ switch modes.

Typical starter/power circuit

- Fuse or circuit breaker frame size, trip unit type and settings against the drawings.
- Correct labelling has been provided.
- Energise the starter/contactor by ‘making’ the control circuit and ensure the starter operates correctly and that power is provided to outgoing terminals.
- Trip the starter and check that it de-energises and the trip indicator lights up.

All switchboards and control panels are to undergo on site checks including though not limited to the following specific items or routines:

- If the control panel is left on site for a long period then undertake adequate steps to ensure that it is protected from dirt, damage and moisture (e.g. by the use of anti-condensation heaters). Remove and store separately sensitive electronic components.
- Check all new connections into the panel and the interlocks re-checked before the power is switched on and is operated.
- Do not hand over the panel until it has been wired in and fully functionally tested and the testing has been witnessed and approved by the engineer.
- Perform a complete panel test on-site if the panel has not been tested in the factory, or if a multi-section panel has been received on-site having been split for shipment.

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).

Undertake including though not limited to the following on site communications network checks and tests:

- All network devices such as routers and bridges are installed correctly.
- All control devices can be addressed over the communication network.
- When used in conjunction with an office IT network ensure that permission has been granted from the IT manager. All network data routing is correctly set up by the IT department including allocation of the appropriate TCP/IP addresses and default router addresses.
- For structured cabling systems ensure that all outlets are properly labelled and assigned. Ensure that any changes to the cabling system are reflected in the updated documentation.

Undertake including though not limited to the following on site insitu field control devices (controllers, outstations and unitary controllers etc) checks and tests using NATA approved testing equipment:

- Type as specified
- Size as specified
- Enclosures as specified
- Number and location (height, access) as specified
- Adequate mechanical fixing
- Identification by mnemonic labelling
- All cables terminated and identified
- All terminals used (check that any unused terminals are intended to be spare)
- Continuous power available and of an appropriate quality
- Fuse correct type/spares if specified
- Hardware configuration agrees with the specification
- All printed circuit boards in place
- All connection cables plugged in
- Document wallet containing wiring diagram where appropriate, i.e. when located in a control panel

2.14 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 2 hours.

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

In addition to the operator training above at times to be agreed with the operator, instruct the operator's maintenance staff in the recommended methods of operation and maintenance of the electrical services. Allow to provide two such operation and maintenance training sessions on site each for duration of 2 hours.

Ensure the maintenance staff training includes the following information:

- A review of the Operations and Maintenance Manual.
- The types of luminaries used.
- The correct types of lamps to be used for each luminaire type.
- The correct type and location of all consumables used within the electrical installation. This is to include though not be limited to lamps, indicating lamps, fuses, surge protection devices etc.
- Advised maintenance cycles.
- Access for maintenance.
- The location of spares.
- The location of switches.
- Basic trouble shooting and fault finding techniques.

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. Reinstate 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. Reinstate 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. Include a copy of the photos in the in the Operations and Maintenance Manual.

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 its 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 manufacturer 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 hop 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

The building includes areas / levels which are required to be fire isolated and all penetrations through such areas as defined on the architectural documents must be appropriately fire rated.

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

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

3.5 ACCESSORIES AND FITTINGS

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

- All switches and outlets provided are of a like appearance, flush set sized at 115 x 70mm.

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

3.6 EARTHING

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

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

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

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

3.7 ACCESS

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

3.8 CATENARY SUPPORTS

Provide catenary supports in accordance with the following requirements:

- Use catenary wire as a minimum as seven strands galvanised steel wire.
- Catenaries are anchored and supported to the ceiling slab or structural members and tensioned by way of 2 wire clamp turnbuckles fixed in place by Dynabolts with a minimum size of 6mm.
- Where the cable loading is excessive for catenary wire or saddled enclosures, use tray/ladder.
- Catenary wire is supported by jack chain or similar at distances of no more than 3 metres. Do not use ceiling hangers as support for catenaries or cabling.
- Where cables leave a catenary, they must be supported in PVC conduit and/or PVC ridged and/or flexible conduit and/or an additional catenary and then the conduits. The conduits will be fastened to the catenary and then at every change of direction in a workmanship like manner. Corrugated conduits should not lay about in ceiling spaces.
- Attach an earth to the catenary with a 2 screw tunnel type connector.
- Catenary wire systems must installed be true to the building line in such a manner that they are not interfered with or in contact by the structure or any other service.

3.9 CABLE LADDER AND TRAY

Bolt the tray/ladder to single sided brackets for horizontal runs and roll steel channel in vertical runs. Provide cable tray as rolled or folded steel at least 1mm thick galvanised prior to delivery or from extruded structural grade aluminium with a thickness not less than 1.5mm. Use cable ladder with cable support rungs between the two rails spaced at intervals of not more than 300mm. Each adjacent length of the cable tray is to be bolted together.

Use tray/ladder 150 mm, 300mm, 450mm or 600mm wide. Provide bends, connectors, trays, ladders, brackets, and other support necessary to make a complete cable or conduit support system of the same manufacture, sized to adequately support the installed cabling.

Provide cable ladder with a cable contact area of less than 10% for power cables required to be supported on tray/ladder. Provide perforated cable tray for all non-power cables required to be supported on cable ladder or tray. Use tray that has slots that on both the normal and reverse sides there are no burrs or sharp edges. All trays and ladders must be galvanised after manufacture, prior to delivery to site.

Do not run cables with an outside diameter smaller than 13mm on cable ladder unless supported at intervals not exceeding 100mm. Slots or ladder rails will be considered suitable for fixing cable ties, strapping or saddles. Ensure all bends have a minimum inside radius of not less than twelve times the outside diameter of the largest diameter cable carried. Provide sufficient space on the tray or ladder for not less than 50% more cables or conduits than specified.

Position the tray/ladder to give adequate access for inspecting, replacing, or adding cable. Fix cable to the tray/ladder by proprietary nylon ties, straps or saddles, at 1000 mm centres for vertical runs and 2000mm centres for horizontal runs. Provide a slightly curved support surface under cables leaving the tray/ladder to protect the cable sheath from impingement by the tray/ladder edge.

Where the tray/ladder is exposed, provide a cover over the tray/ladder. Provide the cover as removable galvanised sheet steel screw fixed to the tray in lengths that allow it to be safely removed by a single person. Ensure the cover is installed in a neat manner without undue gaps and is free from burrs.

3.10 CEILING SUPPORTS

Provide termite resistant plywood support to all components mounted within lay-in ceiling tiles such that the weight of the component and any associated control gear is supported on the ceiling grid and not on the tile. Provide all necessary T Bars and cut tiles required to accommodate the installation of all components mounted within suspended tile ceilings. Provide all necessary additional structural supports and T Bar rails to mount the fittings and support the plywood support. Provide all cutouts in set plaster ceilings and modify the structural support of the ceiling where necessary to accommodate the cut-out.

3.11 MOUNTING REQUIREMENTS

As part of the electrical-sub contract works allow for all necessary mounting brackets, fixings, trims, cutouts, blockouts and any other incidental component that will be required to complete the electrical installation. Provide a shop drawing of all such components including how they are mounted for approval.

Fittings and components that have any moving parts or weigh more than 2.5 kgs that are fixed to the lined ceiling or walls must be provided with independent support system connected to the structure.

4.0 POWER DISTRIBUTION

4.1 SCOPE

Provide a new MCCB in the existing site MSB to protect a new underground submain to a new distribution board DB-13. DB-13 is to contain a number of power and lighting chassis as well as MCCBs supplying a remote distribution board DB-UPS and the adjacent MSSB.

Modify and extend the existing underground pit and conduit system as required.

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

- Power distribution.
- Earthing.
- Trenching.
- Pits.
- Conduits.
- Main switchboard MCCB.
- Submains.
- Distribution boards.
- Cable access.
- Connection to equipment.
- Emergency shut offs.
- Testing and commissioning.
- Removal of all redundant equipment, cabling and switchgear.

Undertake all power distribution cabling works including any temporary works that may be necessary to ensure the power supply is maintained to the school during operating hours. All change overs / cutovers and interruptions to the power supply are to be between 1.00 am and 3.00 am.

Provide the school with two weeks' notice of any interruptions. Should an interruption to the supply be required during the school's hours of operation, an alternative power supply must be provided and be connected / disconnected outside of the school's normal hours of operation.

Allow to reconnect all existing circuits that remain such that any outlets, equipment, fittings and plant that remains which was disconnected by the works is reconnected and is operation to the same level of control that was present prior to the works.

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

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

Provide shop drawings of all distribution boards and the cable termination enclosure.

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.

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

All switchgear is to be provided as Schneider to match that used in the site MSB.

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

4.2.2 OUTLETS AND ACCESSORIES

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

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

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

4.2.3 FAULT PROTECTION

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

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

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

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

4.2.4 CABLING

Unless otherwise specified provide all power cables with copper conductors, a minimum size of 2.5mm^2 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:

- 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.

Schedule the results for each item and component and include a copy of all test results in the Operations and Maintenance Manual.

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

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

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 engineer.

At practical completion provide a Queensland Government, Department of Local Government and Planning Form 16 certifying the power installation and include a copy in the Operations and Maintenance Manual.

4.4 OUTLETS

Provide all power outlets and connections as follows:

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

4.5 SWITCHBOARDS

4.5.1 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 and report equal to that provided 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.

In addition to the above during the maintenance period, provide the following for the MSB and DB-CLI:

- Provide on line chart recording of the mains supply for a period of one week at Practical Completion, at 6 months and at end of Defects Liability Period.
- Ensure the chart recorder includes the following information:
  - Voltage of each phase to earth and each phase to phase.
  - Current of each phase.
  - Power factor.

Include the chart recorder and thermoscans information within the Operations and Maintenance Manual with simple explanation of the findings of each.

4.5.2 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.

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

4.5.3 EXTERNAL DESIGN

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

Provide all switchboards other than those located in the following areas with doors:

- Switchrooms.
- Plantrooms.

Switchboards located in cupboards and risers are required to be provided with doors.

Provide all switchboards with a red oxide chromate undercoat and a baked gloss enamel finish.

Provide all external switchboards with rust proofing and as weatherproof.

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.

Where stainless steel is nominated, use 316 marine grade stainless steel.

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.

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

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.

4.5.4 REMOVABLE PANELS AND COVERS

The maximum width of any removable panel is 750 mm. Hang panels and covers on fixed studs with captive stainless steel 8mm square quarter turn locks such that they remain part of the panel or cover when the panel or cover is removed. Provide two stainless steel 'D' type handles to each removable plate. Provide a resilient strip seal, of foam neoprene or the like, around each cover or panel, housed in a suitable channel or housing, fixed with an approved industrial adhesive. In indoor locations, provide certified smoke seals to all panels and covers. For external switchboards provide a continuous positive line of weatherproof contact.

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

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

4.5.5 ESCUTCHEON PLATES

The maximum width of any escutcheon is 750 mm and the maximum height is 1,200mm. Hang escutcheons on stainless steel lift off pintail hinges and provide captive stainless steel 8mm square quarter turn locks such that they remain part of the panel or cover when the panel or cover is removed. Provide two stainless steel 'D' type handles to each escutcheon. Provide the 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.

4.5.6 FINISHES

Where metal surfaces are to be painted:

- Unprotected steel: Remove rust by abrasive blast to AS 1627.4 Class 3, clean by immersing in trichloroethylene or an alkaline solution, and apply a coat of iron phosphate.

- Galvanised steel: Clean by immersing in a suitable alkaline or acidic solution, apply a chromate or zinc phosphate chemical conversion coating, rinse and degrease.
- Aluminium: Clean by immersing in a suitable alkaline or acidic solution, caustic etch and apply a chromate chemical conversion coating.

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

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

4.5.7 CONDUCTORS

4.5.7.1 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.

4.5.7.2 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.

4.5.7.3 WIRING

Provide all wiring within switchboards as follows:

- Install all internal cabling neatly horizontally and vertically. Cable trough (PVC with slotted sides) may be used, or alternatively cables may be laced/loomed using proprietary cable ties, with adequate insulated supports being provided. Ensure laces/looms are not unnecessarily tight.
- Unless otherwise specified, provide PVC wiring ducts to support and manage all switchboard control wiring and outgoing sub circuits. Ensure the total cross section of the wiring within any one duct, including allowance for outgoing connections, does not exceed 40% of the duct cross sectional area.
- Support cabling to ensure that strain does not occur at terminations.
- Use crimp type lugs at terminations, unless equipment has been specifically designed to preclude terminations being made in this manner. Use lugs with insulated ends.
- Fix cables 25.0mm^2 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 consumer's mains and/or submains with permanent identification to denote phase colours.
- Provide sufficient space on mounting rails for future outgoing circuits possible in any cabling compartment.
- Provide terminal blocks for interconnecting wiring on each side of shipping breaks.
- Identify, by markers, each control core using an approved numbering system.

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

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

Colour code the wiring as follows:
- A Phase: Red.
- B Phase: White.
- C Phase: Blue.
- Neutral: Black.
- Earthing: Green/Yellow.

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

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

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

Segregate terminal groups and install together terminals for each outgoing circuit, in the same order throughout, as follows:
- Terminals for power wiring: 3 phases or phase and neutral;

- Control terminals: In numerical or alphabetical order of wire identification, with the lowest number or letter next to the power terminals.

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

4.5.8 SWITCHGEAR AND CONTROL GEAR

4.5.8.1 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.

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

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

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

Provide all circuit breakers that do not have adjustable trip units that supply motors and / or inductive loads as D curve circuit breakers. All other fixed trip unit circuit breakers are to be provided as C curve circuit breakers. Advise the engineer in writing of the circuits that will be supplied with D Curve circuit breakers so the clearing times of earth faults can be checked.

4.5.8.2 RESIDUAL CURRENT DEVICES

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

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

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

4.5.8.3 SWITCH-ISOLATOR AND FUSE-SWITCH UNITS

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

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

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

4.5.8.4 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.

4.5.8.5 CONTROL RELAYS

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

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

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

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

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

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

4.5.8.6 SURGE PROTECTION

Provide the distribution boards where noted in the distribution board schedule with surge protection in accordance with AS1768 with the following features and requirements:

- The Maximum Discharge Current, Imax, as defined in IEC 61643-1 must be 50kA, 8/20µs per phase.
- The Nominal Discharge Current, In, as defined in IEC 61643-1 must be 25kA, 8/20µs per phase.
- The Voltage Protection Level Up as defined in IEC 61643-1 must be less than 750V at 3kA 8/20us and 6kV 1.2/50us.
- The Voltage Protection Level Up as defined in IEC 61643-1 must be less than 1200V at 20kA 8/20us and 6kV 1.2/50us.
- The Maximum Continuous Operating Voltage, Uc must be 415 Volts three phase 240 Volts single phase.
- The products must be UL recognised under UL1449-2 standard.
- (The product must be equivalent to CRITEC TDS 150 or the CRITEC TDS350)

- The surge diverter must have light indication and voltage free contacts.
- Provide a manufacturer's warranty of a minimum of 5 years for the surge diverter.
- Tested in accordance with the requirements of UL1449 Edition 2 and EC 61643-12 Class I and II

All surge protection devices mounted in switchboards are to be extended through the escutcheon.

4.5.9 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.

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 each switchboard with a neatly typed A4 circuit index schedule, that includes the circuit breaker number, rating and the circuit function (i.e. 4 G.P.O's Sales Area, etc.). Mount the circuit index schedule in an index holder located on the inside of the switchboard door that is provided with a clear perspex cover.

Include a copy of the circuit index schedule and the SLD in the manual.

4.5.10 SWITCHBOARD OPERATING PARAMETERS

Provide the distribution boards 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: DB.
- Mounting: wall mounted.
- Degree of protection: IP55.
- Numerical designation: category 1.
- Form 1.
- Equipment connection: front connected.
- Gland plates: 3mm thick brass or aluminium or 6mm thick grey UV stabilised PVC in internal locations. Provide all gland plates with a neoprene gasket.

4.5.11 MATERIALS AND FINISH

Enclosure: Zincanneal, powder coat Light Grey, (AS 2700 - colour N35).
Escutcheons: Zincanneal, powder coat white.
Doors: Zincanneal, 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.

5.0 LIGHTING

5.1 SCOPE

The lighting component of this contract includes internal lighting to all areas of the building, external lighting, general lighting control, emergency and evacuation lighting and the lighting sub circuit wiring. All of the light fittings and accessories are to be provided as part of this contract.

A programable DALI Zen Control lighting control system is to be provided to control the front of house lighting. Smartscape are to be engaged as a nominated sub-contractor to test and commission the Zen Control lighting control system.

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

- Lighting.
- Light fittings and accessories.
- Earthing of the lighting installation.
- Lighting control.
- Emergency and exit lighting.
- Lighting subcircuits.

Irrespective of the mounting heights given in the electrical documents, the mounting and suspension heights of all wall mounted and suspended light fittings must be confirmed with the architect. Provide written evidence such confirmation has been received. If any wall mounted or suspended lights are installed without the height confirmed by the architect, adjusting the height will not be acceptable grounds for a variation.

Provide Shop Drawings of all custom luminaries.

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.

Provide the DALI Zen Control lighting control system with the following features:

- SP1 and SP2 are to have parallel master switches to control all internal lighting. The master on is to only turn on the internal channels designated to these switch panels in the lighting control schedule. The master off is to turn off all internal lighting.
- SP2 is to have master switch to control all external / undercroft lighting.
- SP1 and SP2 are to have secondary controls over each of the channels designated to these switch panels in the lighting control schedule.
- Provide all switch panels with intrinsically obvious visual feedback on the status of the lighting.
- Provide each channel with an independent adjustable school hour run on time and an independent adjustable after school hours run on time.
- Provide the system with a programable annual calendar with 30-minute time slots to define the school hours and after school hours.
- Provide password protected internet access to allow the system to be remotely programmed / adjusted. the run on times and calendar time slots.
- Provide the school with all necessary timing so the staff can confidently operate the system.

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:

Schedule the results for each item and component and include a copy of all test results in the Operations and Maintenance Manual.

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

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

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

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

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

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

Undertake the following operational tests of the lighting control system.

- Each of the master switches operates correctly
- Each of the individual switches operates correctly.
- Each of the during hours run on times operates correctly.
- Each of the after-hours run-on time operates correctly.
- Changes to the run on times and calendar save and operate correctly.

Smartscape are to adjust the lighting control system four hours four times during the defects and liability period to the satisfaction of the school.

5.2.2 LIGHTING CONTROLS

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

The calibration should take place remotely to the sensor at the lighting controller or at a remote operator workstation (via configuration software).

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

Set all presets, upper and lower limits of all dimmers as advised by the engineer on site.

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

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

5.2.3 INTERIOR LIGHTING

Confirm the aiming and focusing of adjustable luminaries is adequately addressed. If all other lighting needs to be switched off during this process, ensure the site to be free from other workers requiring light.

Provide a safety method statement that allows those aiming and focusing the luminaries to use appropriate access gear belonging to, or hired by, the installer. If it is intended that the luminaries be adjusted by the end user after practical completion of the project, this must be indicated in the commissioning method statement.

5.2.4 EMERGENCY LIGHTING

Undertake the commissioning of emergency lighting in accordance with AS2293.

5.3 LUMINARIES

5.3.1 GENERAL

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

- Mounting requirements.
- Lay in diffusers are sized such that they do not fall out of the light fitting or ceiling when the installation is subjected to normal air pressure changes and or winds.
- Fitting size.
- IP protection.
- Exposure to corrosive environment.
- Hazardous environment.
- UV exposure.
- Safety.
- Heat.
- Vandalism.

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

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

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

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

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

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

Provide luminaries with all internal wiring colour coded to AS3137.

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

5.3.2 MOUNTING

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

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

Provide termite resistant plywood support to all luminaries mounted within lay-in ceiling tiles such that the weight of the light fitting and control gear is supported on the ceiling grid and not on the tile. Provide all necessary T Bars and cut tiles required to accommodate the installation of luminaries mounted within suspended tile ceilings. Provide all necessary additional structural supports and T Bar rails to mount the fittings and support the plywood support. Provide all cutouts in set plaster ceilings and modify the structural support of the ceiling where necessary to accommodate the cut-out.

Provide all light fittings mounted within T Bar ceilings with a flexible lead and plug and an unswitched active. Provide such fittings with an approved plug base securely fixed to the structure above the fitting.

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

In locations light fittings are recessed into thermal or acoustic insulation provide all necessary supports and modifications to the insulation to allow the fitting to be installed and the integrity of the insulation to be maintained.

Provide all fittings in food preparation areas as follows:

- Sealed with no top surfaces less than 45 deg exposed to the room air.
- All lamps are fully enclosed.
- All trims are sealed against the ceiling.
- All diffusers are to be held in place in a sealed frame.
- The diffuser frame is to be fixed in place with a positive contact sealing gasket against the fitting trim and secured in place by a minimum of four stainless steel screws.
- Diffusers sealed into the fitting trim by a sealant are not acceptable.

Provide suspensions and luminaries suspension connectors capable of supporting, without damage, five times the mass of the luminaries, or 25kg, whichever is the greater. Ensure all suspended light fittings hang horizontal and adjacent fittings are hung to the same level. Provide all light fittings suspended from a raked ceiling with an adjustable ceiling mounting such that the fitting equipment hangs vertically. Where light fittings are not supplied with integral suspensions provide the suspensions as follows:

- Structurally support the light fittings on threaded booker rod.

- Cover the booker rod with conduit painted to match the light fitting colour.
- Run all wiring to the light fitting through the conduit.
- Fix the conduit into a ceiling rose on the ceiling to provide a neat finish to the conduit.

In all cases suspended light fittings are subject to movement due to wind or air conditioning breeze provide the suspensions as fixed rod suspensions.

5.4 EMERGENCY LIGHTING

Provide a single point emergency lighting system that complies with the latest issue of all parts.

Install emergency light fittings nominated as maintained as follows:

- The lamp is to be permanently on supplied via an unswitched active mains supply when the mains supply is available. When the mains supply is not available, the lamp is to remain on supplied by the emergency pack. Single lamp maintained emergency lights are not switched with the local general area lighting. (The lamp is always on.)

Install emergency light fittings nominated as non-maintained as follows:

- If the fitting is not shown as being switched, the lamp is to remain off when the mains supply is available. When the mains supply is not available the lamp is to be switched on supplied by the emergency pack. Unswitched single lamp non-maintained emergency lights are not switched with the local general area lighting. (The lamp is on only when the mains supply is not available.)
- If the fitting is shown as being switched, the lamp is to be supplied and controlled with the local general area lighting when the mains supply is available. When the mains supply is not available the lamp is to be switched on, supplied by the emergency pack. (The lamp is on when turned on with the local general lighting or the main supply is not available.)

Provide the emergency lights as the self contained type, Twin rate constant current, constant voltage, and temperature compensated type with automatically selected boost and float charging rates, 70˚C rated sealed plastic type lithium iron with a rated battery life of 10 years. Indelibly stamp each battery with its date of manufacture. Protect the inverter system against damage whilst in operation in the event of failure, removal or replacement of a lamp.

Label each circuit breaker which controls the unswitched active to exit lights with a label fixed adjacent; engraved plastic laminate, green background with white characters:-

WARNING
INTERRUPTING SUPPLY WILL DISCHARGE
EMERGENCY LIGHTING BATTERIES

Provide written evidence of the initial commissioning and testing and testing for the duration of the maintenance period in accordance with AS 2293.2.

This evidence is to be in the form of a log book similar to the General Lighting Service Pty Ltd “Emergency Lighting Maintenance Log Book and Manual” which is to be provided by the electrical sub contractor and have all entries fully completed and be presented for inspection at practical completion. The log book is to be retained by the electrical sub contractor for the duration of the maintenance period, and the six monthly test and maintenance results entered. The log book is to be presented for approval at final completion (expiry of the maintenance period) and will be forwarded to the operator for their use.

Provide maintenance of the emergency and exit lighting installation including records in accordance with the latest issue of all parts AS2293.

Provide the emergency lighting system with a supply sensing and testing facility in accordance with AS 2293.1 where noted in the distribution board schedule.

5.5 LIGHTING CONTROL SYSTEM

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

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. Allow to attend site and adjust the programming of the programmable lighting control system a further four times following practical completion.

Schedule the results of the programming and include a copy of them in the Operations and Maintenance Manual.

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

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

- Setting all PE cells and time clocks.
- Focusing of lights.
- Adjusting mountings and brackets.
- Aiming of fittings.
- 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 school.

Document the final results of all adjusting and aiming of the lighting installation and include them in the Operations and Maintenance Manual.

6.0 COMMUNICATIONS CABLING

6.1 SCOPE

The communications cabling component of this contract includes an integrated telephone and data EIA/TIA 568-A Category 6 Molex certified RJ45 cabling solution.

A new IT network core (core A) is to be created in the building with a dedicated fibre tie to the existing core B and to each of the sites existing communications racks as nominated on the communications schematic.

All new fibre cables are to be run in a different conduit to the existing core B fire that runs to the associated building.

The new fibre installation and configuration including the new FOBOTS is to match the existing core B installation. Provide new communications racks CR-A1, CR-A2 and CR-A3 that match the existing core B racks CR-B1, CR-B2 and CR-B3 in configuration and layout including the type, number and position of the power rails and FOBOTs. Provide a new communications rack CR-A4 to accommodate the new building services. Rack CR-A4 is to match the core B racks in type and size.

All FOBOTs, outlets and patch panels that are required to terminate the cabling provided as part of the communications cabling are to be provided as part of these works.

Within all cases in this contract, Category 6 and Cat 6 is to be read as Category 6 Class E.

The terms Category and Cat are used interchangeably throughout this contract to refer to cabling types and standards.

A telephone reference conductor (TRC) system is not required.

Provide all copper products within the communications cabling scope as being capable of supporting the provision of power to the Data Terminal Equipment via the electrically conductive Media Dependant Interfaces as specified in the latest IEEE 802.3af “Power over Ethernet” standard.

During the 2022 June July school holidays replace the existing tuckshop rack with a new 9RU x 600 deep wall mounted rack in the same position and mount the existing network switch in the new rack. Relocate the existing patch panels into the new rack. Remove the existing OM fibre link from CR20 and replace it with a new Cat6 link from CR-20.

Once the school has relocated all of the servers to core A and are fully operational, replace the existing free-standing CR-20 rack with an 18 RU wall mounted rack. Relocate the existing FOBOT and patch panels into the new CR-20 rack. Remove all of the existing redundant voice and coaxial cabling.

Use only the 568A wiring scheme for 8-position modular components throughout the site. Do not mix 568A and 568B wiring schemes.

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

- Communications cabling.
- Trenching.
- Pits and conduits.
- Cable access ways.
- Earthing.
- Facility cabling.
- 19-inch equipment rack/s.
- Patch panels.
- Fibre cabling.
- FOBOTs.

- Independent certification.
- Communications outlets.
- Independent certification.
- Testing and commissioning.

All UTP and fibre patch leads and fly leads will be by the school.

Provide the communications system as a propriety Molex structured cabling system with a component manufacture's 25 year warranty over the communications installation. Include a copy of the propriety structured cabling system manufacturer's warranty in the Operations and Maintenance Manual.

Provide comprehensive details for approval of the structured cabling solution including the manufacturer's performance and installation requirements as well as details of the FOBOTs, patch panels, frames, patch leads, cables, faceplates, outlets and fly leads.

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

Ensure that the work is performed by the holder of a current ACMA license and the staff member has been trained and is certified by the propriety structured cabling system manufacturer. Provide a copy of the appropriate ACMA license and propriety structured cabling system manufacturer's certification for approval prior to commencing work onsite and include a copy in the Operations and Maintenance Manual.

Provide independent testing and certification of the performance of the communications installation and include a copy of such in the Operations and Maintenance Manual.

Provide as part of the tender response, a list of the technical support staff and installation staff, together with their working experience in the relevant field who are proposed to undertake the installation and provide maintenance support. Include the date each of the nominated staff members received formal classroom training by the structured cable system manufacturer. Nominate the location of the office proposed to control and support the installation and maintenance.

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Provide each FOBOT with the following parts even if all components are not used in the initial installation as the following includes provision for future cabling

- Molex RFR-00311-BK 1RU enclosure
- Molex CMA-00111 Front cable manager
- Molex AFR-00743-BL 24 port LC Duplex faceplate shuttered Single Mode OS2
- Two Molex AFR-00470 Splice trays.
- Two Molex KFR-00034 Kevlar retention clamps.
- Two Molex 91.A0860 Cable Glands
- Irrespective of cable size do not connect / install more than one fibre cable per splice tray, retention clamp or cable gland.
- Label each FOBOT such that the port is clearly identified with the associated cable/s source building name and number. Label the unused ports as spare.

The existing fibre plant must be retained and remain operational. The existing fibre cabling within the existing conduits that are to be reused must be protected during the installation of the new fibre cabling.

Provide all fibre cables designated as SM as Single Mode OS2 Fibre Cables fully terminated with LC duplex connectors.

Ensure that the work is performed by the holder of a current ACMA license and the staff member has been trained and is certified by the propriety structured cabling system manufacturer. Provide a copy of the appropriate ACMA license and propriety structured cabling system manufacture's certification for approval prior to commencing work onsite and include a copy in the operating and maintenance manual.

Provide as part of the tender response, a list of the technical support staff and installation staff, together with their working experience in the relevant field who are proposed to undertake the installation and provide maintenance support. Include the date each of the nominated staff members received formal classroom training by the structured cable system manufacturer. Nominate the location of the office proposed to control and support the installation and maintenance.

Provide the fibre cabling installation in accordance with the requirements of the following standards including all subsequent amendments and addendums:

- AS/NZS 2967-2014 Optical fibre communication cabling systems safety
- AS/NZS 3085.1-2004 Telecommunications installations - Administration of communications cabling systems - Basic requirements
- ACMA Labelling Notices Radiocommunications (Compliance Labelling – Devices) Notice
- ACMA Labelling Notices Radiocommunications Labelling (Electromagnetic Compatibility) Notice
- Australia 2016 AS/NZS 2967:2014 Optical fibre communication cabling systems safety Standards Australia 2014 AS/NZS 3000 Australian/New Zealand Wiring Rules
- AS/CA S008:2010 Requirements for customer cabling products
- AS/CA S009:2013 Installation requirements for customer cabling (Wiring rules)
- AS/NZS 3080:2013 Information technology—Generic cabling for customer premises (ISO/IEC 11801:2011, MOD)
- AS/NZS IEC 60825.1:2014 Safety of laser products Part 1: Equipment classification and requirements
- AS/NZS IEC 60825.2:2011 Safety of laser products Part 2: Safety of optical fibre communication systems (OFCS)
- AS/NZS 60950.1:2015 Information technology equipment - Safety - Part 1: General requirements (IEC 60950-1, Ed. 2.2 (2013), MOD)
- AS/NZS ISO/IEC 24702:2007 Telecommunications installations — Generic cabling — Industrial premises
- CA C524:2013 External Telecommunication Cable Networks Industry Code
- HB 101-1997 (CJC 5) Coordination of power and telecommunications - Low Frequency Induction (LFI): Code of practice for the mitigation of hazardous voltages induced into telecommunications lines
- HB 101-1997 (CJC 5) Amdt 1-1998 Coordination of power and telecommunications - Low Frequency Induction (LFI): Code of practice for the mitigation of hazardous voltages induced into telecommunications
- ANSI/TIA 598-C Optical Fibre Cable Colour Coding
- ANSI/EIA 359-A Colours for Colour Identification and Coding

6.2 INSTALLATION REQUIREMENTS

6.2.1 GENERAL

Unless otherwise specified, install and terminate cables in accordance with the manufacturers' recommendations. Unless noted otherwise, joints are not acceptable.

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.

Inspect all existing cable pathways and remove any existing redundant cabling in the conduits to be used prior to installing the new cabling. The School will confirm which of the existing cables are redundant and need to be removed. Complete all new cable access ways prior to installing the new cabling.

Ensure all communications cables are not installed with a pulling force that exceeds the manufacturer's recommended maximum pulling force and in no case is the maximum hauling tension to exceed 260kg. Use cable mounted pulling eyes / cable netting to install cables with the hauling tension simultaneously applied to the central strength member and outside sheath / jacket.

Do not use motorised winches or vehicles to pull in communications cables.

Ensure the cable manufacturer's minimum bending radii are not exceeded at any time. Any cables that exceed the cable manufacturer's minimum bending radii or are kinked must be entirely replaced. If the cable manufacturer's minimum bending radii is not available ensure that a minimum bending radii at least 10 times the diameter for all fibre cables under no-load and 20 times the cable diameter during installation or long-term under load are not exceeded.

Ensure tension on the cable tie is such that ties must be able to be moved laterally along the cable run and yet still maintain the cable to the support structure.

Utilise installation procedures that ensure that no undue stress is placed on any cable and there is not any evidence of sag or kinks.

Ensure all of the cabling complies with the following requirements:

- 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.
- 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.
- The use of spring clips will not be permitted without approval.
- 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.
- 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 grommeted nylon bushes.
- Replace all wiring that contains kinks or abrasions.
- 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 all optical fibre cables with 1m of loosely looped cable within the FOBOT. Provide all loose tube cables with an additional 2m spare loosely looped cable at each end located either in the first pit or in a pre-approved location.

It is acceptable to install optical fibre cables on the same tray as the UTP provided the optical fibre cables are segregated from all other cables by either a physical barrier or by a separation distance of at least 25 mm.

The communications cables are to avoid areas of concentration of electrical power and mechanical and hydraulic services.

Ensure where cables are reticulated via catenary wire, horizontal cables are tied off loosely, to the catenary wire at intervals no greater than 600 mm. Ensure a maximum of twenty-four (24) four pair UTP cables are supported on a single catenary wire support.

Ensure tension on the cable tie is such that ties must be able to be moved laterally along the cable run and yet still maintain the cable to the support structure.

Utilise installation procedures that ensure that no undue stress is placed on any cable and there is not any evidence of sag or kinks.

Ensure cable entry into a power pole, riser column, duct or cavity is preceded by at least a one-turn service loop of minimum 300 mm in diameter prior to entry into the pole, column, duct or cavity to allow for minor moves and changes allowances.

Use waterfall type control accessories for vertical direction changes of more than 45 degrees.

Ensure all cables have a unique cable identification permanently and legibly placed at each end of the terminated cable within approximately 200 mm from where the cable is terminated utilising a Brady type wrap around each label.

Do not install more than 10 UTP cables in a 35 x 40 duct or 15 UTP cables in a 40 x 50 duct or 18 UTP cables in a 50 x 50 duct. Do not install more than 75 UTP cables on a 150 wide tray or more than 160 UTP cable on a 300 wide tray. Do not install more than 2 UTP cables in a 20 dia conduit or 2 UTP cables in a 25 dia conduit or 7 UTP cables in a 32 dia conduit or 18 UTP cables in a 50 dia conduit. All communications cable trays are to be supported by cantilever L type brackets.

Ensure all communications conduits have 50% of the cross sectional are as spare after all of the cabling has been installed.

Use cable supports that are smooth and at least 34 mm wide with rounded-off edges.

It is not acceptable for any communications cables to be buried direct.

Ensure all cabling that is installed externally is loose tube, gel filled flooded PVC insulated PE sheathed installed in conduit. Ensure all external cabling including locations that are not secure such as sheds, covered areas, pool buildings, etc is installed in conduit and the conduit is arranged such that any water that may enter the conduit will immediately run out and not be trapped in the conduit. Minimise the extent of gel filled cable installed internally. Obtain approval of all internal runs of gel filled cable that are more than 30m. Do not use gel filled cable where the cable does not run externally.

Segregate the communications cables from other services by a minimum of 50mm. Increase the segregation distance as required to ensure the other services do not cause interference in the communications cabling.

For segregation between communications cabling and power cabling where a metallic earthed barrier is not present ensure:

- Where there are no more than 15 bunched circuits and all of the circuit are protected by an overcurrent device less than 60 Amps, a 200mm physical segregation is maintained.
- Where there are between 16 and 30 bunched circuits and all of the circuit are protected by an overcurrent device less than 60 Amps, a 300mm physical segregation is maintained.
- Where there are more than 30 bunched circuits and all of the circuit are protected by an overcurrent device less than 60 Amps, a 600mm physical segregation is maintained.
- Where any circuit is protected by an overcurrent device larger than 60 Amps a 600mm physical segregation is maintained.

For segregation between communications cabling and power cabling where a continuous metallic earthed barrier is present ensure:

- Where there are no more than 15 bunched circuits and all of the circuit are protected by an overcurrent device less than 30 Amps, a 50mm physical segregation is maintained.

- Where there are between 16 and 30 bunched circuits and all of the circuit are protected by an overcurrent device less than 30 Amps, a 100mm physical segregation is maintained.
- Where there are more than 30 bunched circuits and all of the circuit are protected by an overcurrent device less than 30 Amps, a 150mm physical segregation is maintained.
- Where there are no more than 15 bunched circuits and all of the circuit are protected by an overcurrent device less than 60 Amps, a 150mm physical segregation is maintained.
- Where there are more than 16 bunched circuits and all of the circuit are protected by an overcurrent device less than 60 Amps, a 300mm physical segregation is maintained.
- Where there are no more than 30 bunched circuits and all of the circuit are protected by an overcurrent device 60 Amps or more, a 300mm physical segregation is maintained.
- Where there are more than 30 bunched circuits and all of the circuit are protected by an overcurrent device 60 Amps or more, a 450mm physical segregation is maintained.

Ensure all UTP cabling is segregated from the following equipment by at least the dimension given:

- Segregate from all electrical appliances by more than 300mm.
- Segregate from all light fittings including remote control gear by more than 150mm.
- Segregate from all photocopiers and printers by more than 500mm.
- Segregate from all mains switching devices by more than 500mm.
- Segregate from all lighting system dimming equipment by more than 500mm.
- Segregate from all UPS less than 10kVA by more than 100mm.
- Segregate from all UPS between 10kVA and 30kVA by more than 300mm.
- Obtain a specific direction for the segregation distances for UPS larger than 30kVA.
- Segregate from all VSD controllers and VSD to motor cabling by more than 3,000mm.
- Segregate from all radio (wireless) transmitters by more than 3,000mm.
- Segregate from all thermostats by more than 500mm.

6.2.2 FIBRE TERMINATIONS

Terminate all optical fibre cables by fusion splicing onto factory pre-terminated pigtails with a minimum length of 1m. Provide all optical fibre connectors with a ceramic ferrule connector with a physical contact pre-radiused ferrule installed by epoxying the connector onto the fibre end. Secure all optical fibre connectors to the FOBOT via a minimum of two bolts and secure each cable to the communications cabinet at each end with hook and loop cable ties.

Crimp (mechanical) and adhesive type optical fibre terminations and connectors as well as direct terminations are not acceptable.

Ensure all fusion splicing complies with the following:

- Cleaved by a Fujikura CT-30 cleaver or approved equal alternative.
- Spliced by a Fujikura FSM 50 fusion splicer or approved equal alternative.
- Provided with a protective sleeve.

Ensure all cables are installed within the FOBOT in such a manner and with sufficient length that they can be re terminated without having to be removed from the FOBOT or the need for additional jacket to be removed.

6.2.3 UNSHIELDED TWISTED PAIR CABLING

UTP cables within bundles or on tray are to be laid randomly and not installed in straight lines.

Install cables so coils and any bends follow the natural spiral lay of the cable.

Do not bundle more than 24 UTP cables in the same bundle and do not mix different category UTP cables in the same bundle.

Ensure the untwist in a pair at the IDC termination is less than, 13 mm for all cables.

Ensure all permanent Category 6 cables have a minimum length of 15 m.

Secure Cat 6 cables with 6mm wide elastic Velcro™ ties applied at random spacing's up to 300mm apart on catenary wires and on vertical runs such that the weight of the cables are adequately supported.
,
Irrespective of the manufactures recommendations, ensure that the bending radius is not less than 50 mm radius (100 mm dia) during cable pulling, and not less than 25 mm radius (50 mm dia) for hand placement.

Avoid the provision of spare cable where possible unless specifically called for. If spare cable is specified as being required locate the spare cable so it is fully supported and that the minimum bending radius is maintained. Do not locate the spare cable inside service poles or skirting ducts. If spare cable is contained in loops, ensure there are no more than 4 loops in a coil and each loop is a different diameter with minimum diameter of 300 mm.

Ensure the cable sheath stripped back at any termination less than 10 mm from termination module.

Provide all facility cable as unshielded twisted pair having the following characteristics:

- Ensure the facility cables do not exceed 90m in length.
- 24 AWG 0.51mm solid plain annealed copper conductors.
- 4 pair/8 conductors.
- The insulated conductors shall be twisted into pairs, with the pairs balanced for maximum performance and noise reduction.
- Colour coded high density PVC-V75 diameter 1mm insulation.
- PVC-V75 sheath.
- 100+/- 15 Ohm.
- Conductor DC Resistance (Max): 9.38 Ohm/100m @ 20°C.
- DC Resistance unbalanced (Max): 5% @ 20°C.
- Insulation Resistance (Min): 5000 MOhm/km@ 20°C.
- Mutual Capacitance (Typical): 5.6nF/100m.
- Characteristics impedance: 100Ohm+/- 3Ohm@ 100MHz.
- Worst Case Cable Skew : 25 nsec/100 meters

Ensure the length of each cable is based on the distance set out in the tables and formulas in ISO/IEC 11801 plus de-rating for ambient temperature.

Provide all above ground communications conduits with draw-in boxes at least every 30m or after the equivalent of two 90 degree bends whatever being the lesser distance. The draw-in boxes are to be located in straight runs of conduit and are not to be used for bends. Provide the draw-in boxes with an IP66 screw fixed lid and a conduit saddle within 50mm of the draw-in boxes on each conduit.

6.2.4 SERVICE OUTLETS

Provide all UTP service outlets as clip in female RJ45 socket terminals, clipped into an outlet face plate. Mount the outlets with the keyway at the bottom and the contacts at the top. Provide the faceplates with a dust cover flap to prevent dust from entering the outlet when not in use. In locations where outlets are immediately adjacent, up to 6 outlets are to be accommodated on a single faceplate. The general communication outlet faceplates are to match the adjacent GPO in style, brand and colour. Ensure the outlets are a minimum of 150mm from the nearest power outlet contact.

Where there is insufficient depth behind the outlet to accommodate the cable bending radii, utilise angled faceplates. Obtain approval for the use of all angled faceplates prior to installation.

All cables must be arranged such that there is no Z bends or kinks in the cable behind the service outlet once it has been installed.

Ensure the UTP communications outlets have the following performance characteristics:

- Near End Crosstalk (NEXT) performance greater than 54dB @ 100MHz, and greater than 46dB @ 250MHz.
- RJ Interface resistance less than 20 mOhm
- Insulation resistance greater than 100 MOhm at 500 vDC
- Contact resistance less than of 20 mOhm
- Current rating greater than 2A at 20ºC
- Rated for 1000 operations
- A contact force greater than 100g per contact using a FCC-approved plug.
- A plug retention force greater than 133 N.
- Rated for operation with a temperature range of -20ºC to +75ºC
- A minimum thickness hard gold contact plating on each pin of 1.3um
- A minimum thickness nickel contact plating on each pin of 2.0um under the gold coating.

6.2.5 INSULATION DISPLACEMENTS CONNECTIONS (IDC)

Ensure all IDCs have the following performance characteristics and features:

- A minimum of 3 mechanical forces must be applied to the wire to provide a reliable and stress-free resistant connection.
- The IDC termination must have a 45 deg angular configuration when connecting with the cable conductor.
- The IDC contact element is to be spring special brass with silver plating, angularly arranged across the axis of the conductor.
- The contact range is to be silver-plated.
- The insulation displacement connectors of the outlets are to accept two insulated solid conductors of 26 to 22 AWG (0.40 - 0.65 mm) of the same size.
- Insulation resistance greater than 100 MOhm at 500 vDC
- Contact resistance less than of 20 mOhm
- Current rating greater than 2A at 20ºC
- Rated for 1000 operations
- Rated for operation with a temperature range of -20ºC to +75ºC

6.2.6 EARTHING

Provide a dual-purpose telecommunications earthing system for both functional earthing and protective earthing purposes. Bond each communications rack and frame to a Communications Earthing Terminal (CET) Block located not more than 10m away from the communications rack or distribution frame. Bond each CET to the local power distribution system protective earth. Provide permanent machine printed labelling on / adjacent the CET with the wording “Communications Earthing Terminal”. All earthing conductors are to have green/yellow insulation and a stranded copper conductor with a minimum area of 6 mm^2. Ensure each communications rack and frame has a resistance to earth of less than .5 ohm.

Earth a metallic cable access systems with a 2.5mm^2 stranded copper conductor with green/yellow insulation to the power distribution system protective earth and ensure the resistance to earth is less than 1 ohm.

6.2.7 RECORDS AND LABELLING

Label every component within the communications cabling system including though not limited to, outlets, patch panels, break out panels, cables, patch leads, racks, distribution panels, consolidation points and cable access pathways. The labelling between all components is to correspond allowing all associations between the source and destinations to be readily made. All labelling is to be arranged logically and be consecutive. Use a dash between numbers and abbreviations without any spaces.

Confirm the naming standard of the outlets and patch panels with the school. The naming standard is a 2 letter building code with room number followed by a dash followed by a sequence number - e.g. JS12-35 (HM = John Smith room 12, outlet 35). The outlet sequence numbering starts at 1 and ends at the last number for the whole building. The naming standard is for the whole building, not per room.

Provide a machine printed label with the wording “Communications Cabling” on all communications cable pathways every 10 metres.

All names and labels are to read from bottom to top, left to right, omitting the letters “I” and “O”.

Submit the labelling scheme for approval.

Provide each distribution panel and rack containing patch panels with a patching record book that contains the records of the connection of patch panel numbers to work station outlet numbers, the date and signature of the patching installer, a schematic drawing and a floor plan of the area detailing the location and labelling of all communications outlets and equipment within the area the associated panel or rack serves. Ensure the log book is able to simply accommodate future additions, moves and changes and it contains at least 50% or three, whatever is the lesser, spare pages All entries in the log book are to be legible and only in pencil. Clearly designate the sites name and the name of the distribution panel or rack the log book applies to on the cover and on every page of the log book.

Submit a blank example page from the log book for approval.

Provide the data room with a wall mounted laminated A3 floor plan of each level detailing the location and labelling of all communications outlets and equipment within the area the associated panel or rack serves. Include a copy of the floor plan in the Operations and Maintenance Manual.

Ensure all racks and distribution panels are uniquely identified with the label located on the external face of any door or cover that is normally closed and on the body if the door or cover is removable or lift off. For all racks and equipment that are floor mounted, provide the unique identifying label on both the front and rear doors / covers and the body.

Provide a machined typed label either clear wrap around self-adhesive type or slip-on plastic ring type or a long plastic strip type fixed onto each permanent cable within 100 - 150mm from the termination point for UTP cabling and 200 - 400mm for Optical Fibre cabling. In addition to the end labelling, provide a label on each Optical Fibre cable at each side of every penetration and at intervals no greater than 10m. Each cable label is to designate the cable type, size and source / destination.

Permanently label each communications outlet with the channel number in accordance with clause 2.9. In addition to the label that is normally visible, neatly hand write in indelible ink the channel number on the faceplate behind the surround such that it is covered when the faceplate in in place.

6.3 COMMISSIONING

6.3.1 GENERAL

As part of the commissioning of the communications cabling, undertake the following tests as relevant on all components of the communications cabling installation including each pair in every cable for:

- Has been fully commissioned in accordance with this specification.
- Has been fully commissioned in accordance with the requirements of the system manufacturer.
- Compliance with the cabling diagram.
- Continuity.
- Cable location, identification and length.
- The installation of all cables must be complete and the cables and terminations cleaned prior to testing.
- All tests in accordance with the communication system certifying manufacturer’s requirements.
- Undertake all tests in accordance with the recommendation of the testing equipment manufacturer.
- Test the resistance to earth of each Communications Earthing Terminal (CET) Block , each communications rack and each frame.
- Test the resistance to earth of each metallic cable access system.

6.3.2 UNSHIELDED TWISTED PAIR CABLING

Test every UTP cable / link in accordance with the following requirements:

- Correct sequence.
- Reversed pairs.
- Transposition and split pairs.
- Attenuation.
- Impedance matching of all twisted pairs within each UTP cable in the form of impedance Vs distance and impedance Vs frequency graphs.
- All mechanical fixings.
- Electrical length.
- The difference between the signal attenuation and the near-end cross talk (ACR).
- Power Sum ARC (PSARC)
- Near End Cross Talk (NEXT).
- Power Sum Near End Cross Talk (PSNEXT)
- Insertion Loss,
- ELFEXT, PSELFEXT.
- Return Loss.
- Delay Skew.
- Propagation Delay.
- All Cat 5 cables and components are to be tested in accordance with the requirements specified in the latest draft of ISO 11801 Class D.
- All Cat 6 cables and components are to be tested in accordance with the requirements specified in the latest draft of ISO 11801 Class E.

The UTP cables / links are to meet or better the following requirements:

	Cat 6
Correct sequence.	Pass
Reversed pairs.	Pass
Transposition and split pairs.	Pass
Attenuation.	21.7 dB
All mechanical fixings.	Pass
Electrical length.	<90m
ACR	18.2 dB
PSARC	15.4 dB
NEXT	33.9 dB
PSNEXT	37.1 dB
Insertion Loss,	21.3 dB
ELFEXT	23.2 dB
PSELFEXT.	20.2 dB
Return Loss.	12 dB
Delay Skew.	50nsec
Propagation Delay.	548nsec

Tester and testing equipment

- Ensure the tester batteries are adequately charged and do not fall below 25% of the total battery capacity.
- Ensure all test gear and equipment is not worn, dirty and is in good as new working order.
- Ensure the NVP is not set HIGHER than specified for the cable.

- Ensure the tester “Margin Warning” or “Star-Pass” is always enabled during testing.
- The latest software available for the tester is being used.
- The tester has been independently calibrated within 12 months of the test.

Configure the tester for Cat 6 cabling as (F/UTP PVC 65% / UTP LSZH 79% / UTP PVC 69%), permanent Link Test limit to ISO 11801 Class E and channel test limit to ISO 11801 Channel Class E.

Configure the tester for Cat 5 cabling as (F/UTP PVC 69% / UTP LSZH 70% / UTP PVC 69%), permanent Link Test limit to ISO 11801 Class D and channel test limit to ISO 11801 Channel Class D.

The following testers are acceptable:

- Fluke DTX-18003.
- Fluke DTX-1200
- LANTEK 6A and 7G
- LANTEK II
- Agilent WireScope Pro
- Agilent WireScope WS350

Negative results (e.g. - 0.5 dB) for NEXT or RL on runs less than 15m even though a PASS is indicated in the test results are unacceptable and must be considered as unacceptable terminations.

Poor UTP terminations must be fixed by adding twist into the pairs, re-terminated and re-tested.

6.3.3 FIBRE

Commission and test each core of each cable in accordance with the AS/NZS 14763.3 optic fibre testing methodology to ensure the correct performance and replace all termination and cable that do not pass the performance requirements. Arrange for and give two weeks’ notice so the commissioning may be witnessed for approval.

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

Test every Optical Fibre core in accordance with the following requirements:

- Undertake all testing in accordance with the requirements of ISO/IEC 14763-3 and ISO/IEC 11801, using an approved Light Source and Power Meter (LSPM). Provide details of the proposed LSPM and evidence of the operators training and manufactures certification in the use of the proposed LSPM for approval. An OTDR is not acceptable for Link loss measurements.
- The optical attenuation of each fibre core at 2 appropriate wavelengths must be tested after installation in both directions (A to B and B to A) including pre terminated cables Only the single highest test result of each wavelength from either direction needs to be recorded (to 1 decimal place).
- Continuity and Maintenance of Polarity
- Length
- Propagation Delay
- Each termination must be visually inspected as part of the commissioning and be noted as being free of abnormalities
- Record the overall configuration of the link including connector types, cable type and length and number of splices.
- OTDR test results alone are not acceptable.

Provide a Light Source & Power Meter (LSPM) and an Optical Time Domain Reflectometer (OTDR). Ensure all optical fibre testers have been warmed up for 15 minutes prior to commencing testing.

Where LSPM results exceed the Power Loss allowance, use an OTDR to determine the location of the faulty component.

Where the connectors on the LSPM tester are different from the connectors on the Link to be tested (E.g. SC on tester Receive port and MTRJ on Link), use the 3-Test Cord Method of Reference Setting as per Cl 9.1.1.2 of ISO/IEC 14763-3.

Ensure the continuity and polarity of each optical fibre core / termination by either inspecting opposite ends at the same time with a red light source, or by using an LSPM that has been connected to the fibre at the far end, or by using an OTDR with a 'tail cord' connected to the correct fibre at the far end.

Record the cable length marking at each end of the installed cable.

Record the propagation delay on the test sheet by manually calculating it or as recorded by the tester. The propagation delay is to be manually calculated as (propagation delay (in nS) = 5.0 x length in m.

Ensure the connectors on the LSPM tester are the same as the connectors on the core being tested.

Ensure the LSPM Tester is able to meet Encircled Flux requirement in the launch test cord for all multimode cables. Ensure 3mm LSPM launch cords have at least 5 x turns of 17 mm diameter for 62.5 µm and 22 mm diameter for 50 µm cores. Ensure the LSPM launch cord has at least 2 x turns of 40±5 mm diameter, air-coiled or on a mandrel, for all single mode cables. Ensure the launch cord meets the reference conductor requirements and the tail cord insertion loss is less than 0.1 dB for multimode cables and 0.2 dB for single mode cables. The performance of the launch and tail cords are to be confirmed at the start of testing every day and at least once every four hours of continuous testing.

Ensure the OTDR launch and tail cords are longer than the dead zone of the OTDR and the launch cord is at least 25% longer than the tail cord. Use the lowest OTDR pulse width on cables that are less than 300m long. Configure the OTDR and test setup so ghosts are not present in the main part of the OTDR trace.

Provide a copy of the "Plot Data Enabled" test results for each core of each optical fibre cable in a recognised test vendor's application format as well as a copy of all results in PDF. Ensure the test results contain all of the testing and commissioning information required by this specification. Ensure the test results are / include:

- A single file containing all the final commissioning and test results.
- All results and data are relevant to this project.
- The number of test results the number the number of test results on the communications system manufacturer's system warranty form.
- An explanation is provided for all missing cable identification.

Supply a copy of the latest NATA calibration certifications for test instruments that are to be used, before any testing commences.

Schedule the results for each item and component and include a copy of test results in the Operations and Maintenance Manual.

As part of the commissioning of the communications cabling, undertake any necessary adjustments to components of the communications cabling installation which have integral adjustment capacity.

6.4 PATCH PANELS

Provide UTP patch panels as modular, 1RU high, 24 port, Cat 6, RJ45 19inch rack mounted, black fully numbered with outlets to the same specification and performance as the respective service outlets with the worst pair NEXT loss values for the outlet greater than 54dB at 100MHz and greater than 46dB at 250MHz. The rear of the patch panels are to be provided with integrated cable management supports, strain relief posts, colour coded wiring guides and IDC's to facilitate cable termination. Provide patch panels with modular ports that can be removed and that facilitate access to the IDC's without having to remove the entire patch panel.

Provide sufficient patch panels to accommodate all of the facility cabling with a dedicated patch panel port for each service outlet. Provide sufficient patch panel ports to accommodate all of the tie cables with 2 pairs per patch panel port for tie cables.

7.0 SECURITY

7.1 SCOPE

The security component of this contract includes the provision of a new Inner Range Integrity security system with the central controller wall mounted in core A to provide access control and intruder detection. The system is to utilise proximity access key to control access through the nominated doors via readers that incorporate Near Field communication and Radio-frequency identification to allow the school to integrate smart devices into the access control system. Provide the system with Inner Range Integrity Business Edition management software.

The Aperio access control system detailed within the architectural documents is to be provided as part of the security component of this contract. Provide a high-level interface between the Aperio access control system and the Inner Range Integrity security system.

Provide the security system such that it can be expanded across the school in the near future.

Cards are to be read as key tags within the electrical services documents.

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

- Earthing.
- Central processing unit (CPU) / master controller.
- IT network interface.
- Management and data base software.
- Aperio access control system.
- All required licences.
- Zone expanders.
- Pizeo sirens.
- Key panels.
- Movement detectors.
- Door controllers.
- Card readers.
- Card reader mounting brackets.
- 50 Key tags (Cards).
- Electric strikes.
- Magnetic holders.
- Exit push buttons.
- Duress alarm points.
- System battery back-ups.
- Electric strike battery back-ups.
- Battery back-up for the nominated magnetic door holders.
- Interfaces.
- Data bus.
- Cabling.

Provide details of the proposed readers, key tags and transmitters for approval.

Provide the lift car with a card reader to allow the lift to access the authorised level.

Interface the access control system to the lift to authorise the calling of the lift and facility to stop at the nominated level when authority is given via an approved key tag.

Provide a card reader and all necessary software and interfaces for programming and issuing of cards at networked PC.

The school will provide the workstation PCs, mobile smart devices and the server all including hardware and operating systems.

Provide comprehensive details of the proposed equipment and components of the access control system for approval prior to ordering.

Ensure all access control work is completed by a current member ASIAL who holds the appropriate security equipment installer licence. Provide a copy of the ASIAL membership and security equipment installer licence of each staff member working on the access control installation component of the project for approval prior to the commencement of work. Include a copy of such licenses in the Operations and Maintenance Manual.

Ensure all access control work is completed by a current member of ASIAL. Ensure all access control work is completed by staff experienced and specifically trained in the access control system and also hold a current ACMA license and an appropriate security equipment installer licence. Provide evidence of such experience and training of each staff member working on the access control system for approval prior to commencing work. Provide a copy of the ASIAL membership and ACMA license of each staff member working on the access control component of the project for approval prior to the commencement of work. Include a copy of such licences in the Operations and Maintenance Manual.

Coordinate the quantities, locations, signal type, cabling and relay with the Electrical Sub-contractor responsible for the equipment being interfaced to.

As part of the tender submission, the Electrical Sub-contractor must include for all contractual requirements and costs required by the suppliers to the electrical sub-contract to provide the necessary samples. The Electrical Sub-contractor must bear the cost of supplying samples of the components specifically specified as well as those specified generically or by performance.

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

7.2 INSTALLATION

Use multi-stranded copper conductor V75 PVC insulated or V75 PVC-insulated and PVC-sheathed stranded cables for all 240 volt cabling. Use flooded PVC insulated and PE sheathed cables for all cables run underground.

The cable type and sizes indicated on the drawings are provided as a minimum only. The attenuation, interference and voltage drop 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 signals, loads and maintain a spare capacity of 10%. All signals and loads must be confirmed on site by the Electrical Sub Contractor with the actual equipment being supplied. Provide the detector cabling as solid Cu PVC PVC 6 core intruder detection cable and the reed switch cabling as solid Fig 8 Cu PVC cable. Where security system equipment is connected by a communications cable, provide the cable in accordance with the security system manufacture's requirements. Provide configuration, route, pinout and earthing details of such communications cables with the shop drawings.

Install all cabling clear of electric motors, neon signage, transformers etc. In locations with a high level of RF or EM radiation, ensure that the cables are properly shielded from interference.

Segregate the security system cables from other services.

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

The accessories sizes indicated on the drawings are provided as a minimum only. All components and sizes must be confirmed on site with the actual equipment being supplied.

7.3 COMMISSIONING

As part of the commissioning, ensure all components of the security system are adjusted, programmed and are operating correctly.

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

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

Should these items not be complete prior to the adjusting and aiming of security system installation the additional expenses in re-attending the installation to undertake the adjusting and aiming of the security system installation as incurred by the engineer will be charged to the nominated security Sub Contractor.

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

The adjusting and aiming of the security system installation will include the following:

- Adjusting mountings and brackets.
- Aiming of detectors.
- Testing all operations of the security system.

Program the security system to the satisfaction of the school.

The nominated security sub-contractor is to allow to attend site twice during the defects and liability period and undertake any required adjustments to and reprogram the security system as directed by the school.

8.0 SCHOOL BELL SYSTEM

8.1 SCOPE

Provide the building with a two-zone school bell system utilising 100-volt speakers wired to amplifier/s located in the communications rack CR-A4. Connect the system in the building to the school's existing school bell system via IP to audio converters and the school's IT communications network.

Provide the IP to audio converters in the new building in CR-A4 and in a remote location to be agreed to with the school to connect to the existing school bell system. Connect the remote IP to audio converter to the existing school bell system including any necessary upgrades / modifications to the existing school bell system necessary to facilitate the connection. Provide a new cat 6 communications outlet in the administration building cabled to the existing administration building communications rack to facilitate connection of the remote IP to audio converter to the schools IT network.

Provide the IP to audio converters as Barix Exstreamer 100.

Provide tone generators with the following upgradeable tones:

- School bell.
- Alert.
- Evacuation.
- Lockdown.

Provide the school bell components to allow the school in the near future for the school to expand the system to provide a Barix audio over IP solution across the entire school.

Configure the speakers such that the zone 2 speakers do not receive the school bell signal.

Locate the amplifier in the top RUs of CR-A4

Provide all necessary amplifies such that any individual amplifier is not loaded above 50% capacity as if the speakers and horns are all tapped at 75%.

The School Bell System component of this contract includes but is not limited to the following extent of work:

- Speakers and horns.
- Amplifiers
- IP to audio converters
- Cabling.
- Programming.
- Commissioning.

Provide an audio input for testing. Balance and set the volume of the School Bell System to the satisfaction of the school. Allow to attend site twice during the defects and liability period to adjust the balancing and volume as directed by the school.

Provide comprehensive details of the proposed equipment and components of the School Bell System for approval.

8.2 INSTALLATION

8.2.1 CABLING

For all 240 volt cabling use multi-stranded 2.5mm² copper conductor V75 PVC insulated or V75 PVC insulated and PVC sheathed stranded cables unless otherwise specified. Use PVC insulated and PVC sheathed cables for all cables run underground in conduits.

The cable type and sizes indicated on the drawings are provided as a minimum only. The attenuation, interference and voltage drop 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 signals, loads and maintain a spare capacity of 10%. All signals and loads must be confirmed on site by the Electrical Sub Contractor with the actual equipment being supplied.

Provide the Figure 8 cable to the following characteristics:
- Dual colour PVC insulation.
- 2 off 19 AWG conductors.
- 24/0.20 stranded bare copper conductors.

Terminate the Figure 8 cables into screw terminals.

Run all School Bell System cabling clear of electric motors, neon signage, transformers etc. In locations with a high level of RF or EM radiation, ensure that the cables are properly shielded from interference. Ensure all of the School Bell System cabling is segregated from all other services.

8.2.2 HOUSINGS

Ensure all 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.

8.2.3 ACCESSORIES

The accessories' sizes indicated on the drawings are provided as a minimum only. All components and sizes must be confirmed on site by the Electrical Sub Contractor with the actual equipment being supplied.

8.2.4 POWER SUPPLY

Ensure all power supplies to the School Bell System equipment within a building are from the same phase.

8.3 COMMISSIONING

Allow to undertake the full commissioning of the School Bell System at practical completion and at two further times during the defects and liability period as requested by the school.

As part of the commissioning of the School Bell System, undertake the following tests as relevant on all components of the School Bell System installation:
- Power availability.
- Resistance to earth.
- Sound levels.
- Fault protection.
- All mechanical fixings.
- Ensure when the school bell system is not being used there is no discernible sound generated from any speaker when the building is not occupied.

8.4 AMPLIFIERS

Provide amplifiers with the following characteristics:
- 19 inch rack mounted.
- 8 ohm and 100 volt output.
- Balanced XLR auxiliary output.
- Steel chassis and heat sinks.
- Integral on/off switch.
- Master bass control.
- Master treble control.
- Master volume control.

- 240 volt mains supply.
- 19 inch rack mounted.
- Mains fused.
- THD <5%.
- Frequency response 60 Hz to 15 kHz.
- An output impedance is between 80 and 200 ohms.

9.0 FIRE ALARM SYSTEM

9.1 SCOPE

The fire alarm system scope is to include a non-brigade monitored local alarm only AS1670.1 compliant addressable fire detection and alarm system throughout the RSDC building.

Ensure all works installed under the fire alarm system component of the electrical sub-contract is undertaken by, or under the direction of a suitably qualified and experienced fire alarm system installer who hold the required QBCC and Fire Protection Contractors Registration Board of Queensland Inc registrations.

Prior to practical completion certify the installation on a Form 16 as complying with the relevant codes and standards.

In addition to the detectors detailed on the drawings, allow for the following additional detectors to be located on site:

- 12 Duct probe smoke detectors.
- 12 Smoke detectors.
- 6 Thermal detectors.
- 24 Concealed space detectors including famco access brackets.

This contract requires the contractor to provide the following performance guarantees:

- That all components will have adequate size, capacity and performance.
- The installation will be acceptable to the Queensland Fire and Emergency Service.
- The installation will not be subject to faulty equipment or workmanship.
- The installation will not be subject to undue false alarms.
- The installation will be considered fit for purpose.

This contract includes but is not limited to the following specific items extent of work:

- Fire Indicator Panel (FIP) and all associate components.
- Duct probe smoke detectors.
- Smoke detectors.
- Thermal detectors.
- Concealed space detectors.
- System interface diagram (AS1851)
- Speakers and horns.
- Provision of any additional speakers and horns to achieve evacuation sound levels with a minimum of 10dB (A) above ambient, and not less than 65dB (A) and no more than 105dB (A).
- Cabling.
- Maintenance.
- Log book.
- Maintenance during the defects and liability period in accordance with MP6.1 of the QDC and AS1851.
- Pay all costs associated with the isolation and reconnection of the brigade monitoring of the fire alarm system.

Ensure all equipment used has all relevant authority approvals and include a copy of such approvals within the manual. Provide a copy of the authority approvals with the shop drawings.

The work must be performed by a Contractor registered by the QBCC and Fire Protection Contractors Registration Board of Queensland Inc. Provide a copy of the contractor's registration's for approval prior to commencing work and include a copy in the manual.

9.2 INSTALLATION REQUIREMENTS

Ensure that all components and equipment installed as part of the fire alarm system are suitable for the intended location and use.

Provide all wiring within the fire alarm system as "loop-in loop-out" with no joints, except at fittings. Ensure that detector wiring does not pass through a battery compartment. Provide all wiring from the FIP to relays, contactors and control equipment, including air handling plant shut down and the like to be fail safe, supervised circuits using red sheath. It is acceptable to utilise the existing wiring if it is inacceptable condition and meets the requirements of this specification.

Ensure that all wiring within the fire alarm system complies with the following:

- 240-volt wiring: 1.5mm^2 (stranded) minimum.
- DC wiring: 1.5mm^2 (stranded) minimum.
- Wiring to remote indicators: 0.75mm^2 (stranded).
- 240 V wiring: Grey sheath.
- DC fire alarm wiring: Red sheath.
- Multi-stranded copper conductors.
- All smoke fan control wiring is fire rated.

Completely separate all speakers wiring from 240-volt wiring. Space fire alarm system cabling from all other wiring or otherwise protected, to ensure that the magnitude of induced voltages cannot cause interference.

The current capacity, voltage drop and fault capacity of the cables must be established by the Contractor and the cables sized accordingly by the 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 onsite by the Contractor. Provide all components with 25% spare capacity.

Ensure the fire alarm system cabling is protected from mechanical damage and complies with AS 3013 and all fire rated cabling meets or exceeds WS52W installation requirements. Secure all fire alarm system cabling with stainless steel cable ties.

Unless otherwise specified, install and terminate cables in accordance with the manufacturers' recommendations.

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 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.

All cabling and cable support systems are to comply with requirements of AS 1170.4 (earthquake).

All penetrations through building elements used as cable penetrations are to be dedicated to cabling.

9.3 COMMISSIONING

9.3.1 TESTING

Undertake on site the following tests:

- Insulation resistance measurements.
- Functional checks: Full functional and operational checks on energised control equipment and circuits, including adjustments for the correct operation of safety devices.
- Earth resistance.
- Earthing: Confirmation of effective earthing of the exposed metal of all 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 on CD for approval.

Check control systems for correct operation under representative operational conditions.

9.3.2 COMMISSIONING

As part of the commissioning, ensure that all components of the installation are adjusted, programmed and are operating correctly in accordance with the manufacturer's recommendations and the relevant standard the equipment has been installed.

Submit for approval two prior to commencing any testing and commissioning a testing and commissioning method statement and program for the commissioning and testing.

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

- All testing required by AS 1670.
- Authorities' tests: Additional tests, which may be required by the relevant authority.
- Resistance to earth.
- Voltage.
- Overload protection.
- Fault protection.
- All mechanical fixings.
- Map of sound pressure levels at Floor Level.
- The operation of the fans under both simulated automatic and manual control conditions.
- The operation of each MCP and detector.
- The operation of the FIP.
- The operation of the brigade monitoring system.
- The operation of the monitoring of each circuit.

Provide at least two qualified personnel with two-way radios for all testing and commissioning. Ensure all testing equipment is calibrated, within the past six (6) months, and provide supporting documentation of the calibration upon request.
The testing equipment includes, though is not limited to the following:

- Smoke Detector Testing apparatus approved by detector manufacturer
- Thermal Detector Calibrated heater tester
- Manual Call Points (MCP) Suitable MCP Key
- Occupancy Warning speaker Sound level meter and Speech Transmission Index (STI) meter

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

As part of the commissioning of the fire alarm, undertake any necessary adjustments to the installation.

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

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

Provide a copy of the statement of compliance in the manual.

Ensure the following components of the installation are complete and have been checked and tested prior to commissioning:

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

Should these items not be complete prior to the commissioning the additional expenses in re-attending the installation to witness the commissioning as incurred by the engineer will be charged to the Contractor.

Provide all equipment such as ladders, scaffolding and tools necessary for adjusting each detector and speaker. Should the Contractor not have available the necessary equipment to complete the commissioning, the additional expenses in re-attending the witnessing of the commissioning as incurred by the engineer will be charged to the Contractor.

The commissioning of the installation will include the following:

- Adjusting mountings and brackets.
- Adjusting detectors.
- Testing all operations of the fire alarm system.
- Balancing of all speakers.

Demonstrate to the satisfaction of the Authorities the operation of the systems installed in accordance with Authority requirement.

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

Provide all necessary software, equipment and personnel to fully program and configure all systems.

Following the completion of the commissioning and prior to Practical Completion thoroughly clean all components of the 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.

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

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

- Check that time schedules enable the intended operation at/for the correct times.
- Check that the calendar/date function can take leap years into account.
- Check the correct operation of the interfaces by individually switching each item of plant.
- Check for the correct sequencing control in response to varying inputs operates in the correct order and at the desired set points.

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 mains supply by any controller or device.
- Check that the system operates correctly under battery power without mains power.
- Check that the system will automatically return to normal action without operator intervention restoration of the mains electrical power supply.

Check the application software and certify quality control off-site. Specific items or routines to be checked include though is not limited to:

- Specified set points have been configured.
- Each control loop is in place and that realistic default values have been added to enable commissioning to proceed.
- Configured software will operate the specified events, alarm and items of plant in the correct sequence.
- All specified alarms are configured along with any the required time delays, masking and alarm categorisation in order to avoid unwarranted alarms.
- The use of mnemonics and abbreviations is checked between the display and the graphics to avoid inconsistencies.
- Data logging routines and parameters are set up in accordance with the control system specification.

9.4 MAINTENANCE

Provide maintenance of the complete fire alarm system for the defects and liability period. Undertake all inspections, tests, maintenance services and repairs in accordance with the equipment manufacturer's recommendations/ instructions, the Queensland Development Code MP6.1, AS 1851-2005 and the emergency services authority requirements.

Ensure the fire alarm system is maintained in a safe and operative condition. Ensure minimum interruption to the operation of the fire alarm system during the maintenance procedures. Coordinate the start and completion of each maintenance session with the Building Manager.

Ensure all maintenance and associated certification is completed by competent, experienced and licensed technicians equipped with the appropriate testing instruments, tools, equipment, etc. All such maintenance and testing tools and equipment must be appropriate and calibrated for the required task.

At the end of the defects and liability period, provide certification all maintenance has been completed in accordance at the end the annual maintenance period in accordance with the equipment manufacturer's recommendations/ instructions, the Queensland Development Code MP6.1, AS 1851-2005 and the emergency services authority requirements.

Record all maintenance events within the log book.

9.5 DETECTORS

Provide all detectors as addressable and ensure they comply with the requirements of AS1670 and are compatible with the FIP. Reduce the number of detectors permitted to an alarm zone to 75% of that allowed under AS1670.

Provide detectors of a type that will be effective in the location and avoid false alarms.

Unless noted otherwise, provide thermal detectors that comply with AS 1603.1, AS 7240.5, and are type A and smoke detectors that comply with AS 1603.2, AS 7240.7, and are the type photo-optical unless noted otherwise. Ensure the sampling device smoke detectors comply with AS 1603.13. During construction protect all smoke detectors from the build-up of dust and contamination due to building work. Remove the protective covers immediately prior though no earlier than 24 hours prior to practical completion.

Locate and select detectors used to initiate smoke control systems in accordance with AS 1668.1.

Provide detectors that are two part (removable plug and fixed base). Ensure all detectors include an indicator to identify activation.

Provide remote indicator in accordance with AS1603.15 comprising a light emitting diode mounted on an engraved plastic plate identifying the location of the detector for each detector located in a concealed position including locked cupboards.

Provide concealed space detectors as a proprietary item suitable for a concealed space depth of 600mm to 3,000mm, of a type that they can be removed through the exposed surface faceplate and man holes or access panels are not required for maintenance.

9.6 SPEAKERS

Provide speakers in accordance with AS1670.4 to achieve the sound levels as specified in AS1670. The speaker types and locations detailed on the drawings are indicative of an acceptable type and layout. It is the Contractor's responsibility to ensure that the installation meets the tone and alert requirements of AS1670.

Provide ceiling speakers with the following:

- 8 Ohms impedance.
- 93 dB sensitivity.
- Full range multi tapped transformer.
- Circuit fault monitoring.
- Screwed terminal block.
- Match the adjacent sound system (bell, PA or music) speakers or 200mm Dia if the project does not include a sound system.
- Plastic flush grille colour to match the ceiling colour unless noted otherwise.
- Frequency response 60 Hz to 20 kHz.
- Flush mounted in all suspended ceilings.

Provide horn speakers with the following:

- 8 Ohms impedance.
- Full range multi tapped transformer.
- Circuit fault monitoring.
- Screwed terminal block.
- Match the adjacent sound system (bell, PA or music) horn speakers if the project includes a sound system.
- Surface mounted adjustable bracket.
- Metal construction.
- IP56.